SEASONAL INCIDENCE OF MAJOR INSECT PESTS AND SCREENING OF LOCAL MAIZE (*Zea mays* L.) CULTIVARS

Thesis

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Doctor of Philosophy

in

Entomology

by

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2024

Dedicated to my

beloved Mom

(Lt) Thunglano Cecilia

DECLARATION

I, Martha Chakruno, hereby declare that the subject matter of this thesis is the record of work done by me, that the contents of this thesis did not form the basis of the award of any previous degree to me or to the best of my knowledge to anybody else, and that the thesis had not been submitted by me for any research degree in any other University/Institute.

This is being submitted to Nagaland University for the degree of Doctor of Philosophy in Entomology.

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CERTIFICATE – I

This is to certify that the thesis entitled **"Seasonal incidence of major insect pests and screening of local maize (*Zea mays* L.) cultivars"**submitted to Nagaland University in partial fulfilment of the requirements for the award of degree of Doctor of Philosophy (Agriculture) in Entomology is the record of research work carried out by Miss. Martha Chakruno, Registration No. Ph.D./ENT/00241under my personal supervision and guidance.

The result of the investigation reported in the thesis has not been submitted for any other degree or diploma. The assistance of all kinds received by the student has been duly acknowledged.

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This is to certify that the thesis entitled "Seasonal incidence of major insect pests and screening of local maize (*Zea mays* L.) cultivars" submitted by **MARTHA CHAKRUNO** Admission Ph-254/18 Registration No. Ph.D/ENT/00241, to the NAGALAND UNIVERSITY in partial fulfillment of the requirements for the award of degree of Doctor of Philosophy in Entomology has been examined by the Advisory Board and External examiner on…………………

The performance of the student has been found **Satisfactory/Unsatisfactory.**

Member	Signature
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Date: (MARTHA CHAKRUNO)

Place: Medziphema

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LIST OF ABBREVIATIONS

%	:	Per cent
˚C	:	Degree Celsius
et al.	:	*Et alli* (and others)
viz.	:	*Videlicet* (namely)
DAS	:	Days after sowing
m	:	Meter
msl	:	Mean Sea Level
cm	:	Centimeter
cm^2	:	Centimeter square
gm(s)	:	Gram(s)
E	:	East
FAW	:	Fall armyworm
Fig.	:	Figure
Ha	:	Hectare
HR	:	Highly Resistant
HS	:	Highly Susceptible
Kg	:	Kilogram
MR	:	Moderately Resistant
MSB	:	Maize stem borer
MSW	:	Mean Standard Week
N	:	North
R	:	Resistant
RBD	:	Randomized Block Design
S	:	Susceptible
SW	:	Standard Week
SMW	:	Standard Meteorological Week
ANOVA	:	Analysis of variance

ABSTRACT

The study on "Seasonal incidence of major insect pests and screening of local maize (*Zea mays* L.) cultivars" was carried out during March to July 2020 and March to July 2021in Experimental Research Farm of Entomology, School of Agricultural Sciences (SAS), Nagaland University. Randomized Block design (RBD) field layout was used for screening and correlation of weather parameters of maize cultivars (14 local and 1 Hybrid) with three replications. The maximum leaf injury damage was observed in cultivar Medziphema Local -1. The maximum dead hearts damage due to maize stem borer, *Chilo partellus* was observed in the cultivars Khuzama Local and Medziphema Local-1 during 2020 and Khuzama Local during 2021.The maximum leaf whorls damage due to fall armyworm, *Spodoptera frugiperda* was observed in cultivar Medziphema Local-1. The highest population of coccinellid beetles was observed on cultivar Zarsi Socunoma Local. The peak spiders population were observed on the 23rd standard week *i.e*., on 14th June in cultivar Zarsi Socunoma Local. The seasonal incidence of maize stem borer, *C. partellus* as leaf injury damage revealed a significant positive correlation with the minimum temperature in the cultivars Chiechama Local, Khuzama Local and Medziphema Local-1 during 2020. Likewise during 2021, the cultivars Khuzama Local and Medziphema Local-1 revealed a significant positive correlation. It also revealed a significant positive correlation with the minimum relative humidity in the cultivars Chiechama Local, Khonoma Local and Khuzama Local during 2020. The seasonal incidence of maize stem borer, *C. partellus* as dead hearts damage revealed a significant positive correlation with the minimum temperature and maximum relative humidity in all the cultivars. The correlation coefficient on the seasonal incidence of fall armyworm, *S. frugiperda* as leaf whorls damage revealed a significant negative correlation for all the abiotic factors in almost all the cultivars. The correlation coefficient on the seasonal incidence of coccinellid beetles, *Coccinella* spp. with the maximum temperature and maximum and minimum relative humidity revealed a significant positive correlation in all the cultivars. The correlation coefficient on the seasonal incidence of spiders revealed a significant positive correlation with the minimum temperature, maximum and minimum relative humidity in almost all the cultivars. The cultivars which are resistant to leaf injury caused by *C. partellus* were Zarsi Socunoma Local and Shiyam Ngangching Local with 2.45 and 2.88 leaf injury rating, respectively. The cultivar which is resistant to dead hearts caused by *C. partellus* was Zarsi Socunoma Local with 2.83 dead hearts rating. Regarding length of stem tunneling, out of fifteen (15) cultivars, four (4) cultivars were found least susceptible, seven (7) cultivars were moderately susceptible and four (4) cultivars were highly susceptible to *C. partellus.* Among the fifteen (15) cultivars, five (5) cultivars were found resistant and eight (8) cultivars were moderately resistant and two (2) cultivars was observed susceptible to leaf whorl damage by *S. frugiperda.* The correlation coefficient on the seasonal incidence of maize stem borer, *C. partellus* as leaf injury damage with the morphological characteristics of different local maize cultivars revealed a significant positive correlation with the leaf width. The correlation coefficient on the seasonal incidence of maize stem borer, *C. partellus* as dead hearts infestation, stem tunneling and number of exit holes with the morphological characteristics of different local maize cultivars showed a significant positive correlation with 100 grain weight.

Key words: Stem borers, Fall armyworm, natural enemies, seasonal incidence, screening, maize, morpho-physiological

CHAPTER I

INTRODUCTION

INTRODUCTION

Maize (*Zea mays* L.) is widely cultivated throughout the world under varied agro-climatic conditions and is one of the most important food crops. Due to its wider adaptability and high genetic yield potential among cereal crops it is popularly known as the "Queen of cereals". With its high genetic base and extraordinary level of genotypic diversity, maize is a versatile and adaptive crop. It is a major cereal crop both for human consumption as well as for livestock feeds, worldwide. Maize has high content of carbohydrates, fats, proteins, some of the important vitamins and minerals, hence it has acquired a well-deserved reputation *i.e*., 'poor man's nutricereal' (Prasanna*et al*., 2001).

Central America and Mexico is believed to be the primary centre of origin by most authorities. Maize is believed to have been introduced in India during the early days of the East India Company *i.e*., the beginning of the seventeenth century (Singh *et al*., 2015).

In India, maize occupies the third place in food crop after rice and wheat (Sharma *et al*., 2017).In India, maize is cultivated over an area of 10.04million hecares with a total production of 33.62million tonnes in 2021-2022(Anon., 2022a). Important maize growing states in India are Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, Karnataka, Punjab, Rajasthan and West Bengal. In Nagaland, the area under maize cultivation is about 69.19 thousand hectares witha total production of 137.53 thousand tonnes in 2020-2021(Anon., 2022b).

Maize can be cultivated throughout the year in different seasons, namely kharif, rabi and spring. There are many divergent type of maize cultivars which allows it to be cultivated over a wide range of climatic conditions, ranging from near sea-level to several thousand meters above sea level (2700m msl). It can be grown in tropical, sub tropical and temperate climates, however corn production is higher in tropical and sub tropical. The most suitable temperature for germination is 21˚C and for growth 32˚C. Rainfall ranging from 50cm to 75cm distributed well over the growing season is conducive for its proper growth and development.

Maize can be grown in all types of soil but the growth and yield depend on the locations and the cultivars. However, in well drained sandy loam to silty loam soils maize yields with high yield potential can be observed (Singh *et al*.,2015).

In India, maize is a crop of great importance, as its production and demand is continuously increasing at a higher rate in comparison to other cereal crops. Its production is reported to be increasing at a rate three times the annual rate of wheat and two times of annual rate of rice (Yadav *et al*.,2016).

In Nagaland, maize is the second most important crop after rice. It can be found growing in every districts of the state, whether they are Jhum lands or terraced areas. There are several land races that are extensively cultivated with the arrival of monsoon because of its considerable significance in the dietary habits of the people in this region. Due to its preference and adaptability to varied climatic and soil conditions there are evidently many local landraces of maize. The selection of these landraces by the farmers are based on better adaptations to specific environment, prolificacy, flowering, behaviour, yield, nutritive value and resistance to the biotic stresses (Kumar *et al*., 2016). The region being rich in biodiversity has its demerits *i.e*., due to its dynamic weather conditions it makes the environment favorable for the multiplication of insect pests and their natural enemies.

Many factors limit maize production, one of the major biotic constraints in maize production is the high incidence of insect pests which cause heavy losses. Maize is attacked by a number of insects right from germination till the harvest of the crop and this leads to constant strain on the crop making it difficult to produce to its full potential. In addition, the indiscriminate use of hybrids and monocropping has changed the pest status in the recent times.

With varying degree of damage, maize is attacked by about 130 species of insect pests in India (Sarup *et al*., 1987). Among the various insect pests that is infesting maize only a dozen of these are considered a threat, of which maize cob borer and stem borer are of significant importance. In the early stages of maize termites, ear cutting caterpillars and field crickets are found damaging the crop. The other minor pests infesting maize crops are Bihar hairy caterpillar (*Diacrisia obliqua*), aphids (*Rhophalosiphum maidis*), leafhoppers (*Pyrilla perpusilla* Walker), white backed plant hoppers (*Sogatellafurcifera* Horvath), semilooper (*Trichoplusiaorichalcia*), tassel caterpillars (*Helicoverpazea)*, grasshoppers (*Chrotogonusroberstoni*, *Oxyachinensis, Aularchismeliaris*), armyworm *(Mythimnaseparata*), elephant beetle (*Xylotrupesgiddeon*) and termites *(Microtermesobesi* Holmgren) are of minor importance (Nonglait*et al*., 2013).

Fall armyworm (FAW), *Spodoptera frugiperda* (Smith) an invasive pest native to tropical and sub tropical region of America was first observed in India in early May- June 2018 in the maize fields of Karnataka (Sharanabasappa*et al*., 2018). And thereafter, it has spread to all the states of India within a short span of time devastating the maize crops. The devastating attack of FAW also occurred in Nagaland, Mizoram, Tripura, Manipur and the adjoining states (Anon., 2019).

Insect resistant cultivars has become an essential component of integrated pest management as it offers an economic, stable and economically sound approach to reduce the damage caused by the insects (Rasool*et al*., 2017).

Growing insect resistant crops is now highly valued in pest management programmes. Crop varieties that are resistant provide an inherent dominance which requires neither expenses nor environmental pollution problems and is generally compatible with other methods of insect pest control. Depending on the level of resistance, it can be used either as the principal method or as a supplement to other measures of pest management. It also serves as a safeguard against the release of varieties which may be more susceptible than the existing ones (Jayaraj&Uthamasamy, 1990).

Therefore, realizing the importance of the impact of insect pests in the production potential of maize, an attempt has been made to screen out some local cultivars against major insect pests of maize in the prevailing local condition. Considering for the need to identify the resistant or least susceptible cultivars against the major insect pests, the present studies entitled, "Seasonal incidence of major insect pests and Screening of local maize (*Zea mays* L.) cultivars" was undertaken with the following objectives:

1) To study the seasonal incidence of the major insect pests and their natural enemies
2) To correlate the effect of weather parameters on major insect pests and their natural enemy population
3) To screen the local maize cultivars for resistance against the major insect pests

CHAPTER II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Studies on "Seasonal incidence of major insect pests and screening of local maize (*Zea mays* L.) cultivars" are reviewed under the following heads:

2.1. Seasonal incidence of major insect pests and their natural enemies on maize

2.1.1. Seasonal incidence of major insect pests on maize

Farid*et al.* (2007) observed majority of the stem borer damage ranging from 10-50% occurred during the early vegetative stage and decreased as the crop reached the tasseling stage. The moths were first observed by mid- March, with peak activity observed in May and declined in June.

Patra *et al.* (2013) studied the pest complex of maize and observed twenty four insect pests and natural enemies including seven coccinellid beetles, two predatory bugs and thirteen spider species. Out of the twenty four insects, stem borer (*Chilo partellus*Swin.), cob borer (*Stenachroiaelongella* Hamp.), and shoot fly (*Atherigona soccata* Rond.) were recognized as major pests.

Ni *et al.* (2014) observed in 2009 a much more severe Fall armyworm feeding injury as compared to 2010 at 7 days and 14 days after the infestation for both the years on examining ear colonizing pest resisitance from 20 maize lines. During the experiment among the ten (10) species of predators there were five (5) lady beetles (Coleoptera: Coccinellidae) were recorded i.e, convergent lady beetle (*Hippodamia convergens*), the pink-spotted lady beetle (*Coleomegilla maculata*), the multicolored Asian lady beetle (*Harmonia* spp.), the 7-spotted lady beetle (*Coccinella septempunctata*), and the dusky lady beetle (*Scymnus* spp.). The other predators recorded were the hooded (or flower) beetle Notoxus spp. (Coleoptera: Anthicidae), two Earwigs (Dermaptera) *Labidura riparia* (Labiduridae) and *Doru taeniatum* (Forficulidae). Three taxa of hemipteran predators i.e, the insidious flower bugs (also known as minute soldier bug), Orius spp. (Hemiptera: Anthocoridae), the big-eyed bugs, *Geocoris*spp.

(Hemiptera: Geocoridae), and the damsel bugs,*Nabis* spp. (Hemiptera: Nabidae). Out of the 10 predators only 3 predators i.e., the convergent lady beetle, the insidious flower bug, and the earwigs showed a significant difference among the germplasm.

Kumar *et al*. (2015) conducted a periodical study for the identification of the insect pest complex as the status of the insect pest complex for a particular crop changes due to the changing climatic conditions. The study found six (6) major insect pests such as maize stem borer, *Chilo partellus* (Swinhoe); armyworm, *Mythimna separata* walker; maize aphid, *Rhophalosiphum maidis*; cob worm, *Helicoverpa armigera* (Hubner); grey weevil, *Myllocerus discolour* (Bohemann); and the phadka grasshopper, *Hieroglyphus nigrorepletus* (Bolivar).

Behera*et al.* (2019) investigated fifteen (15) numbers of popular cultivars of maize and observed maximum and minimum leaf injury rating on the cultivars HQPM-1 and NK-30 with 8.91 and 1.89 scaling score, respectively. Cultivars HQPM-1 and NK-30 also recorded maximum and minimum dead heart formation with 28.48% and 1.80%, respectively.

Hamid *et al.* (2019) reported the maximum leaf infestation by stem borer was observed on the 28th Standard Week (*i.e*., 2nd week of July) with 48.50% and least incidence of leaf injury damage was observed on the 18th Standard Week (*i.e*., 1st week of May) with 4.00%. The maximum dead heart damage was observed on the 27th Standard Week (*i.e*., 1st week of July) with 37.00% infestation while the minimum dead heart damage was observed on the 20th Standard Week (*i.e*., 3rd week of May) with 6.50% infestation.

Kumar *et al.* (2020b) conducted a survey during two cropping seasons*i.e*., *Kharif* and *Rabi* season of 2019-2020 on the seasonal occurrence of the invasive pest fall armyworm, *Spodoptera frugiperda* at Perambalur district comprising of four blocks *viz*., Perambalur, Veppanthattai, Alathur and Veppur. The study revealed that maximum fall armyworm incidence was recorded during the first fortnight of November 2019 with 72.00% and the minimum incidence was recorded in the second fortnight of October 2019 with 10.00%.

Patel *et al.* (2020) reported that the incidence of fall armyworm started from the first week of August 2019 (31st Standard Mean Week) and the larval population gradually increased to reach the peak with 7.66 larvae/10 damaged plants in the 3rd week of September 2019. However, during the 1st week of October (40th Standard Mean Week) the larval population declined to 4.33 larvae/10 damaged plants.

Reddy *et al*. (2020a) studied the seasonal incidence of fall armyworm during *Kharif* 2019 and *Rabi* 2019-20 and reported the first appearance in the 1st week of August with 9.71% infestation initially and maximum infestation with 35.43% was reported in the third week of August during *Kharif* 2019. During *Rabi* 2019-20, the initial infestation with 3.45% was reported in the first week of January and the maximum infestation was observed in the fourth week of February.

Kurly*et al.* (2021) studied the incidence of maize stem borer infestation on maize crop and reported that on the 33th Standard Week (*i.e*., 3rd week of August 2010) witnessed maximum leaf and dead heart infestation on stem borer with 6.90% and 6.50%, respectively.

Bangambingo*et al.* (2022) conducted a field experiment during two cropping seasons *i.e*., mid-October 2018 and mid-March 2019 to screen three biofortified maize varieties *viz*., SAM4 VITA A, SAM4 VITA B and PVA SYN-18 F2 and Yellow Plata, a local variety as control against fall armyworm. The result revealed that incidence of FAW in the control was significantly similar to the overall average incidence. The maize varieties evaluated displayed varying armyworm attack rates over the course of the two crop seasons with Yellow Plata (14.16%), SAM4 VITA/A (18.05%), SAM4 VITA/B (16.44%) and PVA SYN-18 F2" (14.66%).

Nivetha*et al.* (2022) conducted a study on the incidence of the invasive pest fall armyworm, *Spodoptera frugiperda* on maize and observed the first appearance of fall armyworm from the 34th MSW (0.52 larvae per plant) gradually increasing the population reaching its peak in the 44th MSW (1.20 larvae per plant) corresponding with the highest percentage of infestation (58.33 %) during *Rabi* 2019. The following summer 2020 the incidence of FAW was first observed from the 8th SMW (0.69 larvae per plant), and thereafter increased to the maximum in the 12th SMW (1.69 larvae per plant) corresponding with the highest percentage of infestation of 58.33%.

2.1.2. Seasonal incidence of natural enemies against major insect pests on maize

Kumar *et al*. (2015) conducted a periodical study for the identification of the insect pest complex as the status of the natural enemies for a particular crop changes due to the changing climatic conditions. They reported about four (4) species of Coccinellid beetles; green lacewig and *Cotesia flavipes*, a larval parasitoid of stem borer.

Sidar*et al.* (2017) reported the spider species belonging to the families *Oxyopidae* sp., *Araneidae* sp., *Amphinectidae* sp. and *Agelenidae* sp. were dominated in the maize fields. Adult spider population was initially 0.80 per plant in the first week of August. However, during the fourth week of September the highest population was observed with 4.40 spiders per plant.

Saranya *et al.* (2019) studied the maize ecosystem to identify the predatory spider fauna and found the dominating predatory spider species were *Lycosabarnesi*, *L. pseudoannulata*, *Pardosa birmanica*, *Salticus*sp. and *Hippasalycosina.*

Behera and Mishra (2020) studied the seasonal incidence of natural enemies of maize stem borer in the maize ecosystem for two kharif season (2014 & 2015) and observed the incidence of coccinellid population was between 1.10 to 1.20 beetles per plant from the 30th Standard Mean Week (19 DAS) to 40th

Standard Mean Week (89 DAS) in both the years. The spiders' population peaked on the 39th Standard Mean Week with 1.56 and 1.55 spiders per plant in both the seasons.

2.2. Correlation coefficient studies on the seasonal incidence of major insect pests and natural enemies of maize with weather parameters

2.2.1. Correlation coefficient studies on the seasonal incidence of major insect pests of maize with weather parameters

Deole*et al.* (2017) conducted an experiment to investigate the incidence of the pink stem borer in relation with the weather parameters during spring season of the year 2013-14 and 2014-15. The seasonal incidence of pink stem borer larvae showed a non-significant correlation with the weather parameters. However, during spring 2013-14, the relationship on the incidence of the adult population with the weather parameters showed a negative and significant correlation with maximum temperature (r = -0.652) and minimum temperature (r = -0.682), while a positive significant correlation with morning relative humidity (r = 0.610) but non-significant correlation with evening relative humidity (r = 0.214).

Hamid *et al.* (2019) reported that the correlation of the incidence level of maize stem borer as leaf infestation, dead hearts and moth catch with maximum temperature, minimum temperature and maximum relative humidity showed positive significant correlation while rainfall exhibited a positive and non significant correlation but sunshine and minimum relative humidity revealed a negative and non significant correlation.

Anandhi *et al.* (2020a) reported that the prevailing weather parameters prevailing in the locality affects the population of the *S. frugiperda* incidence.

Kumar *et al.* (2020b) reported that the larval population of fallarmyworm revealed a significant positive correlation with maximum temperature however, correlation was negative and non significant with relative humidity and rainfall.

Kurly *et al.* (2021) reported that the correlation coefficient on the seasonal incidence of maize stem borer as leaf infestation and dead hearts showed a highly significant positive correlation with maximum temperature, while it showed a significant negative correlation with maximum relative humidity.

2.2.2. Correlation coefficient studies on the seasonal incidence of natural enemies of major insect pests on maize with weather parameters

Megha *et al.* (2015) reported that the correlation of coccinellid beetles, *Coccinella* spp. showed non-significant negative correlation with the maximum temperature. However, correlation of coccinellid beetles' incidence exhibited a non-significant positive correlation with minimum temperature, maximum and minimum relative humidity.

Sidar *et al.* (2017) studied the maize ecosystem to investigate the seasonal incidence of spider fauna in the maize field. The studies revealed that correlation of the incidence of spiders with the maximum temperature, minimum temperature, morning relative humidity and evening relative humidity showed non- significant positive correlation with (r = 0.074), (r= 0.28), (r= 0.27) and (r= 0.15) respectively. While, the relationship between the spider population and the rainfall, wind velocity and sunshine hours showed a non- significant negative correlation with (r= -0.20), (r= -0.39), (r= -0.14) respectively.

Tali *et al.* (2018) studied the identification of natural enemies with *Rhapalosiphum maidis* in maize with different intercrops *viz*., with green gram, black gram, cowpea and soybean in Kharif 2017. The correlation of the mean coccinellid population with mean atmospheric temperature showed a significant positive correlation in all the intercrop treatments.

Saranya *et al.* (2019) reported that correlation of the incidence of the predatory spider population with the relative humidity revealed a non-significant positive correlation and with the maximum and minimum temperature showed a non- significant negative correlation.

Kumar *et al.*(2020a) studied the abundance of natural enemies in the maize ecosystem for two years (Spring 2015 and 2016) and reported that during the spring of 2016 the correlation of the abundance of coccinellids with the maximum temperature was positively correlated. However, maximum and minimum temperature had negative effect in both the years. Regarding with correlation of the relative humidity (morning and evening) and rainfall, the population of the coccinellids showed a significant positive correlation during 2015 but in 2016, it was negatively correlated for all weather parameters. With regard to spiders' population during both years it was not affected by these weather parameters *viz.*, maximum and minimum temperature but in 2015, the correlation of the spiders' population with the maximum temperature showed a negative correlation. However, during 2015, correlation of the incidence of spider with rainfall and maximum and minimum relative humidity showed a significant positive correlation but in 2016, the spider population was negatively correlated with all these weather parameters.

2.3. Screening of different maize cultivars against major insect pests of maize

Afzal *et al.* (2009) evaluated twenty (20) different genotypes of maize for their resistance to *Chilo partellus* infestation. The results revealed that the most susceptible genotype was Sahiwal 2002 while the most resistant genotypewas DK-6525. At the end of April maximum infestation was recorded while during the last week of March minimum infestation was recorded. Plant characters *viz.*, number of nodes per plant, plant height, cob height, stem diameter, length of central spike, cob length, leaf length, leaf width, leaf trichomes and 100 grain weight showed significant variation. Except for the number of nodes per plant, cob height and length of central spike the rest of the characters showed a negative but non- significant correlation with the infestation by *Chilo partellus.* Among the genotypes, DK-6525 showed significant variation and recorded maximum trichomes and Sahiwal-2002 recorded minimum trichomes. The results of the multiple linear regression analysis revealed that the plant characters contributing towards resistance against *Chilo partellus* in maize crop were leaf trichomes which played the most significant role contributing to 41.6% followed by stem diameter which accounted for 32.7% towards infestation of pest.

Dindor *et al*. (2016) conducted studies on per cent damage and leaf injury caused by maize stem borer, *Chilo partellus* to evaluate ten (10) varieties for determining the level resistance of maize against maize stem borer. Among those varieties, two (2) cultivars *viz*., Narmada Moti and GAWMH-2 were found Resistant (R) with less than 28.75% damaged plants; five (5) varieties *viz*., GM-3, GM-6, Amber, GAYMH-1 and HQPM-1 with per cent damage rating ranged between 31.21% to 33.67% and falls under the category Moderately Resistant (MR) and three (3) cultivars *viz*., GM-2, GM-4 and Madhuri were found to be Susceptible (S) with damaged plant rating ranging between 36.13% to 38.59% infestation. The level of leaf injury caused by maize stem borer revealed that out of the ten (10) cultivars, only one (1) variety GM-3 was found to be Highly Resistant (HR) with a leaf injury scale of 2.6; four (4) varieties *viz*., Narmada Moti, Amber, GAWMH-2 and GAYMH-1were found to be Moderately Resistant (MR) with leaf injury scale ranging between 2.6 to 3.32; four (4) varieties *viz*., HQPM-1, GM-6, Madhuri and GM-4 were found to be Moderately Susceptible (MS) with leaf injury scale ranging between 4.04 to 4.76 and only one variety GM-2 was found to be Susceptible (S) with leaf injury scale ranging between 4.76 to 5.48.

Rasool *et al*. (2017) evaluated twenty-four (24) maize genotypes tostudy the antixenosis and antibiosis mechanism against *C. partellus*. The leaf injury rating due to *C. partellus* damage at 20, 30 and 40 DAS ranged from 0.33 to 3.26, 0.60 to 7.26 and 0.86 to 8.86, respectively. With the Leaf Damage Score (LDS) of 0.93 and 0.86 in genotypes CM-133 and CM-123respectively, they were found highly resistant. The extremely susceptible genotype Basil-Local scored 8.86 LDS. The highly resistant genotypes were CM-123 and CM-133 with high phenolic content (antibiosis) of 238.05 and 234.76 µg/g, respectively. The extremely susceptible genotype Basi-Local showed lowest phenolic content 117.27 µg/g. Furthermore, the study investigated the combined effect of several morphological characteristics, including stem diameter, intermodal distance, number of nodes, cob length, leaf length, leaf width and leaf trichome density, on the damage caused by *C. partellus.* The results demonstrated that these characteristics collectively accounted for 88.91% of the damage caused by the pest.

Vishvendra *et al.* (2017) conducted an experiment to evaluate the performance of fifteen (15) maize cultivars with respect to their resistance to infestation and dead hearts formation caused by maize stem borer. The maize cultivar tested were Pmh-117, Buland, Prakash, Bio-9637, Seedtech-2324, Hqpm-7, Bio-9681, Hybrid maize gs -802, Dhs-42 hybrid, African tall, Bharat kaveri, Manjira-1 and Malika nmh-920. The result showed the moderately resistant cultivars were Pmh-117, Buland and Prakash; moderately susceptible cultivars were Bio-9637, Seedtech- 2324, Hqpm-7, Bio-9681 and Hybrid maize gs-802 and the susceptible cultivars were Sujata, Dhs-42 hybrid, African tall and Nmh-90. The cultivar Hybrid madhuri recorded the maximum infestation (45.92%). Cultivar Buland exhibited the minimum dead heart formation after forty-five days of sowing followed by Pmh-117, Bio-9637, Hqpm-7, Seedtech-2324 and Hybrid maize gs-802, repectively. Hybrid madhuri recorded the maximum dead hearts formation. After forty-five days of sowing, Cultivar Pmh-117 exhibited the minimum leaf injury rating with 23.33% infestation andHybrid madhuri exhibited maximum leaf injury ratingwith 8.00% infestation.

Cholla *et al.* (2018) assessed the response of thirty maize genotypes to stem borer (*Chilo partellus*) infestation. The infestation levels were measured in terms of leaf Injury Rating (LIR), dead hearts and stem tunneling. The study observed significant variations among the genotypes in terms of the three measured traits, indicating differences in stem borer resistance. The results showed leaf injury rating ranged from 2.16 in genotype PFSR51016/1 to 8.74 in genotype HKI 1352. Among the genotypes, WNZPBTL2 exhibited minimum damage with only 14.03% dead hearts, while genotype HKI 1378 displayed maximum damage, with 55.94% dead hearts. Stem tunneling, an indicator of larval feeding inside the stem, was minimum in WNZPBTL2 (13.75%) and maximum in Basi-Local (44.75%). These findings demonstrate the variation in susceptibility to stem borer infestation among the evaluated genotypes.

Pawar and Goudar (2020) investigated the physiological factors responsible for yield variation among twenty (20) different maize hybrids and observations were recorded for morphological, biochemical and yield and yield attributes. Among all the hybrids, superior performance with respect to higher morphological (plant height, more number of leaves and total dry matter) and physiological parameters (SPAD, Chorophyll, total sugar and starch content) was observed in DMH-01, DMH-13 and GPMH-1101over the rest of the hybrid. Furthermore, DMH-01, DMH-13 and GPMH-1101 recorded significantly higher yield and yield parameters such cob length, cob girth, number of seeds per cob, number of seed rows per cob,100-kernel weight and harvest index. Higher productivity was contributed by the significant improvement in the overall growth of the crop which can be attributed due to increased photosynthetic efficiency resulting in greater availability of photosynthates, metabolites and increased dry matter accumulation facilitatinggrowth and development of reproductive structures.

Paul and Deole (2020a) evaluated twenty-five (25) maize genotypes against fall armyworm *Spodoptera frugiperda* (Swinhoe) and reported that the least leaf damaging genotype was DKC-9190 (2.36), while the highest leaf damage rating was exhibited by genotype NK-30 (8.21). Non-significant correlation was recorded with total number of leaves per plant (r = 0.386) with respect to leaf damage rating and recorded significant correlation with total number of leaf area (cm^2) of the leaves (r = 0.442) and negative highly significant correlation with leaf trichomes (r = -0.609) at 45 DAS. The lowest ear damage rating (1.91) was observed in the genotype Heera-1122 while, the highest ear damage rating (5.91) was observed in the genotype NMH-707. Significant negative correlation was recorded with the length of the central spike (r = -0.446) with respect to ear damage rating. Regarding the kernel damage, NMH-707 showed the lowest damage rating (1.59) while, LG-34.06 showed the highest damage rating (4.31) on the crop. Significant correlation was exhibited with the cob length (cm) (r = -0.403) and a significant negative correlation with the height of the cob (cm) (r = -0.412) with respect to kernel damage rating.

Sebayang *et al.* (2022) conducted an experiment to screen maize genotype resistant to fall armyworm *Spodoptera frugiperda* (J. E. Smith). Thirteen genotypes (POP 02, POP 03, POP 05, POP 10, POP 11, POP 15, POP 18, POP 21, POP 23, POP 24, POP 26, POP 27 and POP 28) and two check varieties (BISI 18 and JH 37) were arranged in randomized block design with three replications. The incidence of the fall armyworm based on the total number of damaged plants, the percentage of attacks according to the Davis Scale and the level of plant resistance were observed from the fourth weeks after planting Moderate resistance or tolerance to FAW was exhibited by the 13 tested genotypes. The line POP 18 exhibited the highest damage percentage (46.26 %), while POP 11 (7.24%) and POP 26 (14.26%) displayed the lowest damage percentages. Genotypes showing moderate resistance to FAW included POP 10, POP 21, POP 23, POP 26, POP 27 and POP 28.

Srinivasan *et al*. (2022) observed during a field experiment that the most commonly used injury rating scales with the 1-9 whorl leaf injury rating scale proposed by Davis *et al*. (1992) and Ni *et al.* (2011) was prone to be bias depending on the observer. To address the issue, a new TNAU 1-5 scale was developed and evaluated as an alternative to the modified Davis *et al.* (1992) 1-9 scale proposed by Ni *et al.* (2011). The new TNAU scale demonstrated improved feasibility, precision, easy to use and reduced time consumption compared to the modified Davis *et al.* (1992) scale.

Varma *et al*. (2022) evaluated evaluated twenty-four (24) cultivars including nine (9) hybrids, nine (9) inbred lines, two (2) composite, three (3) sweet corns and one (1) pop corn hybrid during Kharif 2019 and 2020 and during 2020 experiments were carried out to screen twenty-four (24) for resistance against fall armyworm, *Spodoptera frugiperda*. Based on leaf damage rating scale (1-9), among all the cultivars evaluated the highest leaf damage rating scale was observed in sweet corn hybrid GSCH 0918 (5.73) indicating its susceptibility under natural condition while, the lowest leaf damage rating scale was observed in hybrid maize cultivars *viz*., GAYMH 3 (2.39), GAYMH 1(2.60) and GAYMH 2 (3.07) as well as composite varieties *viz*., NARMADA MOTI and GM 6 and were identified as resistant cultivars.

CHAPTER III

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigation on "Seasonal incidence of major insect pests and screening of local maize (*Zea mays* L.) cultivars" was carried out during March to July 2020 and March to July 2021 in Experimental Research Farm of Entomology, School of Agricultural Sciences (SAS), Nagaland University. The experiment site is stationed at Medziphema located at an altitude of 310 m above mean sea level situated at 25˚45'53" N latitude and 93˚52'04" E longitude. It receives an annual rainfall varying from 200 cm to 270 cm and experiences a sub tropical climate. Temperature ranges between 21˚C to 32 ˚C in summer and minimum temperature at 8 ˚C in winter. The soil is sandy loam in texture, acidic in nature with pH ranging from 4.5-6.5. The weather data on standard meteorological week (SMW) during the growth period was obtained from ICAR Meteorological Observatory, Division of Agronomy, Jharnapani.

A descriptive account of the materials and methodologies followed in these investigations are presented below:

3.1. Source of the seeds

The seeds were collected directly through the farmers from Mon, Kohima, Chumukedima, Phek and Wokha districts. The fourteen (14) local cultivars of different shape, size and shape origin to the particular place were selected from August to October 2019. One (1) hybrid variety was also included in the experiment as check variety. The details of the seed collection are presented in Table 3.1.

3.2. Design and layout of the field

A Randomized Block design (RBD) field layout was used for screening and to study the morpho-physilogical characteristics of different maize cultivars (14 Local and 1 Hybrid) with three replications. Local cultivar Medziphema Local-1 was maintained as the ecological plots to observe the seasonal incidence of major insect pests in the maize ecosystem. The details of

Table 3.1: Details of the seedscollection

Sl. No	*Cultivar (Local Name)*	*Place of collection*	*Month of collection*
C1	Shiyam Ngangching Local	Mon	October 2019
C2	Yang leng Ngangching Local	Mon	October 2019
C3	Yempong Ngangching Local	Mon	October 2019
C4	Watak Ngangching Local	Mon	October 2019
C5	Chiechama Local	Kohima	October 2019
C6	Khonoma Local	Kohima	October 2019
C7	Khuzama Local	Kohima	October 2019
C8	Medziphema Local-1	Chumukedima	September 2019
C9	Medziphema Local -2	Chumukedima	August 2019
C10	Zarsi Socunoma Local	Chumukedima	October 2019
C11	Phek Local-1	Phek	December 2019
C12	Phek Local-2	Phek	December 2019
C13	Wokha Local-1	Wokha	December 2019
C14	Wokha Local-2	Wokha	December 2019

the experimental layout are presented in Fig. 3.1.

1. Crop : Maize
2. Local cultivars : 14
3. Hybrid variety : 1
3. Experimental design : Randomized Block Design (RBD)
4. Number of replication : 3
5. Total Number of plots : 45
6. Size of the plot : 3.5 m x 3.2 m
7. Plot to plot spacing : 0.5 m
8. Spacing between the replication : 0.5 m
9. Spacing between the rows : 60 cm
10. Spacing between the plants : 30 cm

Plate 1: Different maize cultivars collected from Mon and Kohima Districts

Plate 2: Different maize cultivars collected from Chumukedima, Phek and Wokha Districts

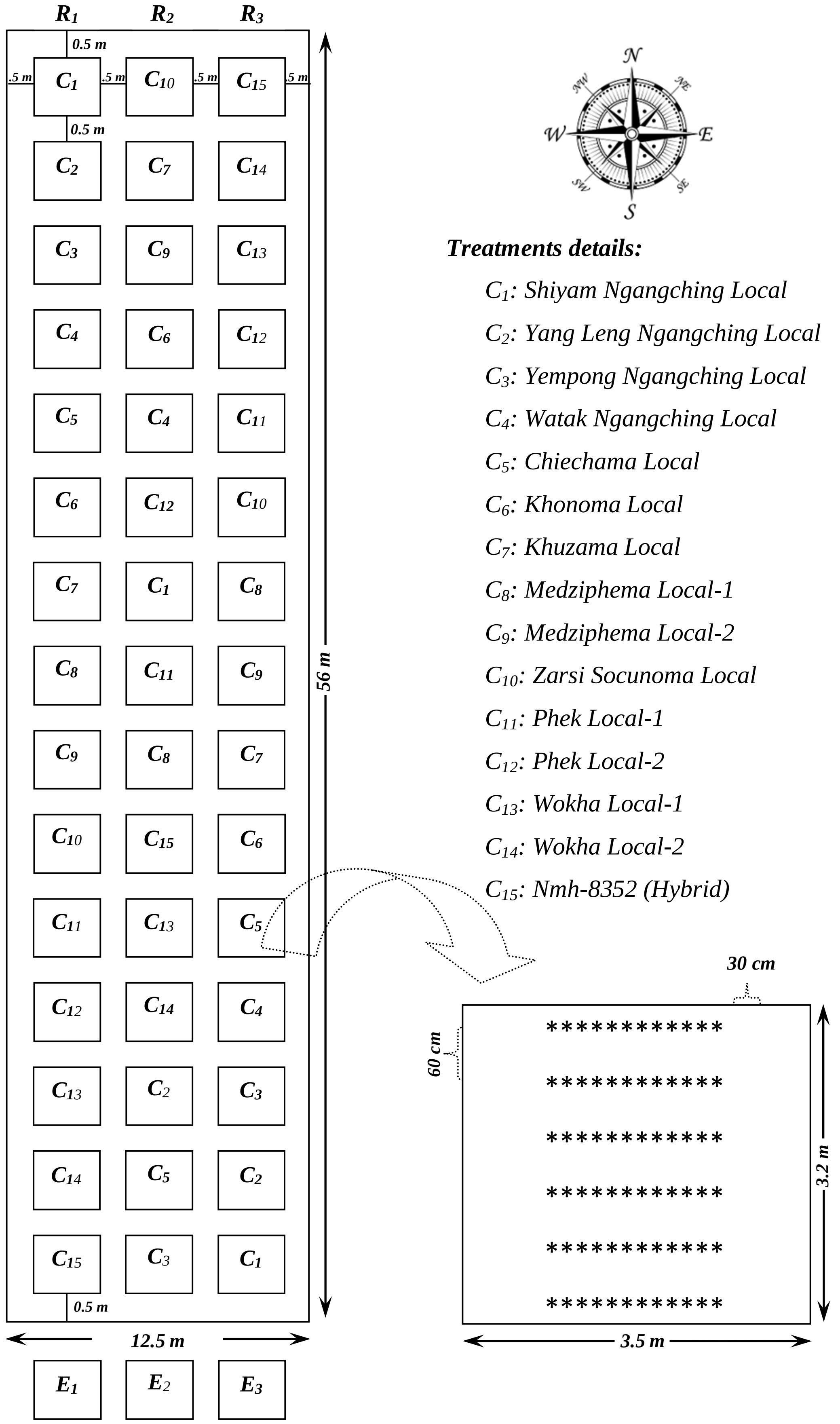

Fig. 3.1: Field layout of the experiment in Randomized Block Design (RBD)

11. Seed rate : 20 kg ha^{-1}

12. Method of planting : Line sowing

3.3. Cultivation practices

3.3.1. Land preparation

The selected field was thoroughly ploughed with tractor to remove the weeds, plant roots, and stubbles etc., followed by harrowing. The field was ploughed and exposed before sowing to expose the soil insects to birds and predators. The field was properly leveled and the plots were prepared according to the recommendations.

3.3.2. Manuring

Well decomposed Farm yard manure was incorporated into the field 30 days prior to the sowing of the maize seeds. Chemical fertilizers were not utilized during the present study.

3.3.3. Sowing of the seeds

The seeds were soaked for 1 hour prior to sowing to accelerate the seed germination. The seeds were sown on 8th March on both the years (2020 & 2021). Seeds are dibbled maintaining a distance of 60 cm row to row and 30 cm plant to plant with a plant population of seventy-two (72) plants per plot.

3.3.4. Irrigation

Light irrigation was given soon after sowing and thereafter irrigation was given as and when required.

3.3.5. Weeding

The fields were kept weed free and weeding was done manually. Noherbicides were utilized to manage the weeds.

3.3.6. Harvesting

The crop was harvested at maturity when the sheath covering the cob turned yellow and grains became fairly hard and dry.

3.4. Observations on seasonal incidence of major insect pests and their natural enemies

In order to study the seasonal incidence of major insect pests and their natural enemies observations were taken at the first appearance of the infestation and continued till the harvest of the crop at fortnightly intervals and the datas were correlated with meteorological parameters. Observation on per cent infestation by the major insect pests and their natural enemies were recorded from 10 randomly selected plants from each plots at fortnightly intervals. The weather data on standard meteorological week (SMW) during the growth period was obtained from ICAR Meteorological Observatory, Jharnapani (Table 3.2 and Fig. 3.2a & 3.2b).

3.4.1. On stem borer infestation

The observations on stem borer infestation were observed at fortnightly intervals from the first appearance of the infestation till the disappearance. The leaf injury and dead hearts were recorded from ten (10) randomly selected plants in each plot at fortnightly intervals. The percentage of infestation of leaf injury and dead hearts were recorded from the infested plants.

$$\text{Percentage of infestation (\%)} = \frac{\text{No. of infested plants}}{\text{Total number of plants}} \times 100$$

3.4.2. On Fall armyworm infestation

The observations on fall armyworm were observed from 10 randomly elected plants in each plot from the first appearance of the damaged whorls till the disappearance of the damage symptoms. The percentage infestation of whorls damaged in each plots were recorded from the infested plants.

$$\text{Percentage of infestation (\%)} = \frac{\text{No. of infested plants}}{\text{Total number of plants}} \times 100$$

Table 3.2: Meteorological observations during the period of study (April 2020 to June 2020 and April 2021 to June 2021)

Standard Mean week	*2020*						*2021*					
	Date of observation	*Temperature (ºC)*		*Relative humidity (%)*		*Rainfall (mm)*	*Date of observation*	*Temperature (ºC)*		*Relative humidity (%)*		*Rainfall (mm)*
		Max.	*Min.*	*Max.*	*Min.*			*Max.*	*Min.*	*Max.*	*Min.*	
14	12 April 2020	33.70	14.50	89.00	35.00	9.60	12 April 2021	32.60	15.80	88.00	34.00	14.60
15	19 April 2020	32.50	16.40	88.00	39.00	4.60	19 April 2021	34.60	17.70	90.00	34.00	15.10
16	26 April 2020	29.90	18.40	91.00	60.00	53.10	26 April 2021	32.60	18.80	87.00	41.00	17.90
17	03 May 2020	27.30	18.00	93.00	72.00	78.10	03 May 2021	34.40	18.80	83.00	27.00	0.00
18	10 May 2020	30.70	20.30	90.00	60.00	20.50	10 May 2021	32.20	20.50	85.00	49.00	31.10
19	17 May 2020	32.20	19.90	87.00	56.00	22.60	17 May 2021	30.30	20.60	89.00	62.00	19.40
20	24 May 2020	32.00	21.50	92.00	61.00	4.10	24 May 2021	31.70	21.60	91.00	58.00	3.20
21	31 May 2020	30.50	22.90	92.00	79.00	38.60	31 May 2021	35.60	23.90	92.00	60.00	31.10
22	07 June 2020	30.10	21.20	92.00	63.00	74.00	07 June 2021	33.10	22.90	91.00	61.00	17.40
23	14 June 2020	31.90	22.70	94.00	68.00	16.50	14 June 2021	33.60	23.60	92.00	63.00	39.10

Source: ICAR Meteorological Observatory, Jharnapani

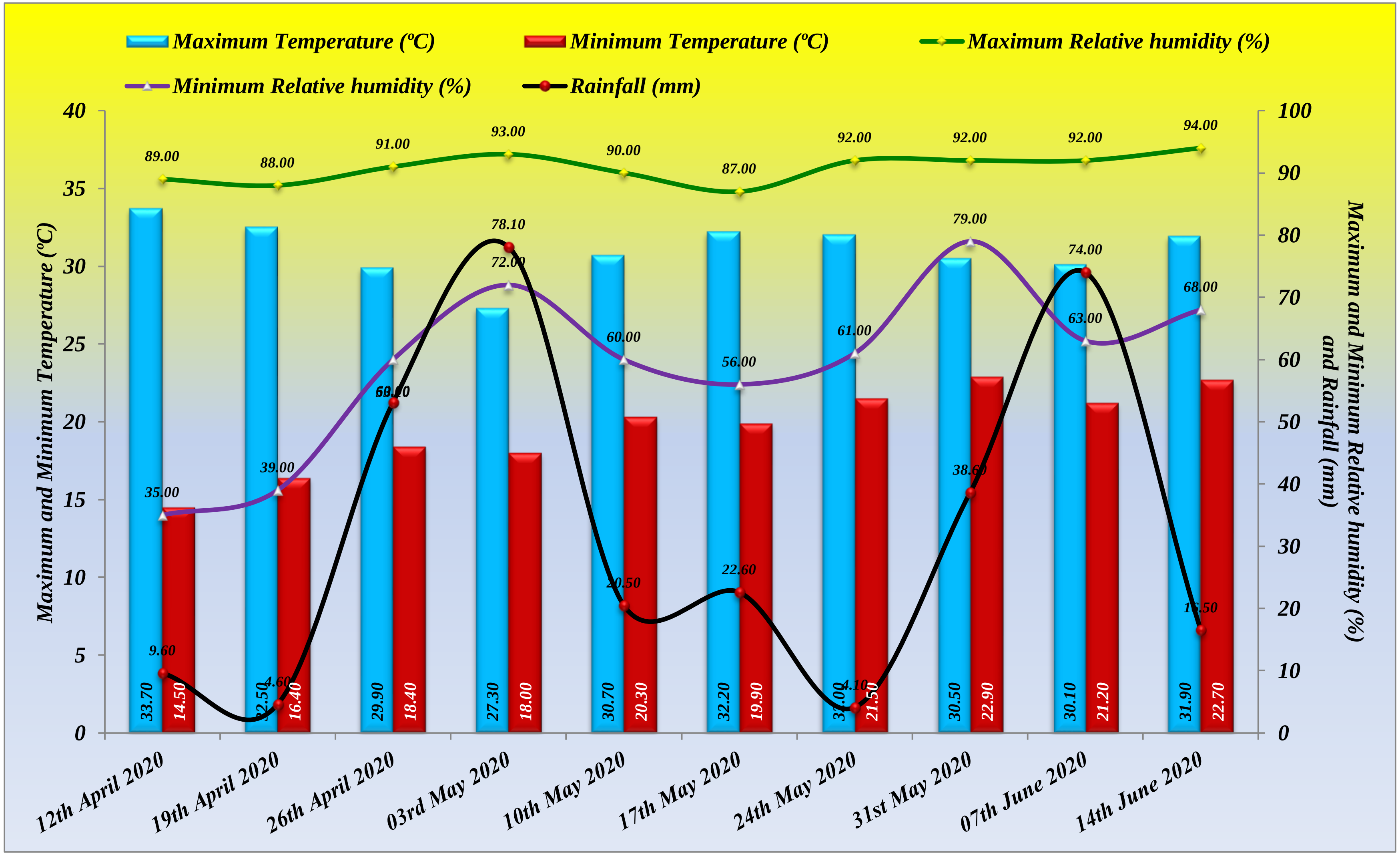

Fig 3.2a: Graphical presentation of different weather parameters during the study period (April to June 2020)

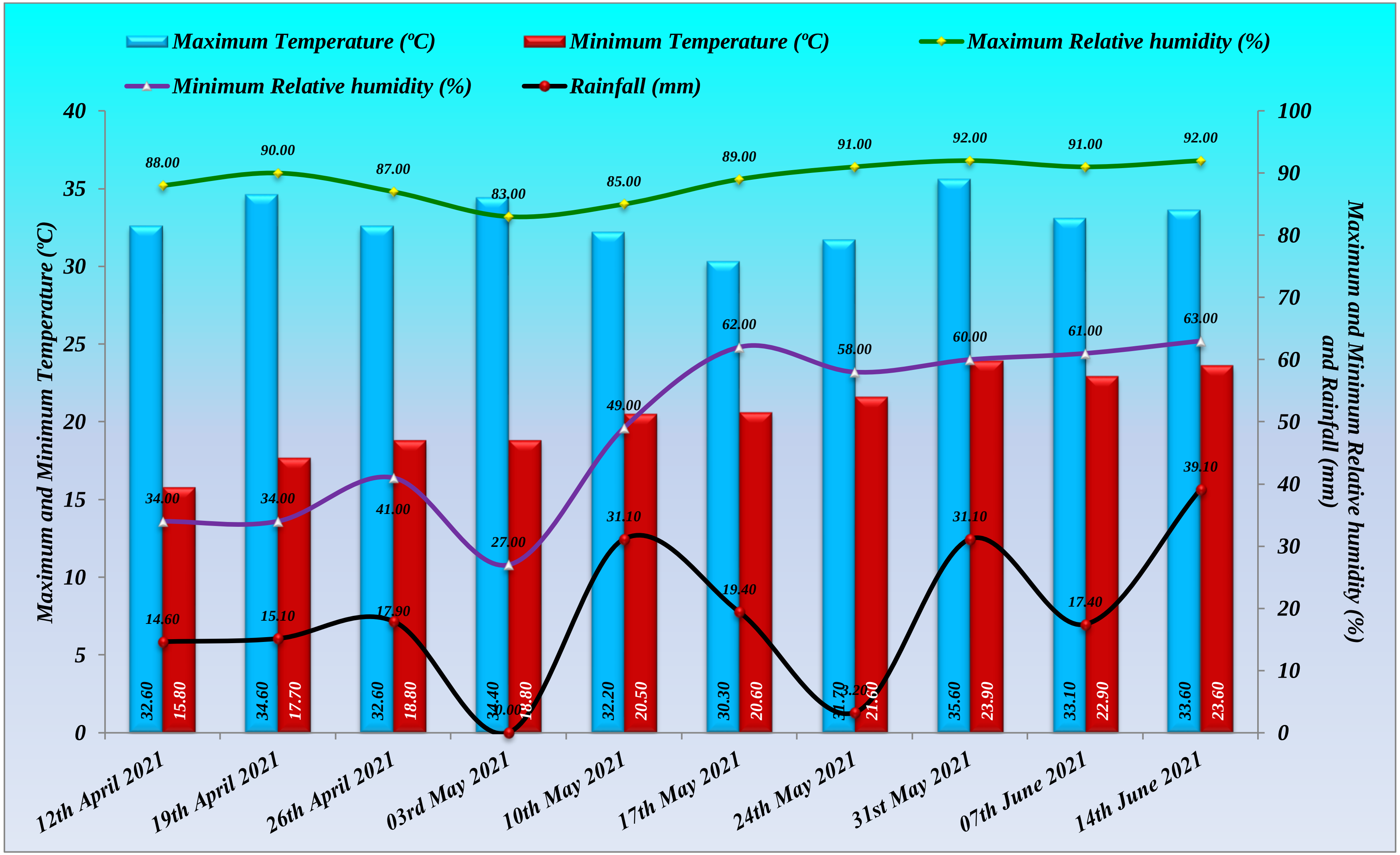

Fig 3.2b: Graphical presentation of different weather parameters during the study period (April to June 2021)

3.4.3. Coorelation studies of major insect pests and their natural enemies with the weather parameters

Datas on weather parameters such as maximum and minimum temperature, maximum and minimum relative humidity and rainfall were recorded for the entire period of study at Standard Meteorological Week (SMW) and was correlated with the incidence of major insect pests and their natural enemies influenced by these abiotic factors. Observations were taken from 10 randomly selected plants from each plots and correlated with the weather parameters.

3.5. Screening of different local maize cultivars against major insect pests of maize

3.5.1. Maize stem borer infestation

The collection of datas for infestation of maize stem borer on the different cultivars was recorded starting from the incidence of the pest till the harvest of the crop. The observations were taken from 10 randomly selected plants from each plot at fortnightly intervals.

3.5.1.1. Plant damage percentage

Dead hearts, leaf injury and stem tunneling were recorded for evaluating the resistance level of the tested maize cultivars against maize stem borer. Plant damage percent was calculated by using the formula given below as described by Bhandari *et al.* (2016).

$$\text{Damage percentage (\%)} = \frac{\text{Numberofinfectedplant}}{\text{Totalnumberofplant}} \times 100$$

3.5.1.2. Leaf injury rating

In order to study the leaf injury due to the attack of the stem borer were observed 15 days after sowing and the plants showing the injury symptoms were recorded. According to the scoring scale given by Sarup (1983), the following are the leaf damage scale for the maize stem borer (Table 3.3).

Table 3.3: Maize stem borer leaf damage scoring scale (1-9)

Scale	*Description*	*Host reaction*
0	No visible damage	(Likely escape)
1	No visible leaf feeding damage	Highly Resistant (HR)
2	Few pin holes on older leaves	Resistant(R)
3	Several shot holes injury on a few leaves	Resistant(R)
4	Several shot holes injuries common on several leaves or small lesions	Moderately Resistant (MR)
5	Elongated lesions (<2) cm long on a few leaves	Moderately Resistant (MR)
6	Elongated lesions on several leaves	Suceptible (S)
7	Several leaves with elongated lesions or tattering	Suceptible (S)
8	Most leaves with elongated lesions or severe tattering	Highly Susceptible (HS)
9	Plant dying as a result of foliar damage	Highly Susceptible (HS)

Source: Sarup (1983)

3.5.1.3. Dead hearts infestation

The plants showing dead heart symptoms due to the attack of stem borer were observed and recorded after the appearance of the symptoms.

3.5.1.4. Stem tunneling length

After harvesting the maize plants were uprooted for studying the stem tunneling damage due to the stem borer infestation and split cut. The plant height and tunnel length were recorded and their mean were calculated. According to the categories given by Rajasekhar and Srivastav (2013), the following three categories were related to the stem tunnel length (Table 3.4).

Table 3.4: Tunnel length and exit holes measurement scale

Sl. No.	*Rating scale*	*Host reaction*
1	0-5	Least susceptible
2	5-10	Moderately susceptible
3	>10	Highly susceptible

Source: Rajasekhar and Srivastav (2013)

3.5.2. Fall armyworm infestation

The collection of datas for infestation of fall armyworm on the different cultivars was recorded starting from the incidence of the pest till the harvest of the crop. The observations were taken from 10 randomly selected plants from each plot at fortnightly intervals. The plants showing leaf whorls damage due to the attack of fall armyworm were observed and recorded after the appearance of the symptoms. According to the scoring scale given by Davis *et al.* (1992), the following are the leaf whorl damage scale for the fall armyworm (Table 3.5).

Table 3.5: Fall armyworm leaf whorls damage scoring scale (1-9)

Scale	***Description***	***Host reaction***
0	No visible damage	(Likely escape
1	Only pinholes on whorl leaves	Highly Resistant (HR)
2	Pinholes and small circular lesions on whorl leaves	Resistant(R)
3	Pinholes, small circular lesions and a few small < 1.3 cm (< 1/2") elongated lesions on whorl and/or furl leaves	Resistant(R)
4	Small elongated and a few mid-sized 1.3-2.5 cm (1/2"-1") elongated lesions on whorl and/or furl leaves	Moderately Resistant (MR)
5	Small elongated and several mid-sized 1.3-2.5 cm (1/2"-1") elongated lesions on whorl and/or furl leaves	Moderately Resistant (MR)
6	Small and mid-sized elongated lesions plus a few large > 2.5 cm (> 1") elongated lesions on whorl and/or furl leaves	Suceptible (S)
7	Many small and mid-sized elongated lesions plus several large > 2.5 cm (> 1") elongated lesions on whorl and furl leaves	Suceptible (S)
8	Many small and mid-sized elongated lesions on whorl leaves plus many large > 2.5 cm (1") elongated lesions on whorl and furl leaves	Highly Susceptible (HS)
9	Whorl and furl leaves almost totally destroyed	Highly Susceptible (HS)

Source: Davis *et al.* (1992)

3.6. Studies on morphological characteristics of different maize cultivars

At the end of the cropping season before harvesting different morpho-physiological characters *viz*., stem diameter, leaf length, leaf breadth, leaf area and number of leaf trichomes were recorded from ten randomly selected plants per plot (Das *et al*., 2016). After harvesting the other plant characteristics like number of nodes per plant, plant height, cob height, cob length, length of the central spike and 100 grain weight were recorded from the different maize cultivars (Kumar, 2018).

3.6.1. Stem diameter

With the help of a vernier caliper the stem diameter was measured from the 3rd inter node above the ground level from 10 randomly selected plants from each plot and the mean average was calculated.

3.6.2. Leaf length and leaf width

For measuring the leaf length and leaf width five (5) plants were randomly selected from each plot. The length of the leaf blade was recorded from five (5) healthy leaves from each plant and the mean average was calculated. The leaf widths were measured with the help of a standard centimeter ruler from the centre of the leaf blade and the mean average was calculated.

3.6.3. Leaf area

For studying the leaf area, five (5) plants from each plot were chosen randomly and five (5) healthy leaves were selected from each plant and measured with the help of a leaf area meter and the mean average was calculated.

3.6.4. Number of leaf trichomes

Ten (10) plants were randomly selected from each plot and the leaf trichomes were counted under the binocular microscope from an area of 1cm at five (5) different points of a leaf and the average is calculated to get the mean number of leaf trichomes from each cultivar.

3.6.5. Plant height (cm)

To determine the above ground plant height, ten (10) plants were randomly selected and the plants were uprooted and measured with the help of a standard measuring tape and the average was calculated to get the mean plant height.

3.6.6. Cob length (cm)

For measuring the cob length ten (10) plants were randomly selected from each cultivar and thelengths of each cob were measured with measuring tape and average was calculated to get the mean cob length from each cultivar.

3.6.7. Cob height (cm)

Cob height were taken from ten (10) randomly selected plants from each cultivar and recorded by taking the measurements from above ground level up to the node position of cob with the help of a measuring tape and the average was calculated.

3.6.8. Length of central spike (cm)

For measuring the length of central spike, ten (10) plants were randomlyselected from each plot and were measured and then, the average was calculated to get mean length.

3.6.9. 100 grains weight (g)

Ten (10) plants were randomly selected during harvest from each cultivar. To calculate the 100 grains weight, matured cobs were removed and sun dried for one week. The grains were then separated and mixed and 100 grains were taken randomly and weighed with an electronic balance to get the average weight.

3.7. Statistical analysis

The data collected regarding the screening of different maize cultivars during the experiment in both the years were analyzed by Randomized Block Design (RBD) using one-way analysis of variance (ANOVA) given by Gomez and Gomez (1984). Further, differences between the treatments were analyzed by using one-way analysis of variance (ANOVA) to find out their difference at 5% level of significance.

Regarding the correlation studies on the seasonal incidence of major insect pests in relationship with the abiotic factors and morpho-physiological characteristics in different local maize cultivars, correlation coefficient werecalculated by using the formula given by Pearson (1948).

$$r=\frac{\sum xy-\frac{\sum x.\sum y}{n}}{\sqrt{\left\{\sum x^2-\frac{(\sum x^2)}{n}\right\}\left\{\sum y^2-\frac{(y^2)}{n}\right\}}} \qquad (or)$$

$$r=\frac{n(\sum xy)-(\sum x)(\sum y)}{\sqrt{\{n(\sum x^2-(\sum x^2)\}\{n\sum y^2-(\sum y^2)\}}}$$

where, r = Coefficient of correlation

n = Number of observation

x = Mean number of pest infestation

y = Independent variables (weather parameters)

The data collected regarding the morphological characteristics of different maize cultivars during the experiment in both the years were analyzed by Randomized Block Design (RBD) using one-way analysis of variance (ANOVA) given by Gomez and Gomez (1984). Further, differences between the treatments were analyzed by using one-way analysis of variance (ANOVA) to find out their difference at 5% level of significance. Before conducting Fisher Shedecor'F-test", the datas were transformed to square roottransformation data ($\sqrt{x+0.5}$)to find out the significance and non-significance of the variance due to different treatments at 5% level of significance.

Plate 3: General view of the experimental field

CHAPTER IV

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

The findings of present investigations on “Seasonal incidence of major insect pests and screening of local maize (*Zea mays* L.) cultivars” carried out during April to June 2020 and April to June 2021 are discussed under this chapter.

4.1: Insect pests and natural enemies recorded on maize during April to June 2020 and April to June 2021

The details of insect pests encountered during the research period i.e., April to June 2020 and April to June 2021 are presented in Table 4.1. A total of three (3) insect pests belong to two orders and three (3) families were recorded on maize. The crop was found to be mainly infested with Maize stem borer, *Chilo partellus* (Lepidoptera: Crambidae) and Fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in both the years. Regarding the minor pests, only one pest i.e., Maize aphid, *Rhopalosiphum maidis* (Hompotera: Aphididae) was recorded during the period of studies in both the years. Among the natural enemies a total of two (2) species i.e., Coccinellid beetles, *Coccinella* spp. (Coleoptera: Coccinellidae) and one Arachnid species, *Salticusscenicus* (Araneae : Salticidae) were recorded on maizeduring the period of studies in both the years.

4.2. Seasonal incidence of major insect pests and their natural enemies in different local maize cultivars during April to June 2020 and April to June 2021

In the present investigations maize was found to be infested by a number of insects out of which Maize stem borer, *Chilo partellus* and Fall armyworm, *Spodoptera frugiperda* were the major insect pests during April to June 2020 and April to June 2021. The natural enemies which were observed during the present investigations were coccinellid beetles, *Coccinella* speciesand spidersin both the years. The details of the results pertaining on the

Table 4.1: Insect pests and natural enemies recorded on maize during the period of studies (April to June 2020 and April to June 2021)

Sl. No.	***Common Name***	***Scientific Name/Order/Family***	***Crop Phenology***	***Feeding Site***
Insects pests				
1.	Maize stem borer	*Chilo partellus* (Swinhoe) (Lepidoptera : Crambidae)	Vegetative stage till harvest	Leaves, stems and tender parts of the plant
2.	Fall armyworm	*Spodoptera frugiperda* (Lepidoptera : Noctuidae)	Vegetative stage till harvest	Leaves, central whorl of the plant, cobs
3.	Maize aphid	*Rhopalosiphum maidis*(Hompotera : Aphididae)	Tasseling and cob formation stage	Leaves, tassels and cobs
Natural enemies				
Sl. No.	***Common Name***	***Scientific Name/Order/Family***	***Crop Phenology***	***Host range***
1.	Coccinellid beetles	*Coccinella* spp (Coleoptera: Coccinellidae)	Vegetative stage till harvest	Aphids and mealy bugs
2.	Zebra spider	*Salticusscenicus* (Araneae:Salticidae)	Vegetative stage till harvest	Caterpillars and beetles

seasonal incidence of major insect pests and their natural enemies are emphasized under the following heads:

4.2.1. Seasonal incidence of maize stem borer, *Chilo partellus* as leaf injury damage in different local maize cultivars during April to June 2020 and April to June 2021

The incidence of maize stem borer, *Chilo partellus* as leaf injury damage was observed from 15th standard week (*i.e.*, on 19th April) during April to June 2020 and 16th standard week (*i.e.*, on 26th April) during April to June 2021 as evident from the Table 4.2a & Table 4.2b and Fig. 4.1a & Fig. 4.1b which continued upto 23rd standard week *i.e.*, on 14th June. Among the cultivars, the leaf injury damage was first observed in Yempong Ngangching Local, Medziphema Local-1, Medziphema Local-2, Wokha Local-1 and Wokha Local-2 with 3.33% infestation each on the 15th standard week *i.e.*, on 19th April during 2020. But during the year 2021, the leaf injury damage wasfirst observed from the 16th standard week *i.e.*, on 26th April in most of the cultivars except the cultivars Shiyam Ngangching Local, Zarsi Socunoma Local, Phek Local-1 and Nmh-8352 in which the leaf injury damage was observed only from the 17th standard week *i.e.*, on 3rd May onwards. The maximum leaf injury damage was observed in the cultivars Khonoma Local and Khuzama Local with 20.00% infestation each on the 19th (*i.e.*, on 17th May) and 20th (*i.e.*, on 24th May) standard week during 2020 and 2021, respectively. On the 21st standard week *i.e.*, on 31st May the leaf injury damage was observed in cultivar Medziphema Local-1 with 16.67% and 13.33% infestation during 2020 and 2021, respectively while the minimum leaf injury damage was observed in the cultivars Shiyam Ngangching Local, Yang Leng Ngangching Local, Watak Ngangching Local, Medziphema Local-2, Zarsi Socunoma Local and Wokha Local-2 with 3.33% infestation each in both the years.

Overall the maximum leaf injury damage was observed in cultivar Medziphema Local-1 with 8.67% and 8.00% infestation and the least incidence

Table 4.2a: Seasonal incidence of maize stem borer, *Chilo partellus* as leaf injury infestation recorded during April to June 2020 on different local maize cultivars

Cultivars	Maize stem borer, *Chilo partellus* as leaf injury infestation (%)										
	Mean standard week										***Overall mean***
	14	***15***	***16***	***17***	***18***	***19***	***20***	***21***	***22***	***23***	
	12th April 20	***19th April 20***	***26h April 20***	***3rd May 20***	***10th May 20***	***17th May 20***	***24th May 20***	***31th May 20***	***07th June 20***	***14th June 20***	
C_1: Shiyam Ngangching Local	0.00	0.00	3.33	3.33	6.67	10.00	6.67	3.33	0.00	0.00	***3.33***
C_2: Yang Leng Ngangching Local	0.00	0.00	3.33	6.67	6.67	10.00	6.67	3.33	3.33	0.00	***4.00***
C_3: Yempong Ngangching Local	0.00	3.33	3.33	6.67	6.67	16.67	13.33	6.67	3.33	0.00	***6.00***
C_4: Watak Ngangching Local	0.00	0.00	3.33	3.33	6.67	10.00	6.67	6.67	3.33	0.00	***4.00***
C_5: Chiechama Local	0.00	0.00	3.33	6.67	6.67	6.67	10.00	6.67	3.33	0.00	***4.33***
C_6: Khonoma Local	0.00	0.00	3.33	6.67	16.67	20.00	16.67	6.67	3.33	3.33	***7.67***
C_7: Khuzama Local	0.00	0.00	3.33	6.67	16.67	20.00	16.67	10.00	6.67	3.33	***8.33***
C_8: Medziphema Local-1	0.00	3.33	3.33	6.67	10.00	16.67	20.00	16.67	6.67	3.33	***8.67***
C_9: Medziphema Local-2	0.00	3.30	3.33	6.67	10.00	16.67	6.67	3.33	3.33	0.00	***5.33***
C_{10}: Zarsi Socunoma Local	0.00	0.00	0.00	3.33	6.67	6.67	10.00	3.33	0.00	0.00	***3.00***
C_{11}: Phek Local-1	0.00	0.00	3.33	3.33	6.67	10.00	13.33	6.67	3.33	0.00	***4.67***
C_{12}: Phek Local-2	0.00	0.00	3.33	6.67	10.00	16.67	20.00	6.67	3.33	0.00	***6.67***
C_{13}: Wokha Local-1	0.00	3.33	3.33	6.67	10.00	16.67	20.00	6.67	3.33	0.00	***7.00***
C_{14}: Wokha Local-2	0.00	3.33	6.67	6.67	10.00	16.67	6.67	3.33	3.33	0.00	***5.67***
C_{15}: Nmh-8352 (Hybrid)	0.00	0.00	3.33	6.67	6.67	10.00	16.67	6.67	3.33	0.00	***5.33***
SEm±	-	***0.04***	***0.05***	***0.10***	***0.13***	***0.19***	***0.20***	***0.10***	***0.06***	***0.02***	-
CD (P=0.05)	-	***0.11***	***0.15***	***0.30***	***0.38***	***0.56***	***0.57***	***0.28***	***0.18***	***0.07***	-

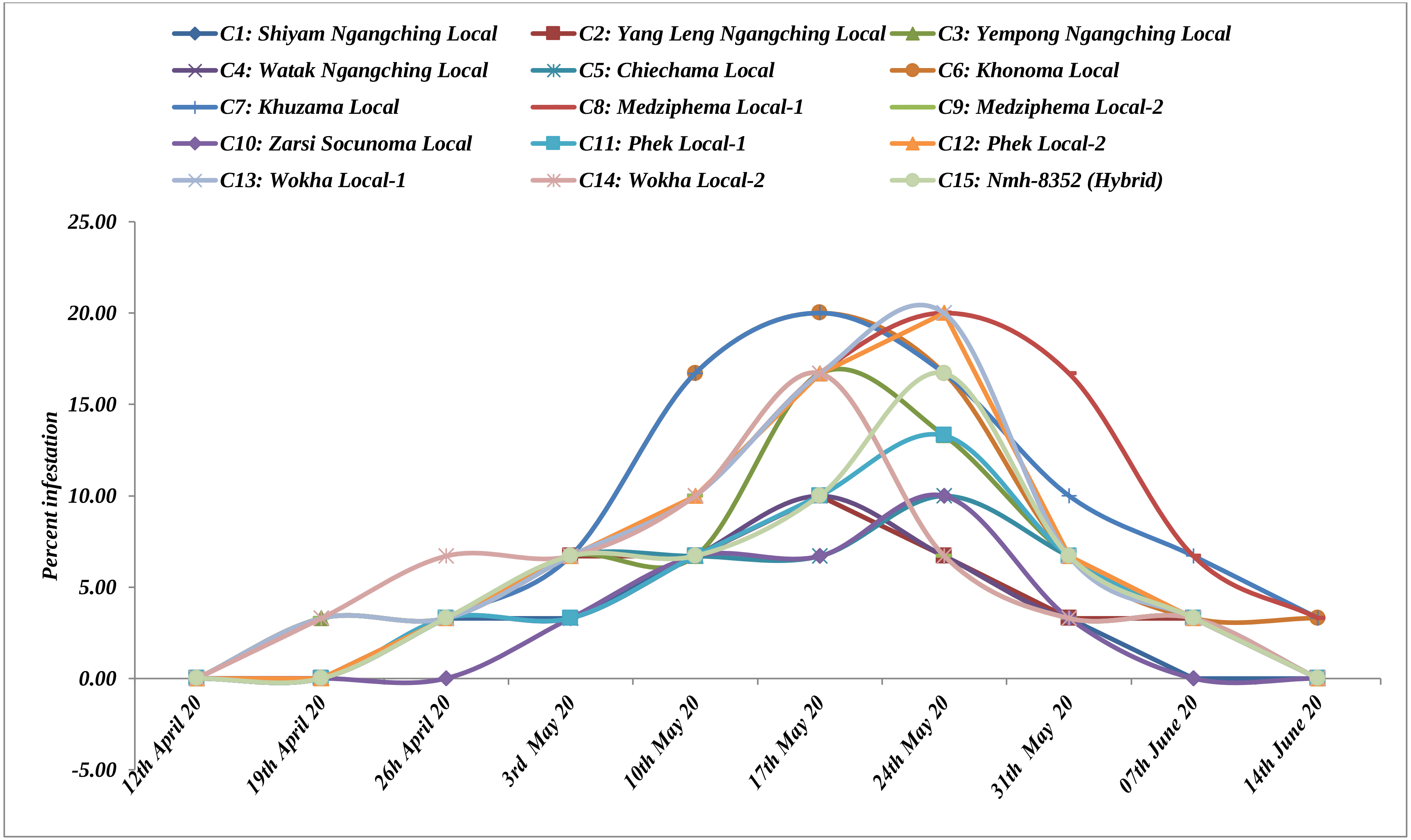

Fig 4.1a: Seasonal incidence of maize stem borer, *Chilo partellus* as leaf injury damage in different local maize cultivars during April to June 2020

Table 4.2b: Seasonal incidence of maize stem borer, *Chilo partellus* as leaf injury infestation recorded during April to June 2021 on different local maize cultivars

Cultivars	Maize stem borer, *Chilo partellus* as leaf injury infestation (%)										
	Mean standard week										***Overall mean***
	14	***15***	***16***	***17***	***18***	***19***	***20***	***21***	***22***	***23***	
	12th April 21	***19th April 21***	***26h April 21***	***3rd May 21***	***10th May 21***	***17th May 21***	***24th May 21***	***31th May 21***	***07th June 21***	***14th June 21***	
C_1: Shiyam Ngangching Local	0.00	0.00	0.00	3.33	6.67	10.00	6.67	3.33	0.00	0.00	***3.00***
C_2: Yang Leng Ngangching Local	0.00	0.00	3.33	3.33	6.67	10.00	6.67	3.33	0.00	0.00	***3.33***
C_3: Yempong Ngangching Local	0.00	0.00	3.33	3.33	6.67	16.67	10.00	6.67	3.33	0.00	***5.00***
C_4: Watak Ngangching Local	0.00	0.00	3.33	3.33	6.67	10.00	6.67	3.33	0.00	0.00	***3.33***
C_5: Chiechama Local	0.00	0.00	3.33	3.33	6.67	10.00	6.67	3.33	3.33	0.00	***3.67***
C_6: Khonoma Local	0.00	0.00	3.33	6.67	10.00	16.67	13.33	6.67	3.33	3.33	***6.33***
C_7: Khuzama Local	0.00	0.00	3.33	6.67	13.33	16.67	20.00	6.67	3.33	3.33	***7.33***
C_8: Medziphema Local-1	0.00	0.00	3.33	6.67	10.00	16.67	20.00	13.33	6.67	3.33	***8.00***
C_9: Medziphema Local-2	0.00	0.00	3.33	6.67	6.67	10.00	6.67	3.33	3.33	0.00	***4.00***
C_{10}: Zarsi Socunoma Local	0.00	0.00	0.00	3.33	6.67	10.00	3.33	3.33	0.00	0.00	***2.67***
C_{11}: Phek Local-1	0.00	0.00	0.00	3.33	6.67	10.00	10.00	6.67	3.33	0.00	***4.00***
C_{12}: Phek Local-2	0.00	0.00	3.33	6.67	10.00	16.67	13.33	6.67	3.33	0.00	***6.00***
C_{13}: Wokha Local-1	0.00	0.00	3.33	6.67	10.00	20.00	13.33	6.67	3.33	0.00	***6.33***
C_{14}: Wokha Local-2	0.00	0.00	3.33	6.67	10.00	16.67	6.67	3.33	3.33	0.00	***5.00***
C_{15}: Nmh-8352 (Hybrid)	0.00	0.00	0.00	3.33	6.67	10.00	16.67	6.67	3.33	0.00	***4.67***
SEm±	-	-	***0.05***	***0.08***	***0.13***	***0.17***	***0.17***	***0.06***	***0.05***	***0.02***	-
CD (P=0.05)	-	-	***0.14***	***0.24***	***0.38***	***0.50***	***0.50***	***0.18***	***0.13***	***0.05***	-

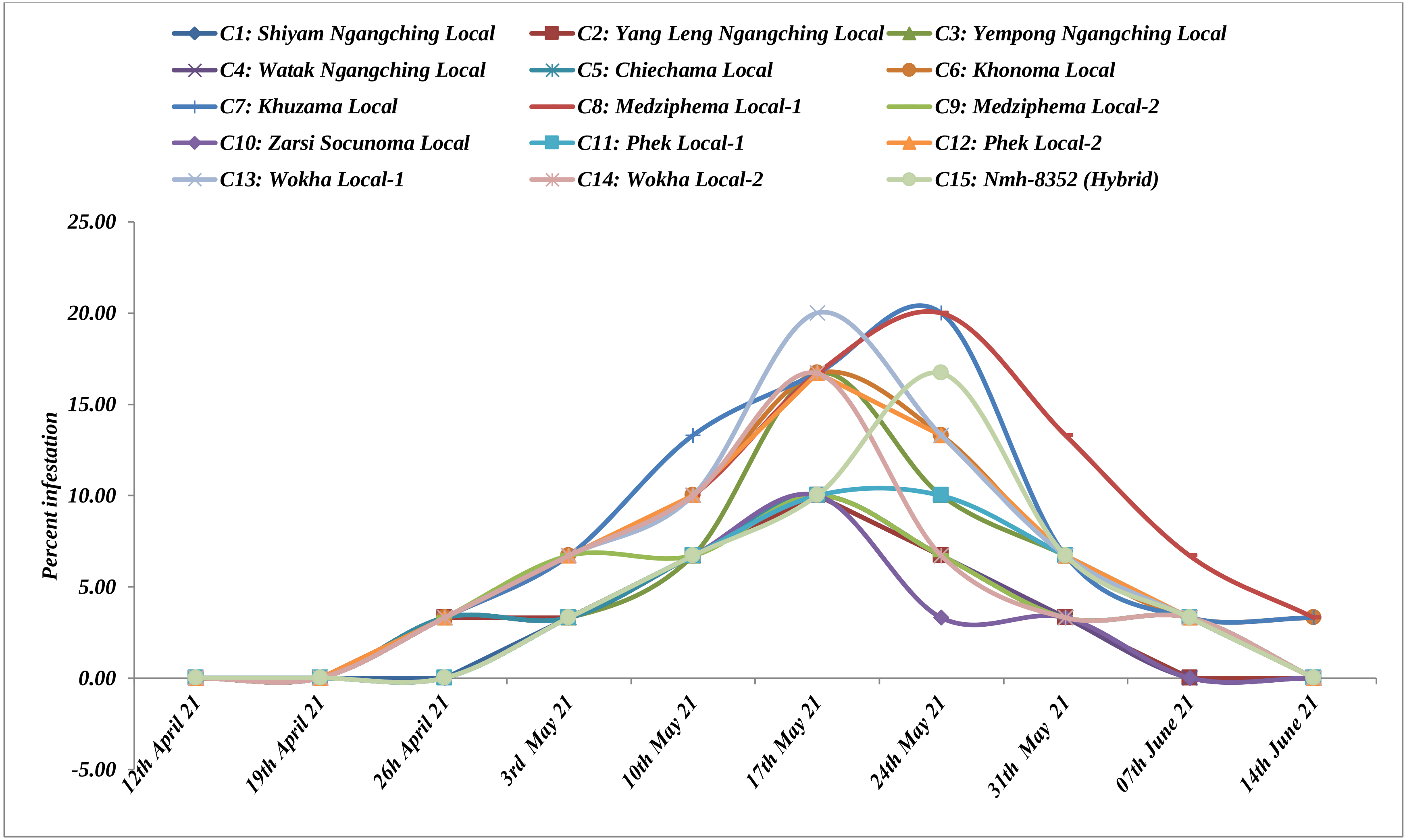

Fig 4.1b: Seasonal incidence of maize stem borer, *Chilo partellus* as leaf injury damage in different local maize cultivars during April to June 2021

of leaf injury damage was observed in cultivar Zarsi Socunoma Local with 3.00% and 2.67% infestation during 2020 and 2021, respectively.

Similar findings were reported by Hamid*et al.* (2019) who observed that on the 21st standard week the leaf injury damage by *C. partellus* was recorded with 17.60% infestation. The results are also in conformity with the findings of Achhami*et al.* (2015) who reported that the leaf injury damage was observed during the month of May with 11.23% infestation which was closely related with the present findings. The results are further supported by Behera*et al.* (2019) who found that the maximum leaf injury damage by *C. partellus* was on variety Vivek QPM-9 with 24.20% and 22.57% infestation at 45 days after sowing during 2014 and 2015, respectively.

4.2.2. Seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts damage in different local maize cultivars during April to June 2020 and April to June 2021

The incidence of maize stem borer**,** *Chilo partellus* as dead hearts damage was observed from 17th standard week *i.e.*, on 3rd May in both the years as evident from the Table 4.3a & Table 4.3b and Fig. 4.2a & Fig. 4.2b which continued upto 23rd standard week *i.e.*, on 14th June. On the 17th standard week *i.e.*, on 3rd May the maximum dead hearts damage was observed in most of the cultivars with 5.58% infestation each while the cultivars Shiyam Ngangching Local, Watak Ngangching Local, Chiechama Local, Zarsi Socunoma Local and Phek Local-1 showed the minimum dead hearts damage with 2.75% infestation each during 2020 and 2021, respectively. The maximum dead hearts damage was observed on the 23rd standard week *i.e.*, on 14th June in cultivars Khonoma Local and Medziphema Local-1 with 27.75% infestation each while the minimum dead hearts damage was observed in Zarsi Socunoma Local with 13.93% infestation during 2020. But during the year 2021, the maximum dead hearts damage was also observed on the 23rd standard week *i.e.*, on 14th June in the cultivars Yempong Ngangching Local, Khonoma

Table 4.3a: Seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts infestation recorded during April to June 2020 on different local maize cultivars

Cultivars	Maize stem borer, *Chilo partellus* as dead hearts infestation (%)										
	Mean standard week										*Overall mean*
	14	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	
	12th April 20	*19th April 20*	*26h April 20*	*3rd May 20*	*10th May 20*	*17th May 20*	*24th May 20*	*31th May 20*	*07th June 20*	*14th June 20*	
C_1: Shiyam Ngangching Local	0.00	0.00	0.00	2.75	5.67	8.33	11.07	13.93	16.67	16.67	***7.51***
C_2: Yang Leng Ngangching Local	0.00	0.00	0.00	5.67	8.33	11.07	13.93	13.93	16.67	19.43	***8.90***
C_3: Yempong Ngangching Local	0.00	0.00	0.00	5.67	8.33	11.07	13.93	16.67	22.25	25.00	***10.29***
C_4: Watak Ngangching Local	0.00	0.00	0.00	2.65	5.67	8.33	13.93	16.67	16.67	19.43	***8.34***
C_5: Chiechama Local	0.00	0.00	0.00	5.67	5.67	8.33	11.07	13.93	16.67	22.25	***8.36***
C_6: Khonoma Local	0.00	0.00	0.00	5.67	13.93	13.93	16.67	19.43	22.25	27.75	***11.96***
C_7: Khuzama Local	0.00	0.00	0.00	5.67	13.93	16.67	19.43	19.43	22.25	25.00	***12.23***
C_8: Medziphema Local-1	0.00	0.00	0.00	5.67	11.07	13.93	16.67	22.25	25.00	27.75	***12.23***
C_9: Medziphema Local-2	0.00	0.00	0.00	5.67	8.33	13.93	16.67	22.25	25.00	25.00	***11.69***
C_{10}: Zarsi Socunoma Local	0.00	0.00	0.00	2.65	5.67	5.67	8.33	11.07	11.07	13.93	***5.84***
C_{11}: Phek Local-1	0.00	0.00	0.00	2.65	5.67	13.93	13.93	16.67	19.43	22.25	***9.45***
C_{12}: Phek Local-2	0.00	0.00	0.00	5.67	8.33	13.93	16.67	16.67	22.25	25.00	***10.85***
C_{13}: Wokha Local-1	0.00	0.00	0.00	5.67	8.33	13.93	16.67	22.25	22.25	25.00	***11.41***
C_{14}: Wokha Local-2	0.00	0.00	0.00	5.67	8.33	13.93	13.93	19.43	19.43	22.25	***10.30***
C_{15}: Nmh-8352 (Hybrid)	0.00	0.00	0.00	5.67	8.33	13.93	13.93	16.67	19.43	22.25	***10.02***
SEm±	-	-	-	***0.07***	***0.11***	***0.18***	***0.24***	***0.29***	***0.34***	***0.34***	-
CD (P=0.05)	-	-	-	***0.21***	***0.33***	***0.52***	***0.69***	***0.85***	***0.99***	***0.99***	-

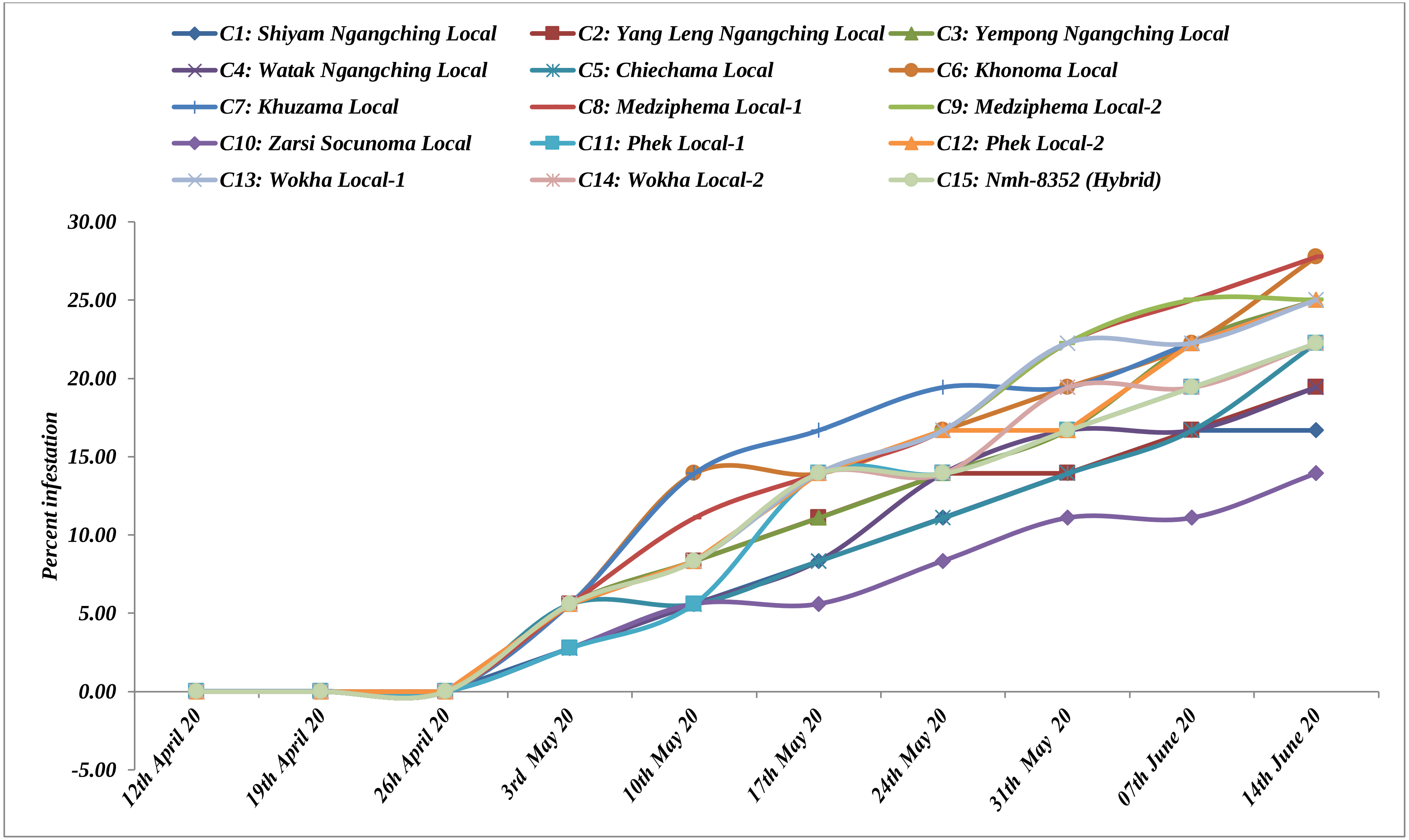

Fig 4.2a: Seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts damage in different local maize cultivars during April to June 2020

Table 4.3b: Seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts infestation recorded during April to June 2021 on different local maize cultivars

Cultivars	**Maize stem borer, *Chilo partellus* as dead hearts infestation (%)**										
	Mean standard week										***Overall mean***
	14	***15***	***16***	***17***	***18***	***19***	***20***	***21***	***22***	***23***	
	12th April 21	***19th April 21***	***26h April 21***	***3rd May 21***	***10th May 21***	***17th May 21***	***24th May 21***	***31th May 21***	***07th June 21***	***14th June 21***	
C_1: Shiyam Ngangching Local	0.00	0.00	0.00	2.75	2.75	5.67	8.33	11.07	13.93	16.67	***6.12***
C_2: Yang Leng Ngangching Local	0.00	0.00	0.00	5.67	8.33	8.33	13.93	13.93	16.67	16.67	***8.35***
C_3: Yempong Ngangching Local	0.00	0.00	0.00	5.67	8.33	8.33	13.93	16.67	22.25	22.25	***9.74***
C_4: Watak Ngangching Local	0.00	0.00	0.00	2.75	5.67	8.33	13.93	13.93	16.67	16.67	***7.80***
C_5: Chiechama Local	0.00	0.00	0.00	2.75	5.67	8.33	11.07	13.93	16.67	16.67	***7.51***
C_6: Khonoma Local	0.00	0.00	0.00	5.67	8.33	13.93	16.67	19.43	22.25	22.25	***10.85***
C_7: Khuzama Local	0.00	0.00	0.00	5.67	13.93	16.67	16.67	19.43	22.25	22.25	***11.69***
C_8: Medziphema Local-1	0.00	0.00	0.00	5.67	11.07	11.07	16.67	16.67	22.25	22.25	***10.57***
C_9: Medziphema Local-2	0.00	0.00	0.00	5.67	8.33	11.07	13.93	16.67	22.17	22.25	***10.01***
C_{10}: Zarsi Socunoma Local	0.00	0.00	0.00	2.75	2.75	5.67	8.33	8.33	11.07	13.93	***5.27***
C_{11}: Phek Local-1	0.00	0.00	0.00	2.75	5.67	13.93	13.93	16.67	16.67	19.43	***8.91***
C_{12}: Phek Local-2	0.00	0.00	0.00	5.67	8.33	8.33	13.93	16.67	19.43	22.25	***9.46***
C_{13}: Wokha Local-1	0.00	0.00	0.00	5.67	8.33	11.07	13.93	16.67	22.25	22.25	***10.02***
C_{14}: Wokha Local-2	0.00	0.00	0.00	5.67	8.33	8.33	13.93	16.67	19.43	19.43	***9.18***
C_{15}: Nmh-8352 (Hybrid)	0.00	0.00	0.00	5.67	5.67	8.33	13.93	13.93	16.67	22.25	***8.65***
SEm±	-	-	-	***0.07***	***0.11***	***0.14***	***0.19***	***0.25***	***0.23***	***0.31***	-
CD (P=0.05)	-	-	-	***0.22***	***0.32***	***0.40***	***0.56***	***0.72***	***0.68***	***0.90***	-

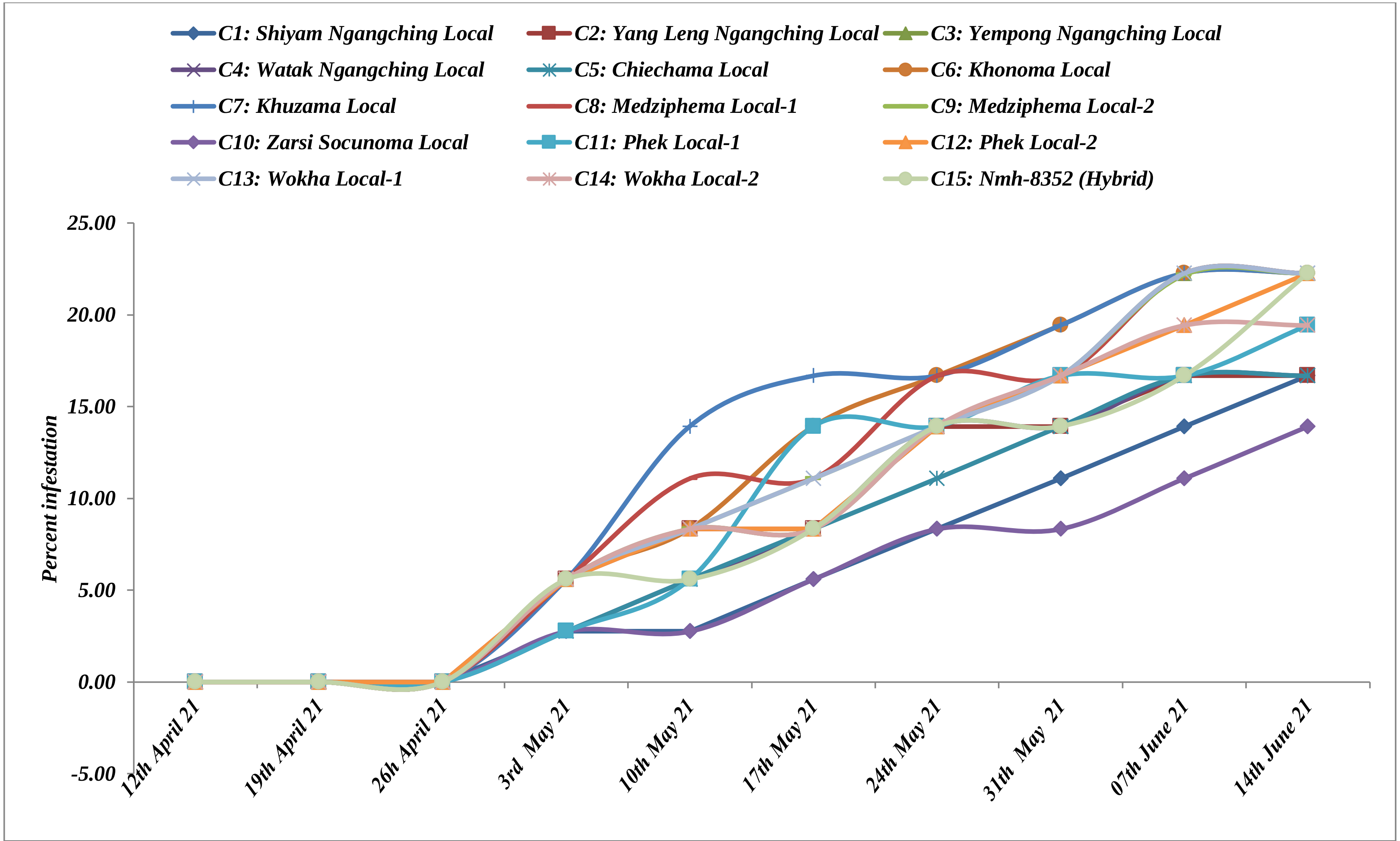

Fig 4.2b: Seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts damage in different local maize cultivars during April to June 2021

Local, Khuzama Local, Medziphema Local-1, Medziphema Local-2, Phek Local-2, Wokha Local-1 and Nmh-8352 with 22.25% infestation each while the minimum dead hearts damage was observed in cultivar Zarsi Socunoma Local with 13.93% infestation.

Overall the maximum dead hearts damage was observed in the cultivars Khuzama Local and Medziphema Local-1 with 12.23% infestation each and the least dead hearts damage was observed in cultivar Zarsi Socunoma Local with 5.84% infestation during 2020. While during the year 2021, the overall maximum dead hearts damage was observed in cultivar Khuzama Local with 11.69% infestation and the minimum dead hearts damage was observed in cultivar Zarsi Socunoma Local with 5.27% infestation.

Similar findings were reported by Hamid*et al.* (2019) who observed that on the 23rd standard week the dead hearts damage by *C. partellus* was recorded with 24.92% infestation which was closely related with the present findings. The results are also in conformity with the findings of Behera*et al.* (2019) who found that the maximum dead hearts damage by *C. partellus* was on variety HQPM-1 with 25.67% and 25.60% during 2014 and 2015, respectively. The results are further supported by Dhaliwal*et al.* (2018) who found that the maximum dead hearts damage by *C. partellus* was on the last week of June with 15.42% and 16.27% infestation during 2013 and 2014, respectively.

4.2.3. Seasonal incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage in different local maize cultivars during April to June 2020 and April to June 2021

The incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage was observed from 14th standard week *i.e.*, on 12th April during both the years as evident from the Table 4.4a & Table 4.4b and Fig. 4.3a & Fig. 4.3b which continued upto 23rd standard week. During the first year experiment *i.e.*, during 2020, on the 14th standard week *i.e.*, on 12th April the maximum leaf whorls damage was observed in the cultivars Medziphema Local-1 and Phek

Local-1 with 21.65% infestation each followed by the cultivars Khuzama Local, Khonoma Local, Wokha Local-1, Yempong Ngangching Local, Yang Leng Ngangching Local and Phek Local-2 with 20.00%, 13.35%, 13.35%, 10.00%, 8.35% and 6.65%, respectively. On the 15th standard week *i.e*., on 19th April the maximum leaf whorls damage was observed in cultivar Khuzama Local with 36.65% infestation and the minimum leaf whorls damage was observed in the cultivars Shiyam Ngangching Local, Watak Ngangching Local, Chiechama Local, Medziphema Local-2 and Phek Local-2 with 8.35% infestation each. On the 16th standard week *i.e*., on 26th April the maximum leaf whorls damage was observed in cultivar Medziphema Local-1 with 31.65% infestation and the minimum leaf whorls damage was observed incultivar Zarsi Socunoma Local with 6.65% infestation. From the 18th standard week *i.e*., on 10th May onwards the percentage of leaf whorls damage was reduced in all the cultivars and on the 23rd standard week *i.e*., on 14th June the leaf whorls damage was reduced to 0.00% in most of the cultivars except in cultivar Nmh-8352 with leaf whorls damage of 1.65% infestation. Overall the maximum leaf whorls damage was observed in cultivar Medziphema Local-1 with 13.83% infestation followed by cultivar Khuzama Local with 11.17% infestation and the least leaf whorls damage was observed in cultivar Zarsi Socunoma Local with 2.83% infestation during 2020.

During the second year experiment *i.e*., during 2021, on the 14th standard week *i.e*., on 12th April the maximum leaf whorls damage was observed in cultivar Khuzama Local with 25.00% infestation followed by the cultivars Medziphema Local-1, Phek Local-2 (20.00% each), Medziphema Local-2 and Wokha Local-1 (15.00% each) and the minimum leaf whorls damage was observed in cultivar Yang Leng Ngangching Local with 3.35% infestation. On the 15th standard week *i.e*., on 19th April the maximum leafwhorls damage was observed in cultivar Medziphema Local-1 with 14.00% infestation followed by cultivar Khuzama Local with 13.84% infestation and

Table 4.4.a: Seasonal incidence of fall armyworm, *Spodoptera fugiperda* as leaf whorls damage recorded during April to June 2020 on different local maize cultivars

Cultivars	**Fall armyworm, *Spodoptera fugiperda*as leaf whorls damage (%)**										
	Mean standard week										***Overall mean***
	14	***15***	***16***	***17***	***18***	***19***	***20***	***21***	***22***	***23***	
	12th April 20	***19th April 20***	***26h April 20***	***3rd May 20***	***10th May 20***	***17th May 20***	***24th May 20***	***31th May 20***	***07th June 20***	***14th June 20***	
C_1: Shiyam Ngangching Local	5.00	8.35	13.35	10.00	6.65	3.35	0.00	0.00	0.00	0.00	***4.67***
C_2: Yang Leng Ngangching Local	8.35	10.00	11.65	9.35	6.65	5.00	3.35	1.65	0.00	0.00	***5.60***
C_3: Yempong Ngangching Local	10.00	15.00	16.65	10.00	9.35	5.00	3.35	1.65	0.00	0.00	***7.10***
C_4: Watak Ngangching Local	5.00	8.35	10.00	9.35	8.35	5.00	4.35	3.35	1.65	0.00	***5.54***
C_5: Chiechama Local	5.00	8.35	16.65	10.00	8.35	5.00	3.35	1.65	0.00	0.00	***5.84***
C_6: Khonoma Local	13.35	23.35	20.00	15.00	11.65	8.35	3.35	1.65	0.00	0.00	***9.67***
C_7: Khuzama Local	20.00	36.65	23.35	13.35	8.35	5.00	3.35	1.65	0.00	0.00	***11.17***
C_8: Medziphema Local-1	21.65	25.00	31.65	20.00	15.00	11.65	8.35	3.35	1.65	0.00	***13.83***
C_9: Medziphema Local-2	5.00	8.35	15.00	18.35	13.35	8.35	6.65	5.00	1.65	0.00	***8.17***
C_{10}: Zarsi Socunoma Local	5.00	11.65	6.65	3.35	1.65	0.00	0.00	0.00	0.00	0.00	***2.83***
C_{11}: Phek Local-1	21.65	15.00	11.65	8.35	3.35	1.65	0.00	0.00	0.00	0.00	***6.17***
C_{12}: Phek Local-2	6.65	8.35	13.35	15.00	11.65	9.35	5.00	3.35	1.65	0.00	***7.44***
C_{13}: Wokha Local-1	13.35	20.00	16.65	15.00	13.35	8.35	3.35	1.65	0.00	0.00	***9.17***
C_{14}: Wokha Local-2	5.00	9.35	11.65	15.00	10.00	9.35	5.00	3.35	1.65	0.00	***7.04***
C_{15}: Nmh-8352 (Hybrid)	5.00	9.35	10.00	11.65	10.00	6.65	5.00	4.35	3.35	1.65	***6.70***
SEm±	***0.13***	***0.21***	***0.22***	***0.20***	***0.17***	***0.14***	***0.06***	***0.04***	***0.02***	***0.01***	***-***
CD (P=0.05)	***0.37***	***0.61***	***0.65***	***0.59***	***0.50***	***0.40***	***0.18***	***0.13***	***0.06***	***0.03***	***-***

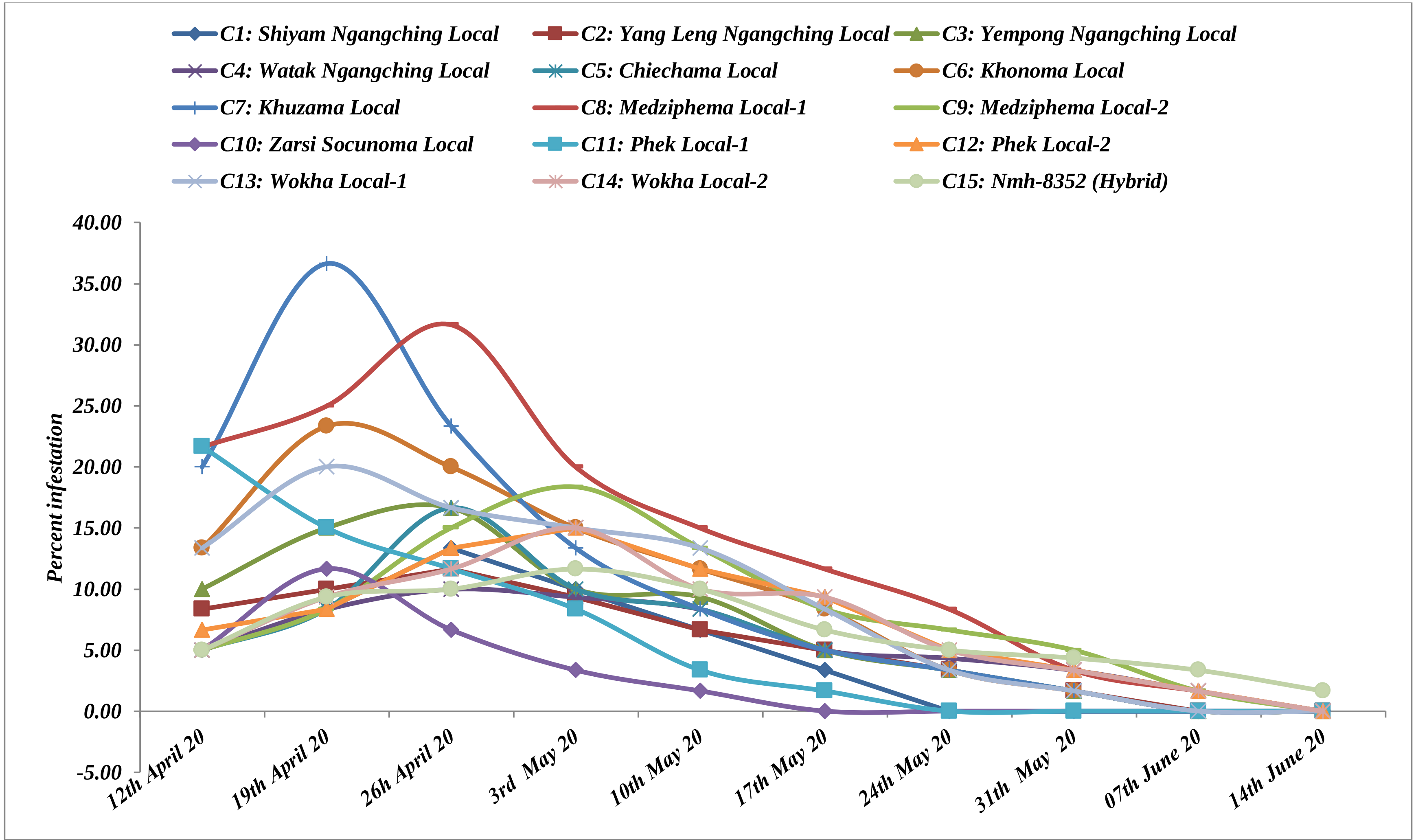

Fig 4.3a: Seasonal incidence of fall armyworm, *Spodoptera frugiperda* as whorls damage in different local maize cultivars during April to June 2020

Table 4.4b: Seasonal incidence of fall armyworm, *Spodoptera fugiperda* as leaf whorls damage recorded during April to June 2021 on different local maize cultivars

Cultivars	**Fall armyworm, *Spodoptera fugiperda*as leaf whorls damage (%)**										
	Mean standard week										***Overall mean***
	14	***15***	***16***	***17***	***18***	***19***	***20***	***21***	***22***	***23***	
	12th April 21	***19th April 21***	***26h April 21***	***3rd May 21***	***10th May 21***	***17th May 21***	***24th May 21***	***31th May 21***	***07th June 21***	***14th June 21***	
C_1: Shiyam Ngangching Local	5.00	8.35	10.00	6.65	3.35	1.65	1.65	0.00	0.00	0.00	***3.67***
C_2: Yang Leng Ngangching Local	3.35	8.35	10.00	9.35	8.35	5.00	4.35	3.35	1.65	1.65	***5.54***
C_3: Yempong Ngangching Local	5.00	9.35	11.65	13.35	10.00	9.35	5.00	3.35	1.65	1.65	***7.04***
C_4: Watak Ngangching Local	5.00	8.35	10.00	9.35	6.65	5.00	3.35	1.65	0.00	0.00	***4.94***
C_5: Chiechama Local	5.00	8.35	10.00	11.65	8.35	5.00	4.35	3.35	1.65	0.00	***5.77***
C_6: Khonoma Local	3.35	10.00	18.35	21.65	13.35	8.35	6.65	5.00	3.35	1.65	***9.17***
C_7: Khuzama Local	25.00	33.35	25.00	18.35	13.35	10.00	6.65	3.35	1.65	1.65	***13.84***
C_8: Medziphema Local-1	20.00	26.65	31.65	20.00	15.00	11.65	8.35	3.35	1.65	1.65	***14.00***
C_9: Medziphema Local-2	15.00	20.00	16.65	15.00	13.35	8.35	3.35	1.65	1.65	0.00	***9.50***
C_{10}: Zarsi Socunoma Local	5.00	10.00	8.35	3.35	1.65	1.65	0.00	0.00	0.00	0.00	***3.00***
C_{11}: Phek Local-1	5.00	8.35	10.00	13.35	11.65	5.00	3.35	1.65	0.00	0.00	***5.84***
C_{12}: Phek Local-2	20.00	18.35	13.35	10.00	5.00	3.35	1.65	1.65	0.00	0.00	***7.34***
C_{13}: Wokha Local-1	15.00	23.35	20.00	15.00	11.65	8.35	3.35	1.65	0.00	0.00	***9.84***
C_{14}: Wokha Local-2	8.35	13.35	15.00	8.35	6.65	5.00	3.35	1.65	0.00	0.00	***6.17***
C_{15}: Nmh-8352 (Hybrid)	5.00	10.00	16.65	10.00	8.35	5.00	3.35	1.65	0.00	0.00	***6.00***
SEm±	***0.11***	***0.26***	***0.25***	***0.21***	***0.15***	***0.08***	***0.07***	***0.03***	***0.03***	***0.01***	**-**
CD (P=0.05)	***0.31***	***0.76***	***0.73***	***0.61***	***0.44***	***0.24***	***0.21***	***0.08***	***0.08***	***0.03***	**-**

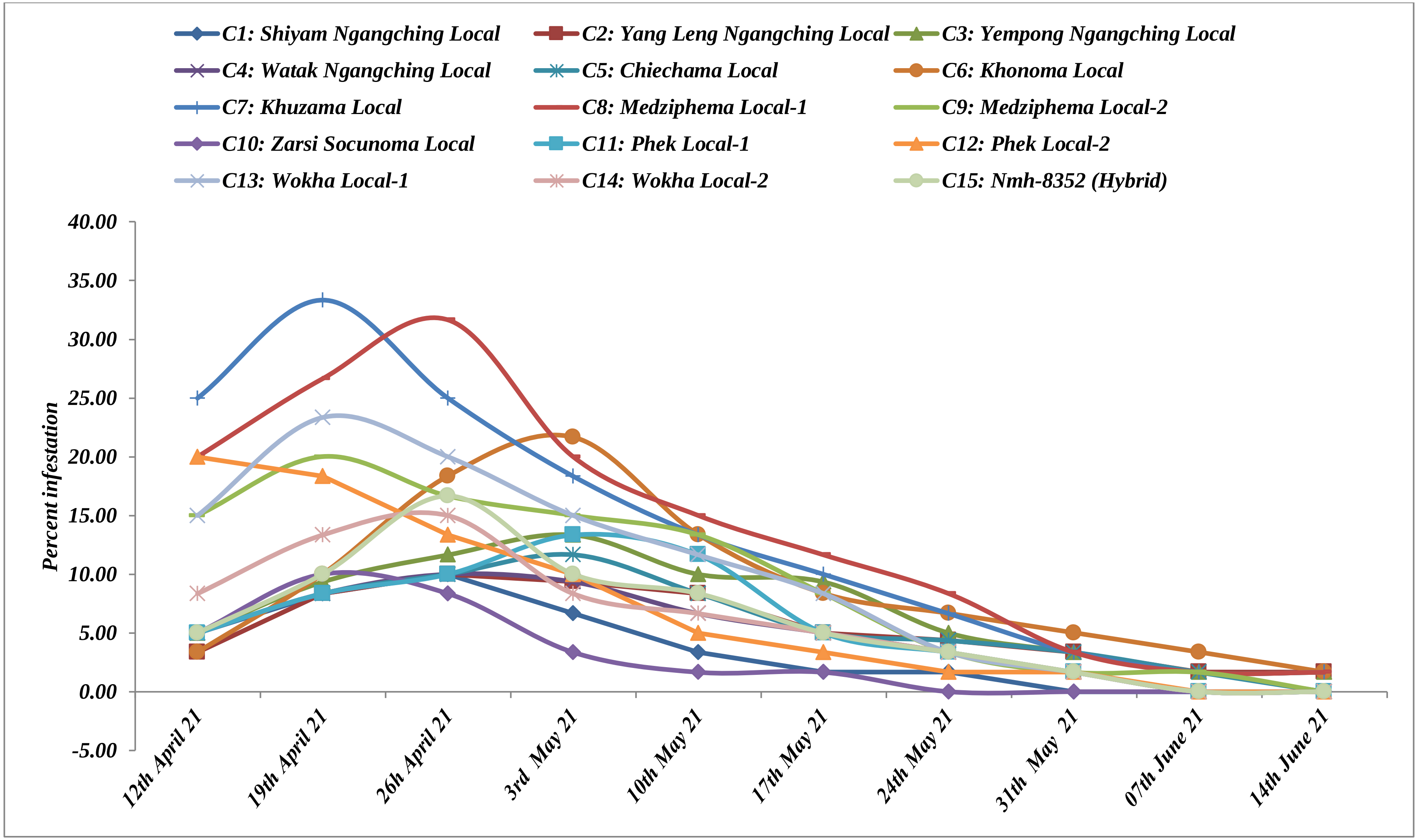

Fig 4.3b: Seasonal incidence of fall armyworm, *Spodoptera frugiperda* as whorls damage in different local maize cultivars during April to June 2021

the least leaf whorls damage was observed in cultivar Zarsi Socunoma Localwith 3.00% infestation during 2021.

Similar findings were reported by Darshan and Prasnna (2022) who observed that the leaf whorls damage by *S. frugiperda* ranged between 23.10% to 33.77% infestation which was closely related with the present findings. The results are further supported by Nivetha *et al.* (2022) who found that on the 16th standard week of 2020 the leaf whorls damage by *S. frugiperda* was 31.00% infestation which was in accordance with the present findings.

4.2.4. Seasonal incidence of coccinellid beetles, *Coccinella* spp. in different local maize cultivars during April to June 2020 and April to June 2021

The incidence of coccinellid beetles species was observed from 16th standard week *i.e*., on 26th April onwards and continued upto 23rd standard week *i.e*., on 14th June in both the years as evident from the Table 4.5a & Table 4.5b and Fig. 4.4a & Fig. 4.4b. On the 16th standard week *i.e*., on 26th April the highest population of coccinellid beetles was observed in cultivar Zarsi Socunoma Local with 0.87 and 0.97 beetles per plant while the lowest population was in the cultivars Khuzama Local and Medziphema Local-1 with 0.20 and 0.20 beetles per plant during 2020 and 2021, respectively. Similarly on the 17th standard week *i.e*., on 3rd May the highest population of coccinellid beetles was observed in cultivar Zarsi Socunoma Local with 1.07 beetles per plant each in both the years while the lowest population was in the cultivars Khuzama Local and Medziphema Local-1 with 0.33 and 0.33 beetles per plant during 2020 and 2021, respectively. The abundance of the coccinellid beetles increased with the crop age with corresponding to the pest population and the peak population of coccinellid beetles was observed on the 21st standard week *i.e*., on 31st May in cultivar Zarsi Socunoma Local with 1.60 and 1.73 beetles per plant which was followed by Shiyam Ngangching Local with 1.53 and 1.53 beetles per plant while the lowest population was observed in cultivar

Table 4.5a: Seasonal incidence of coccinellid beetles, *Coccinella* spp. recorded during April to June 2020 on different local maize cultivars

Cultivars	**Seasonal incidence of coccinellid beetles, *Coccinella* spp.**										
	Mean standard week										***Overall mean***
	14	***15***	***16***	***17***	***18***	***19***	***20***	***21***	***22***	***23***	
	12^{th} April 20	***19^{th} April 20***	***26^{h} April 20***	***3^{rd} May 20***	***10^{th} May 20***	***17^{th} May 20***	***24^{th} May 20***	***31^{th} May 20***	***07^{th} June 20***	***14^{th} June 20***	
C_1: Shiyam Ngangching Local	0.00	0.00	0.80	1.00	1.13	1.27	1.47	1.53	1.20	1.00	***0.94***
C_2: Yang Leng Ngangching Local	0.00	0.00	0.60	0.73	0.87	1.00	1.20	1.33	1.00	0.87	***0.76***
C_3: Yempong Ngangching Local	0.00	0.00	0.40	0.53	0.73	0.87	1.00	1.13	0.87	0.80	***0.63***
C_4: Watak Ngangching Local	0.00	0.00	0.67	0.80	1.07	1.20	1.33	1.47	1.20	1.00	***0.87***
C_5: Chiechama Local	0.00	0.00	0.53	0.67	0.87	1.00	1.13	1.27	0.87	0.80	***0.71***
C_6: Khonoma Local	0.00	0.00	0.27	0.40	0.53	0.67	0.87	1.00	0.87	0.77	***0.54***
C_7: Khuzama Local	0.00	0.00	0.20	0.33	0.47	0.53	0.73	0.87	0.67	0.67	***0.45***
C_8: Medziphema Local-1	0.00	0.00	0.20	0.33	0.47	0.67	0.80	0.93	0.77	0.70	***0.49***
C_9: Medziphema Local-2	0.00	0.00	0.33	0.47	0.67	0.80	0.93	1.07	0.80	0.73	***0.58***
C_{10}: Zarsi Socunoma Local	0.00	0.00	0.87	1.07	1.33	1.47	1.60	1.60	1.43	1.20	***1.06***
C_{11}: Phek Local-1	0.00	0.00	0.53	0.67	0.80	0.93	1.07	1.20	1.00	0.87	***0.71***
C_{12}: Phek Local-2	0.00	0.00	0.40	0.53	0.67	0.80	0.93	1.07	0.80	0.73	***0.59***
C_{13}: Wokha Local-1	0.00	0.00	0.27	0.40	0.53	0.73	0.87	1.00	0.73	0.73	***0.52***
C_{14}: Wokha Local-2	0.00	0.00	0.40	0.53	0.67	0.80	0.87	1.00	0.73	0.67	***0.57***
C_{15}: Nmh-8352 (Hybrid)	0.00	0.00	0.47	0.67	0.80	0.87	1.00	1.07	0.80	0.70	***0.64***
SEm±	-	-	***0.006***	***0.010***	***0.015***	***0.015***	***0.012***	***0.016***	***0.016***	***0.012***	-
CD (P=0.05)	-	-	***0.016***	***0.030***	***0.043***	***0.042***	***0.036***	***0.047***	***0.045***	***0.035***	-

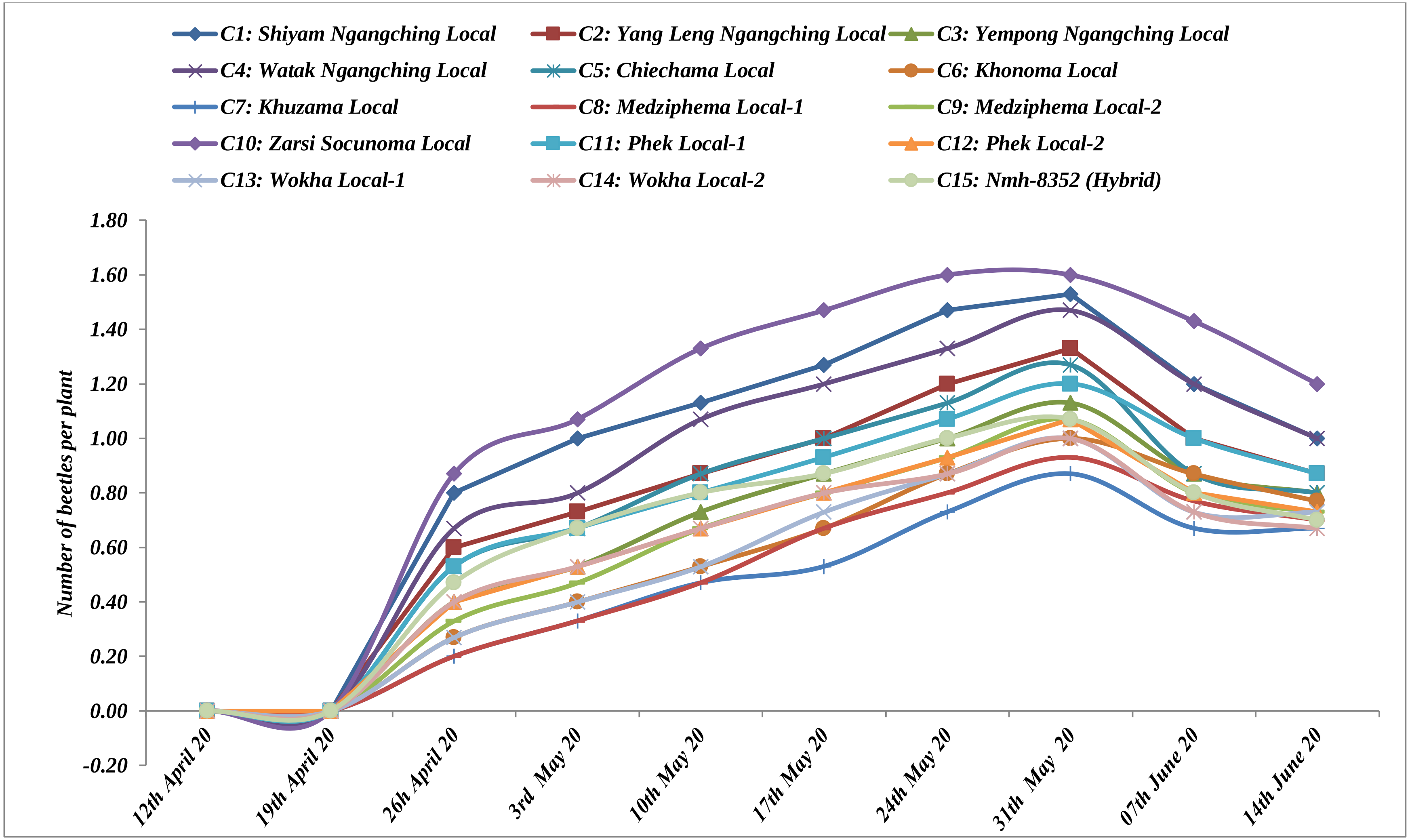

Fig 4.4a: Seasonal incidence of coccinellid beetles, *Coccinella* spp. in different local maize cultivars during April to June 2020

Table 4.5b: Seasonal incidence of coccinellid beetles, *Coccinella* spp. recorded during April to June 2021 on different local maize cultivars

Cultivars	**Seasonal incidence of coccinellid beetles, *Coccinella* spp.**										
	Mean standard week										***Overall mean***
	14	***15***	***16***	***17***	***18***	***19***	***20***	***21***	***22***	***23***	
	12th April 21	***19th April 21***	***26th April 21***	***3rd May 21***	***10th May 21***	***17th May 21***	***24th May 21***	***31th May 21***	***07th June 21***	***14th June 21***	
C_1: Shiyam Ngangching Local	0.00	0.00	0.93	1.00	1.13	1.33	1.47	1.53	1.20	1.13	***0.94***
C_2: Yang Leng Ngangching Local	0.00	0.00	0.73	0.87	1.00	1.13	1.27	1.33	1.13	1.00	***0.76***
C_3: Yempong Ngangching Local	0.00	0.00	0.40	0.53	0.73	0.87	1.00	1.13	1.00	0.87	***0.63***
C_4: Watak Ngangching Local	0.00	0.00	0.80	0.87	1.00	1.20	1.33	1.47	1.23	1.07	***0.87***
C_5: Chiechama Local	0.00	0.00	0.67	0.73	0.87	1.07	1.20	1.27	1.00	0.87	***0.71***
C_6: Khonoma Local	0.00	0.00	0.33	0.47	0.60	0.73	0.93	1.00	0.87	0.73	***0.54***
C_7: Khuzama Local	0.00	0.00	0.20	0.33	0.53	0.60	0.73	0.87	0.80	0.70	***0.45***
C_8: Medziphema Local-1	0.00	0.00	0.20	0.33	0.53	0.67	0.80	0.93	0.80	0.70	***0.49***
C_9: Medziphema Local-2	0.00	0.00	0.33	0.47	0.67	0.80	0.93	1.07	0.97	0.93	***0.58***
C_{10}: Zarsi Socunoma Local	0.00	0.00	0.97	1.07	1.33	1.47	1.60	1.73	1.40	1.20	***1.06***
C_{11}: Phek Local-1	0.00	0.00	0.67	0.80	0.93	1.07	1.20	1.33	1.13	1.00	***0.71***
C_{12}: Phek Local-2	0.00	0.00	0.47	0.53	0.67	0.80	0.93	1.07	1.00	0.87	***0.59***
C_{13}: Wokha Local-1	0.00	0.00	0.40	0.53	0.67	0.80	0.87	1.00	0.87	0.73	***0.52***
C_{14}: Wokha Local-2	0.00	0.00	0.47	0.53	0.67	0.80	0.93	1.00	0.87	0.70	***0.57***
C_{15}: Nmh-8352 (Hybrid)	0.00	0.00	0.53	0.67	0.80	0.93	1.07	1.13	1.00	0.87	***0.64***
SEm±	-	-	***0.005***	***0.011***	***0.016***	***0.014***	***0.015***	***0.017***	***0.016***	***0.011***	-
CD (P=0.05)	-	-	***0.015***	***0.031***	***0.047***	***0.040***	***0.044***	***0.051***	***0.046***	***0.033***	-

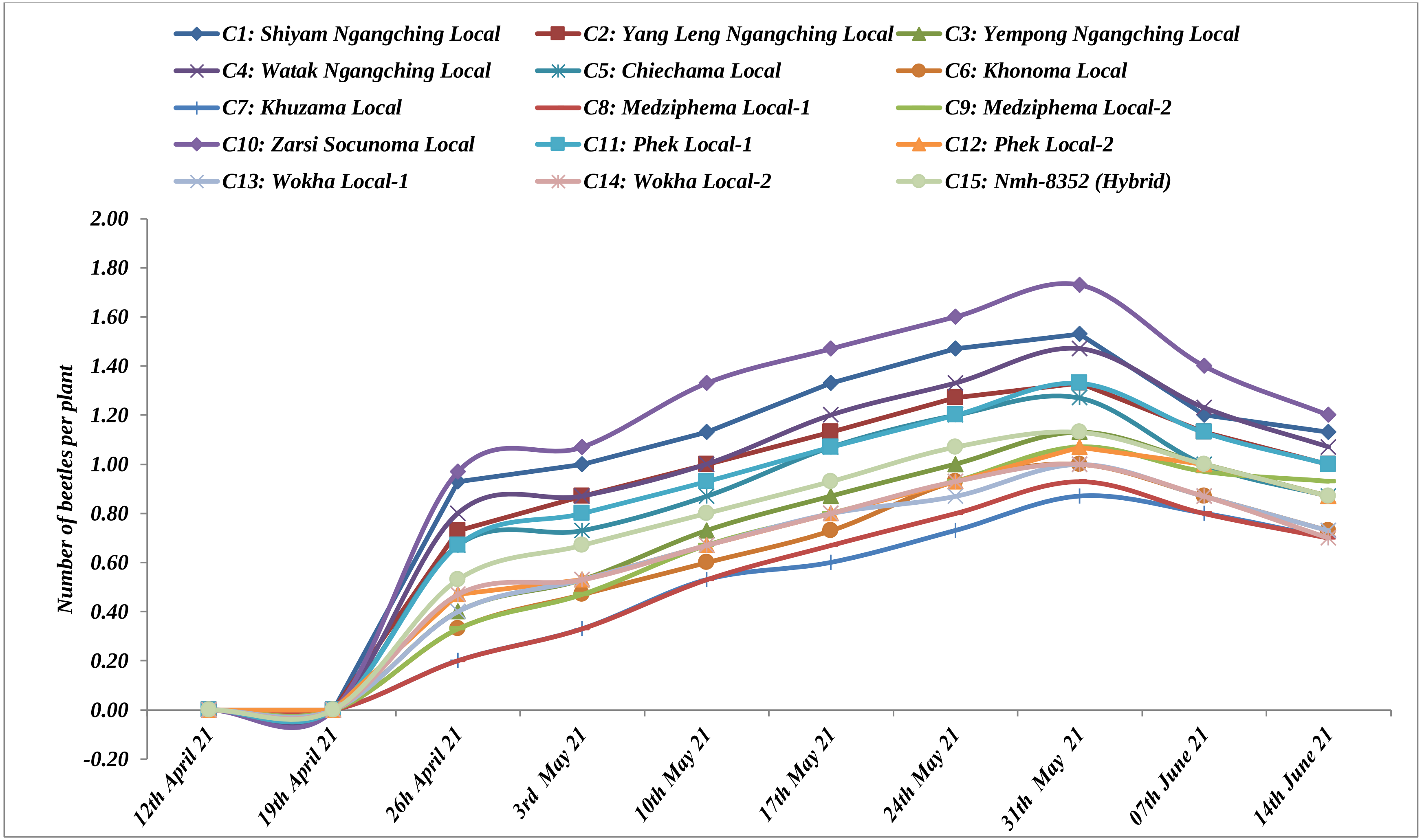

Fig 4.4b: Seasonal incidence of coccinellid beetles, *Coccinella* spp. in different local maize cultivars during April to June 2021

Plate 4a: Ladybird beetle, *Coccinella transversalis*

Plate 4b: Fifteen spotted ladybird beetle, *Harmonia dimidiata*

Plate 4c: Zebra spider, *Salticusscenicus*

Plate 4: Natural enemies of major insect pests of maize observed during the period of study

Khuzama Local with 0.87 and 0.87 beetles per plant during 2020 and 2021, respectively. From the 22nd standard week *i.e.*, on 7th June onwards the population of coccinellid beetles started decreasing in all the cultivars and the highest population of coccinellid beetles was observed in cultivar Zarsi Socunoma Local with 1.43 and 1.20 beetles per plant while the lowest population was observed in cultivar Khuzama Local with 0.67 and 0.67 beetles per plant on the 22nd (*i.e.*, on 7th June) and 23rd (*i.e.*, on 14th June) standard week, respectively during 2020.

Similarly during the year 2021, the population of coccinellid beetles started decreasing in all the cultivars from the 22nd standard week *i.e.*, on 7th June onwards and the highest population of coccinellid beetles was also observed in cultivar Zarsi Socunoma Local with 1.40 and 1.20 beetles per plant while the lowest population was observed in the cultivars Khuzama Local and Medziphema Local-1 with 0.80 and 0.70 beetles per plant each on the 22nd (*i.e.*, on 7th June) and 23rd (*i.e.*, on 14th June) standard week, respectively. Overall the highest population of coccinellid beetles was observed on in cultivar Zarsi Socunoma Local with 1.06 and 1.07 beetles per plant followed by Shiyam Ngangching Local with 0.94 and 0.97 beetles per plant while the lowest population was observed in cultivar Khuzama Local with 0.45 and 0.48 beetles per plant during 2020 and 2021, respectively.

The results are in conformity with the findings of Kumar *et al.*(2020a) who observed that the population of coccinelid beetles on the 19th standard week was 0.93 and 0.83 beetles per plant during 2015 and 2016, respectively. The results are further supported with the findings of Behera and Mishra (2020) who observed that the peak population of coccinelid beetles was on the 39th standard week with 1.86 and 1.64 beetles per plant during 2014 and 2015, respectively which were close with the present findings where the peak population of coccinelid beetles was recorded with 1.60 and 1.73 beetles per plant during 2020 and 2021, respectively.

4.2.5. Seasonal incidence of spiders in different local maize cultivars during April to June 2020 and April to June 2021

The incidence of spiders was observed from 15th standard week *i.e*., 19th April onwards and continued upto 23rd standard week *i.e*., on 14th June in both the years as evident from the Table 4.6a & Table 4.6b and Fig. 4.5a & Fig. 4.5b. The abundance of the spiders increased with the crop age with corresponding to the pest population. On the 15th standard week *i.e*., on 19th April the highest population of spiders was observed in cultivar Zarsi Socunoma Local with 0.57 and 0.67 spiders per plant while the lowest population was observed in the cultivars Yempong Ngangching Local, Khuzama Local and Medziphema Local-1 with 0.13 and 0.20 spiders per plant during 2020 and 2021, respectively. Similarly on the 16th standard week *i.e*., on 26th April the highest population of spiders was observed in cultivar Zarsi Socunoma Local with 0.63 and 0.73 spiders per plant during 2020 and 2021, respectively while the lowest population was recorded in cultivar Medziphema Local-1 with 0.10 spiders per plant during 2020 and the cultivars Medziphema Local-1, Medziphema Local-2, Wokha Local-1 and Wokha Local-1 with 0.13 spiders each per plant during 2021. On the 17th standard week *i.e*., on 3rd May the highest population of spiders was also observed in cultivar Zarsi Socunoma Local with 0.70 and 0.80 spiders per plant followed by Shiyam Ngangching Local with 0.67 and 0.73 beetles per plant while the lowest population was recorded in cultivar Medziphema Local-1 with 0.17 and 0.20 spiders per plant during 2020 and 2021, respectively.

On the 18th standard week *i.e*., on 10th May the highest population of spiders was also observed in cultivar Zarsi Socunoma Local with 0.87 spiders per plant in both the years followed by Shiyam Ngangching Local with 0.80 and 0.80 spiders per plant during 2020 and 2021, respectively while the lowest population was recorded in the cultivars Khuzama Local and Medziphema Local-1 with 0.30 spiders per plant each during 2020 and 0.33 spiders per

Table 4.6a: Seasonal incidence of spiders recorded during April to June 2020 on different local maize cultivars

Cultivars	**Seasonal incidence of spiders**										
	Mean standard week										***Overall mean***
	14	***15***	***16***	***17***	***18***	***19***	***20***	***21***	***22***	***23***	
	12th April 20	***19th April 20***	***26h April 20***	***3rd May 20***	***10th May 20***	***17th May 20***	***24th May 20***	***31th May 20***	***07th June 20***	***14th June 20***	
C_1: Shiyam Ngangching Local	0.00	0.40	0.53	0.67	0.80	0.87	1.00	1.20	1.33	1.47	***0.83***
C_2: Yang Leng Ngangching Local	0.00	0.37	0.43	0.50	0.67	0.73	0.87	1.00	1.20	1.20	***0.70***
C_3: Yempong Ngangching Local	0.00	0.13	0.20	0.30	0.47	0.53	0.67	0.87	1.00	1.10	***0.53***
C_4: Watak Ngangching Local	0.00	0.30	0.40	0.57	0.70	0.87	1.00	1.20	1.33	1.40	***0.78***
C_5: Chiechama Local	0.00	0.00	0.20	0.33	0.47	0.60	0.77	0.90	1.10	1.17	***0.55***
C_6: Khonoma Local	0.00	0.13	0.13	0.20	0.37	0.47	0.53	0.67	0.80	0.87	***0.42***
C_7: Khuzama Local	0.00	0.13	0.17	0.20	0.30	0.43	0.57	0.73	0.90	1.00	***0.44***
C_8: Medziphema Local-1	0.00	0.00	0.10	0.17	0.30	0.43	0.57	0.70	0.87	0.90	***0.41***
C_9: Medziphema Local-2	0.00	0.00	0.13	0.23	0.37	0.50	0.67	0.80	0.80	0.93	***0.44***
C_{10}: Zarsi Socunoma Local	0.00	0.57	0.63	0.70	0.87	1.00	1.20	1.30	1.47	1.60	***0.93***
C_{11}: Phek Local-1	0.00	0.30	0.33	0.43	0.57	0.63	0.77	0.93	1.10	1.20	***0.63***
C_{12}: Phek Local-2	0.00	0.17	0.23	0.30	0.43	0.57	0.70	0.87	1.00	1.10	***0.54***
C_{13}: Wokha Local-1	0.00	0.00	0.13	0.20	0.37	0.47	0.53	0.70	0.87	0.93	***0.42***
C_{14}: Wokha Local-2	0.00	0.00	0.13	0.27	0.43	0.57	0.70	0.87	1.00	1.10	***0.51***
C_{15}: Nmh-8352 (Hybrid)	0.00	0.17	0.20	0.30	0.53	0.70	0.80	1.00	1.10	1.17	***0.60***
SEm±	-	***0.003***	***0.005***	***0.006***	***0.008***	***0.010***	***0.011***	***0.014***	***0.017***	***0.015***	-
CD (P=0.05)	-	***0.007***	***0.014***	***0.016***	***0.023***	***0.028***	***0.032***	***0.041***	***0.050***	***0.045***	-

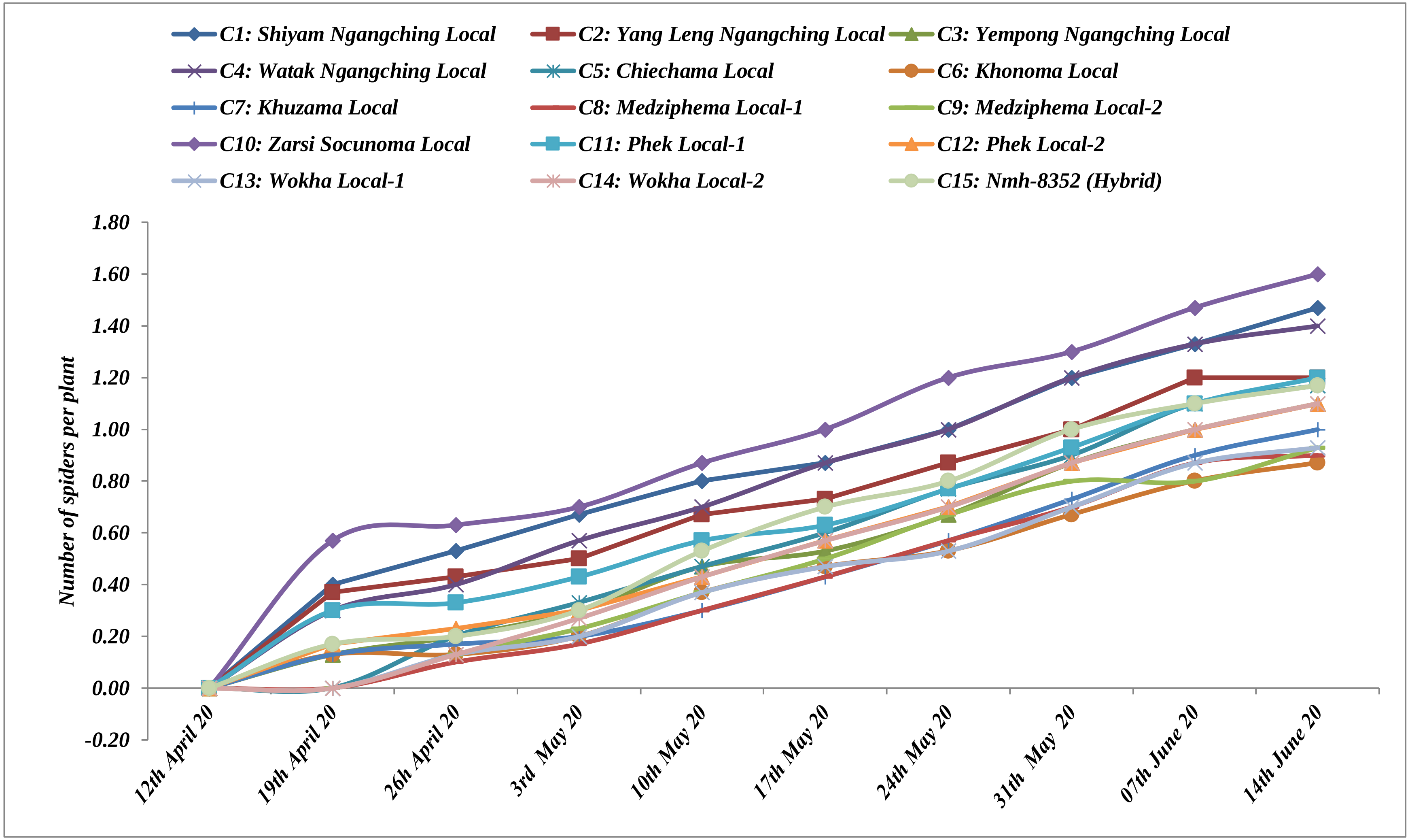

Fig 4.5a: Seasonal incidence of spiders in different local maize cultivars during April to June 2020

Table 4.6b: Seasonal incidence of spiders recorded during April to June 2021 on different local maize cultivars

Cultivars	**Seasonal incidence of spiders**										
	Mean standard week										***Overall mean***
	14	***15***	***16***	***17***	***18***	***19***	***20***	***21***	***22***	***23***	
	12th April 21	***19th April 21***	***26h April 21***	***3rd May 21***	***10th May 21***	***17th May 21***	***24th May 21***	***31th May 21***	***07th June 21***	***14th June 21***	
C_1: Shiyam Ngangching Local	0.00	0.47	0.60	0.73	0.80	0.87	1.00	1.23	1.37	1.47	***0.85***
C_2: Yang Leng Ngangching Local	0.00	0.43	0.50	0.67	0.77	0.83	0.90	1.00	1.20	1.27	***0.76***
C_3: Yempong Ngangching Local	0.00	0.20	0.33	0.47	0.53	0.63	0.70	0.87	1.00	1.20	***0.59***
C_4: Watak Ngangching Local	0.00	0.37	0.43	0.60	0.70	0.87	1.00	1.20	1.33	1.43	***0.79***
C_5: Chiechama Local	0.00	0.00	0.20	0.33	0.47	0.60	0.77	0.90	1.10	1.20	***0.56***
C_6: Khonoma Local	0.00	0.20	0.30	0.40	0.47	0.53	0.63	0.77	0.87	0.97	***0.51***
C_7: Khuzama Local	0.00	0.20	0.33	0.40	0.50	0.63	0.70	0.80	0.97	1.07	***0.56***
C_8: Medziphema Local-1	0.00	0.00	0.13	0.20	0.33	0.43	0.57	0.73	0.90	1.00	***0.43***
C_9: Medziphema Local-2	0.00	0.00	0.13	0.27	0.37	0.50	0.67	0.80	0.93	1.07	***0.47***
C_{10}: Zarsi Socunoma Local	0.00	0.67	0.73	0.80	0.87	1.00	1.20	1.33	1.47	1.63	***0.97***
C_{11}: Phek Local-1	0.00	0.37	0.43	0.50	0.60	0.67	0.80	0.93	1.10	1.23	***0.66***
C_{12}: Phek Local-2	0.00	0.27	0.33	0.47	0.53	0.60	0.70	0.87	1.00	1.17	***0.59***
C_{13}: Wokha Local-1	0.00	0.00	0.13	0.23	0.37	0.47	0.53	0.70	0.87	1.00	***0.43***
C_{14}: Wokha Local-2	0.00	0.00	0.13	0.27	0.37	0.57	0.70	0.87	1.00	1.10	***0.50***
C_{15}: Nmh-8352 (Hybrid)	0.00	0.23	0.30	0.40	0.53	0.77	0.87	1.00	1.10	1.20	***0.64***
SEm±	-	***0.005***	***0.006***	***0.010***	***0.009***	***0.010***	***0.009***	***0.012***	***0.013***	***0.020***	-
CD (P=0.05)	-	***0.014***	***0.019***	***0.030***	***0.026***	***0.028***	***0.027***	***0.036***	***0.037***	***0.058***	-

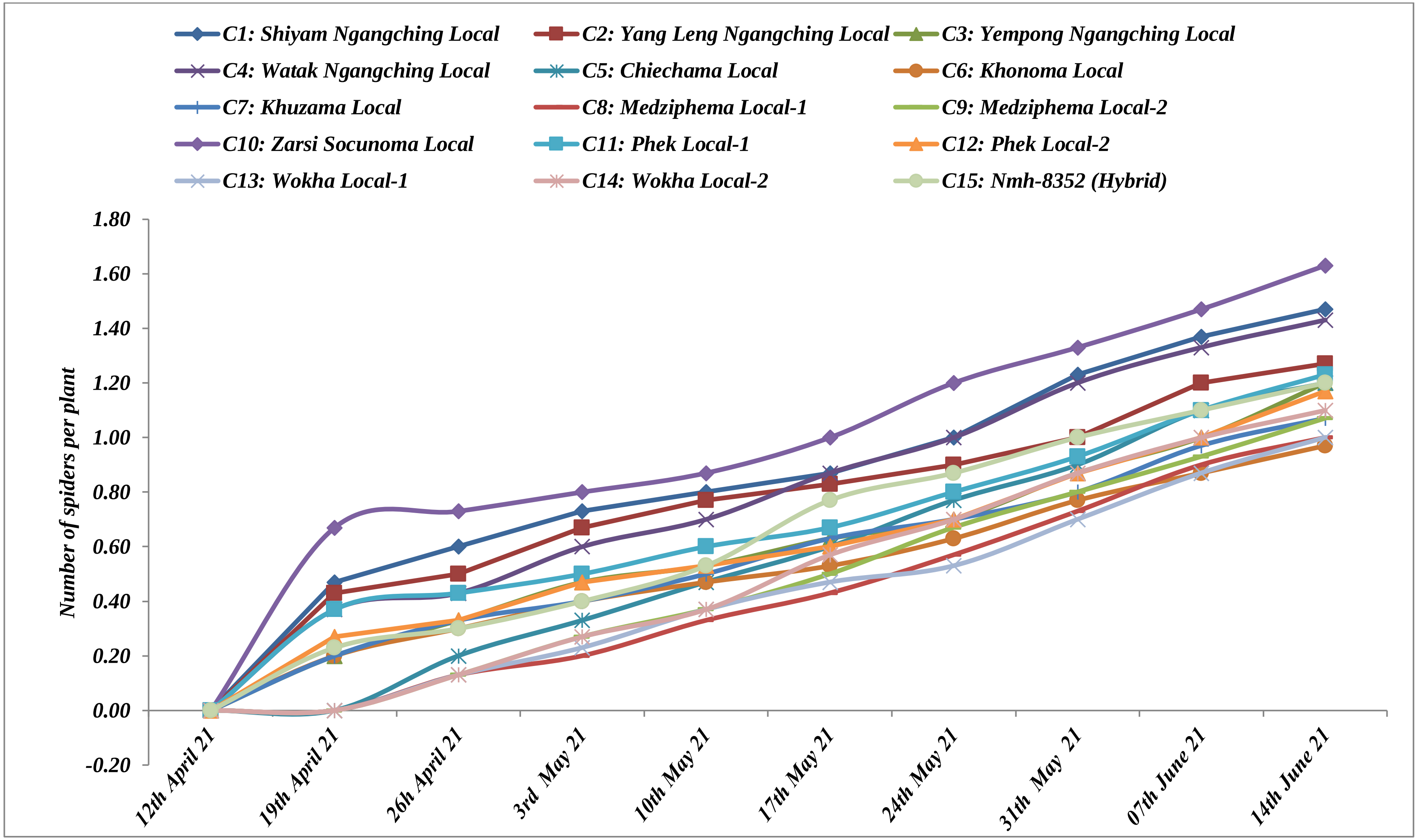

Fig 4.5b: Seasonal incidence of spiders in different local maize cultivars during April to June 2021

plantin cultivar Medziphema Local-1 during 2021. On the 19th standard week *i.e.*, on 17th May the highest population of spiders was also observed in cultivar Zarsi Socunoma Local with 1.00 and 1.00 spiders per plant followed by Shiyam Ngangching Local with 0.87 and 0.87 spiders per plant during 2020 and 2021, respectively while the lowest population was recorded in the cultivars Khuzama Local and Medziphema Local-1 with 0.43 spiders per plant each during 2020 and 0.43 spiders per plant in cultivar Medziphema Local-1 during 2021. On the 20th standard week *i.e.*, on 24th May the highest population of spiders was also observed in cultivar Zarsi Socunoma Local with 1.20 spiders per plant followed by Shiyam Ngangching Local with 1.00 spiders per plant in both the years while the lowest population was recorded in cultivar Wokha Local-1 with 0.53 and 0.53 spiders per plant during 2020 and 2021, respectively.

On the 21st standard week *i.e.*, on 31st May the highest population of spiders was also observed in cultivar Zarsi Socunoma Local with 1.30 and 1.33 spiders per plant followed by Shiyam Ngangching Local with 1.20 and 1.23 spiders per plant during 2020 and 2021, respectively while the lowest population of spiders was recorded in the cultivars Medziphema Local-1 and Wokha Local-1 with 0.70 spiders per plant each during 2020 and 0.70 spiders per plant in cultivar Wokha Local-1 during 2021. On the 22nd standard week *i.e.*, on 7th June the highest population of spiders was also observed in cultivar Zarsi Socunoma Local with 1.47 and 1.47 spiders per plant followed by Shiyam Ngangching Local with 1.33 and 1.37 spiders per plant during 2020 and 2021, respectively while the lowest population of spiders was recorded in the cultivars Khonoma Local and Medziphema Local-2 with 0.80 spiders per plant each during 2020 but during 2021, the lowest population of spiders was recorded in the cultivars Khonoma Local and Wokha Local-1 with 0.87 spiders per plant each. The peak population spiders was observed on the 23st standard week *i.e.*, on 14th June in cultivar Zarsi Socunoma Local with 1.60 and 1.63 spiders per plant followed by Shiyam Ngangching Local with 1.47 and 1.47 spiders per plant while the lowest population of spiders was observed in cultivar Khonoma Local with 0.87 and 0.97 spiders per plant during 2020 and 2021, respectively.

The results are in conformity with the findings of Kumar *et al.*(2020a) who observed that the population of spiders on the 19th standard week was 1.21 and 1.51 spiders per plant during 2015 and 2016, respectively. The results are further supported with the findings of Behera and Mishra (2020) who observed that the highest population of spiders was 1.56 and 1.55 spiders per plant during 2014 and 2015, respectively which were close with the present findings where the highest population of spiders was recorded with 1.60 and 1.63 spiders per plant during 2020 and 2021, respectively.

4.3. Correlation coefficient (r) on the seasonal incidence of major insect pests and their natural enemies with abiotic factors in different local maize cultivars during April to June 2020 and April to June 2021

In the present findings, simple linear correlation analysis was performed to find out the relationship of incidence of major pests and their natural enemies with their abiotic factors like maximum and minimum temperature, maximumand minimum relative humidity and rainfall in maize.

4.3.1. Correlation coefficient (r) on the seasonal incidence of maize stem borer, *Chilo partellus* as leaf injury damage with abiotic factors in different local maize cultivars during April to June 2020 and April to June 2021

The correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as leaf injury damage with the abiotic factors showed a non-significant negative correlation with the maximum temperature in all the cultivars in both the years (Table 4.7a & 4.7b). But the seasonal incidence of maize stem borer, *Chilo partellus* as leaf injury damage revealed a significant positive correlation with the minimum temperature in the cultivars Chiechama Local, Khuzama Local and Medziphema Local-1 with (r = 0.653), (r = 0.680) and (r = 0.660), respectively during 2020 while the rest of the cultivars showed

Table 4.7a: Correlation coefficient (r) of maize stem borer, *Chilo partellus* as leaf injury infestation in relation to weather parameters recorded during April to June 2020

Cultivars	*Pearson's correlation coefficient*				
	Temperature (ºC)		*Relative humidity (%)*		*Rainfall (mm)*
	Max.	*Min.*	*Max.*	*Min.*	
C_1: Shiyam Ngangching Local	-0.289	0.460	0.320	0.541	0.355
C_2: Yang Leng Ngangching Local	-0.425	0.603	0.417	0.629	0.352
C_3: Yempong Ngangching Local	-0.122	0.516	0.236	0.494	0.328
C_4: Watak Ngangching Local	-0.206	0.562	0.419	0.578	0.282
C_5: Chiechama Local	-0.362	0.653*	0.421	0.685*	0.621
C_6: Khonoma Local	-0.228	0.608	0.496	0.632*	0.296
C_7: Khuzama Local	-0.158	0.680*	0.550	0.677*	0.379
C_8: Medziphema Local-1	0.013	0.660*	0.397	0.628	0.584
C_9: Medziphema Local-2	-0.266	0.435	0.265	0.439	0.187
C_{10}: Zarsi Socunoma Local	-0.200	0.541	0.365	0.551	0.386
C_{11}: Phek Local-1	-0.070	0.579	0.371	0.579	0.424
C_{12}: Phek Local-2	-0.146	0.568	0.357	0.562	0.325
C_{13}: Wokha Local-1	-0.119	0.515	0.272	0.494	0.293
C_{14}: Wokha Local-2	-0.331	0.369	0.223	0.420	0.170
C_{15}: Nmh-8352 (Hybrid)	-0.192	0.589	0.348	0.585	0.421

Note: df = (10-2) = 8 $r_{0.05}$ = 0.632 $r_{0.01}$ = 0.765

* = Significant at 5% level of significance

Those values which do not assign any symbol are non-significant at 5% level of significance

Table 4.7b: Correlation coefficient (r) of maize stem borer, *Chilo partellus* as leaf injury infestation in relation to weather parameters recorded during April to June 2021

Cultivars	***Pearson's correlation coefficient***				
	Temperature (ºC)		***Relative humidity (%)***		***Rainfall (mm)***
	Max.	***Min.***	***Max.***	***Min.***	
C_1: Shiyam Ngangching Local	-0.406	0.418	0.203	0.393	0.264
C_2: Yang Leng Ngangching Local	-0.498	0.475	0.290	0.510	0.333
C_3: Yempong Ngangching Local	-0.286	0.504	0.254	0.456	0.283
C_4: Watak Ngangching Local	-0.498	0.475	0.290	0.510	0.333
C_5: Chiechama Local	-0.440	0.567	0.369	0.534	0.249
C_6: Khonoma Local	-0.452	0.604	0.374	0.562	0.270
C_7: Khuzama Local	-0.314	0.633*	0.339	0.546	0.407
C_8: Medziphema Local-1	-0.314	0.632*	0.339	0.546	0.407
C_9: Medziphema Local-2	-0.440	0.595	0.348	0.568	0.308
C_{10}: Zarsi Socunoma Local	-0.413	0.374	0.203	0.372	0.284
C_{11}: Phek Local-1	-0.286	0.518	0.237	0.429	0.361
C_{12}: Phek Local-2	-0.388	0.539	0.281	0.499	0.312
C_{13}: Wokha Local-1	-0.351	0.509	0.257	0.466	0.264
C_{14}: Wokha Local-2	-0.421	0.478	0.297	0.458	0.184
C_{15}: Nmh-8352 (Hybrid)	-0.238	0.475	0.194	0.379	0.268

Note: df = (10-2) = 8 $r_{0.05}$ = 0.632 $r_{0.01}$ = 0.765

* = Significant at 5% level of significance

Those values which do not assign any symbol are non-significant at 5% level of significance

a non-significant positive correlation. Likewise during 2021, the seasonal incidence of maize stem borer, *Chilo partellus* as leaf injury damage with the minimum temperature showed a non-significant positive correlation in most of the cultivars but in the cultivars Khuzama Local and Medziphema Local-1 revealed a significant positive correlation with (r = 0.633) and (r = 0.632), respectively.

The correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as leaf injury damage with the maximum relative humidity and rainfall showed a non-significant positive correlation in all the cultivars in both the years. But the seasonal incidence of maize stem borer, *Chilo partellus* as leaf injury damage revealed a significant positive correlation with the minimum relative humidity in the cultivars Chiechama Local, Khonoma Local and Khuzama Local with (r = 0.685), (r = 0.632) and (r = 0.677), respectively during 2020 while during 2021 the rest of the cultivars showed a non-significant positive correlation.

The results are in conformity with findings of several workers who reported that the correlation of the incidence level of maize stem borer, *Chilo partellus* as leaf injury damage with the minimum temperature and rainfall showed a significant positive correlation and non-significant positive correlation, respectively (Dhaliwal, 2016; Hamid *et al*., 2019). However, they reported that the correlation of *C.partellus* incidence as leaf injury damage with maximum temperature exhibited a significant positive correlation. This might be due to different temperature ranges prevailing at different locations and cropping seasons. The results are further supported with the findings ofAhad*et al.* (2008) who reported that the correlation of *C.partellus* incidence as leaf injury damage with minimum temperature showed a significant positive correlation. The correlation of the incidence level of *C. partellus* as leaf injury damage with the maximum relative humidity are in conformity with the findings of Hamid *et al*. (2019)who reported that the incidence of *C.partellus* as leaf injury damage exhibited a non-significant positive correlation. Regarding the minimum relative humidity the results are in contradiction with the findings of Kurly*et al.* (2021) who reported that the correlation of *C.partellus* incidence as leaf injury damage with the minimum relative humidity showed a non-significant negative correlation. This might be due to different relative humidity ranges prevailing at different locations and cropping seasons.

4.3.2. Correlation coefficient (r) on the seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts damage with abiotic factors in different local maize cultivars during April to June 2020 and April to June 2021

The correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts damage with the abiotic factors showed a non-significant positive correlation with the maximum temperature in all the cultivars in both the years (Table 4.8a & 4.8b). But during 2020, the seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts damage revealed a significant positive correlation with the minimum temperature in all the cultivars while during 2021, the seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts damage revealed a significant positive correlation with the minimum temperature in most of the cultivars except in the cultivars Shiyam Ngangching Local, Yempong Ngangching Local and Chiechama Local which showed a non-significant positive correlation with (r = 0.576), (r = 0.628) and (r = 0.614), respectively.

The correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts damage with the maximum relative humidity showed a significant positive correlation and non-significant positive correlation in all the cultivars during 2020 and 2021, respectively. Likewiseduring 2020, the seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts damage revealed a significant positive correlation with the minimum relative humidity in most of the cultivars except in cultivar Shiyam

Table 4.8a: Correlation coefficient (r) of maize stem borer, *Chilo partellus* as dead hearts infestation in relation to weather parameters recorded during April to June 2020

Cultivars	***Pearson's correlation coefficient***				
	Temperature (ºC)		***Relative humidity (%)***		***Rainfall (mm)***
	Max.	***Min.***	***Max.***	***Min.***	
C_1: Shiyam Ngangching Local	0.248	0.766**	0.771*	0.630	0.169
C_2: Yang Leng Ngangching Local	0.125	0.847**	0.849**	0.727*	0.172
C_3: Yempong Ngangching Local	0.171	0.779**	0.815**	0.650*	0.107
C_4: Watak Ngangching Local	0.244	0.751*	0.748*	0.633*	0.216
C_5: Chiechama Local	0.127	0.761*	0.800**	0.650*	0.118
C_6: Khonoma Local	0.132	0.813**	0.862**	0.709*	0.168
C_7: Khuzama Local	0.153	0.848**	0.854**	0.733*	0.193
C_8: Medziphema Local-1	0.192	0.791**	0.812**	0.671*	0.194
C_9: Medziphema Local-2	0.227	0.787**	0.775**	0.654*	0.211
C_{10}: Zarsi Socunoma Local	0.162	0.778**	0.811**	0.676*	0.227
C_{11}: Phek Local-1	0.261	0.761*	0.762*	0.635*	0.124
C_{12}: Phek Local-2	0.183	0.807**	0.816**	0.675*	0.104
C_{13}: Wokha Local-1	0.207	0.795**	0.780**	0.677*	0.246
C_{14}: Wokha Local-2	0.180	0.816**	0.803**	0.702*	0.249
C_{15}: Nmh-8352 (Hybrid)	0.167	0.825**	0.825**	0.702*	0.172

Note: df = (10-2) = 8 $r_{0.05}$ = 0.632 $r_{0.01}$ = 0.765

* = Significant at 5% level of significance

Those values which do not assign any symbol are non-significant at 5% level of significance

Table 4.8b: Correlation coefficient (r) of maize stem borer, *Chilo partellus* as dead hearts infestation in relation to weather parameters recorded during April to June 2021

Cultivars	*Pearson's correlation coefficient*				
	Temperature (ºC)		*Relative humidity (%)*		*Rainfall (mm)*
	Max.	*Min.*	*Max.*	*Min.*	
C_1: Shiyam Ngangching Local	-0.082	0.576	0.556	0.401	-0.030
C_2: Yang Leng Ngangching Local	-0.210	0.684*	0.604	0.499	0.077
C_3: Yempong Ngangching Local	-0.146	0.628	0.594	0.442	0.010
C_4: Watak Ngangching Local	-0.122	0.633*	0.555	0.442	0.035
C_5: Chiechama Local	-0.118	0.623	0.567	0.436	0.037
C_6: Khonoma Local	-0.143	0.664*	0.573	0.475	0.068
C_7: Khuzama Local	-0.259	0.687*	0.619	0.511	0.076
C_8: Medziphema Local-1	-0.213	0.666*	0.619	0.478	0.010
C_9: Medziphema Local-2	-0.213	0.666*	0.619	0.478	0.010
C_{10}: Zarsi Socunoma Local	-0.125	0.614	0.578	0.433	-0.063
C_{11}: Phek Local-1	-0.133	0.638*	0.545	0.462	0.065
C_{12}: Phek Local-2	-0.184	0.638*	0.603	0.466	0.046
C_{13}: Wokha Local-1	-0.150	0.648*	0.599	0.456	0.002
C_{14}: Wokha Local-2	-0.168	0.652*	0.589	0.470	0.084
C_{15}: Nmh-8352 (Hybrid)	-0.169	0.633*	0.592	0.463	-0.014

Note: df = (10-2) = 8 $r_{0.05}$ = 0.632 $r_{0.01}$ = 0.765

* = Significant at 5% level of significance

Those values which do not assign any symbol are non-significant at 5% level of significance

Ngangching Local which showed a non-significant positive correlation with (r = 0.630) but during 2021, the seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts damage revealed a non-significant positive correlation with the minimum relative humidity in all the cultivars. Regarding the relationship on the seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts damage with rainfall revealed a non-significant positive correlation in all the cultivars during 2020 whereas during 2021 it showed a non-significant negative correlation in the cultivars Shiyam Ngangching Local, Zarsi SocunomaLocal and Nmh-8352 with (r = -0.030), (r = -0.063) and (r = -0.014), respectively.

The results are in conformity with findings of several workers who reported that the correlation of the incidence level of maize stem borer, *Chilo partellus* as dead hearts damage with the minimum temperature and rainfall showed a significant positive correlation and non-significant positive correlation, respectively (Dhaliwal, 2016; Hamid *et al.*, 2019). However, they reported that the correlation of *C.partellus* incidence as dead hearts damage with maximum temperature exhibited a significant positive correlation. This might be due to different temperature ranges prevailing at different locations and cropping seasons. The results are further supported with the findings ofAhad*et al.* (2008) who reported that the correlation of *C.partellus* incidence as dead hearts damage with minimum temperature revealed a significant positive correlation. Regarding the maximum relative humidity, the results are similar with the findings of several workers who reported that the correlation of *C.partellus* incidence as dead hearts damage with the maximum relative humidity showed a significant positive correlation (Hamid *et al.*, 2019; Kumar *et al.*, 2020a). However, the correlation of *C.partellus* incidence as dead hearts damage with minimum relative humidity the results are in contradiction with the findings of several workers who reported that the correlation of *C.partellus* incidence as dead hearts damage exhibited a non-significant negative correlation. This might be due to different relative humidity ranges prevailing at different locations and time (Kumar *et al.*, 2020a; Kurly *et al.*, 2021).

4.3.3. Correlation coefficient (r) on the seasonal incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage with abiotic factors in different local maize cultivars during April to June 2020 and April to June 2021

The correlation coefficient on the seasonal incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage with the abiotic factors showed a non-significant negative correlation with the maximum temperature in most of the cultivars except in the cultivars Medziphema Local-2, Phek Local-2, Wokha Local-2 and Nmh-8352 which revealed a significant negative correlation with (r = -0.799), (r = -0.692) , (r = -0.697) and (r = -0.678), respectively during 2020 (Table 4.9a). But during 2021 (Table 4.9b), the correlation coefficient on the seasonal incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage with the maximum temperature showed a non-significant negative correlation in most of the cultivars except the cultivars Shiyam Ngangching Local, Khuzama Local, Medziphema Local-1, Medziphema Local-2, Zarsi Socunoma Local, Phek Local-2, Wokha Local-1 and Wokha Local-2 which revealed a non-significant positive correlation with (r = 0.148), (r = 0.343) , (r = 0.108), (r = 0.161), (r = 0.398), (r = 0.388), (r = 0.219) and (r = 0.146), respectively. Regarding with the minimum temperature, the seasonal incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage revealed a significant negative correlation in the cultivars Yang Leng Ngangching Local, Yempong Ngangching Local, Khonoma Local, Khuzama Local, Medziphema Local-1, Zarsi Socunoma Local, Phek Local-1 and Wokha Local-1 with (r = -0.680), (r = -0.728), (r = -0.723), (r = -0.854), (r = -0.740), (r = -0.831), (r = -0.945) and (r = -0.687), respectively while the rest of the cultivars showed non-significant negative correlation during 2020. But during2021, the correlation coefficient on the seasonal incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage with the minimum temperatureshowed a non-significant negative correlation in most of the cultivars except

Table 4.9a: Correlation coefficient (r) of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage in relation to weather parameters recorded during April to June 2020

Cultivars	***Pearson's correlation coefficient***				
	Temperature (ºC)		***Relative humidity (%)***		***Rainfall (mm)***
	Max.	***Min.***	***Max.***	***Min.***	
C_1: Shiyam Ngangching Local	-0.572	-0.527	-0.501	-0.338	-0.107
C_2: Yang Leng Ngangching Local	-0.385	-0.680*	-0.703*	-0.519	-0.121
C_3: Yempong Ngangching Local	-0.320	-0.728*	-0.717*	-0.568	-0.181
C_4: Watak Ngangching Local	-0.574	-0.410	-0.490	-0.243	0.102
C_5: Chiechama Local	-0.581	-0.450	-0.439	-0.229	-0.018
C_6: Khonoma Local	-0.291	-0.723*	-0.755*	-0.601	-0.212
C_7: Khuzama Local	-0.025	-0.854**	-0.886**	-0.788**	-0.319
C_8: Medziphema Local-1	-0.298	-0.740*	-0.737*	-0.582	-0.197
C_9: Medziphema Local-2	-0.799**	-0.099	-0.193	0.086	0.266
C_{10}: Zarsi Socunoma Local	-0.006	-0.831**	-0.858**	-0.782**	-0.340
C_{11}: Phek Local-1	0.113	-0.945**	-0.870**	-0.886**	-0.356
C_{12}: Phek Local-2	-0.692*	-0.240	-0.308	-0.064	0.129
C_{13}: Wokha Local-1	-0.338	-0.687*	-0.705*	-0.562	-0.176
C_{14}: Wokha Local-2	-0.697*	-0.191	-0.324	-0.044	0.141
C_{15}: Nmh-8352 (Hybrid)	-0.678*	-0.252	-0.354	-0.107	0.136

Note: df = (10-2) = 8 $r_{0.05}$ = 0.632 $r_{0.01}$ = 0.765

* = Significant at 5% level of significance

** = Significant at 1% level of significance

Those values which do not assign any symbol are non-significant at 5% level of significance

Table 4.9b: Correlation coefficient (r) of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage in relation to weather parameters recorded during April to June 2021

Cultivars	*Pearson's correlation coefficient*				
	Temperature (ºC)		*Relative humidity (%)*		*Rainfall (mm)*
	Max.	*Min.*	*Max.*	*Min.*	
C_1: Shiyam Ngangching Local	0.148	-0.440	-0.335	-0.271	-0.023
C_2: Yang Leng Ngangching Local	-0.161	-0.071	-0.018	0.087	0.255
C_3: Yempong Ngangching Local	-0.185	-0.044	-0.064	0.103	0.208
C_4: Watak Ngangching Local	-0.043	-0.276	-0.249	-0.100	0.141
C_5: Chiechama Local	-0.093	-0.164	-0.183	-0.010	0.265
C_6: Khonoma Local	-0.275	0.164	0.136	0.309	0.345
C_7: Khuzama Local	0.343	-0.728*	-0.622	-0.591	-0.166
C_8: Medziphema Local-1	0.108	-0.488	-0.389	-0.302	-0.027
C_9: Medziphema Local-2	0.161	-0.600	-0.498	-0.451	-0.096
C_{10}: Zarsi Socunoma Local	0.398	-0.625	-0.473	-0.503	-0.166
C_{11}: Phek Local-1	-0.245	-0.145	-0.109	0.019	0.197
C_{12}: Phek Local-2	0.388	-0.848**	-0.759*	-0.702*	-0.196
C_{13}: Wokha Local-1	0.219	-0.592	-0.484	-0.439	-0.080
C_{14}: Wokha Local-2	0.146	-0.485	-0.379	-0.307	0.000
C_{15}: Nmh-8352 (Hybrid)	-0.122	-0.181	-0.085	0.022	0.165

Note: df = (10-2) = 8 $r_{0.05}$ = 0.632 $r_{0.01}$ = 0.765

* = Significant at 5% level of significance

** = Significant at 1% level of significance

Those values which do not assign any symbol are non-significant at 5% level of significance

the cultivars Khuzama Local, and Phek Local-2 which revealed a significant negative correlation with (r = -0.728) and (r = -0.848), respectively.

The correlation coefficient on the seasonal incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage with the maximum relative humidity showed a significant negative correlation in the cultivars Yang Leng Ngangching Local, Yempong Ngangching Local, Khonoma Local, Khuzama Local, Medziphema Local-1, Zarsi Socunoma Local, Phek Local-1 and Wokha Local-1 with (r = -0.703), (r = -0.717), (r = -0.755), (r = -0.886), (r = -0.737), (r = -0.858), (r = -0.870) and (r = -0.705), respectively during 2020. But during 2021, the correlation coefficient on the seasonal incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage with the maximum relative humidity showed a non-significant negative correlation in most of the cultivars except in cultivar Phek Local-2 which revealed a significant negative correlation with (r = -0.759). Regarding the relationship on the seasonal incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage with the minimum relative humidity showed a non-significant negative correlation in most of the cultivars except the cultivars Khuzama Local, Zarsi Socunoma Local and Phek Local-1 which revealed a significant negative correlation with (r = -0.788), (r = -0.782) and (r = -0.886), respectively during 2020. While during 2021, the seasonal incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage with the minimum relative humidity showed a non-significant negative correlation in most of the cultivars except in cultivar Phek Local-2 which revealed a significant negative correlation with (r = -0.702). The relationship on the seasonal incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage with the rainfall revealed a positive as well as negative non-significant correlation in all the cultivars in both the years.

The results are similar with findings of Nivetha*et al.* (2022) who reported that the correlation of the incidence level of fall armyworm, *Spodoptera frugiperda* as whorls damagewith the maximum temperature exhibited a non-significant negative correlation which was closely related with the second year experiment. Several workers reported that the correlation of the incidence level of fall armyworm, *Spodoptera frugiperda* as whorls damagewith the maximum and minimum relative humidity showed a significant negative correlation and non-significant negative correlation, respectively (Ahir*et al*., 2017; Paul &Deole, 2020b; Darshan&Prasnna, 2022). However, they reported that the correlation of *S.frugiperda* incidence as whorls damagewith the maximum and minimum temperatures showed a significant positive correlation which was in contradiction with the present findings. This might be due to different temperature ranges prevailing at different locations and cropping seasons. The correlation of the incidence level of *S. frugiperda* as whorls damagewith the rainfall are in conformity with the findings of several workers who reported that the correlation exhibited a non-significant negative correlation (Yadav *et al*., 2015; Ahir*et al*., 2017; Paul &Deole, 2020b; Reddy *et al*., 2020a; Nivetha*et al.*, 2022). The results are further supported with the findings ofYadav *et al*., (2015) in black gram who also reported that the incidence of *S. litura*showed a non-significant negative correlation with rainfall while temperature (minimum and maximum), relative humidity (morning and evening) and sunshine showed a non significant positive correlation.

4.3.4. Correlation coefficient (r) on the seasonal incidence of coccinellid beetles, *Coccinella* spp. with abiotic factors in different local maize cultivars during April to June 2020 and April to June 2021

The correlation coefficient on the seasonal incidence of coccinellid beetles, *Coccinella* spp. with the abiotic factors showed a non-significant negative correlation with the maximum temperature in most of the cultivars except in the cultivars Khonoma Local, Khuzama Local, Medziphema Local-1and Wokha Local-1 revealed a non-significant positive during 2020 (Table 4.10a). But during 2021 (Table 4.10b), the correlation coefficient on the

Table 4.10a: Correlation coefficient (r) of coccinellid beetles, *Coccinellid* spp. in relation to weather parameters recorded during April to June 2020

Cultivars	*Pearson's correlation coefficient*				
	Temperature (ºC)		*Relative humidity (%)*		*Rainfall (mm)*
	Max.	*Min.*	*Max.*	*Min.*	
C_1: Shiyam Ngangching Local	-0.247	0.916**	0.805**	0.924**	0.573
C_2: Yang Leng Ngangching Local	-0.165	0.906**	0.801**	0.903**	0.577
C_3: Yempong Ngangching Local	-0.076	0.911**	0.820**	0.883**	0.531
C_4: Watak Ngangching Local	-0.154	0.916**	0.826**	0.904**	0.539
C_5: Chiechama Local	-0.167	0.901**	0.792**	0.905**	0.601
C_6: Khonoma Local	0.039	0.887**	0.808**	0.819**	0.454
C_7: Khuzama Local	0.024	0.881**	0.809**	0.826**	0.495
C_8: Medziphema Local-1	0.080	0.879**	0.789**	0.805**	0.453
C_9: Medziphema Local-2	-0.048	0.903**	0.807**	0.869**	0.542
C_{10}: Zarsi Socunoma Local	-0.233	0.934**	0.851**	0.931**	0.499
C_{11}: Phek Local-1	-0.145	0.924**	0.836**	0.905**	0.527
C_{12}: Phek Local-2	-0.105	0.910**	0.810**	0.890**	0.559
C_{13}: Wokha Local-1	0.006	0.890**	0.791**	0.845**	0.513
C_{14}: Wokha Local-2	-0.147	0.915**	0.812**	0.907**	0.574
C_{15}: Nmh-8352 (Hybrid)	-0.324	0.876**	0.736*	0.752*	0.320

Note: df = (10-2) = 8 $r_{0.05}$ = 0.632 $r_{0.01}$ = 0.765

* = Significant at 5% level of significance

** = Significant at 1% level of significance

Those values which do not assign any symbol are non-significant at 5% level of significance

Table 4.10b: Correlation coefficient (r) of coccinellid beetles, *Coccinellid* spp. in relation to weather parameters recorded during April to June 2021

Cultivars	*Pearson's correlation coefficient*				
	Temperature (ºC)		*Relative humidity (%)*		*Rainfall (mm)*
	Max.	*Min.*	*Max.*	*Min.*	
C_1: Shiyam Ngangching Local	-0.542	0.942**	0.799**	0.885**	0.452
C_2: Yang Leng Ngangching Local	-0.499	0.930**	0.762*	0.852**	0.461
C_3: Yempong Ngangching Local	-0.379	0.855**	0.701*	0.734*	0.375
C_4: Watak Ngangching Local	-0.465	0.922**	0.754*	0.842**	0.470
C_5: Chiechama Local	-0.467	0.908**	0.725*	0.832**	0.486
C_6: Khonoma Local	-0.346	0.843**	0.668*	0.716*	0.385
C_7: Khuzama Local	-0.312	0.792**	0.660*	0.649*	0.311
C_8: Medziphema Local-1	-0.297	0.784**	0.629	0.642*	0.333
C_9: Medziphema Local-2	-0.360	0.834**	0.704*	0.704*	0.319
C_{10}: Zarsi Socunoma Local	-0.515	0.921**	0.754*	0.855**	0.495
C_{11}: Phek Local-1	-0.465	0.917**	0.754*	0.830**	0.453
C_{12}: Phek Local-2	-0.385	0.879**	0.741*	0.764*	0.369
C_{13}: Wokha Local-1	-0.408	0.879**	0.713*	0.770**	0.417
C_{14}: Wokha Local-2	-0.419	0.892**	0.718*	0.791**	0.435
C_{15}: Nmh-8352 (Hybrid)	-0.446	0.907**	0.741*	0.806**	0.417

Note: df = (10-2) = 8 $r_{0.05}$ = 0.632 $r_{0.01}$ = 0.765

* = Significant at 5% level of significance

** = Significant at 1% level of significance

Those values which do not assign any symbol are non-significant at 5% level of significance

seasonal incidence of coccinellid beetles, *Coccinella* spp. with the maximum temperature showed a non-significant negative correlation in all the cultivars. Regarding with the minimum temperature, the seasonal incidence of coccinellid beetles, *Coccinella* spp. revealed a significant positive correlation in all the cultivars in both the years.

The correlation coefficient on the seasonal incidence of coccinellid beetles, *Coccinella* spp. with the maximum relative humidity showed a significant positive correlation in all the cultivars during 2020. But during 2021, the correlation coefficient on the seasonal incidence of coccinellid beetles, *Coccinella* spp. with the maximum relative humidity showed a significant positive correlation in most of the cultivars except in cultivar Medziphema Local-1 revealed a non-significant positive correlation with (r = 0.629). The correlation coefficient on the seasonal incidence of coccinellid beetles, *Coccinella* spp. with the minimum relative humidity showed a significant positive correlation in all the cultivars in both the years. Regarding the relationship on the seasonal incidence of coccinellid beetles, *Coccinella* spp. with the rainfall revealed a non-significant positive correlation in all the cultivars in both the years.

The results are in conformity with findings of Megha*et al.* (2015) who reported that the correlation of the incidence of coccinellid beetles, *Coccinella* spp. with the maximum temperature showed a non-significant negative correlation which was more or less similar with the present findings. However, they reported that the correlation of *Coccinella* spp.incidence with minimum temperature, maximum and minimum relative humidity exhibited a non-significant positive correlation. This might be due to different temperature and humidity ranges prevailing at different locations. The results are further supported with the findings ofGaikwad*et al.* (2021) who reported that the correlation of *Coccinella* spp.incidence with minimum temperature revealed a significant positive correlation. Regarding the correlation of *Coccinella* spp.incidence with rainfall, the results are similar with the findings of Tali*et al.* (2018) who reported that the correlation of *Coccinella* spp.incidence with rainfall showed a non-significant positive correlation.

4.3.5. Correlation coefficient (r) on the seasonal incidence of spiders with abiotic factors in different local maize cultivars during April to June 2020 and April to June 2021

The correlation coefficient on the seasonal incidence of spiders with the abiotic factors showed a non-significant positive correlation with the maximum temperature in most of the cultivars except in cultivar Shiyam Ngangching revealed a non-significant negative correlation with r = -0.024 during 2020 (Table 4.11a). But during 2021 (Table 4.11b), the correlation coefficient on the seasonal incidence of spiders with the maximum temperature showed a non-significant negative correlation in all the cultivars. Regarding with the minimum temperature, the seasonal incidence of spiders revealed a significant positive correlation in all the cultivars in both the years.

Similarly, the correlation coefficient on the seasonal incidence of spiders with the maximum relative humidity showed a significant positive correlation in all the cultivars in both the years. The correlation coefficient on the seasonal incidence of spiders with the minimum relative humidity showed a significant positive correlation in most of the cultivars except in cultivar Khuzama Local which revealed a non-significant positive correlation with (r = 0.610) during 2020. But during 2021, the correlation coefficient on the seasonal incidence of spider with the minimum relative humidity showed a non-significant positive correlation in most of the cultivars except in cultivar Yang Leng Ngangching Local which revealed a significant positive correlation with (r = 0.638). Regarding the relationship on the seasonal incidence of spiders with the rainfall revealed a non-significant positive correlation in allthe cultivars in both the years.

Table 4.11a: Correlation coefficient (r) of spiders in relation to weather parameters recorded during April to June 2020

Cultivars	*Pearson's correlation coefficient*				
	Temperature (ºC)		*Relative humidity (%)*		*Rainfall (mm)*
	Max.	*Min.*	*Max.*	*Min.*	
C_1: Shiyam Ngangching Local	-0.024	0.854**	0.843**	0.774**	0.227
C_2: Yang Leng Ngangching Local	0.048	0.831**	0.815**	0.729*	0.185
C_3: Yempong Ngangching Local	0.132	0.790**	0.814**	0.686*	0.182
C_4: Watak Ngangching Local	0.060	0.851**	0.828**	0.752*	0.233
C_5: Chiechama Local	0.117	0.817**	0.841**	0.714*	0.177
C_6: Khonoma Local	0.180	0.781**	0.800**	0.663*	0.143
C_7: Khuzama Local	0.200	0.726*	0.754*	0.610	0.104
C_8: Medziphema Local-1	0.203	0.768**	0.793**	0.650*	0.147
C_9: Medziphema Local-2	0.143	0.816**	0.819**	0.724*	0.252
C_{10}: Zarsi Socunoma Local	0.012	0.836**	0.804**	0.747*	0.189
C_{11}: Phek Local-1	0.075	0.805**	0.810**	0.702*	0.163
C_{12}: Phek Local-2	0.149	0.785**	0.793**	0.677*	0.167
C_{13}: Wokha Local-1	0.157	0.786**	0.830**	0.680*	0.151
C_{14}: Wokha Local-2	0.148	0.807**	0.829**	0.702*	0.192
C_{15}: Nmh-8352 (Hybrid)	0.173	0.806**	0.801**	0.693*	0.203

Note: df = (10-2) = 8 $r_{0.05}$ = 0.632 $r_{0.01}$ = 0.765

* = Significant at 5% level of significance

** = Significant at 1% level of significance

Those values which do not assign any symbol are non-significant at 5% level of significance

Table 4.11b: Correlation coefficient (r) of spiders in relation to weather parameters recorded during April to June 2021

Cultivars	***Pearson's correlation coefficient***				
	Temperature (ºC)		***Relative humidity (%)***		***Rainfall (mm)***
	Max.	***Min.***	***Max.***	***Min.***	
C_1: Shiyam Ngangching Local	-0.203	0.794**	0.776**	0.630	0.150
C_2: Yang Leng Ngangching Local	-0.232	0.813**	0.794**	0.638*	0.104
C_3: Yempong Ngangching Local	-0.238	0.754*	0.746*	0.599	0.080
C_4: Watak Ngangching Local	-0.173	0.757*	0.716*	0.580	0.117
C_5: Chiechama Local	-0.232	0.717*	0.680*	0.555	0.060
C_6: Khonoma Local	-0.220	0.766**	0.744*	0.603	0.114
C_7: Khuzama Local	-0.223	0.768**	0.748*	0.600	0.065
C_8: Medziphema Local-1	-0.186	0.664*	0.648*	0.501	0.031
C_9: Medziphema Local-2	-0.207	0.690*	0.651*	0.528	0.059
C_{10}: Zarsi Socunoma Local	-0.160	0.786**	0.772**	0.614	0.124
C_{11}: Phek Local-1	-0.177	0.750*	0.753*	0.578	0.068
C_{12}: Phek Local-2	-0.195	0.738*	0.734*	0.572	0.076
C_{13}: Wokha Local-1	-0.224	0.681*	0.672*	0.523	0.026
C_{14}: Wokha Local-2	-0.184	0.688*	0.636*	0.521	0.069
C_{15}: Nmh-8352 (Hybrid)	-0.172	0.738*	0.683*	0.560	0.095

Note: df = (10-2) = 8 $r_{0.05}$ = 0.632 $r_{0.01}$ = 0.765

* = Significant at 5% level of significance

** = Significant at 1% level of significance

Those values which do not assign any symbol are non-significant at 5% level of significance

The results are in conformity with findings of Sidar *et al.* (2017) whoreported that the correlation of the incidence of spiders with the maximum temperature showed a non-significant positive correlation. However, Saranya*et al.* (2019) reported that the correlation of the incidence of spiders with the maximum temperature showed a non-significant negative correlation. This might be due to different temperatures and cropping seasons prevailing at different locations. The results are further supported with the findings ofPatel *et al.* (2020) on cotton who reported that the correlation of spidersincidence with minimum temperature revealed a significant positive correlation. The results are further supported with the findings of Kumar (2012) who reported that the correlation of spidersincidence with the maximum and minimum relative humidity showed a significant positive correlation. Regarding the correlation of spidersincidence with rainfall, the results are also similar with the findings of several workers who reported that the correlation of spiders incidence with rainfall showed a non-significant positive correlation (Kumar, 2012; Patel *et al.*, 2020).

4.4. Screening of different local cultivars for resistance against the major insect pests of maize

In the present findings, leaf injury damage, dead hearts damage, stem tunneling and exit holes caused by maize stem borer and leaf whorls damage caused by fall armyworm were evaluated from fourteen (14) local cultivars and one hybrid variety to determine the level of resistance of maize cultivars against maize stem borer, *Chilo partellus* and fall armyworm, *Spodoptera frugiperda*. The details of the findings are emphasized under the following heads:

4.4.1. Screening of different local cultivars of maize on leaf injury caused by maize stem borer, *Chilo partellus* during April to June 2020 and April to June 2021

The level of leaf injury caused by maize stem borer, *Chilo partellus* on different local maize cultivars showed a significant difference with respect to leaf injury rating as evident from the Table 4.12 and Fig. 4.6. Among the cultivars, the leaf injury rating ranged between 2.86 to 6.26 and 2.05 to 5.25 during 2020 and 2021, respectively. Out of fifteen (15) cultivars, only one cultivar were found resistant; nine (9) cultivars were moderately resistant and five (5) cultivars was observed susceptible to *C. partellus* during 2020. The cultivars which are resistant to leaf injury caused by *C. partellus* were observed in cultivar Zarsi Socunoma Local with 2.86 leaf injury rating. The cultivars which are moderately resistant to leaf injury caused by *C. partellus* were Shiyam Ngangching Local, Yang Leng Ngangching Local, Yempong Ngangching Local, Watak Ngangching Local, Chiechama Local, Phek Local-1, Phek Local-2, Wokha Local-2 and Nmh-8352with 3.27, 3.95, 4.76, 3.40, 4.42, 4.69, 4.87, 4.76 and 4.69 leaf injury rating, respectively. Among these moderately resistant cultivars, the minimum leaf injury was observed in cultivar Shiyam Ngangching Local with 3.27 leaf injury rating and the maximum was observed in cultivar Phek Local-2 with 4.87 leaf injury rating. The cultivars which are susceptible to leaf injury caused by *C. partellus* were Khonoma Local, Khuzama Local, Medziphema Local-1, Medziphema Local-2 and Wokha Local-1 with5.78, 5.85, 6.26, 5.03 and 5.37 leaf injury rating, respectively. Among these susceptible cultivars, the minimum leaf injury was observed in cultivar Medziphema Local-2 with 5.03 leaf injury rating and the maximum was observed in cultivar Medziphema Local-1 with 6.26 leaf injury rating.

During the year 2021, out of fifteen (15) cultivars, four (4) cultivars were found resistant, nine (9) cultivars were moderately resistant and two (2) of the cultivars was observed susceptible to *C. partellus*. The cultivarswhich are resistant to leaf injury caused by *C. partellus* were Shiyam Ngangching Local, Yang Leng Ngangching Local, Watak Ngangching Local and Zarsi Socunoma Local with 2.50, 2.93, 2.80 and 2.05 leaf injury rating, respectively. Among these resistant cultivars, the minimum leaf injury was recorded in

Table 4.12: Screening of different local maize cultivars on leaf injury caused by maize stem borer, *Chilo partellus* based on scoring scale during April to June 2020 and April to June 2021

Cultivars	***Leaf injury caused by Chilo partellus***		
	2020	***2021***	***Pooled***
C_1: Shiyam Ngangching Local	3.27 (MR)	2.50 (R)	2.88 (R)
C_2: Yang Leng Ngangching Local	3.95 (MR)	2.93 (R)	3.44 (MR)
C_3: Yempong Ngangching Local	4.76 (MR)	3.75 (MR)	4.26 (MR)
C_4: Watak Ngangching Local	3.40 (MR)	2.80 (R)	3.10 (MR)
C_5: Chiechama Local	4.42 (MR)	3.30 (MR)	3.86 (MR)
C_6: Khonoma Local	5.78 (S)	4.63 (MR)	5.20 (S)
C_7: Khuzama Local	5.85 (S)	5.05 (S)	5.45 (S)
C_8: Medziphema Local-1	6.26 (S)	5.25 (S)	5.75 (S)
C_9: Medziphema Local-2	5.03 (S)	3.90 (MR)	4.47 (MR)
C_{10}: Zarsi Socunoma Local	2.86 (R)	2.05 (R)	2.45 (R)
C_{11}: Phek Local-1	4.69 (MR)	3.43 (MR)	4.06 (MR)
C_{12}: Phek Local-2	4.87 (MR)	4.05 (MR)	4.46 (MR)
C_{13}: Wokha Local-1	5.37 (S)	4.10 (MR)	4.74 (MR)
C_{14}: Wokha Local-2	4.76 (MR)	3.68 (MR)	4.22 (MR)
C_{15}: Nmh-8352 (Hybrid)	4.69 (MR)	3.50 (MR)	4.10 (MR)
SEm±	***0.26***	***0.27***	***0.23***
CD (P= 0.05)	***0.55***	***0.79***	***0.35***

Note: R = Resistant (1 - 3); MR = Moderately Resistant (>3 - 5);
S = Susceptible (>5 - 7); HS = Highly Susceptible (>7 - 9)

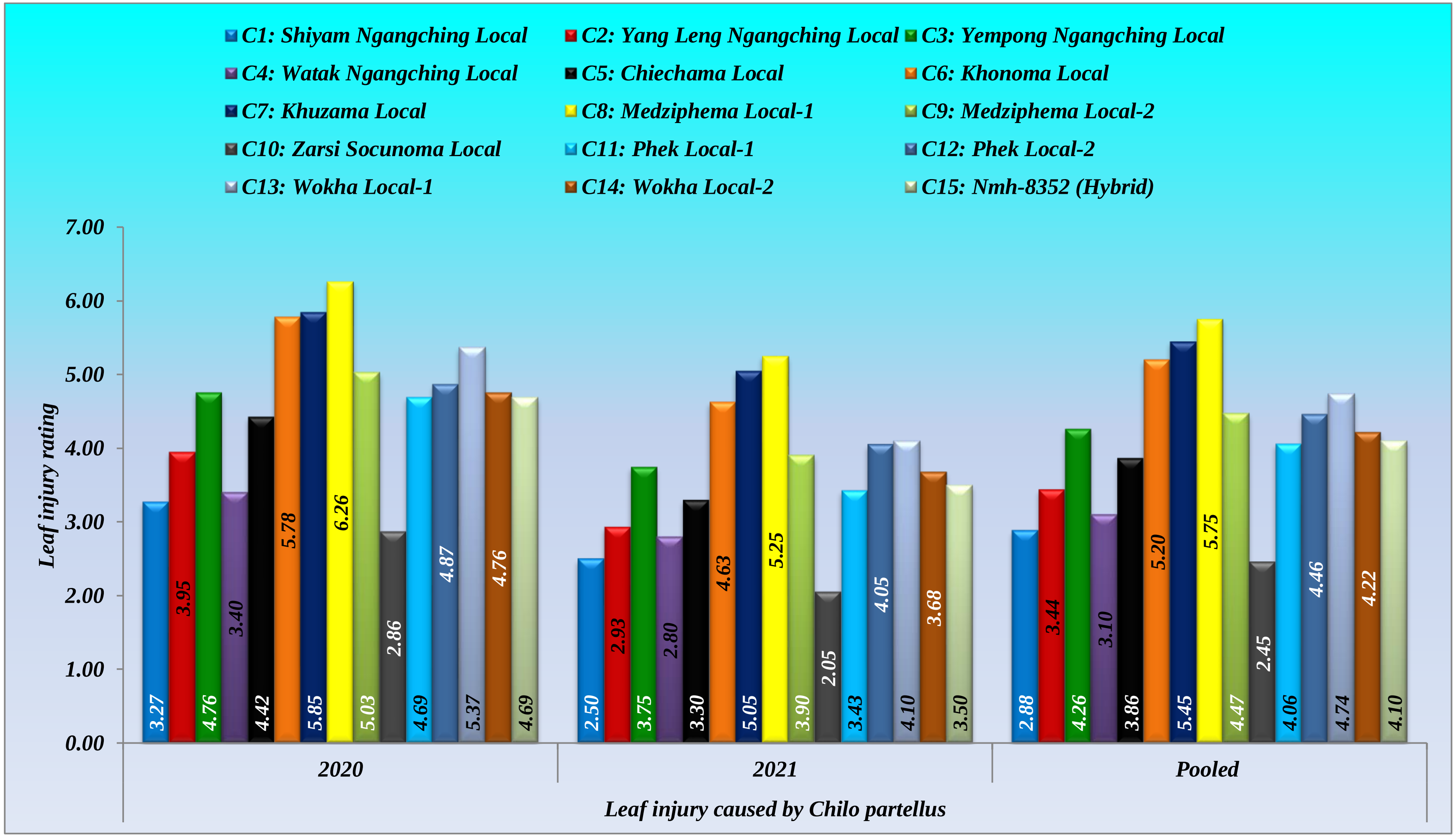

Fig 4.6: Screening of different local cultivars of maize on leaf injury caused by maize stem borer, *Chilo partellus* during April to June 2020 and April to June 2021

cultivar Zarsi Socunoma Local with 2.05 leaf injury and the maximum was recorded in cultivar Yang Leng Ngangching Local with 2.93 leaf injury rating. The cultivars which are moderately resistant to leaf injury caused by *C. partellus* were Yempong Ngangching Local, Chiechama Local, Khonoma Local, Medziphema Local-2, Phek Local-1, Phek Local-2, Wokha Local-1, Wokha Local-2 and Nmh-8352 and with 3.75, 3.30, 4.63, 3.90, 3.43, 4.05, 4.10, 3.68 and 3.50 leaf injury rating, respectively. Among these moderately resistant cultivars, the minimum leaf injury was recorded in cultivar Chiechama Local with 3.30 and the maximum was recorded in cultivar Khonoma Local with 4.63 leaf injury rating. The cultivars which are susceptible to leaf injury caused by *C. partellus* were Khuzama Local and Medziphema Local-1 with5.05 and 5.25 leaf injury rating, respectively.

Pooled data revealed that out of fifteen (15) cultivars, two (2) cultivars were found resistant and ten (10) cultivars were moderately resistant and three (3) cultivars was observed susceptible to *C. partellus*. The cultivars which are resistant to leaf injury caused by *C. partellus* were Zarsi Socunoma Local and Shiyam Ngangching Local with 2.45 and 2.88 leaf injury rating, respectively. The cultivars which are moderately resistant to leaf injury caused by *C. partellus* were Watak Ngangching Local, Chiechama Local, Yang Leng Ngangching Local, Phek Local-1, Nmh-8352, Wokha Local-2, Yempong Ngangching Local, Phek Local-2, Medziphema Local-2 and Wokha Local-1 with 3.10, 3.44, 3.86, 4.06, 4.10, 4.22, 4.26, 4.47 and 4.74 leaf injury rating, respectively. Among these moderately resistant cultivars, the minimum leaf injury was observed in cultivar Watak Ngangching Local with 3.10 leaf injury rating and the maximum was observed in cultivar Wokha Local-1 with 4.74 leaf injury rating. The cultivars which are susceptible to leaf injury caused by *C. partellus* were Khonoma Local, Khuzama Local and Medziphema Local-1 with5.20, 5.45 and 5.75 leaf injury rating, respectively.

The results are similar with findings of Cholla*et al.* (2018) who reported that the leaf injury rating caused by maize stem borer ranged from 2.16 to 8.74 among the thirty test genotypes. The results are further supported by Joshi *et al.* (2019) who reported that the leaf injury rating ranged from 3.06 to 4.27 among fifteen genotypes in which the highest was recorded in genotype BYMH 14-18 with 4.27 and lowest in HQPM-1 with 3.06. The results are also in conformity with the findings of Behera*et al.* (2019) who reported that out of fifteen test genotypes the leaf injury rating ranged from 1.80 to 8.73 and 2.50 to 8.97 during 2014 and 2015, respectively. Further they reported that the leaf injury rating of Nmh-1247 caused by maize stem borer was 5.67 and 6.07 during 2014 and 2015, respectively.

4.4.2. Screening of different local cultivars of maize on dead hearts damage caused by maize stem borer, *Chilo partellus* during April to June 2020 and April to June 2021

The level of dead hearts infestation caused by maize stem borer, *Chilo partellus* on different local maize cultivars showed a significant difference with respect to dead hearts rating as evident from the Table 4.13 and Fig. 4.7. Among the cultivars, the dead hearts rating ranged between 2.83 to 9.27 and 2.27 to 8.67 during 2020 and 2021, respectively. Out of fifteen (15) cultivars, only one cultivar was found resistant; four (4) cultivars were moderately resistant, five (5) cultivars were susceptible and five (5) cultivars were observed highly susceptible to *C. partellus* during 2020. A cultivar which is resistant to dead hearts caused by *C. partellus* was Zarsi Socunoma Local with 2.83 dead hearts rating. The cultivars which are moderately resistant to dead hearts were Shiyam Ngangching Local, Yang Leng Ngangching Local, Watak Ngangching Local and Chiechama Local with 3.50, 4.87, 4.33 and 4.40 dead hearts rating, respectively. Among these moderately resistant cultivars, the minimum dead hearts was observed in cultivar Shiyam Ngangching Local with 3.50 dead heart rating and the maximum was observed in cultivar Yang Leng Ngangching Local with 4.87 dead hearts rating. The cultivars which are susceptible to dead hearts caused by *C. partellus* were Yempong Ngangching

Table 4.13: Screening of different local maize cultivars on dead hearts infestation caused by maize stem borer, *Chilo partellus* during April to June 2020 and April to June 2021

Cultivars	*Dead hearts infestation (%) caused by Chilo partellus*		
	2020	***2021***	***Pooled***
C_1: Shiyam Ngangching Local	3.50 (MR)	3.17 (MR)	3.33 (MR)
C_2: Yang Leng Ngangching Local	4.87 (MR)	4.40 (MR)	4.63 (MR)
C_3: Yempong Ngangching Local	6.27 (S)	5.73 (S)	6.00 (S)
C_4: Watak Ngangching Local	4.33 (MR)	3.77 (MR)	4.05 (MR)
C_5: Chiechama Local	4.40 (MR)	3.50 (MR)	3.95 (MR)
C_6: Khonoma Local	8.93 (HS)	7.83 (HS)	8.38 (HS)
C_7: Khuzama Local	9.27 (HS)	8.67 (HS)	8.97 (HS)
C_8: Medziphema Local-1	9.23 (HS)	8.57 (HS)	8.90 (HS)
C_9: Medziphema Local-2	8.67 (HS)	8.00 (HS)	8.33 (HS)
C_{10}: Zarsi Socunoma Local	2.83 (R)	2.27 (R)	2.55 (R)
C_{11}: Phek Local-1	5.45 (S)	4.87 (MR)	5.16 (S)
C_{12}: Phek Local-2	6.83 (S)	5.45 (S)	6.14 (S)
C_{13}: Wokha Local-1	7.40 (HS)	7.00 (S)	7.20 (HS)
C_{14}: Wokha Local-2	6.27 (S)	5.77 (S)	6.02 (S)
C_{15}: Nmh-8352 (Hybrid)	6.00 (S)	5.63 (S)	5.82 (S)
SEm±	***0.50***	***0.45***	***0.34***
CD (P= 0.05)	***1.44***	***1.30***	***0.95***

Note: R = Resistant (1 - 3); MR = Moderately Resistant (>3 - 5);
S = Susceptible (>5 - 7) HS = Highly susceptible (>7 - 9)

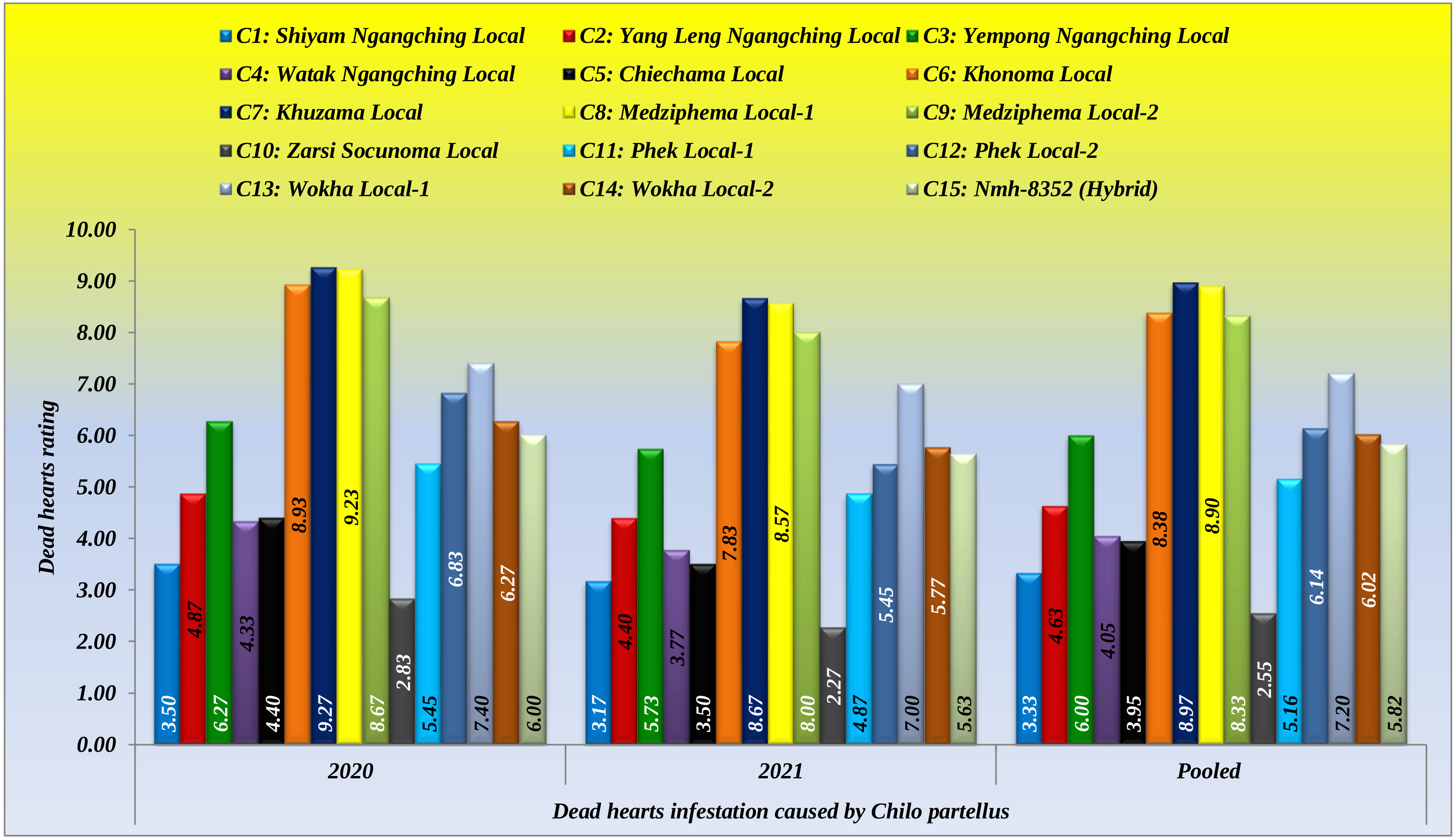

Fig 4.7: Screening of different local cultivars of maize on dead hearts caused by maize stem borer, *Chilo partellus* during April to June 2020 and April to June 2021

Local, Phek Local-1, Phek Local-2, Wokha Local-2 and Nmh-8352 with 6.27, 5.45, 6.83, 6.27 and 6.00 dead hearts rating, respectively. Among these susceptible cultivars, the minimum dead hearts was observed in cultivar Phek Local-1 with 5.45 dead hearts rating and the maximum was observed in cultivar Phek Local-2 with 6.83 dead hearts rating. The cultivars which are highly susceptible to dead hearts caused by *C. partellus* were Khonoma Local, Khuzama Local, Medziphema Local-1, Medziphema Local-2 andWokha Local-1 with 8.93, 9.27, 9.23, 8.67 and 7.40 dead hearts rating, respectively. Among these highly susceptible cultivars, the minimum dead hearts was observed in cultivar Wokha Local-1 with 7.40 dead hearts rating and the maximum was observed in cultivar Khuzama Local with 9.27 dead hearts rating.

During the year 2021, Out of fifteen (15) cultivars, only one cultivar was found resistant, five (5) cultivars were moderately resistant, five (5) cultivars were susceptible and four (4) cultivars were observed highly susceptible to *C. partellus.* A cultivar which is resistant to dead hearts caused by *C. partellus* was Zarsi Socunoma Local with 2.27 dead hearts rating. The cultivars which are moderately resistant to dead hearts caused by *C. partellus* were Shiyam Ngangching Local, Yang Leng Ngangching Local, Watak Ngangching Local, Chiechama Local and Phek Local-1 with 3.17, 4.40, 3.77, 3.50 and 4.87 dead hearts rating, respectively. Among these moderately resistant cultivars, the minimum dead hearts was observed in cultivar Shiyam Ngangching Local with 3.17 dead hearts rating and the maximum was observed in cultivar Phek Local-1 with 4.87 dead hearts rating. The cultivars which are susceptible to dead hearts caused by *C. partellus* were Yempong Ngangching Local, Phek Local-2, Wokha Local-1, Wokha Local-2 and Nmh-835 with 5.73, 5.45, 7.00, 5.77 and 5.63 dead hearts rating, respectively. Among these susceptible cultivars, the minimum dead hearts was observed in cultivar Phek Local-2 with 5.45 dead hearts rating and the maximum was observed in cultivar Wokha Local-1 with 7.00 dead hearts rating. The cultivars which are highly susceptible to dead hearts caused by *C. partellus* were Khonoma Local, Khuzama Local, Medziphema Local-1 and

Medziphema Local-2 with 7.83, 8.67, 8.57 and 8.00 dead hearts rating, respectively. Among these highly susceptible cultivars, the minimum dead hearts was observed in cultivar Khonoma Local with 7.83 dead hearts rating and the maximum was observed in cultivar Khuzama Local with 8.67 dead hearts rating.

Pooled data revealed that out of fifteen (15) cultivars, only one cultivar were found resistant, four (4) cultivars were moderately resistant, five (4) cultivars were susceptible and five (5) cultivars were highly susceptible to *C. partellus*. A cultivar which is resistant to dead hearts caused by *C. partellus* was Zarsi Socunoma Local with 2.55 dead hearts rating. The cultivars which are moderately resistant to dead hearts caused by *C. partellus* were Shiyam Ngangching Local, Yang Leng Ngangching Local, Watak Ngangching Local and Chiechama Local with 3.33, 4.63, 4.05 and 3.95 dead hearts rating, respectively. Among these moderately resistant cultivars, the minimum dead hearts was observed in cultivar Shiyam Ngangching Local with 3.33 dead hearts rating and the maximum was observed in cultivar Yang Leng Ngangching Local with 4.63 dead hearts rating. The cultivars which are susceptible to dead hearts caused by *C. partellus* were Yempong Ngangching Local, Phek Local-1, Phek Local-2, Wokha Local-2 and Nmh-835 with 6.00, 5.16, 6.14, 6.02 and 5.82 dead hearts rating, respectively. Among these susceptible cultivars, the minimum dead hearts was observed in cultivar Phek Local-1 with 5.45 dead hearts rating and the maximum was observed in cultivar Phek Local-2 with 6.14 dead hearts rating. The cultivars which are highly susceptible to dead hearts caused by *C. partellus* were Khonoma Local, Khuzama Local, Medziphema Local-1, Medziphema Local-2 and Wokha Local-1 with 8.38, 8.97, 8.90, 8.33 and 7.20 dead hearts rating, respectively. Among these highly susceptible cultivars, the minimum dead hearts was observed in cultivar Wokha Local-1 with 7.20 dead hearts rating and the maximum was observed in cultivar Khuzama Local with 8.97 dead hearts rating.

The present results are in agreement with findings of Joshi *et al.* (2019) who reported that the dead hearts rating caused by maize stem borer ranged from 1.28% to 5.14% among fifteen genotypes. The highest damage was recorded in genotype BYMH 14-21 with 5.14% and lowest in GAYMH 1 and HQPM-5 with 1.28%. The genotypes GAYMH-1 (1.28%), HQPM-1 (1.28%) were found resistant genotypes, GM-2 (1.92%), HQPM-5 (1.98%), P-3507 (2.56%) and P-740 (2.56%) were found moderately resistant genotypes, BYMH 14-20 (3.20%), BYMH 13-7 (3.20%), P-3502 (3.20%), BYMH 14-18 (3.84%), BYMH 13-3 (3.84%) and Prabal (3.84%) were found moderately susceptible genotypes, BYMH 14-22 (4.49%), BYMH 13-5 (5.13%) and BYMH 14-21 (5.14%) were found susceptible. The dead hearts rating caused by maize stem borer based on scaling in the present findings have a slight increase in percentage in comparison to other literatures. This might be due to different genotypes at different locations and host preference by the pest.

4.4.3. Screening of different local cultivars of maize on stem tunneling length caused by maize stem borer, *Chilo partellus* during April to June 2020 and April to June 2021

The level of stem tunneling caused by maize stem borer, *Chilo partellus* on different local maize cultivars showed a significant difference with respect to the length of stem tunnel as evident from the Table 4.14 and Fig. 4.8. Among the cultivars, the length of stem tunneling ranged between 3.33 to 13.33 cm and 3.00 to 13.00 cm per plant during 2020 and 2021, respectively. Out of fifteen (15) cultivars, four (4) cultivars were found least susceptible, seven (7) cultivars were moderately susceptible and four (4) cultivars werehighly susceptible to *C. partellus* in both the years. The cultivars which are least susceptible to stem tunneling caused by *C. partellus* were Shiyam Ngangching Local (4.29 & 4.33 cm), Watak Ngangching Local (4.87 & 4.70

Table 4.14: Screening of different local maize cultivars on stem tunneling length caused by maize stem borer, *Chilo partellus*based on the measuring scale during April to June 2020 and April to June 2021

Cultivars	***Stem tunneling length caused by Chilo partellus (cm)***		
	2020	***2021***	***Pooled***
C_1: Shiyam Ngangching Local	4.29 (LS)	4.33 (LS)	4.31 (LS)
C_2: Yang Leng Ngangching Local	5.77 (MS)	5.50 (MS)	5.63 (MS)
C_3: Yempong Ngangching Local	8.80 (MS)	8.50 (MS)	8.65 (MS)
C_4: Watak Ngangching Local	4.87 (LS)	4.70 (LS)	4.78 (LS)
C_5: Chiechama Local	4.67 (LS)	4.40 (LS)	4.53 (LS)
C_6: Khonoma Local	12.33 (HS)	12.00 (HS)	12.16 (HS)
C_7: Khuzama Local	13.33 (HS)	13.00 (HS)	13.16 (HS)
C_8: Medziphema Local-1	13.00 (HS)	12.67 (HS)	12.83 (HS)
C_9: Medziphema Local-2	12.00 (HS)	11.73 (HS)	11.87 (HS)
C_{10}: Zarsi Socunoma Local	3.33 (LS)	3.00 (LS)	3.17 (LS)
C_{11}: Phek Local-1	6.67 (MS)	6.50 (MS)	6.58 (MS)
C_{12}: Phek Local-2	8.87 (MS)	8.60 (MS)	8.73 (MS)
C_{13}: Wokha Local-1	9.67 (MS)	9.50 (MS)	9.58 (MS)
C_{14}: Wokha Local-2	8.50 (MS)	8.33 (MS)	8.42 (MS)
C_{15}: Nmh-8352 (Hybrid)	7.77 (MS)	7.60 (MS)	7.68 (MS)
SEm±	***0.59***	***0.54***	***0.40***
CD (P= 0.05)	***1.70***	***1.56***	***1.13***

Note:LS = Least susceptible (0 - 5); MS = Moderately susceptible (5 - 10); S = Highly susceptible (> 10)

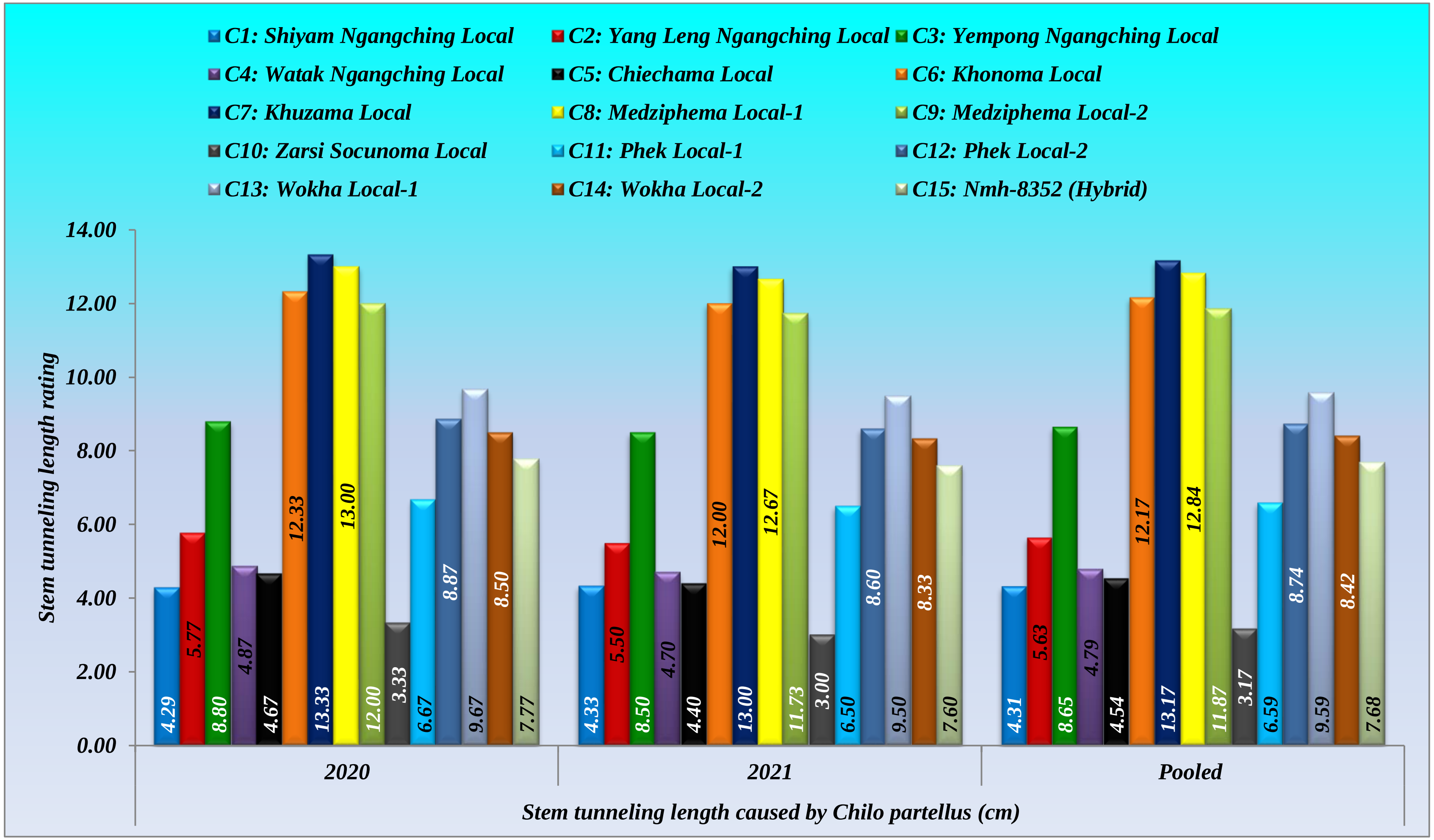

Fig 4.8: Screening of different local cultivars of maize on stem tunneling caused by maize stem borer, *Chilo partellus* during April to June 2020 and April to June 2021

cm), Chiechama Local (4.67 & 4.40 cm) and Zarsi Socunoma Local (3.33 &3.00 cm) during 2020 and 2021, respectively. Among these least susceptible cultivars, the minimum stem tunneling was observed in cultivar Zarsi Socunoma Local with 3.33 and 3.00 cm per plant and the maximum stem tunneling was observed in cultivar Watak Ngangching Local with 4.87 and 4.70 cm per plant during 2020 and 2021, respectively.

The cultivars which are moderately susceptible to stem tunneling caused by *C. partellus* were Yang Leng Ngangching Local (5.77 & 5.50 cm), Yempong Ngangching Local (8.80 & 8.50 cm), Phek Local-1 (6.67 & 6.50 cm), Phek Local-2 (8.87 & 8.60 cm), Wokha Local-1 (9.67 & 9.50 cm), Wokha Local-2 (8.50 & 8.33 cm) and Nmh-8352 (7.77 & 7.60 cm) per plant during 2020 and 2021, respectively. Among these moderately susceptible cultivars, the minimum stem tunneling was observed in cultivar Yang Leng Ngangching Local with 5.77 and 5.50 cm per plant and the maximum stem tunneling was found in cultivar Wokha Local-1 with 9.67 and 9.50 cm per plant during 2020 and 2021, respectively.

The cultivars which are highly susceptible to stem tunneling caused by *C. partellus* were Khonoma Local (12.33 & 12.00 cm), Khuzama Local (13.33 & 13.00 cm), Medziphema Local-1 (13.00 & 12.67 cm) and Medziphema Local-2 (12.00 & 11.73 cm) per plant during 2020 and 2021, respectively. Among these highly susceptible cultivars, the minimum stem tunneling was observed in cultivar Medziphema Local-2 with 12.00 and 11.73 cm per plant and the maximum stem tunneling was found in Khuzama Local with 13.33 and 13.00 cm per plant during 2020 and 2021, respectively.

Similarly pooled data also revealed that out of fifteen (15) cultivars, four (4) cultivars were found least susceptible, seven (7) cultivars were moderately susceptible and four (4) cultivars were highly susceptible to *C. partellus*. The cultivars which are least susceptible to stem tunneling caused by *C. partellus* were Shiyam Ngangching Local, Watak Ngangching Local, Chiechama Local and Zarsi Socunoma Local with 4.31, 4.78, 4.53 and 3.17, respectively. Among these least susceptible cultivars, the minimum stem tunneling was observed in cultivar Zarsi Socunoma Local 3.17 cm per plant and the maximum stem tunneling was observed in cultivar Watak Ngangching Local with 4.78 cm per plant.

The cultivars which are moderately susceptible to stem tunneling caused by *C. partellus* were Yang Leng Ngangching Local, Yempong Ngangching Local, Phek Local-1, Phek Local-2, Wokha Local, Wokha Local-2 and Nmh-8352 with 5.63, 8.65, 6.58, 8.73, 9.58, 8.42 and 7.68 cm per plant, respectively. Among these moderately susceptible cultivars, the minimum stem tunneling was observed in cultivar Yang Leng Ngangching Local with 5.63 cm per plant and the maximum stem tunneling was found in cultivar Wokha Local-1 with 9.58 cm per plant during 2020 and 2021, respectively.

The cultivars which are highly susceptible to stem tunneling caused by *C. partellus* were Khonoma Local, Khuzama Local, Medziphema Local-1 and Medziphema Local-2 with 12.16, 13.16, 12.83 and 11.87 cm per plant, respectively. Among these highly susceptible cultivars, the minimum stem tunneling was observed in cultivar Medziphema Local-2 with 11.87 cm per plant and the maximum stem tunneling was found in Khuzama Local with 13.16 cm per plant.

The present results are in accordance with the findings of Bhandari *et al.* (2016) who reported that the stem tunneling length caused by maize stem borer ranged from 3.20 to 22.50 and 4.20 to 20.40 cm among forty-five genotypes in which the highest was recorded in genotypes Narayani and Khumal yellow with 22.50 and 20.40 cm and the lowest in genotypes RML-32 and RampurSO3F8 with 3.20 and 4.20 cm during 2013 and 2014, respectively. The results are also in conformity with the findings ofBhandari *et al.* (2018) who reported that the mean stem tunneling length caused by maize stem borer was 7.10 and 8.40 cm in genotypes RML-95 and S03TLE, respectively. Further, the results are also supported with the findings of Longkumer (2020) who reported the stem tunneling length ranged from 11.20 to 16.75 cm among five cultivars in which the highest was recorded in cultivar Ronimi with 16.75 cm and the lowest in hybrid HQPM1 with 11.20 cm.

4.4.4. Screening of different local cultivars of maize on number of exit holes caused by maize stem borer, *Chilo partellus* during April to June 2020 and April to June 2021

The number of exit holes caused by maize stem borer, *Chilo partellus* on different local maize cultivars showed a significant difference as evident from the Table 4.15 and Fig. 4.9. Among the cultivars, the number of exit holes ranged between 2.33 to 4.33 per plant and 2.00 to 4.33 per plant during 2020 and 2021, respectively. Out of fifteen (15) cultivars, the minimum number of exit holes was observed in the cultivars Shiyam Ngangching Local, Watak Ngangching Local and Zarsi Socunoma Local with 2.33 each per plant whereas the maximum number of exit holes was observed in the cultivars Khuzama Local and Medziphema Local-1 with 4.33 each per plant during 2020. Similarly, during the year 2021, the minimum number of exit holes was also observed in the cultivars Shiyam Ngangching Local, Watak Ngangching Local and Zarsi Socunoma Local with 2.00 each per plant whereas the maximum number of exit holes was observed in the cultivars Medziphema Local-1 with 4.33 each per plant.

Similarly, pooled data also revealed that the minimum number of exit holes was also observed in the cultivars Shiyam Ngangching Local, Watak Ngangching Local and Zarsi Socunoma Local with 2.17 each per plant whereas the maximum number of exit holes was observed in cultivars Medziphema Local-1 with 4.33 each per plant.

The present results are in conformity with the findings of Munyiri*et al.* (2013) who reported that the number of exit holes caused by maize stem borerranged from 3.90 to 6.70 per plant among fifteen genotypes in which the

Table 4.15: Screening of different local maize cultivars on number of exit holes caused by maize stem borer, *Chilo partellus* during April to June 2020 and April to June 2021

Cultivars	***Number of exit holes caused by Chilo partellus***		
	2020	***2021***	***Pooled***
C_1: Shiyam Ngangching Local	2.33	2.00	2.17
C_2: Yang Leng Ngangching Local	2.67	2.33	2.50
C_3: Yempong Ngangching Local	3.33	3.33	3.33
C_4: Watak Ngangching Local	2.33	2.00	2.17
C_5: Chiechama Local	3.67	3.33	3.50
C_6: Khonoma Local	4.00	3.67	3.83
C_7: Khuzama Local	4.33	4.00	4.17
C_8: Medziphema Local-1	4.33	4.33	4.33
C_9: Medziphema Local-2	4.00	3.67	3.83
C_{10}: Zarsi Socunoma Local	2.33	2.00	2.17
C_{11}: Phek Local-1	2.67	2.33	2.50
C_{12}: Phek Local-2	3.00	2.67	2.83
C_{13}: Wokha Local-1	3.33	3.33	3.33
C_{14}: Wokha Local-2	3.00	2.67	2.83
C_{15}: Nmh-8352 (Hybrid)	2.67	2.33	2.50
SEm±	***0.29***	***0.28***	***0.20***
CD (P= 0.05)	***0.83***	***0.80***	***0.56***

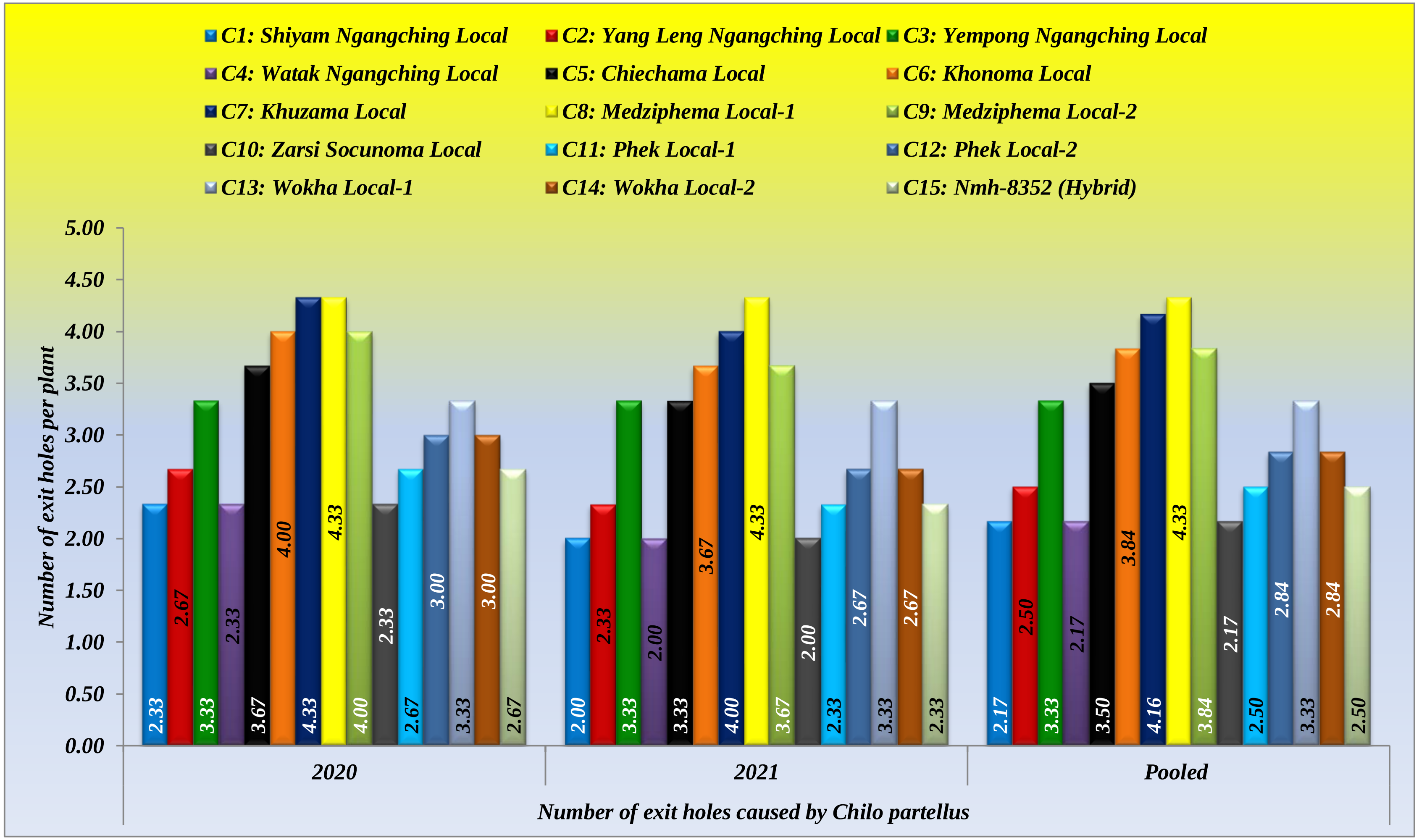

Fig 4.9: Screening of different local cultivars of maize on number of exit holes caused by maize stem borer, *Chilo partellus* during April to June 2020 and April to June 2021

Plate 5a

Plate 5b

Plate 5c

Plate 5a, 5b & 5c: Dead heart symptoms caused by *Chilo partellus*

Plate 5d: Pin holes caused by *Chilo partellus*

Plate 5e: Shoot holes caused by *Chilo partellus*

Plate 5f: Stem tunneling caused by*Chilo partellus*

Plate 5g: Stem breakage caused by*Chilo partellus*

Plate 5: Damaged and symptoms caused bymaize stem borer, *Chilo partellus*

highest number of exit holes was recorded in genotype CKPH09001 with 6.70 per plant and lowest in GUAT 1050 with 3.90 per plant. Similarly, the findings ofBhandari *et al.* (2016) also reported that the number of exit holes caused by maize stem borer ranged from 2.00 to 7.00 per plant in which the highest number of exit holes was recorded in genotype RML-78 with 7.00 and lowest in Rampur SO3F8 with 2.00 per plant. The results are also in conformity with the findings ofBhandari *et al.* (2018) who reported that the mean number of exit holes caused by maize stem borer was 1.60 and 1.90 per plant in genotype RML-95 and S03TLE, respectively during the month of April to August. Further, the results are also supported with the findings ofLongkumer (2020) who reported the number of exit holes ranged from 2.11 to 4.12 per plant among five cultivars in which the highest was recorded in cultivar Ronimi with 4.12 and the lowest in hybrid HQPM1 with 2.11 per plant.

4.4.5. Screening of different local cultivars of maize on leaf whorls damage caused by fall armyworm, *Spodoptera frugiperda* during April to June 2020 and April to June 2021

The level of leaf whorls damage caused by fall armyworm, *Spodoptera frugiperda* on different local maize cultivars showed a significant difference with respect to leaf whorls damage rating as evident from the Table 4.16 and Fig. 4.10. Among the cultivars, the leaf whorl damage rating ranged between 2.43 to 7.93 and 2.50 to 8.00 during 2020 and 2021, respectively. Out of fifteen (15) cultivars, five (5) cultivars were found resistant; eight (8) cultivars were moderately resistant and two (2) cultivars were observed susceptible to *S. frugiperda* during 2020. The cultivars which are resistant to leaf whorls damage caused by *S. frugiperda* were Shiyam Ngangching Local, Yang Leng Ngangching Local, Watak Ngangching Local, Chiechama Local and Zarsi Socunoma Local with 3.33, 3.80, 3.67 3.93 and 2.43 leaf whorls damagerating, respectively. Among these resistant cultivars, the minimum leaf whorls damage was observed in cultivar Zarsi Socunoma with 2.43 leaf whorls damage rating and the maximum was observed in cultivar Chiechama Local

Table 4.16: Screening of different local maize cultivars on leaf whorls damage caused by fall armyworm, *Spodoptera frugiperda* based on scoring scale during April to June 2020 and April to June 2021

Cultivars	***Leaf whorls damage caused by Spodoptera frugiperda***		
	2020	***2021***	***Pooled***
C_1: Shiyam Ngangching Local	3.33 (R)	2.83 (R)	3.08 (R)
C_2: Yang Leng Ngangching Local	3.80 (R)	3.77 (R)	3.78 (R)
C_3: Yempong Ngangching Local	4.57 (MR)	4.53 (MR)	4.55 (MR)
C_4: Watak Ngangching Local	3.67 (R)	3.47 (R)	3.57 (R)
C_5: Chiechama Local	3.93 (R)	3.87 (R)	3.90 (R)
C_6: Khonoma Local	5.87 (MR)	5.60 (MR)	5.73 (MR)
C_7: Khuzama Local	6.67 (S)	7.93 (S)	7.30 (S)
C_8: Medziphema Local-1	7.93 (S)	8.00 (HS)	7.97 (S)
C_9: Medziphema Local-2	5.10 (MR)	5.73 (MR)	5.42 (MR)
C_{10}: Zarsi Socunoma Local	2.43 (R)	2.50 (R)	2.47 (R)
C_{11}: Phek Local-1	4.10 (MR)	3.93 (R)	4.02 (MR)
C_{12}: Phek Local-2	4.73 (MR)	4.67 (MR)	4.70 (MR)
C_{13}: Wokha Local-1	5.60 (MR)	5.93 (MR)	5.77 (MR)
C_{14}: Wokha Local-2	4.53 (MR)	4.10 (MR)	4.32 (MR)
C_{15}: Nmh-8352 (Hybrid)	4.37 (MR)	4.00 (MR)	4.18 (MR)
SEm±	***0.27***	***0.25***	***0.18***
CD (P= 0.05)	***0.78***	***0.73***	***0.52***

Note: R = Resistant (2 - 3); MR = Moderately Resistant (4 - 5);
S = Susceptible (6 - 7); HS = Highly Susceptible (8 - 9)

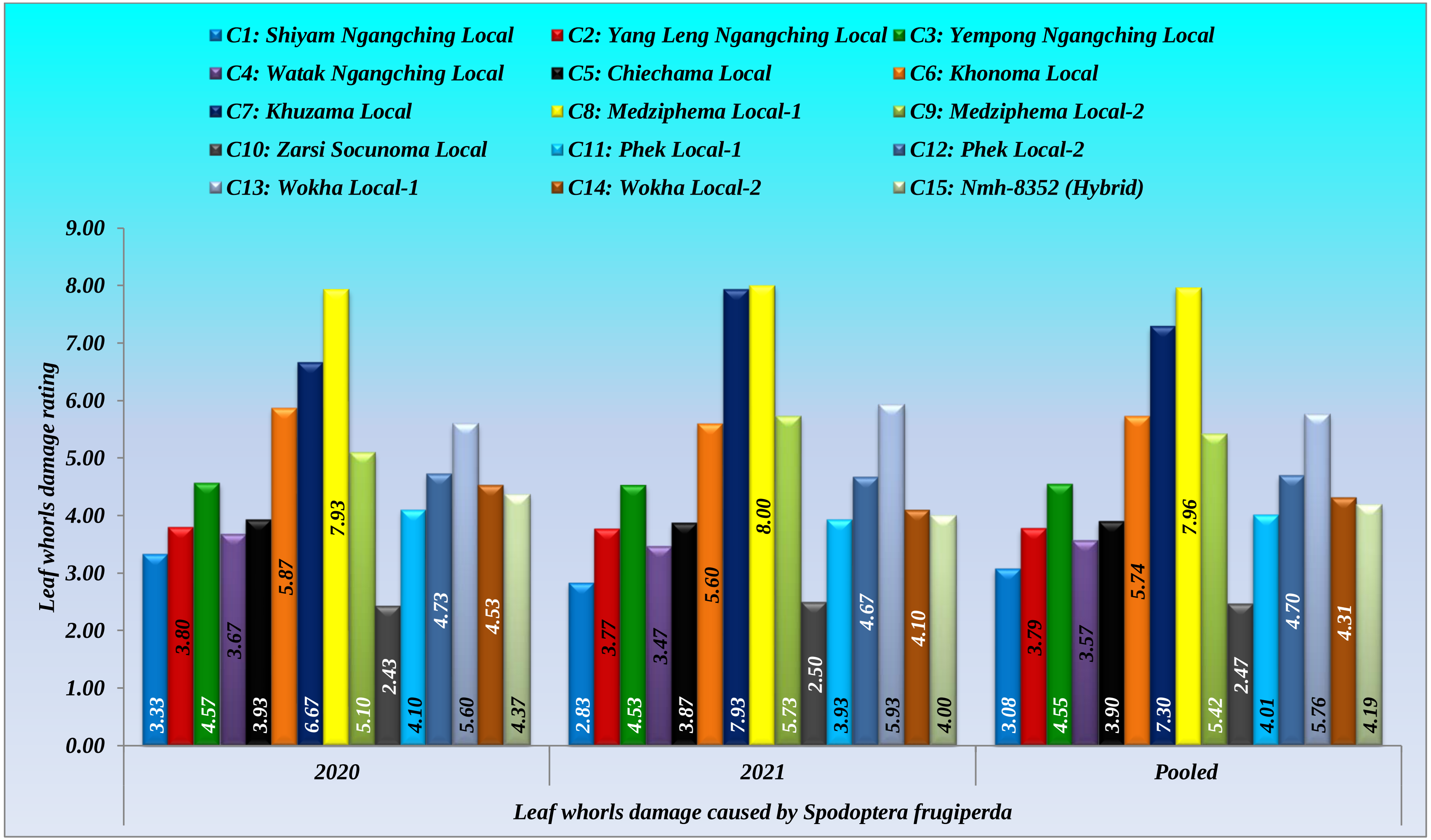

Fig 4.10: Screening of different local cultivars of maize on leaf whorls damage caused by fall armyworm, *Spodoptera frugiperda* during April to June 2020 and April to June 2021

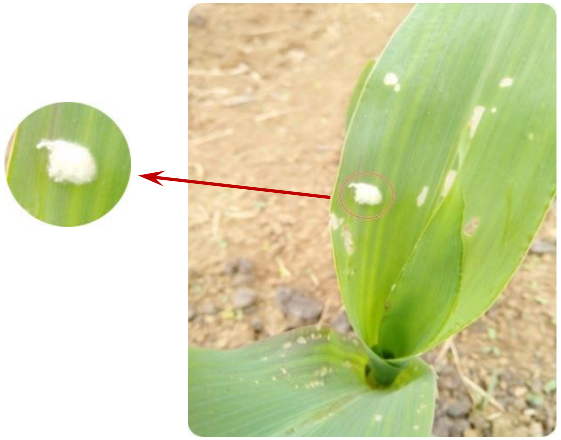

Plate 6a: Egg mass of *Spodoptera frugiperda*

Plate 6b: 2nd instar larva of *Spodoptera frugiperda* feeding on leaf whorls

Plate 6c: 4th instar larva of *Spodoptera frugiperda* feeding on leaf whorls

Plate 6d: Cob infestation caused by *Spodoptera frugiperda*

Plate 6e: Deformed cob caused by *Spodoptera frugiperda*

Plate 6f: Deformed cob caused by *Spodoptera frugiperda*

Plate 6: Damaged and symptoms caused byfall armyworm, *Spodoptera frugiperda*

with 3.93 leaf whorls damage rating. The cultivars which are moderately resistant to leaf whorls damage caused by *S. frugiperda* were Yempong Ngangching Local, Khonoma Local, Medziphema Local-2, Phek Local-1, Phek Local-2, Wokha Local-1, Wokha Local-2 and Nmh-8352 with 4.57, 5.87, 5.10, 4.10, 4.73, 5.60, 4.53 and 4.37 leaf whorls damage rating, respectively. Among these moderately resistant cultivars the minimum leaf whorls damage was observed in cultivar Phek Local-1 with 4.10 leaf whorls damage rating and the maximum leaf whorls damage was observed in cultivar Khonoma Local with 5.87 leaf whorls damage rating. The two cultivars which are susceptible to leaf whorls damage caused by *S. frugiperda* were Khuzama Local and Medziphema Local-1 with 6.67 and 7.93 leaf whorls damage rating, respectively during 2020.

During the year 2021, out of fifteen (15) cultivars, six (6) cultivars were found resistant; seven (7) cultivars were moderately resistant, one (1) cultivar was susceptible and one (1) cultivar was found highly susceptible to *S. frugiperda* during 2021. The cultivars which are resistant to leaf whorls damage caused by *S. frugiperda* were Shiyam Ngangching Local, Yang Leng Ngangching Local, Watak Ngangching Local, Chiechama Local, Zarsi Socunoma Local and Phek Local-2 with 2.83, 3.77, 3.47, 3.87, 2.50 and 3.93 leaf whorls damage rating, respectively. Among these resistant cultivars, the minimum leaf whorls damage was observed in cultivar Zarsi Socunoma with 2.50 leaf whorls damage rating and the maximum was observed in cultivar Phek Local-1 with 3.93 leaf whorls damage rating. The cultivars which are moderately resistant to leaf whorls damage caused by *S. frugiperda* were Yempong Ngangching Local, Khonoma Local, Medziphema Local-2, Phek Local-2, Wokha Local-1, Wokha Local-2 and Nmh-8352 with 4.53, 5.60, 5.73, 4.67, 5.93, 4.10 and 4.00 leaf whorls damage rating, respectively. Among these moderately resistant cultivars, the minimum leaf whorls damage was observed in cultivar Nmh-8352 with 4.00 leaf whorls damage rating and the maximum leaf whorls damage was observed in cultivar Wokha Local-1 with 5.93 leaf whorls damage rating. The only cultivar which was susceptible and highly susceptible to leaf whorls damage caused by *S. frugiperda* was Khuzama Local and Medziphema Local-1 with 7.93 and 8.00 leaf whorls damage rating, respectively during 2021.

Pooled data revealed that out of fifteen (15) cultivars, five (5) cultivars were found resistant and eight (8) cultivars were moderately resistant and two (2) cultivars was observed susceptible to *S. frugiperda*. The cultivars which are resistant to leaf whorls damage caused by *S. frugiperda* were Shiyam Ngangching Local, Yang Leng Ngangching Local, Watak Ngangching Local, Chiechama Local and Zarsi Socunoma Local with 3.08, 3.78, 3.57, 3.90 and 2.47 leaf whorls damage rating, respectively. Among these resistant cultivars, the minimum leaf whorls damage was observed in cultivar Zarsi Socunoma with 3.08 leaf whorls damage rating and the maximum was observed in cultivar Chiechama Local with 3.90 leaf whorls damage rating. The cultivars which are moderately resistant to leaf whorls damage caused by *S. frugiperda* were Yempong Ngangching Local, Khonoma Local, Medziphema Local-2, Phek Local-1, Phek Local-2, Wokha Local-1, Wokha Local-2 and Nmh-8352 with 4.55, 5.73, 5.42, 4.02, 4.70, 5.77, 4.32 and 4.18 leaf whorls damage rating, respectively. Among these moderately resistant cultivars, the minimum leaf whorls damage was observed in cultivar Phek Local-1 with 4.02 leaf whorls damage rating and the maximum leaf whorls damage was observed in cultivar Wokha Local-1 with 5.77 leaf whorls damage rating. The two cultivars which are susceptible to leaf whorls damage caused by *S. frugiperda* were Khuzama Local and Medziphema Local-1 with 7.30 and 7.97 leaf whorls damage rating, respectively.

The present results are in accordance with the findings ofPaul andDeole (2020a) who reported that the leaf whorls damage caused by fall armyworm ranged from 2.36 to 8.21 among twenty five genotypes in which the highest was recorded in genotype NK-30 with 8.21 and the lowest in genotype

DKC-9182 with 2.36. The results are also in agreement with the findings ofKasoma*et al.* (2020) who reported that the leaf whorls damage caused by fall armyworm ranged from 1.00 to 5.00 among fifteen genotypes in which the highest was recorded in genotype EBL169550 with 5.00 and the lowest in the genotypes CML545-B, CZL1466, CZL16095, MM501 and Pool 16 with 1.00 rating each. The results are also in conformity with the findings of Sebayang*et al.* (2022) who reported that the leaf whorls damage caused by fall armyworm ranged from 4.18 to 6.05 rating among fifteen genotypes in which the highest was recorded in genotype Pop.11 with 6.05 and the lowest in Pop.02 with 4.18 rating.

4.5. Studies on the morphological characteristics of different local cultivars of maize during April to June 2020 and April to June 2021

In the present findings, the morpho-physiological characteristics viz., stem diameter, leaf length, leaf width, leaf area, number of trichomes, plant height, cob length, cob height, length of central spike, and 100 grain weight were evaluated from fifteen (14) localcultivars and one hybrid variety to determine the significant difference among the maize cultivars. The details of the findings are emphasized under the following heads:

4.5.1. Studies on the stem diameter of different local cultivars of maize during April to June 2020 and April to June 2021

The stem diameter per plant on different local cultivars of maize showed a significant difference as evident from the Table 4.17 and Fig. 4.11 in both the years. Among the fifteen (15) cultivars, the stem diameter ranged between 3.10 to 3.77 cm per plant and 3.13 to 3.83 cm per plant during 2020 and 2021, respectively. Out of fifteen (15) cultivars, the maximum stem diameter was observed in cultivar Yempong Ngangching Local with 3.77 and 3.83 cm per plant during 2020 and 2021, respectively. These were followed by the cultivars Khuzama Local, Phek Local-1, Watak Ngangching Local, Wokha Local-2, Shiyam Ngangching Local, Khonoma Local and Phek Local-2 with (3.67,

Table 4.17: Effect of different local maize cultivars on stem diameter during May to June 2020 and May to June 2021

Cultivars	***Stem diameter (cm)***		
	2020	***2021***	***Pooled***
C_1: Shiyam Ngangching Local	3.37 (1.97)	3.40 (1.97)	3.38 (1.97)
C_2: Yang Leng Ngangching Local	3.17 (1.91)	3.23 (1.93)	3.20 (1.92)
C_3: Yempong Ngangching Local	3.77 (2.07)	3.83 (2.08)	3.80 (2.07)
C_4: Watak Ngangching Local	3.43 (1.98)	3.50 (2.00)	3.47 (1.99)
C_5: Chiechama Local	3.20 (1.92)	3.27 (1.94)	3.23 (1.93)
C_6: Khonoma Local	3.30 (1.95)	3.37 (1.97)	3.33 (1.96)
C_7: Khuzama Local	3.67 (2.04)	3.73 (2.06)	3.70 (2.05)
C_8: Medziphema Local-1	3.13 (1.91)	3.17 (1.91)	3.15 (1.91)
C_9: Medziphema Local-2	3.17 (1.91)	3.23 (1.93)	3.20 (1.92)
C_{10}: Zarsi Socunoma Local	3.10 (1.90)	3.13 (1.91)	3.12 (1.90)
C_{11}: Phek Local-1	3.57 (2.02)	3.60 (2.02)	3.58 (2.02)
C_{12}: Phek Local-2	3.30 (1.95)	3.37 (1.97)	3.33 (1.96)
C_{13}: Wokha Local-1	3.23 (1.93)	3.30 (1.95)	3.27 (1.94)
C_{14}: Wokha Local-2	3.37 (1.97)	3.43 (1.98)	3.40 (1.97)
C_{15}: Nmh-8352 (Hybrid)	3.10 (1.90)	3.17 (1.91)	3.13 (1.91)
SEm±	***0.08***	***0.10***	***0.06***
CD (P= 0.05)	***0.24***	***0.28***	***0.18***

Note:Figures in the table are mean values and those in parenthesis are square root transformed values

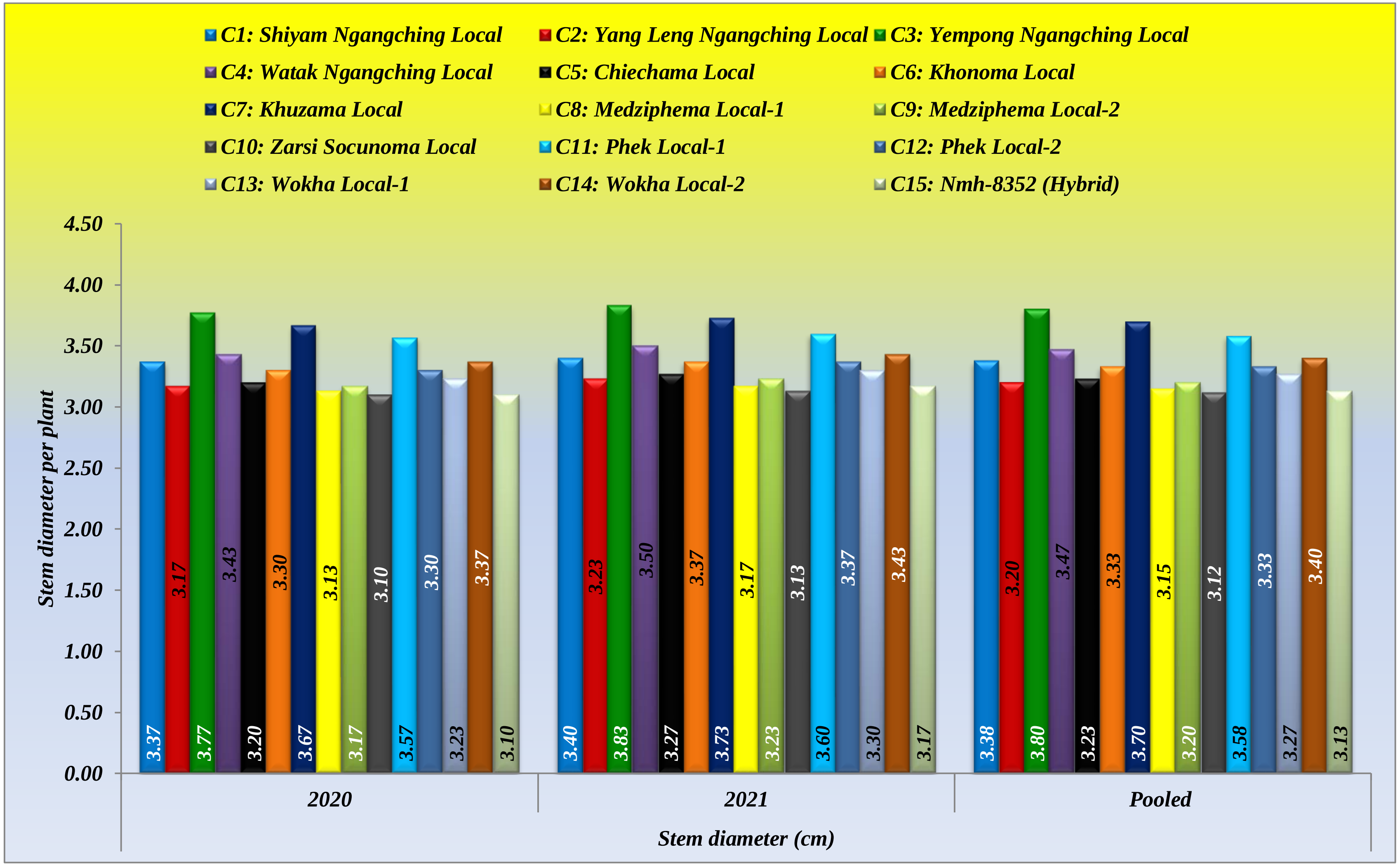

Fig 4.11:Effect of different local maize cultivars on stem diameter during May to June 2020 and May to June 2021

3.57, 3.43, 3.37, 3.37, 3.30 & 3.30 cm) and (3.73, 360, 350, 3.43, 3.40&3.37 cm) per plant during 2020 and 2021, respectively. The minimum stem diameter was observed in the cultivars Zarsi Socunoma Local and Nmh-8352 with 3.10 cm each per plant during 2020 but during 2021 the minimum stem diameter was observed in cultivar Zarsi Socunoma Local with 3.13 cm per plant.

Similarly, pooled data also revealed that the maximum stem diameter was observed in cultivar Yempong Ngangching Local with 3.80 cm per plant. These was followed by the cultivars Khuzama Local, Phek Local-1, Watak Ngangching Local, Wokha Local-2, Shiyam Ngangching Local, Khonoma Local and Phek Local-2 with 3.70, 3.58, 3.47, 3.40, 3.38, 3.33 and 3.33 cm per plant and the minimum stem diameter was observed in the cultivars Zarsi Socunoma Local with 3.12 cm per plant.

The present results are in conformity with the findings ofPatil*et al.* (2018) who reported that the stem diameter ranged from 2.00 to 3.94 cm among nineteen cultivars in which the highest was recorded in cultivar M-01 with 3.94 cm and the lowest in the cultivar M-89 with 2.00 cm. Further, the results are in supported with the findings ofMoshood*et al.* (2018) who reported that the stem diameter ranged from 3.13 to 3.73 cm among four cultivars in which the highest was recorded in cultivar EV99 QPM with 3.73 and the lowest in the cultivar 99 TZEE-Y STR with 3.13 cm. However, the results reported by Farnia and Mansouri (2015) was in contradiction with the present findings who reported that the cultivar AS54 showed the highest stem diameter with 2.10 cm and the lowest was in cultivar AS31 with 1.80 cm. This might be due to different in the physio-morphological characters of the cultivars, geographical location of the study area and and climatic conditions.

4.5.2. Studies on the number of nodes per plant of different local cultivars of maize during April to June 2020 and April to June 2021

The number of nodes per plant on different local cultivars of maize showed a significant difference as evident from the Table 4.18 and Fig. 4.12 in both the years. Among the fifteen (15) cultivars, the number of nodes per plant ranged between 8.00 to 13.25 and 8.17 to 13.82 cm during 2020 and 2021, respectively. Out of fifteen (15) cultivars, the maximum number of nodes per plant was observed in cultivar Yempong Ngangching Local with 13.25 and 13.82 during 2020 and 2021, respectively. These were followed by the cultivars Khuzama Local, Phek Local-1, Wokha Local-2, Watak Ngangching Local, Shiyam Ngangching Local with (12.43, 11.45, 11.03, 10.03 & 10.00) and (12.82, 11.65, 11.28, 10.37 & 10.37) per plant during 2020 and 2021, respectively. The minimum number of nodes per plant was observed in the cultivars Zarsi Socunoma Local and Nmh-8352 with 8.00 each during 2020 but during 2021 the minimum number of nodes per plant was observed in cultivar Zarsi Socunoma Local with 8.17.

Similarly, pooled data also revealed that the maximum number of nodes per plant was observed in cultivar Yempong Ngangching Local with 13.54. These was followed by the cultivars Khuzama Local, Phek Local-1, Wokha Local-2, Watak Ngangching Local, Shiyam Ngangching Local with 12.63, 11.55, 11.16, 10.20 and 10.18 per plant and the minimum number of nodes per plant was observed in cultivar Zarsi Socunoma Local with 8.08.

The present results are in agreement with the findings ofMoshood*et al.* (2018) who reported that the number of nodes per plant ranged from 10.11 to 12.44 among four genotypes in which the highest was recorded in genotypeTZEE-Y POP STRC4 with 12.44 and the lowest in genotype EV99 QPM with 10.11 nodes per plant. Further, the results are in supported with the findings of Afzal *et al.* (2009) who reported that the number of nodes per plant ranged from 12.93 to 16.07 among six genotypes in which the highest was recorded in genotype EV-6098 with 16.07 and the lowest in genotype Sahiwal-2002 with 12.93 nodes per plant.

Table 4.18: Effect of different local maize cultivars on number of nodes per plant during May to June 2020 and May to June 2021

Cultivars	***Number of nodes per plant***		
	2020	***2021***	***Pooled***
C_1: Shiyam Ngangching Local	10.00 (3.24)	10.37 (3.29)	10.18 (3.27)
C_2: Yang Leng Ngangching Local	8.68 (3.03)	9.00 (3.08)	8.84 (3.06)
C_3: Yempong Ngangching Local	13.25 (3.71)	13.82 (3.78)	13.54 (3.74)
C_4: Watak Ngangching Local	11.03 (3.40)	11.28 (3.43)	11.16 (3.41)
C_5: Chiechama Local	9.32 (3.13)	9.50 (3.16)	9.41 (3.14)
C_6: Khonoma Local	9.50 (3.16)	9.83 (3.21)	9.67 (3.19)
C_7: Khuzama Local	12.43 (3.60)	12.82 (3.65)	12.63 (3.62)
C_8: Medziphema Local-1	8.33 (2.97)	8.50 (3.00)	8.42 (2.99)
C_9: Medziphema Local-2	8.45 (2.99)	8.62 (3.02)	8.53 (3.00)
C_{10}: Zarsi Socunoma Local	8.00 (2.91)	8.17 (2.94)	8.08 (2.93)
C_{11}: Phek Local-1	11.45 (3.46)	11.65 (3.48)	11.55 (3.47)
C_{12}: Phek Local-2	9.98 (3.24)	10.28 (3.28)	10.13 (3.26)
C_{13}: Wokha Local-1	9.00 (3.08)	9.25 (3.12)	9.13 (3.10)
C_{14}: Wokha Local-2	10.03 (3.24)	10.37 (3.30)	10.20 (3.27)
C_{15}: Nmh-8352 (Hybrid)	8.00 (2.91)	8.32 (2.97)	8.16 (2.94)
SEm±	***0.52***	***0.49***	***0.35***
CD (P= 0.05)	***1.49***	***1.41***	***1.00***

Note: Figures in the table are mean values and those in parenthesis are square root transformed values

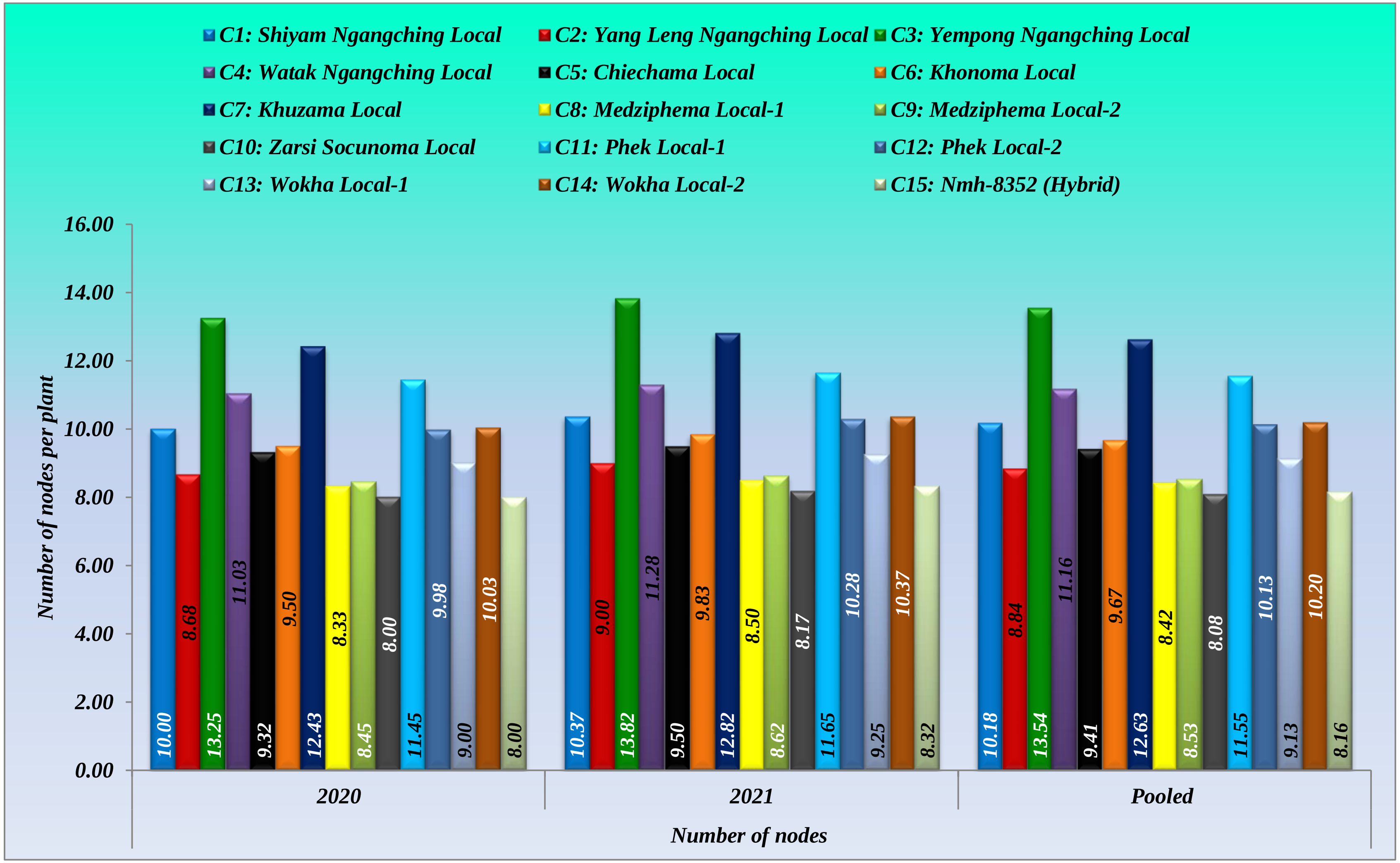

Fig 4.12: Effect of different local maize cultivars on number of nodesduring May to June 2020 and May to June 2021

4.5.3. Studies on the leaf length of different local cultivars of maize during April to June 2020 and April to June 2021

The leaf length on different local cultivars of maize showed a significant difference as evident from the Table 4.19 and Fig. 4.13 in both the years. Among the fifteen (15) cultivars, the leaf length ranged between 56.56 to 88.72 cm and 58.72 to 90.80 cm during 2020 and 2021, respectively. Out of fifteen (15) cultivars, the maximum leaf length was observed in cultivar Yempong Ngangching Local with 88.72 and 90.80 cm during 2020 and 2021, respectively. These were followed by the cultivars Phek Local-1, Watak Ngangching Local, Yang Leng Ngangching Local, Phek Local-2 and Khuzama Local with (85.22, 83.37, 80.85, 80.00 & 79.32 cm) and (87.20, 85.84, 82.43, 81.95 & 80.80 cm) during 2020 and 2021, respectively. The minimum leaf length was observed in cultivar Zarsi Socunoma Local with 56.56 and 58.72 cm during 2020 and 2021, respectively.

Similarly, pooled data also revealed that the maximum leaf length was observed in cultivar Yempong Ngangching Local with 89.76 cm. These was followed by the cultivars Phek Local-1, Watak Ngangching Local, Yang Leng Ngangching Local, Phek Local-2 and Khuzama Local with 86.21, 84.61, 81.64, 80.98 and 80.06 cm and the minimum leaf length was observed in cultivar Zarsi Socunoma Local with 57.64 cm.

The present results are in conformity with the findings ofRasool*et al.* (2017) who reported that the leaf length ranged from 71.60 to 91.13 cm among twenty four cultivars in which the highest was recorded in cultivar C-15 with91.13 cm and the lowest in cultivar Basi Local with 71.60 cm. Similar findings was also reported by Patil*et al.* (2018) who stated that the leaf length ranged from 69.06 to 95.56 cm among nineteen cultivars in which the highest was recorded in cultivar M-87 with 95.56 cm and the lowest in cultivar M-13 with 69.06 cm. Further, the results are in supported with the findings ofAfzal *et al.* (2009) who reported that the leaf length ranged from 76.87 to 91.43 cm among

Table 4.19: Effect of different local maize cultivars on leaf length during April to June 2020 and April to June 2021

Cultivars	***Leaf length (cm)***		
	2020	***2021***	***Pooled***
C_1: Shiyam Ngangching Local	73.38 (8.59)	75.62 (8.72)	74.50 (8.66)
C_2: Yang Leng Ngangching Local	80.85 (9.02)	82.43 (9.11)	81.64 (9.06)
C_3: Yempong Ngangching Local	88.72 (9.45)	90.80 (9.55)	89.76 (9.50)
C_4: Watak Ngangching Local	83.37 (9.16)	85.84 (9.29)	84.61 (9.22)
C_5: Chiechama Local	71.20 (8.45)	73.35 (8.58)	72.27 (8.52)
C_6: Khonoma Local	76.85 (8.79)	78.92 (8.91)	77.88 (8.85)
C_7: Khuzama Local	79.32 (8.93)	80.80 (9.02)	80.06 (8.98)
C_8: Medziphema Local-1	59.18 (7.72)	60.87 (7.83)	60.02 (7.78)
C_9: Medziphema Local-2	60.95 (7.84)	62.98 (7.93)	61.97 (7.90)
C_{10}: Zarsi Socunoma Local	56.56 (7.54)	58.72 (7.68)	57.64 (7.61)
C_{11}: Phek Local-1	85.22 (9.26)	87.20 (9.36)	86.21 (9.31)
C_{12}: Phek Local-2	80.00 (8.97)	81.95 (9.08)	80.98 (9.02)
C_{13}: Wokha Local-1	77.12 (8.81)	79.12 (8.92)	78.12 (8.87)
C_{14}: Wokha Local-2	73.52 (8.60)	75.20 (8.70)	74.36 (8.65)
C_{15}: Nmh-8352 (Hybrid)	62.35 (7.93)	64.27 (8.05)	63.31 (7.99)
SEm±	***2.40***	***2.47***	***1.72***
CD (P= 0.05)	***6.97***	***7.14***	***4.88***

Note: Figures in the table are mean values and those in parenthesis are square root transformed values

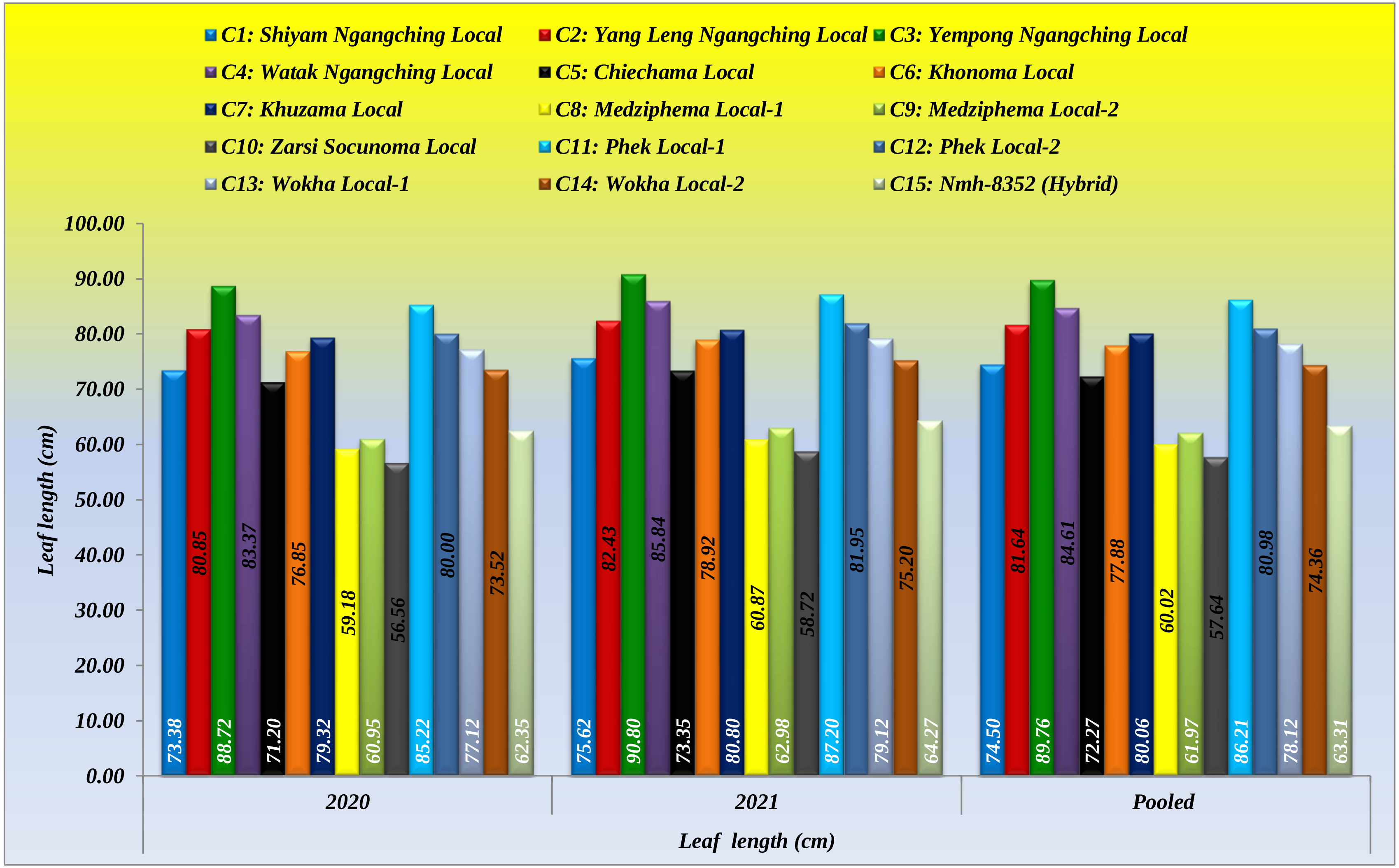

Fig 4.13: Effect of different local maize cultivars on leaf length during April to June 2020 and May to June 2021

six genotypes in which the highest was recorded in genotype 32-W-86 with 91.43 cm and the lowest in genotype 34-N-43 with 76.87 cm.

4.5.4. Studies on the leaf width of different local cultivars of maize during April to June 2020 and April to June 2021

The leaf width on different local cultivars of maize showed a significant difference as evident from the Table 4.20 and Fig. 4.14 in both the years. Among the fifteen (15) cultivars, the leaf width ranged between 7.25 to 8.30 cm and 7.69 to 8.69 cm during 2020 and 2021, respectively. Out of fifteen (15) cultivars, the maximum leaf width was observed in cultivar Medziphema Local-1 with 8.30 and 8.69 cm per plant during 2020 and 2021, respectively. These were followed by the cultivars Wokha Local-2, Phek Local-1, Khuzama Local and Nmh-8352 with (8.18, 8.11, 8.02 & 8.01 cm) and (8.62, 8.53, 8.50 & 8.34 cm) during 2020 and 2021, respectively. The minimum leaf width was observed in cultivar Medziphema Local-2 with 7.25 and 7.69 cm during 2020 and 2021, respectively.

Similarly, pooled data also revealed that the maximum leaf width was also observed in cultivar Medziphema Local-1 with 8.50 cm. These was followed by the cultivars Wokha Local-2, Phek Local-1, Khuzama Local and Nmh-8352 with 8.40, 8.32, 8.26 and 8.18 cm and the minimum leaf width was observed in cultivar Medziphema Local-2 with 7.47 cm.

The present results are in conformity with the findings of Afzal *et al.* (2009) who reported that the leaf width ranged from 7.93 to 9.40 cm among six genotypes in which the highest was recorded in genotype EV-6098 with 9.40cm and the lowest in genotype Sahiwal-2002 with 7.93 cm. Further, the results are in supported with the findings ofMoshood*et al.* (2018) who reported that the leaf width ranged from 8.11 to 9.89 cm among four genotypes in which the highest was recorded in genotype TZEE-Y POP STRC4 with 9.89 cm and the lowest in (genotype 99 TZEE-Y STR with 8.11 cm. However, the results reported by Patil*et al.* (2018) was in contradiction with the present findings

Table 4.20: Effect of different local maize cultivars on leaf width during April to June 2020 and April to June 2021

Cultivars	*Leaf width (cm)*		
	2020	***2021***	***Pooled***
C_1: Shiyam Ngangching Local	7.67 (2.86)	8.22 (2.95)	7.95 (2.91)
C_2: Yang Leng Ngangching Local	7.74 (2.87)	8.26 (2.96)	8.00 (2.91)
C_3: Yempong Ngangching Local	7.81 (2.88)	8.32 (2.97)	8.06 (2.93)
C_4: Watak Ngangching Local	7.63 (2.85)	7.97 (2.91)	7.80 (2.88)
C_5: Chiechama Local	7.86 (2.89)	8.26 (2.96)	8.06 (2.93)
C_6: Khonoma Local	7.81 (2.88)	8.18 (2.95)	8.00 (2.91)
C_7: Khuzama Local	8.02 (2.92)	8.50 (3.00)	8.26 (2.96)
C_8: Medziphema Local-1	8.30 (2.97)	8.69 (3.03)	8.50 (3.00)
C_9: Medziphema Local-2	7.25 (2.78)	7.69 (2.86)	7.47 (2.82)
C_{10}: Zarsi Socunoma Local	7.45 (2.82)	7.83 (2.89)	7.64 (2.85)
C_{11}: Phek Local-1	8.11 (2.93)	8.53 (3.00)	8.32 (2.97)
C_{12}: Phek Local-2	7.80 (2.88)	8.15 (2.94)	7.98 (2.91)
C_{13}: Wokha Local-1	7.99 (2.91)	8.39 (2.98)	8.19 (2.95)
C_{14}: Wokha Local-2	8.18 (2.95)	8.62 (3.03)	8.40 (2.98)
C_{15}: Nmh-8352 (Hybrid)	8.01 (2.92)	8.34 (2.97)	8.18 (2.95)
SEm±	***0.12***	***0.19***	***0.11***
CD (P= 0.05)	***0.34***	***0.55***	***0.32***

Note: Figures in the table are mean values and those in parenthesis are square root transformed values

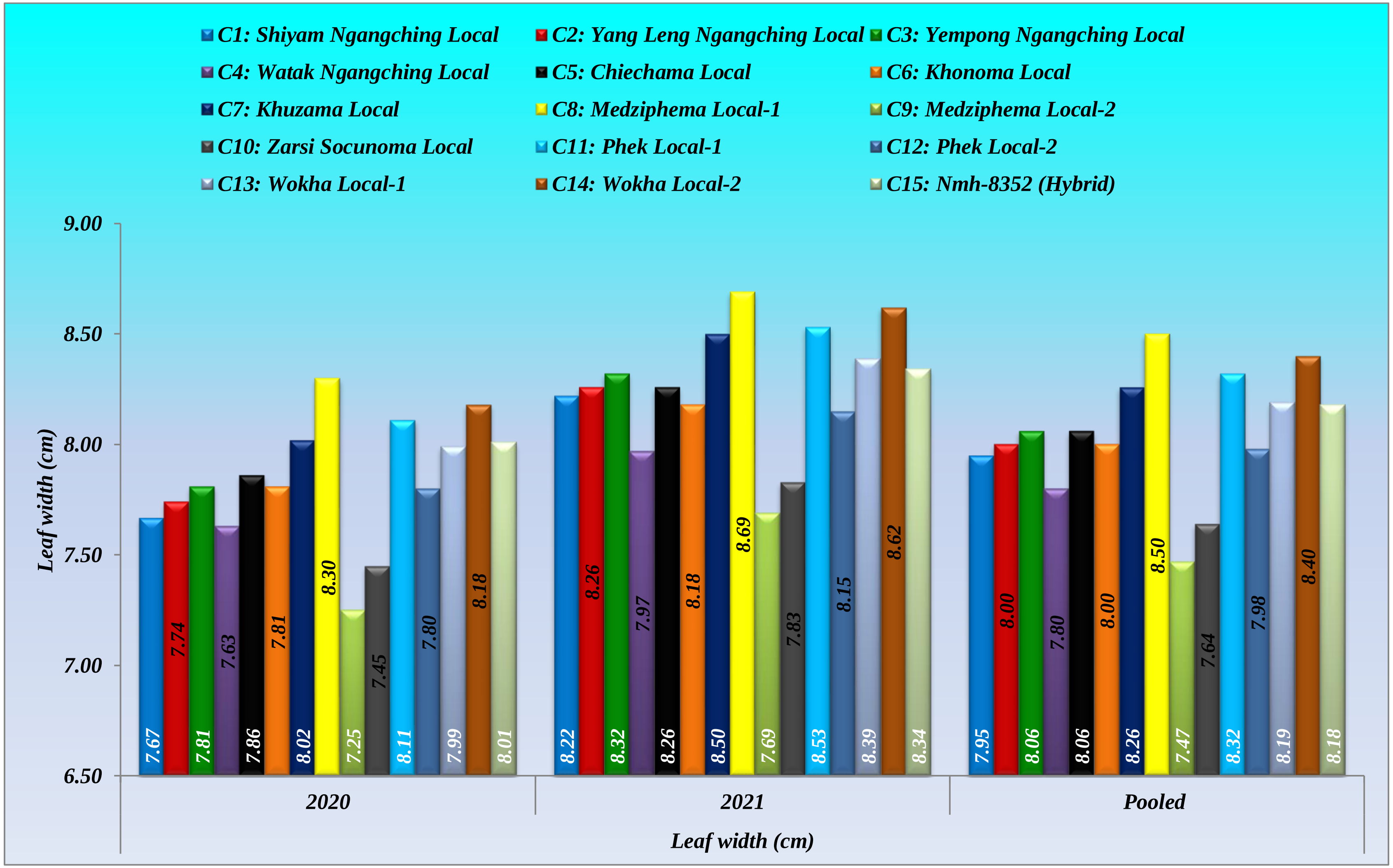

Fig 4.14: Effect of different local maize cultivars on leaf widthduring April to June 2020 and May to June 2021

who reported that the genotypes M-13 and M-18 showed the highest leaf width with 11.38 cm each and the lowest was in genotype M-77 with 7.28 cm. This might be due to different in the physio-morphological characters of the cultivars, geographical location of the study area and and climatic conditions.

4.5.5. Studies on the leaf area of different local cultivars of maize during April to June 2020 and April to June 2021

The leaf area on different local cultivars of maize showed a significant difference as evident from the Table 4.21 and Fig. 4.15 in both the years. Among the fifteen (15) cultivars, the leaf area ranged between 420.30 to 692.73 cm^2 and 458.98 to 755.20 cm^2 during 2020 and 2021, respectively. Out of fifteen (15) cultivars, the maximum leaf area was observed in cultivar Yempong Ngangching Local with 692.73 and 755.20 cm^2 during 2020 and 2021, respectively. These were followed by the cultivars Phek Local-1, Khuzama Local, Watak Ngangching Local, Yang Leng Ngangching Local and Phek Local-2 with (691.89, 636.31, 635.66, 625.65 & 623.43 cm^2) and (744.09, 686.46, 683.60, 680.94 & 668.22 cm^2) during 2020 and 2021, respectively. The minimum leaf area was observed in cultivar Zarsi Socunoma Local with 420.30 and 458.98 cm^2 during 2020 and 2021, respectively.

Similarly, pooled data also revealed that the maximum leaf area was also observed in cultivar Yempong Ngangching Local with 723.97 cm^2. These was followed by the cultivars Phek Local-1, Khuzama Local, Watak Ngangching Local, Yang Leng Ngangching Local and Phek Local-2 with 717.99, 661.38, 659.63, 653.29 and 645.83 cm^2 and the minimum leaf area wasobserved in cultivar Zarsi Socunoma Local with 439.64 cm^2.

The present results are in agreement with the findings ofPaul and Deole (2020a) who reported that the leaf area ranged from 298.67 to 732.54 cm^2 among twenty five genotypes in which the highest was recorded in genotype INDAM1122 with 732.54 cm^2 and the lowest in genotype DKC-9182 with 298.67 cm^2.

Table 4.21: Effect of different local maize cultivars on leaf areaduring April to June 2020 and April to June 2021

Cultivars	*Leaf area (cm^2)*		
	2020	***2021***	***Pooled***
C_1: Shiyam Ngangching Local	563.04 (25.02)	622.51 (24.94)	592.78 (24.35)
C_2: Yang Leng Ngangching Local	625.65 (23.73)	680.94 (26.10)	653.29 (25.56)
C_3: Yempong Ngangching Local	692.73 (26.33)	755.20 (27.49)	723.97 (26.91)
C_4: Watak Ngangching Local	635.66 (25.22)	683.60 (26.15)	659.63 (25.69)
C_5: Chiechama Local	560.15 (23.63)	607.60 (24.59)	583.87 (24.11)
C_6: Khonoma Local	600.57 (24.51)	645.91 (25.42)	623.24 (24.97)
C_7: Khuzama Local	636.31 (25.23)	686.46 (26.20)	661.38 (25.73)
C_8: Medziphema Local-1	491.43 (22.17)	529.63 (23.01)	510.53 (22.60)
C_9: Medziphema Local-2	442.09 (21.04)	484.10 (22.01)	463.10 (21.53)
C_{10}: Zarsi Socunoma Local	420.30 (20.49)	458.98 (21.41)	439.64 (20.95)
C_{11}: Phek Local-1	691.89 (26.30)	744.09 (27.27)	717.99 (26.79)
C_{12}: Phek Local-2	623.43 (24.98)	668.22 (25.85)	645.83 (25.42)
C_{13}: Wokha Local-1	616.71 (24.84)	663.41 (25.76)	640.06 (25.30)
C_{14}: Wokha Local-2	602.61 (24.54)	648.07 (24.46)	625.34 (25.00)
C_{15}: Nmh-8352 (Hybrid)	499.42 (22.35)	536.23 (23.17)	517.82 (22.76)
SEm±	***21.48***	***26.86***	***17.20***
CD (P= 0.05)	***62.21***	***77.82***	***48.72***

Note: Figures in the table are mean values and those in parenthesis are square root transformed values

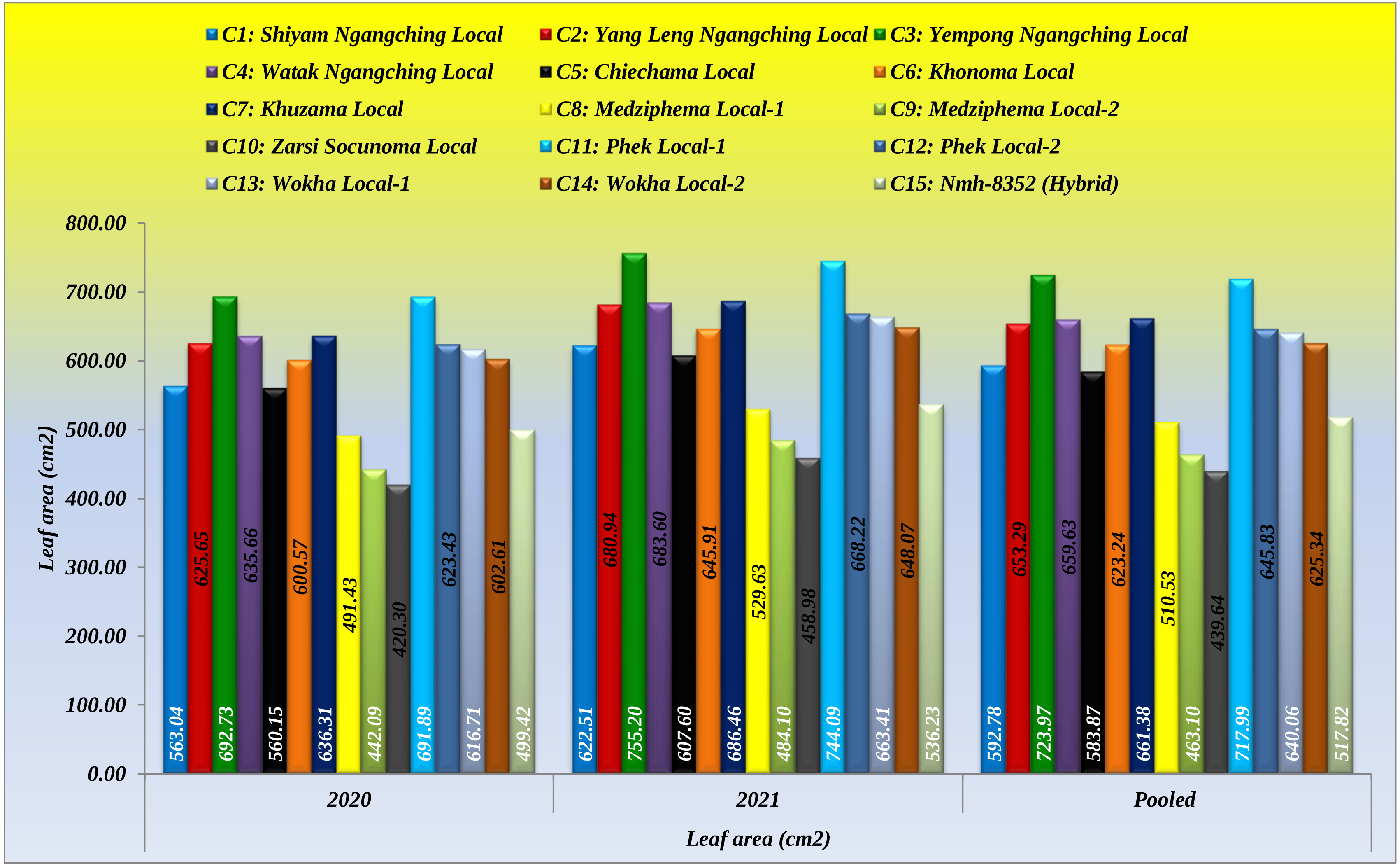

Fig 4.15: Effect of different local maize cultivars on leaf area during April to June 2020 and May to June 2021

4.5.6. Studies on the number of leaf trichomes of different local cultivars of maize during April to June 2020 and April to June 2021

The number of leaf trichomes on different local cultivars of maize showed a significant difference as evident from the Table 4.22 and Fig. 4.16 in both the years. Among the fifteen (15) cultivars, the number of leaf trichomes ranged between 10.72 to 38.92 and 10.60 to 43.87 during 2020 and 2021, respectively. Out of fifteen (15) cultivars, the maximum number of leaf trichomes was observed in cultivar Chiechama Local with 38.92 and 43.87 during 2020 and 2021, respectively. These were followed by the cultivars Khuzama Local, Wokha Local-1, Medziphema Local-2, Watak Ngangching Local and Phek Local-1 with (37.27, 36.82, 34.50, 32.50 & 30.27) and (40.20, 39.87, 37.20, 36.50 & 32.70) during 2020 and 2021, respectively. The minimum number of leaf trichomes was observed in cultivar Yang Leng Ngangching Local with 10.72 and 10.60 during 2020 and 2021, respectively.

Similarly, pooled data also revealed that the maximum number of leaf trichomes was also observed in cultivar Chiechama Local with 41.40. These was followed by the cultivars Khuzama Local, Wokha Local-1, Medziphema Local-2, Watak Ngangching Local and Phek Local-1 with 38.73, 38.35, 35.85, 34.50 and 31.48 and the minimum number of leaf trichomes was observed in cultivar Yang Leng Ngangching Local with 10.66.

The present results are in contradiction with the findings ofPaul and Deole (2020a) who reported that the number of leaf trichomes ranged from26.98 to 73.68 among twenty five genotypes in which the highest was recorded in genotype ADV-9293 with 73.68 and the lowest in genotype Pro-4212 with 26.98. This might be due to different in the physio-morphological characters of the cultivars, geographical location of the study area and and climatic conditions.

Table 4.22: Effect of different local maize cultivars on number of leaf trichomesduring April to June 2020 and April to June 2021

Cultivars	*Number of leaf trichomes*		
	2020	***2021***	***Pooled***
C_1: Shiyam Ngangching Local	12.00 (3.53)	12.80 (3.65)	12.40 (3.59)
C_2: Yang Leng Ngangching Local	10.72 (3.35)	10.60 (3.33)	10.66 (3.34)
C_3: Yempong Ngangching Local	15.80 (4.02)	19.13 (4.43)	17.47 (4.23)
C_4: Watak Ngangching Local	32.50 (5.74)	36.50 (6.08)	34.50 (5.92)
C_5: Chiechama Local	38.92 (6.28)	43.87 (6.66)	41.40 (6.47)
C_6: Khonoma Local	22.80 (4.83)	24.67 (5.02)	23.73 (4.92)
C_7: Khuzama Local	37.27 (6.13)	40.20 (6.37)	38.73 (6.25)
C_8: Medziphema Local-1	29.92 (5.52)	32.70 (5.76)	31.31 (5.64)
C_9: Medziphema Local-2	34.50 (5.92)	37.20 (6.14)	35.85 (6.03)
C_{10}: Zarsi Socunoma Local	26.00 (5.14)	28.67 (5.38)	27.33 (5.26)
C_{11}: Phek Local-1	30.27 (5.54)	32.70 (5.76)	31.48 (5.65)
C_{12}: Phek Local-2	22.62 (4.81)	24.97 (5.04)	23.80 (4.93)
C_{13}: Wokha Local-1	36.82 (6.11)	39.87 (6.35)	38.35 (6.23)
C_{14}: Wokha Local-2	16.27 (4.09)	19.47 (4.46)	17.87 (4.28)
C_{15}: Nmh-8352 (Hybrid)	18.42 (4.34)	20.50 (4.58)	19.46 (4.46)
SEm±	***1.46***	***1.68***	***1.11***
CD (P= 0.05)	***4.23***	***4.85***	***3.15***

Note: Figures in the table are mean values and those in parenthesis are square root transformed values

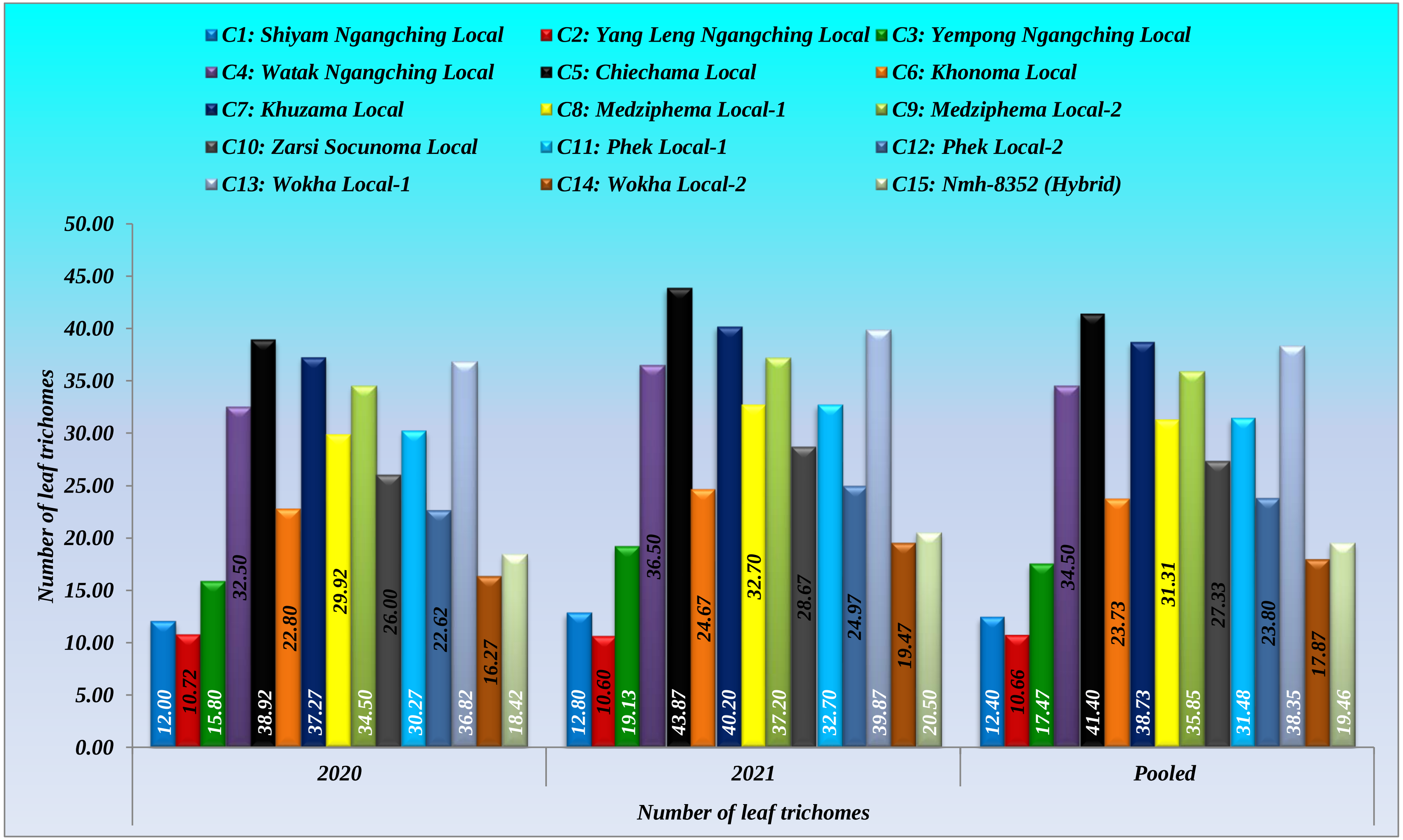

Fig 4.16: Effect of different local maize cultivars on number of leaf trichomes during April to June 2020 and May to June 2021

4.5.7. Studies on the plant height of different local cultivars of maize during April to June 2020 and April to June 2021

The plant height on different local cultivars of maize showed a significant difference as evident from the Table 4.23 and Fig. 4.17 in both the years. Among the fifteen (15) cultivars, the plant height ranged between 130.00 to 265.00 cm and 133.33 to 276.67 cm during 2020 and 2021, respectively. Out of fifteen (15) cultivars, the maximum plant height was observed in cultivar Yempong Ngangching Local with 265.00 and 276.67 cm during 2020 and 2021, respectively. These were followed by the cultivars Khuzama Local, Phek Local-1, Watak Ngangching Local, Wokha Local-2 and Shiyam Ngangching Local with (248.33, 229.00, 220.67, 200.67 & 200.00 cm) and (256.67, 233.00, 225.67, 207.33 & 207.33 cm) during 2020 and 2021, respectively. The minimum plant height was observed in cultivar Zarsi Socunoma Local with 130.00 and 133.33 cm during 2020 and 2021, respectively.

Similarly, pooled data also revealed that the maximum plant height was also observed in cultivar Yempong Ngangching Local with 270.83 cm. These was followed by the cultivars Khuzama Local, Phek Local-1, Watak Ngangching Local, Wokha Local-2 and Shiyam Ngangching Local with 252.50, 231.00, 223.17, 204.00 and 203.67 cm and the minimum plant height was observed in cultivar Zarsi Socunoma Local with 131.67 cm.

The present results are in agreement with the findings ofAfzal *et al.* (2009) who reported that the plant height ranged from 192.93 to 255.77 cm among six genotypes in which the highest was recorded in genotype 32-W-86 with 255.77 cm and the lowest in genotype 34-N-43 with 192.93 cm. Similarly, the results are in supported with the findings ofMoshood*et al.* (2018) who reported that the plant height ranged from 190.33 to 216.89 cm among four genotypes in which the highest was recorded in genotype TZEE-Y POP STRC4 with 216.89 cm and the lowest in genotype EV99 QPM with 190.33 cm. Further, the results are also in supported with the findings of

Table 4.23: Effect of different local maize cultivars on plant heightduring April to June 2020 and April to June 2021

Cultivars	*Plant height (cm)*		
	2020	***2021***	***Pooled***
C_1: Shiyam Ngangching Local	200.00 (14.16)	207.33 (14.41)	203.67 (14.29)
C_2: Yang Leng Ngangching Local	155.67 (12.50)	160.00 (12.66)	157.83 (12.58)
C_3: Yempong Ngangching Local	265.00 (16.29)	276.67 (16.65)	270.83 (16.47)
C_4: Watak Ngangching Local	220.67 (14.87)	225.67 (15.04)	223.17 (14.95)
C_5: Chiechama Local	176.33 (13.30)	180.00 (13.44)	178.17 (13.37)
C_6: Khonoma Local	190.00 (13.80)	196.67 (14.03)	193.33 (13.92)
C_7: Khuzama Local	248.33 (15.77)	256.67 (16.04)	252.50 (15.91)
C_8: Medziphema Local-1	136.67 (11.71)	140.00 (11.85)	138.33 (11.78)
C_9: Medziphema Local-2	149.00 (12.22)	152.33 (12.36)	150.67 (12.29)
C_{10}: Zarsi Socunoma Local	130.00 (11.42)	133.33 (11.56)	131.67 (11.49)
C_{11}: Phek Local-1	229.00 (15.14)	233.00 (15.28)	231.00 (15.21)
C_{12}: Phek Local-2	199.67 (14.15)	205.67 (14.36)	202.67 (14.25)
C_{13}: Wokha Local-1	180.00 (13.43)	185.00 (13.61)	182.50 (13.52)
C_{14}: Wokha Local-2	200.67 (14.18)	207.33 (14.41)	204.00 (14.30)
C_{15}: Nmh-8352 (Hybrid)	130.00 (11.42)	136.67 (11.69)	133.33 (11.56)
SEm±	***3.55***	***6.46***	***3.69***
CD (P= 0.05)	***10.30***	***18.73***	***10.45***

Note:Figures in the table are mean values and those in parenthesis are square root transformed values

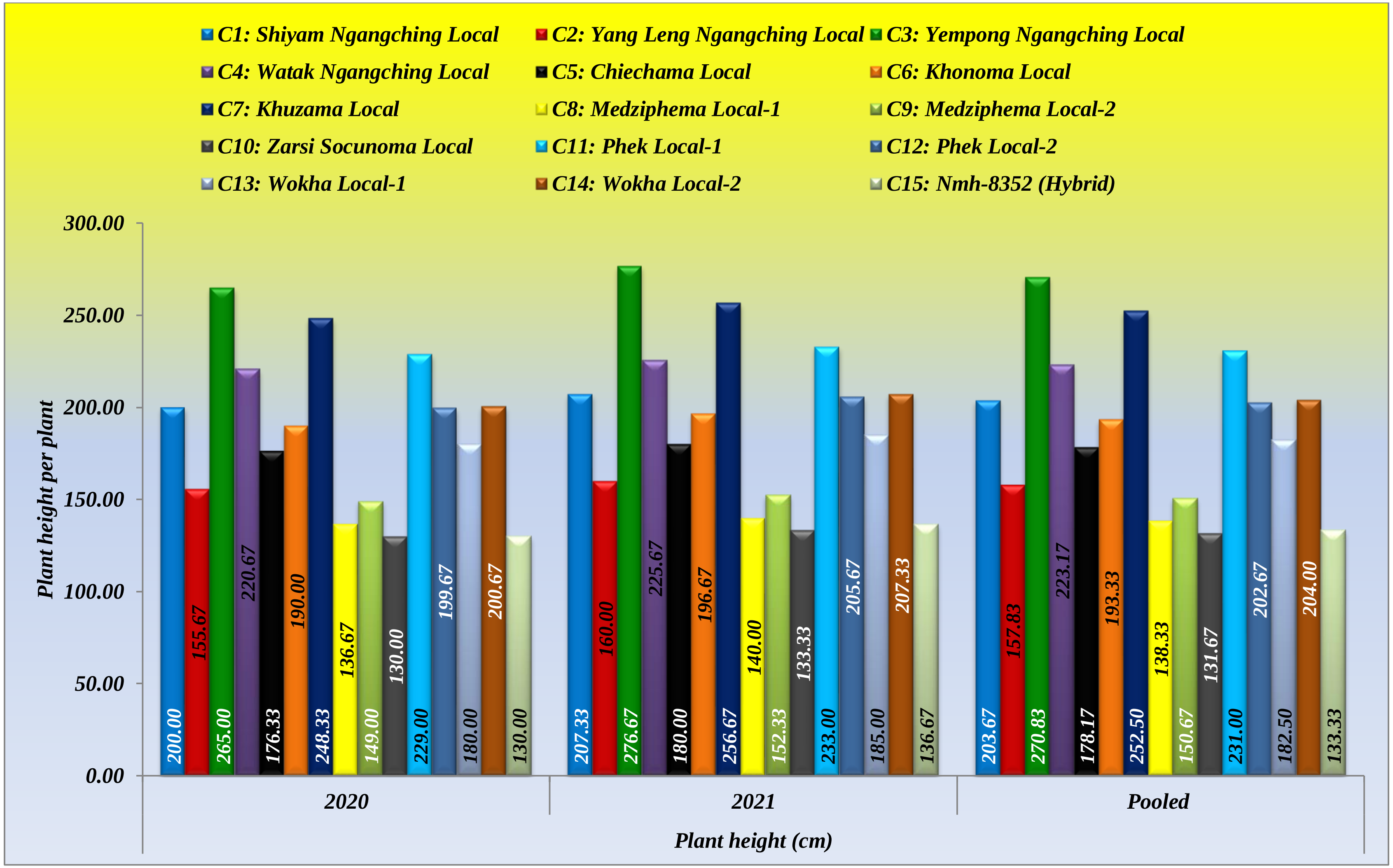

Fig 4.17: Effect of different local maize cultivars on plant height during April to June 2020 and May to June 2021

Longkumer (2020) who reported that the plant height ranged from 196.09 to 224.13 cm among five cultivars in which the highest was recorded in cultivar Sipho with 224.13 cm and the lowest in cultivar Ronimi with 196.09 cm.

4.5.8. Studies on the cob length of different local cultivars of maize during April to June 2020 and April to June 2021

The cob length on different local cultivars of maize showed a significant difference as evident from the Table 4.24 and Fig. 4.18 in both the years. Among the fifteen (15) cultivars, the cob length ranged between 16.67 to 27.67 cm and 18.77 to 29.20 cm during 2020 and 2021, respectively. Out of fifteen (15) cultivars, the maximum cob length was observed in cultivar Phek Local-1 with 27.67 and 29.20 cm during 2020 and 2021, respectively. These were followed by the cultivars Yempong Ngangching Local, Wokha Local-2, Khuzama Local, Watak Ngangching Local and Phek Local-2 with (26.33, 26.23, 25.73, 25.67 & 24.67 cm) and (29.67, 28.30, 28.67, 28.67 & 27.40 cm) during 2020 and 2021, respectively. The minimum cob length was observed in cultivar Medziphema Local-1 with 16.67 and 18.77 cm during 2020 and 2021, respectively.

Similarly, pooled data also revealed that the maximum cob length was also observed in cultivar Phek Local-1 with 28.44 cm. These was followed by the cultivars Yempong Ngangching Local, Wokha Local-2, Phek Local-2, Khuzama Local, Watak Ngangching Local and Phek Local-1 with 28.00, 27.27, 27.20, 27.17 and 26.04 cm and the minimum cob length was observed in cultivar Medziphema Local-1 with 17.72 cm.

The present results are in accordance with the findings of Afzal *et al.* (2009) who reported that the cob length ranged from 18.83 to 26.63 cm amongsix genotypes in which the highest was recorded in genotype 32-W-86 with 26.63 cm and the lowest in genotype Sahiwal-2002 with 18.83 cm. Similar findings was also reported by ofRasool*et al.* (2017) who stated that the cob length ranged from 18.53 to 26.40 cm among twenty four cultivars in which

Table 4.24: Effect of different local maize cultivars on cob lengthduring April to June 2020 and April to June 2021

Cultivars	***Cob length (cm)***		
	2020	***2021***	***Pooled***
C_1: Shiyam Ngangching Local	24.27 (4.61)	27.20 (4.93)	25.73 (4.77)
C_2: Yang Leng Ngangching Local	20.73 (4.98)	23.80 (5.26)	22.27 (5.12)
C_3: Yempong Ngangching Local	26.33 (5.11)	29.67 (5.40)	28.00 (5.26)
C_4: Watak Ngangching Local	25.67 (5.17)	28.67 (5.37)	27.17 (5.27)
C_5: Chiechama Local	24.40 (4.99)	26.40 (5.19)	25.40 (5.09)
C_6: Khonoma Local	22.37 (4.78)	24.20 (4.97)	23.28 (4.87)
C_7: Khuzama Local	25.73 (5.08)	28.67 (5.31)	27.20 (5.20)
C_8: Medziphema Local-1	16.67 (4.14)	18.77 (4.39)	17.72 (4.27)
C_9: Medziphema Local-2	18.67 (4.38)	20.80 (4.61)	19.73 (4.50)
C_{10}: Zarsi Socunoma Local	22.73 (4.82)	25.67 (5.11)	24.20 (4.97)
C_{11}: Phek Local-1	27.67 (5.11)	29.20 (5.47)	28.44 (5.29)
C_{12}: Phek Local-2	24.67 (5.18)	27.40 (5.49)	26.04 (5.34)
C_{13}: Wokha Local-1	24.33 (5.31)	26.67 (5.54)	25.50 (5.42)
C_{14}: Wokha Local-2	26.23 (5.12)	28.30 (5.40)	27.27 (5.26)
C_{15}: Nmh-8352 (Hybrid)	19.60 (4.48)	21.33	20.47 (4.58)
SEm±	***0.75***	***0.71***	***0.52***
CD (P= 0.05)	***2.17***	***2.05***	***1.46***

Note: Figures in the table are mean values and those in parenthesis are square root transformed values

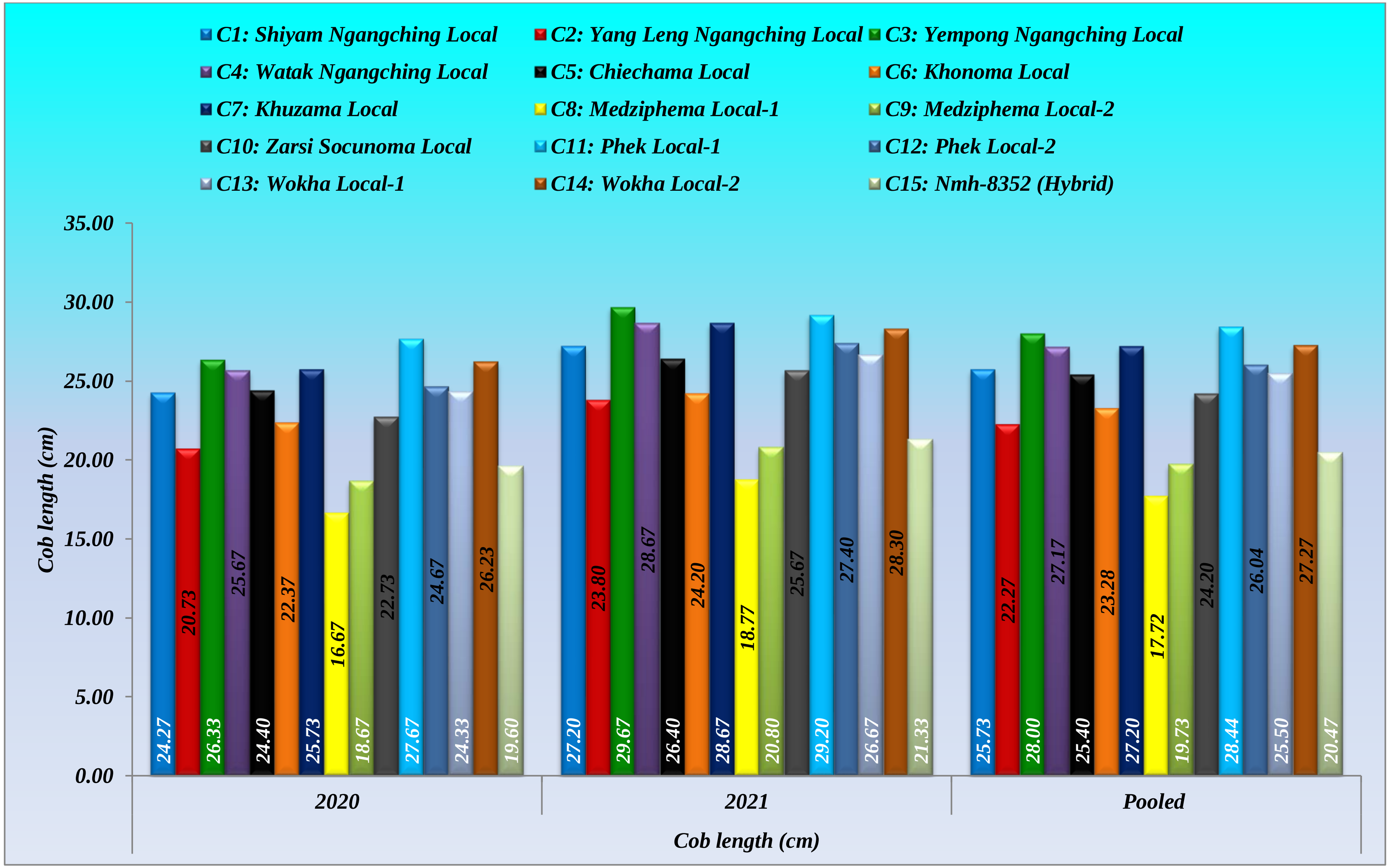

Fig 4.18: Effect of different local maize cultivars on cob length during April to June 2020 and May to June 2021

the highest was recorded in cultivar CM-133 with 26.40 cm and the lowest in cultivar Basi Local with 18.53 cm. Further, the results are in supported with the findings ofPaul and Deole(2020a) who reported that the cob length ranged from 12.56 to 24.98 cm among thirty three genotypes in which the highest was recorded in genotype Heera-1122 with 24.98 cm and the lowest in genotype VMH-150 with 12.56 cm.

4.5.9. Studies on the cob height of different local cultivars of maize during April to June 2020 and April to June 2021

The cob height on different local cultivars of maize showed a significant difference as evident from the Table 4.25 and Fig. 4.19 in both the years. Among the fifteen (15) cultivars, the cob height ranged between 70.00 to 162.33 cm and 73.33 to 171.67 cm during 2020 and 2021, respectively. Out of fifteen (15) cultivars, the maximum cob height was observed in cultivar Yempong Ngangching Local with 162.33 and 171.67 cm during 2020 and 2021, respectively. These were followed by the cultivars Khuzama Local, Shiyam NgangchingLocal, Phek Local-1, Watak Ngangching Local and Phek Local-2 with (155.67, 135.73, 134.67, 132.67 & 130.33 cm) and (160.67, 140.67, 140.00, 138.33 & 135.67 cm) during 2020 and 2021, respectively. The minimum cob height was observed in cultivar Zarsi Socunoma Local with 70.00 and 73.33 cm during 2020 and 2021, respectively.

Similarly, pooled data also revealed that the maximum cob height was also observed in cultivar Yempong Ngangching Local with 167.00 cm. These was followed by the cultivars Khuzama Local, Shiyam NgangchingLocal, Phek Local-1, Watak Ngangching Local and Phek Local-2 with 158.17, 138.20, 137.33, 135.00 and 133.00 cm and the minimum cob height wasobserved in cultivar Zarsi Socunoma Local with 73.67 cm.

The present results are in contradiction with the findings of Afzal *et al.* (2009) who reported that the cob height ranged from 84.67 to 108.53 cm among six genotypes in which the highest was recorded in genotype 32-W-86

Table 4.25: Effect of different local maize cultivars on cob height during April to June 2020 and April to June 2021

Cultivars	***Cob height (cm)***		
	2020	***2021***	***Pooled***
C_1: Shiyam Ngangching Local	135.73 (11.67)	140.67 (11.88)	138.20 (11.78)
C_2: Yang Leng Ngangching Local	114.00 (10.69)	117.33 (10.85)	115.67 (10.77)
C_3: Yempong Ngangching Local	162.33 (12.76)	171.67 (13.12)	167.00 (12.94)
C_4: Watak Ngangching Local	132.67 (11.54)	138.33 (11.78)	135.50 (11.66)
C_5: Chiechama Local	100.67 (10.06)	107.33 (10.38)	104.00 (10.22)
C_6: Khonoma Local	100.33 (10.04)	105.67 (10.30)	103.00 (10.17)
C_7: Khuzama Local	155.67 (12.50)	160.67 (12.70)	158.17 (12.60)
C_8: Medziphema Local-1	82.00 (9.08)	86.67 (9.34)	84.33 (9.21)
C_9: Medziphema Local-2	80.67 (9.01)	85.00 (9.24)	82.83 (9.12)
C_{10}: Zarsi Socunoma Local	70.00 (8.40)	73.33 (8.59)	71.67 (8.49)
C_{11}: Phek Local-1	134.67 (11.62)	140.00 (11.83)	137.33 (11.73)
C_{12}: Phek Local-2	130.33 (11.44)	135.67 (11.67)	133.00 (11.55)
C_{13}: Wokha Local-1	115.67 (10.78)	120.67 (11.01)	118.17 (10.87)
C_{14}: Wokha Local-2	107.33 (10.38)	110.67 (10.54)	109.00 (10.46)
C_{15}: Nmh-8352 (Hybrid)	70.67 (8.44)	76.67 (8.78)	73.67 (8.61)
SEm±	***3.26***	***3.95***	***2.56***
CD (P= 0.05)	***9.44***	***11.44***	***7.25***

Note: Figures in the table are mean values and those in parenthesis are square root transformed values

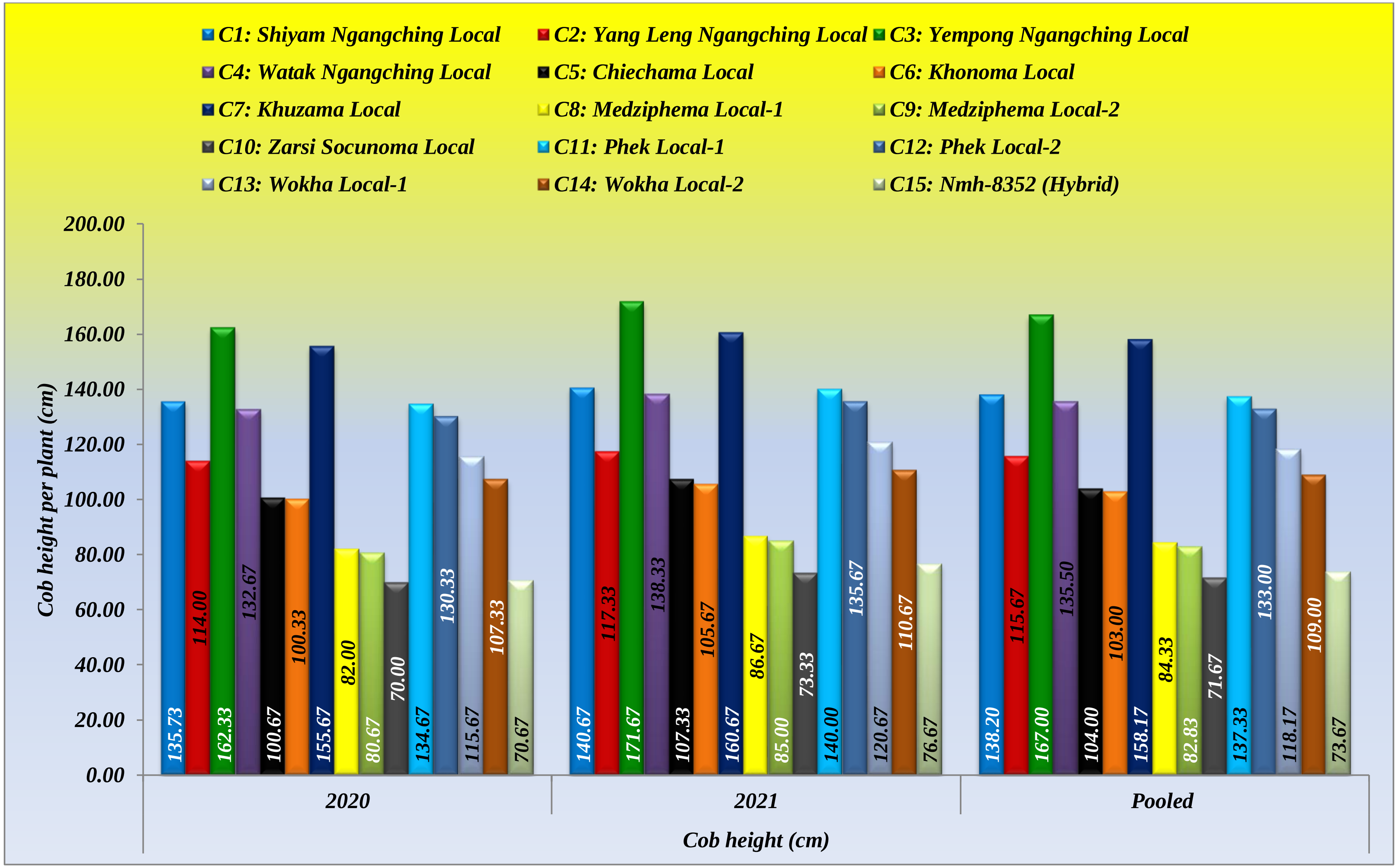

Fig 4.19: Effect of different local maize cultivars on cob height during April to June 2020 and May to June 2021

with 108.53 cm and the lowest in genotype 34-N-43 with 84.67 cm. This might be due to different in the morphological characters of the cultivars, geographical location of the study area and and climatic conditions.

4.5.10. Studies on the length of central spike of different local cultivars of maize during April to June 2020 and April to June 2021

The length of central spike on different local cultivars of maize showed a significant difference as evident from the Table 4.26 and Fig. 4.20 in both the years. Among the fifteen (15) cultivars, the length of central spike ranged between 21.60 to 42.27 cm and 23.38 to 44.20 cm during 2020 and 2021, respectively. Out of fifteen (15) cultivars, the maximum length of central spike was observed in cultivar Wokha Local-2 with 42.27 and 44.20 cm during 2020 and 2021, respectively. These were followed by the cultivars Yempong Ngangching Local, Watak Ngangching Local, Shiyam NgangchingLocal, Khonoma Local and Phek Local-1 with (40.97, 38.93, 37.83, 35.33 & 34.17 cm) and (42.93, 40.80, 39.90, 37.40 & 36.07 cm) during 2020 and 2021, respectively. The minimum length of central spike was observed in cultivar Medziphema Local-1 with 21.60 and 23.38 cm during 2020 and 2021, respectively.

Similarly, pooled data also revealed that the maximum length of central spike was also observed in cultivar Wokha Local-2 with 43.23 cm. These was followed by the cultivars Yempong Ngangching Local, Watak Ngangching Local, Shiyam NgangchingLocal, Khonoma Local and Phek Local-1 with 41.95, 39.87, 38.87, 36.37 and 35.12 cm and the minimum length of central spike was observed in cultivar Medziphema Local-1 with 22.49 cm.

The present results are in contradiction with the findings of Afzal *et al.* (2009) who reported that the length of central spike ranged from 20.27 to 29.93 cm among six genotypes in which the highest was recorded in genotype EV-6098 with 29.93 cm and the lowest in genotype 34-N-43 with 20.27 cm. This

Table 4.26: Effect of different local maize cultivars on length of central spikeduring April to June 2020 and April to June 2021

Cultivars	*Length of central spike (cm)*		
	2020	***2021***	***Pooled***
C_1: Shiyam Ngangching Local	37.83 (6.19)	39.90 (6.36)	38.87 (6.27)
C_2: Yang Leng Ngangching Local	27.42 (5.28)	29.57 (5.48)	28.49 (5.38)
C_3: Yempong Ngangching Local	40.97 (6.44)	42.93 (6.59)	41.95 (6.51)
C_4: Watak Ngangching Local	38.93 (6.28)	40.80 (6.43)	39.87 (6.35)
C_5: Chiechama Local	27.30 (5.27)	29.37 (5.46)	28.33 (5.37)
C_6: Khonoma Local	35.33 (5.99)	37.40 (6.16)	36.37 (6.07)
C_7: Khuzama Local	33.57 (5.84)	35.27 (5.98)	34.42 (5.91)
C_8: Medziphema Local-1	21.60 (4.70)	23.38 (4.89)	22.49 (4.79)
C_9: Medziphema Local-2	33.43 (5.82)	35.30 (5.98)	34.37 (5.90)
C_{10}: Zarsi Socunoma Local	22.70 (4.81)	24.65 (5.10)	23.68 (4.92)
C_{11}: Phek Local-1	34.17 (5.89)	36.07 (6.05)	35.12 (5.97)
C_{12}: Phek Local-2	29.33 (5.46)	31.30 (5.64)	30.32 (5.55)
C_{13}: Wokha Local-1	30.87 (5.60)	32.77 (5.77)	31.82 (5.68)
C_{14}: Wokha Local-2	42.27 (6.54)	44.20 (6.69)	43.23 (6.61)
C_{15}: Nmh-8352 (Hybrid)	30.10 (5.53)	32.17 (5.71)	31.13 (5.62)
SEm±	***0.77***	***0.66***	***0.51***
CD (P= 0.05)	***2.25***	***1.92***	***1.44***

Note: Figures in the table are mean values and those in parenthesis are square root transformed values

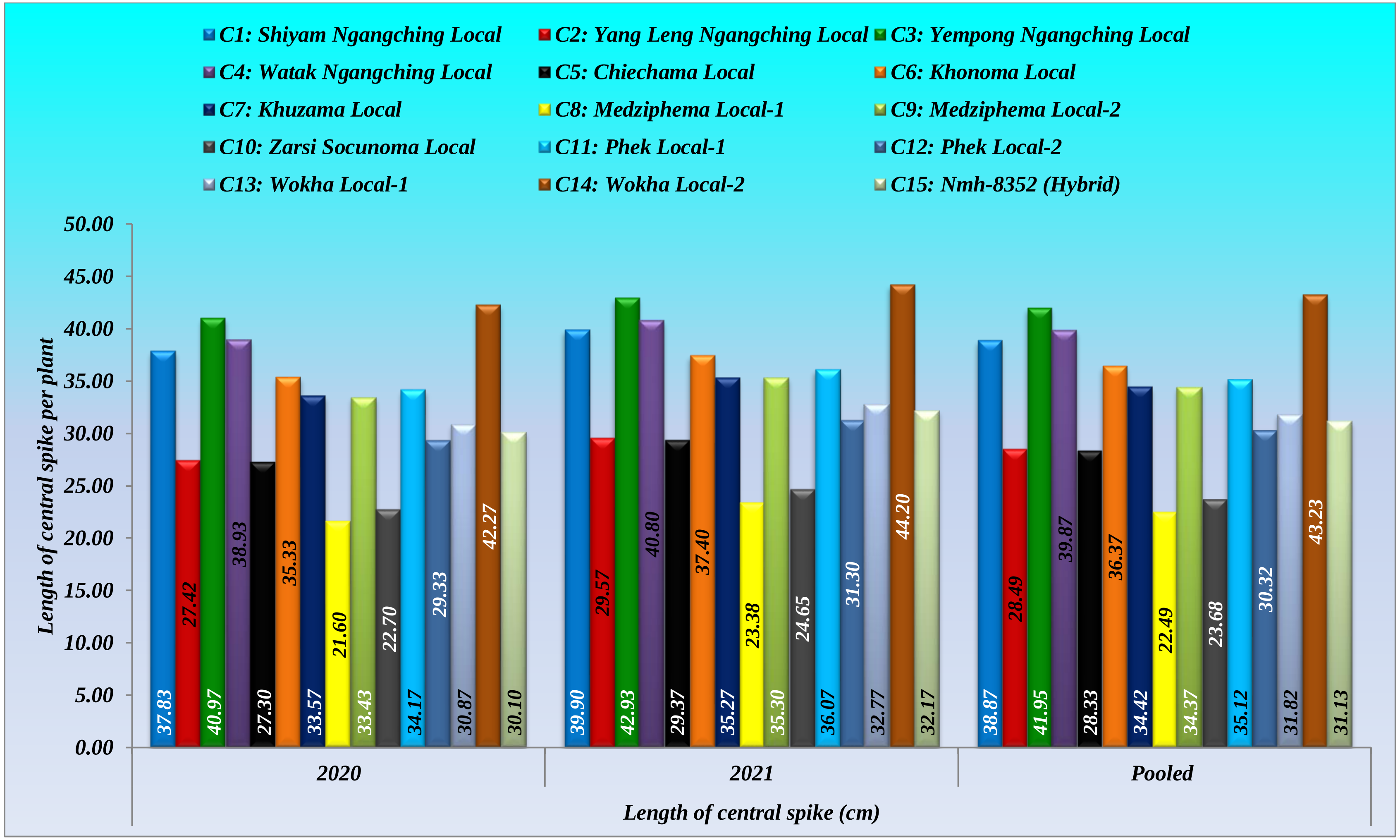

Fig 4.20: Effect of different local maize cultivars on length of central spike during April to June 2020 and May to June 2021

might be due to different in the morphological characters of the cultivars, geographical location of the study area and and climatic conditions.

4.5.11. Studies on the 100 grain weight of different local cultivars of maize during April to June 2020 and April to June 2021

The 100 grain weight on different local cultivars of maize showed a significant difference as evident from the Table 4.27 and Fig. 4.21 in both the years. Among the fifteen (15) cultivars, the 100 grain weight ranged between 17.77 to 30.78 g and 18.23 to 33.90 g during 2020 and 2021, respectively. Out of fifteen (15) cultivars, the maximum 100 grain weight was observed in cultivar Phek Local-1 with 30.78 and 33.90 g during 2020 and 2021, respectively. These were followed by the cultivars Khonoma Local, Wokha Local-1, PhekLocal-2, Medziphema Local-2 and Wokha Local-2 with (29.90, 29.85, 29.17, 28.47 & 28.47 g) and (31.78, 29.85, 29.17, 30.74 & 28.47 g) during 2020 and 2021, respectively. The minimum 100 grain weight was observed in cultivar Zarsi Socunoma Local with 17.77 and 18.23 g during 2020 and 2021, respectively.

Similarly, pooled data also revealed that the maximum 100 grain weight was also observed in cultivar Phek Local-1 with 32.34 g. These was followed by the cultivars Khonoma Local, Wokha Local-1, Medziphema Local-2, PhekLocal-2 and Wokha Local-2 with 30.84, 29.85, 29.61, 29.17 and 28.47 g and the minimum 100 grain weight were observed in cultivar Zarsi Socunoma Localwith 18.00 g.

The present results are in corroboration with the findings of Afzal *et al.* (2009) who reported that 100 grain weight ranged from 16.10 to 26.27 g among six genotypes in which the highest was recorded in genotype 32-F-10with 26.27 g and the lowest in genotype Sahiwal-2002 with 16.10 g which is similar with the present findings.

Table 4.27: Weight of 100 grains of different local maizeduring April to June 2020 and April to June 2021

Cultivars	***100 grain weight (g)***		
	2020	***2021***	***Pooled***
C_1: Shiyam Ngangching Local	19.33 (4.45)	20.00 (4.52)	19.67 (4.49)
C_2: Yang Leng Ngangching Local	17.80 (4.27)	18.58 (4.37)	18.19 (4.32)
C_3: Yempong Ngangching Local	23.67 (4.91)	23.67 (4.91)	23.67 (4.91)
C_4: Watak Ngangching Local	26.17 (5.16)	26.17 (5.16)	26.17 (5.16)
C_5: Chiechama Local	27.48 (5.28)	27.48 (5.28)	27.48 (5.28)
C_6: Khonoma Local	29.90 (5.51)	31.78 (5.68)	30.84 (5.6)
C_7: Khuzama Local	26.87 (5.23)	26.87 (5.23)	26.87 (5.23)
C_8: Medziphema Local-1	18.33 (4.34)	18.33 (4.34)	18.33 (4.34)
C_9: Medziphema Local-2	28.47 (5.38)	30.74 (5.59)	29.61 (5.48)
C_{10}: Zarsi Socunoma Local	17.77 (4.27)	18.23 (4.35)	18.00 (4.31)
C_{11}: Phek Local-1	30.78 (5.59)	33.90 (5.86)	32.34 (5.73)
C_{12}: Phek Local-2	29.17 (5.44)	29.17 (5.44)	29.17 (5.44)
C_{13}: Wokha Local-1	29.85 (5.50)	29.85 (5.50)	29.85 (5.50)
C_{14}: Wokha Local-2	28.47 (5.38)	28.47 (5.38)	28.47 (5.38)
C_{15}: Nmh-8352 (Hybrid)	26.12 (5.16)	28.15 (5.35)	27.14 (5.26)
SEm±	***1.03***	***1.10***	***0.75***
CD (P= 0.05)	***2.97***	***3.18***	***2.13***

Note: Figures in the table are mean values and those in parenthesis are square root transformed values

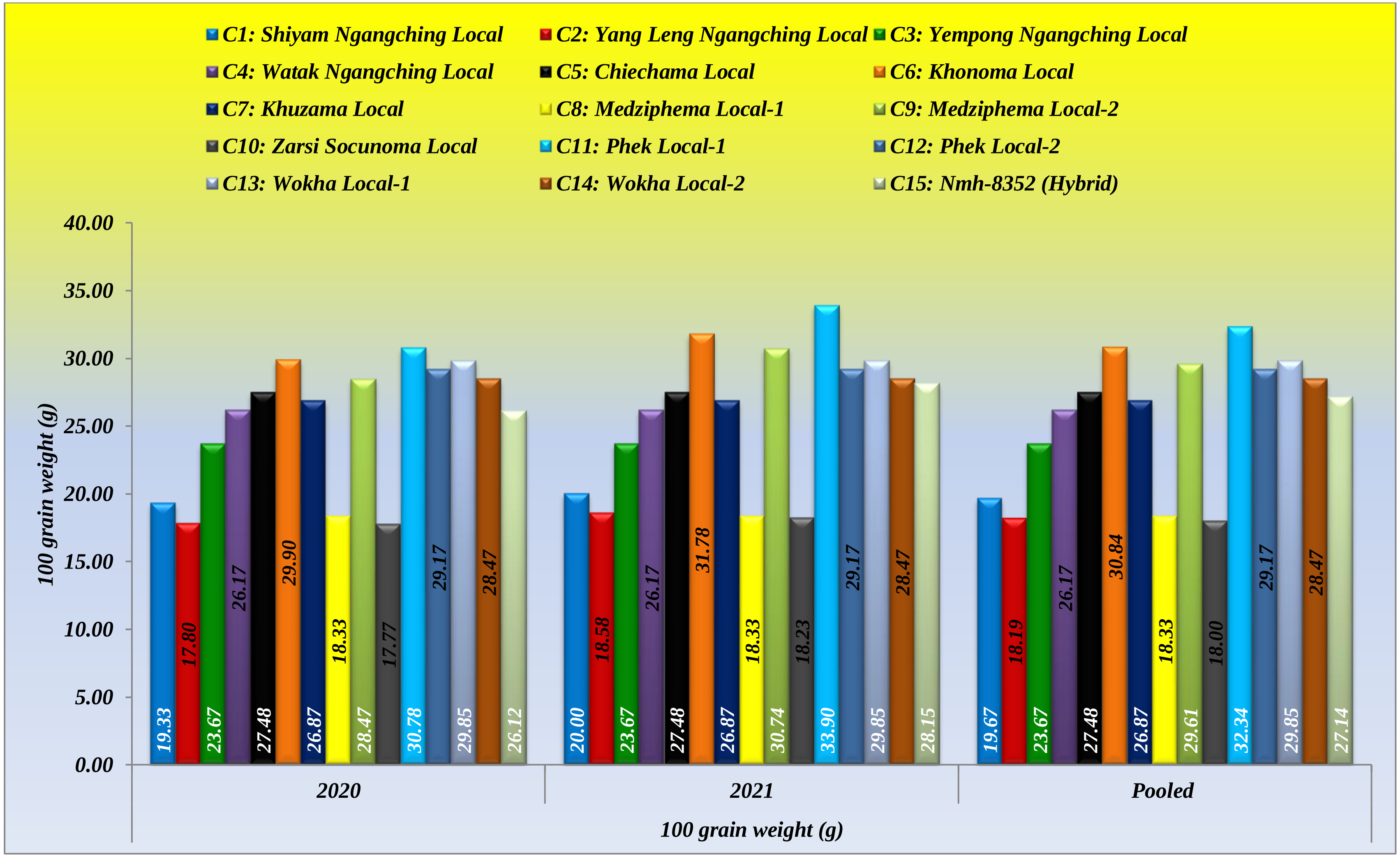

Fig 4.21: Weight of 100 grains of different local maizeduring April to June 2020 and April to June 2021

4.6. Correlation coefficient (r) on the seasonal incidence of major insect pests in relation to morphological characteristics of different local maize cultivars during April to June 2020 and April to June 2021

In the present findings, simple linear correlation analysis was performed to find out the relationship of incidence of major pests with the morphological characteristics of different local maize cultivars.

4.6.1. Correlation coefficient (r) on the seasonal incidence of maize stem borer, *Chilo partellus* as leaf injury damage with the morphological characteristics of different local maize cultivars during April to June 2020 and April to June 2021

The correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as leaf injury damage with the morphological characteristics of different local maize cultivars showed a non-significant positive correlation in most of the characters in both the years except with the cob length and length of central spike which showed a non-significant negative correlation with (r = -0.165 & r = -0.198) and (r = -0.067 & r = -0.065) during 2020 and 2021, respectively (Table 4.28). But the correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as leaf injury damage with the morphological characteristics of different local maize cultivars revealed a significant positive correlation with the leaf width with (r = 0.529) and (r = 0.553) during 2020 and 2021, respectively.

Similarly, pooled data also revealed that the correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as leaf injury damage with the morphological characteristics of different local maize cultivars showed a non-significant positive correlation in most of the characters except with the cob length and length of central spike which showed a non-significant negative correlation with (r = -0.189) and (r = -0.066). But the correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as leaf injury damage with the morphological characteristics of

Table 4.28: Correlation coefficient (r) of maize stem borer, *Chilo partellus* as leaf injury damage in relation to morphological characteristics recorded during April to June 2020 and April to June 2021

Morphological characters	***Pearson's correlation coefficient***		
	2020	***2021***	***Pooled***
Stem diameter (cm)	0.120^{NS}	0.199^{NS}	0.159^{NS}
Number of nodes per plant	0.096^{NS}	0.161^{NS}	0.128^{NS}
Leaf length (cm)	0.016^{NS}	0.021^{NS}	0.018^{NS}
Leaf width (cm)	0.529*	0.553*	0.536*
Leaf area (cm^2)	0.141^{NS}	0.124^{NS}	0.129^{NS}
Number of leaf trichomes	0.333^{NS}	0.354^{NS}	0.396^{NS}
Plant height (cm)	0.096^{NS}	0.159^{NS}	0.127^{NS}
Cob length (cm)	-0.165^{NS}	-0.198^{NS}	-0.189^{NS}
Cob height (cm)	0.019^{NS}	0.097^{NS}	0.057^{NS}
Length of central spike (cm)	-0.067^{NS}	-0.065^{NS}	-0.066^{NS}
100 grain weight (g)	0.417^{NS}	0.318^{NS}	0.377^{NS}

Note: df = (15-2) = 13 $r_{0.05}$ = 0.514 $r_{0.01}$ = 0.64

* = Significant at 5% level of significance

NS = Non-significant at 5% level of significance

different local maize cultivars revealed a significant positive correlation with the leaf width with (r = 0.536).

The results are in partial conformity with findings of Rasool*et al*. (2017) who reported that the correlation coefficient of *Chilo partellus* as leaf injury damage with stem diameter and cob height showed a non-significant negative correlation with (r = -0.293) and (r = -0.091), respectively. Regarding the number of nodes per plant, leaf length, leaf width, number of leaf trichomes and cob length the results are also in partial conformity with findings of Rasool*et al*. (2017) who reported that the correlation coefficient of *Chilo partellus* as leaf injury damage with the number of nodes per plant, leaf length, leaf width, number of leaf trichomes and cob length exhibited a significant negative correlation with (r = -0.485), (r = -0.628), (r = -0.718), (r = -0.625) and r = (-0.655), respectively. Regarding the length of central spike, the results are also in accordance with findings of Rasool*et al*. (2017) who reported that the correlation coefficient of *Chilo partellus* as leaf injury damage with the length of central spike showed a non-significant negative correlation with (r = -0.284). Regarding the 100 grain weight, the results are also in partial conformity with findings of Afzal *et al*. (2009) who reported that the correlation coefficient of *Chilo partellus* as leaf injury damage with the 100 grain weight exhibited a significant negative correlation with (r = -0.559).

Out of eleven morphological characteristics of different local maize cultivars, only the length of central spike was in accordance with the findings of Rasool*et al*. (2017) while the rest of the characters are in contradiction with the present findings. This might be due to different in the morphological characters of the cultivars or genotypes at different locations and climatic conditions.

4.6.2. Correlation coefficient (r) on the seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts damage with the morphological characteristics of different local maize cultivars during April to June 2020 and April to June 2021

The correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts infestation with the morphological characteristics of different local maize cultivars showed a non-significant positive correlation in most of the characters in both the years except with cob length which showed a non-significant negative correlation with (r = -0.149) and (r = -0.024) during 2020 and 2021, respectively (Table 4.29). But the correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts infestation with the morphological characteristics of different local maize cultivars revealed a significant positive correlation with 100 grain weight which showed a significant positive correlation with (r = 0.520) and (r = 0.528) during 2020 and 2021, respectively.

Pooled data also revealed that the correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts infestation with the morphological characteristics of different local maize cultivars showed a non-significant positive correlation in most of characters except with cob length which showed a non-significant negative correlation with (r = -0.091). But the correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as dead hearts infestation with the morphological characteristics of different local maize cultivars revealed a significant positive correlation with 100 grain weight which showed a significant positive correlation with (r = 0.518).

The results are in partial conformity with findings of Ali *et al*. (2015) who reported that the correlation coefficient of *Chilo partellus* as dead hearts infestation with stem diameter showed a significant positive correlation with (r = 0.686). Regarding the number of nodes per plant, the results are also in

Table 4.29: Correlation coefficient (r) of maize stem borer, *Chilo partellus* as dead hearts infestation in relation to morphological characteristics recorded during April to June 2020 and April to June 2021

Morphological characters	***Pearson's correlation coefficient***		
	2020	***2021***	***Pooled***
Stem diameter (cm)	0.165^{NS}	0.344^{NS}	0.253^{NS}
Number of nodes per plant	0.140^{NS}	0.293^{NS}	0.215^{NS}
Leaf length (cm)	0.096^{NS}	0.223^{NS}	0.158^{NS}
Leaf width (cm)	0.407^{NS}	0.413^{NS}	0.413^{NS}
Leaf area (cm^2)	0.181^{NS}	0.276^{NS}	0.227^{NS}
Number of leaf trichomes	0.261^{NS}	0.338^{NS}	0.356^{NS}
Plant height (cm)	0.154^{NS}	0.295^{NS}	0.224^{NS}
Cob length (cm)	-0.149^{NS}	-0.024^{NS}	-0.091^{NS}
Cob height (cm)	0.097^{NS}	0.225^{NS}	0.160^{NS}
Length of central spike (cm)	0.094^{NS}	0.135^{NS}	0.115^{NS}
100 grain weight (g)	0.520*	0.528*	0.518*

Note: df = (15-2) = 13 $r_{0.05}$ = 0.514 $r_{0.01}$ = 0.64

* = Significant at 5% level of significance

NS = Non-significant at 5% level of significance

partial conformity with findings of several workers who reported that the correlation coefficient of *Chilo partellus* as dead hearts infestation with the number of nodes per plant exhibited a significant negative correlation and non-significant negative correlation with (r = -0.514) and (r = -0.268), respectively (Ali *et al*., 2015; Afzal *et al*., 2009). Regarding the leaf length and leaf width, the results are also in partial conformity with findings of Afzal *et al*. (2009) who reported that the correlation coefficient of *Chilo partellus* as dead hearts infestation with the leaf length and leaf width showed a significant negative correlation with (r = -0.542) and (r = -0.628), respectively.

Regarding the number of leaf trichomes, cob length and 100 grain weight, the results are also in partial conformity with findings of several workers who reported that the correlation coefficient of *Chilo partellus* as dead hearts infestation with the number of leaf trichomes, cob length and 100 grain weight exhibited a significant negative correlation with (r = -0.880, r = -0.545 & r = -0.559), (r = -0.866, r = -0.585 & r = -0.677), respectively (Afzal *et al*., 2009; Ali *et al*., 2015). Regarding the cob height, the results are also in partial conformity with findings of several workers who reported that the correlation coefficient of *Chilo partellus* as dead hearts infestation with the cob height exhibited a non-significant negative correlation with (r = -0.023) and (r = -0.071), respectively (Afzal *et al*., 2009; Ali *et al*., 2015). Regarding the length of central spike, the results are also in accordance with findings of several workers who reported that the correlation coefficient of *Chilo partellus* as dead hearts infestation with the length of central spike showed a non-significant negative correlation with (r = -0.271) and (r = -0.160), respectively (Afzal *et al*., 2009; Ali *et al*., 2015).

Out of eleven morpho-physiological characteristics of different local maize cultivars, only the length of central spike was in accordance with the findings of Afzal *et al*. (2009) and Ali *et al*. (2015) while the rest of the characters are in contradiction with the present findings. This might be due to different in the morphological characters of the cultivars, geographical location of the study area and and climatic conditions.

4.6.3. Correlation coefficient (r) on the seasonal incidence of maize stem borer, *Chilo partellus* as stem tunneling with the morphological characteristics of different local maize cultivars during April to June 2020 and April to June 2021

The correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as stem tunneling with the morphological characteristics of different local maize cultivars showed a non-significant positive correlation in most of the characters except with the leaf length and cob length which revealed a non-significant negative correlation with (r = -0.058) and (r = -0.266), respectively during 2020 (Table 4.30). But the correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as stem tunneling with the morpho-physiological characteristics of different local maize cultivars revealed a significant positive correlation with 100 grain weight with (r = 0.524).

Similarly, during 2021, the coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as stem tunneling with the morphological characteristics of different local maize cultivars showed a non-significant positive correlation in most of the characters except with the leaf length and cob length which revealed a non-significant negative correlation with (r = -0.068) and (r = -0.294), respectively during 2021. But the seasonal incidence of maize stem borer, *Chilo partellus* as stem tunneling with the morphological characteristics of different local maize cultivars revealed a significant positive correlation with 100 grain weight (r = 0.531).

Pooled data also revealed that the coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as stem tunneling with the morphological characteristics of different local maize cultivars showed a non-significant positive correlation in most of the characters except with the leaf length and

Table 4.30: Correlation coefficient (r) of maize stem borer, *Chilo partellus* as stem tunneling length in relation to morphological characteristics recorded during April to June 2020 and April to June 2021

Morphological characters	***Pearson's correlation coefficient***		
	2020	***2021***	***Pooled***
Stem diameter (cm)	0.142^{NS}	0.167^{NS}	0.154^{NS}
Number of nodes per plant	0.103^{NS}	0.109^{NS}	0.106^{NS}
Leaf length (cm)	-0.058^{NS}	-0.068^{NS}	-0.063^{NS}
Leaf width (cm)	0.310^{NS}	0.301^{NS}	0.308^{NS}
Leaf area (cm^2)	0.065^{NS}	0.039^{NS}	0.051^{NS}
Number of leaf trichomes	0.306^{NS}	0.277^{NS}	0.291^{NS}
Plant height (cm)	0.091^{NS}	0.102^{NS}	0.097^{NS}
Cob length (cm)	-0.266^{NS}	-0.294^{NS}	-0.281^{NS}
Cob height (cm)	0.014^{NS}	0.022^{NS}	0.018^{NS}
Length of central spike (cm)	0.023^{NS}	0.026^{NS}	0.025^{NS}
100 grain weight (g)	0.524*	0.531*	0.520*

Note: df = (15-2) = 13 $r_{0.05}$ = 0.514 $r_{0.01}$ = 0.64

* = Significant at 5% level of significance

NS = Non-significant at 5% level of significance

cob length which revealed a non-significant negative correlation with (r = -0.063) and (r = -0.281), respectively. But the seasonal incidence of maize stem borer, *Chilo partellus* as stem tunneling with the morphological characteristics of different local maize cultivars revealed a significant positive correlation with 100 grain weight with (r = 0.520).

The results are in partial conformity with findings of Kumar (2018) who reported that the correlation coefficient of *Chilo partellus* as stem tunneling with stem diameter and plant height showed a non-significant negative correlation with (r = -0.099) and (r = -0.095), respectively. Regarding the cob length, cob height, length of central spike and 100 grain weight the results are also in partial conformity with findings of Kumar (2018) who reported that the correlation coefficient of *Chilo partellus* as stem tunneling with the cob length, cob height, length of central spike and 100 grain weight exhibited a significant negative correlation with (r = -0.588), (r = -0.914), (r = -0.890) and (r = -0.578), respectively.

Based on the findings by Kumar (2018) among the six morphological characteristics of different local maize cultivars in correlation with stem tunneling caused by *Chilo partellus*, none of the characters are in agreement with the present findings. This might be due to different in the morphological characters of the cultivars or genotypes at different locations and climatic conditions. Since no literatures or citations were available regarding the number of nodes per plant, leaf length, leaf width, leaf area and number of leaf trichomes in correlation with the *Chilo partellus* as stem tunneling, therefore no further comparison could be conducted with the present findings.

4.6.4. Correlation coefficient (r) on the seasonal incidence of maize stem borer, *Chilo partellus* as number of exit holes with the morphological characteristics of different local maize cultivars during April to June 2020 and April to June 2021

The correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as number of exit holes with the morpho-physiological characteristics of different local maize cultivars showed a non-significant positive correlation with the stem diameter, number of nodes per plant, leaf width, number of leaf trichomes and plant height with (r = 0.069), (r = 0.063), (r = 0.224), (r = 0.494) and (r = 0.040), respectively during 2020 (Table 4.31). But the seasonal incidence of maize stem borer, *Chilo partellus* as number of exit holes with the morphological characteristics of different local maize cultivars showed a non-significant negative correlation with the leaf length, leaf area, cob length, cob height and length of central spike with (r = -0.147), (r = -0.037), (r = -0.117), (r = -0.045) and (r = -0.154), respectively except with 100 grain weight which revealed a significant positive correlation with (r = 0.530) during 2020.

Similarly, during 2021, the correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as number of exit holes with the morphological characteristics of different local maize cultivars showed a non-significant positive correlation with the stem diameter, number of nodes per plant, leaf width, number of leaf trichomes and plant height with (r = 0.107), (r = 0.077), (r = 0.292), (r = 0.473) and (r = 0.054), respectively. But the seasonal incidence of maize stem borer, *Chilo partellus* as number of exit holes with the morphological characteristics of different local maize cultivars showed a non-significant negative correlation with the leaf length, leaf area, cob length, cob height and length of central spike with (r = -0.138), (r = -0.022), (r = -0.136), (r = -0.008) and (r = -0.169), respectively except with 100 grain weight which revealed a significant positive correlation with (r = 0.524) during 2021.

Table 4.31: Correlation coefficient (r) of maize stem borer, *Chilo partellus* as number of exit holes in relation to morphological characteristics recorded during April to June 2020 and April to June 2021

Morphological characters	***Pearson's correlation coefficient***		
	2020	***2021***	***Pooled***
Stem diameter (cm)	0.069^{NS}	0.107^{NS}	0.089^{NS}
Number of nodes per plant	0.063^{NS}	0.077^{NS}	0.070^{NS}
Leaf length (cm)	-0.147^{NS}	-0.138^{NS}	-0.143^{NS}
Leaf width (cm)	0.244^{NS}	0.292^{NS}	0.271^{NS}
Leaf area (cm^2)	-0.037^{NS}	-0.022^{NS}	-0.030^{NS}
Number of leaf trichomes	0.494^{NS}	0.473^{NS}	0.485^{NS}
Plant height (cm)	0.040^{NS}	0.054^{NS}	0.047^{NS}
Cob length (cm)	-0.117^{NS}	-0.136^{NS}	-0.127^{NS}
Cob height (cm)	-0.045^{NS}	-0.008^{NS}	-0.027^{NS}
Length of central spike (cm)	-0.154^{NS}	-0.169^{NS}	-0.162^{NS}
100 grain weight (g)	0.530*	0.524*	0.517*

Note: df = (15-2) = 13 $r_{0.05}$ = 0.514 $r_{0.01}$ = 0.64

* = Significant at 5% level of significance

NS = Non-significant at 5% level of significance

Pooled data also revealed that the correlation coefficient on the seasonal incidence of maize stem borer, *Chilo partellus* as number of exit holes with the morphological characteristics of different local maize cultivars showed a non-significant positive correlation with the stem diameter, number of nodes, leaf width, number of leaf trichomes and plant height and 100 grain weight with (r = 0.089), (r = 0.070), (r = 0.271), (r = 0.485) and (r = 0.047) and respectively. But the seasonal incidence of maize stem borer, *Chilo partellus* as number of exit holes with the morphological characteristics of different local maize cultivars showed a non-significant negative correlation with the leaf length, leaf area, cob length, cob height and length of central spike with (r = -0.143), (r = -0.030), (r = -0.127), (r = -0.027) and (r = -0.162), respectively except with 100 grain weight which revealed a significant positive correlation with (r = 0.517).

The results are in partial conformity with findings of Reddy *et al.* (2020) who reported that the correlation coefficient of *Chilo partellus* as number of exit holes with plant height showed a non-significant negative correlation with (r = -0.467) and (r = -0.428) during 2018 and 2019, respectively. Regarding the stem diameter and number of nodes per plant, the results are also in partial conformity with findings of Reddy *et al.* (2020) who reported that the correlation coefficient of *Chilo partellus* as number of exit holes with the stem diameter and number of nodes per plant exhibited a significant negative correlation with (r =-0.759 & r = -0.869) and (r = -0.507 & r = -0.473) during 2018 and 2019, respectively.

Based on the findings by Reddy *et al.* (2020b) among the three morpho-physiological characteristics of different local maize cultivars in correlation with the number of exit holes caused by *Chilo partellus*, none of the characters are in agreement with the present findings. This might be due to different in the physio-morphological characters of the genotypes, geographical location of the study area and and climatic conditions. Since no literatures or citations were available regarding the leaf length, leaf width, leaf area, number of leaf trichomes, cob length, cob height, length of central spike and 100 grain weight in correlation with the *Chilo partellus* as number of exit holes, therefore no further comparison could be conducted with the present findings.

4.6.5. Correlation coefficient (r) on the seasonal incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage with the morphological characteristics of different local maize cultivars during April to June 2020 and April to June 2021

The correlation coefficient on the seasonal incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage with the morphological characteristics of different local maize cultivars showed a non-significant positive correlation in most of the characters in both the years except with the leaf length, cob length and length of central spike which showed a non-significant negative correlation with (r = -0.071 & r = -0.095), (r = -0.129 & r = -0.111) and (r = -0.139 & r = -0.192) during 2020 and 2021, respectively (Table 4.32). But the seasonal incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage revealed a significant positive correlation with leaf width with (r = 0.530) and (r = 0.522) during 2020 and 2021, respectively.

Pooled data also revealed that the correlation coefficient on the seasonal incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage with the morphological characteristics of different local maize cultivars showed a non-significant positive correlation in most of the characters in both the years except with the leaf length, cob length and length of central spike which showed a non-significant negative correlation with (r = -0.084), (r = -0.119) and (r = -0.168) during 2020 and 2021, respectively. But the seasonal incidence of fall armyworm, *Spodoptera frugiperda* as leaf whorls damage revealed a significant positive correlation with leaf width with (r = 0.524).

The results are in partial conformity with findings of Tiwari *et al.*

Table 4.32: Correlation coefficient (r) of fall armyworm, *Spodoptera frugiperda* as whorls damage in relation to morphological characteristics recorded during April to June 2020 and April to June 2021

Morphological characters	***Pearson's correlation coefficient***		
	2020	***2021***	***Pooled***
Stem diameter (cm)	0.075^{NS}	0.132^{NS}	0.106^{NS}
Number of nodes per plant	0.059^{NS}	0.095^{NS}	0.080^{NS}
Leaf length (cm)	-0.071^{NS}	-0.095^{NS}	-0.084^{NS}
Leaf width (cm)	0.530*	0.522*	0.524*
Leaf area (cm^2)	0.120^{NS}	0.046^{NS}	0.079^{NS}
Number of leaf trichomes	0.362^{NS}	0.445^{NS}	0.412^{NS}
Plant height (cm)	0.043^{NS}	0.070^{NS}	0.059^{NS}
Cob length (cm)	-0.129^{NS}	-0.111^{NS}	-0.119^{NS}
Cob height (cm)	0.017^{NS}	0.056^{NS}	0.039^{NS}
Length of central spike (cm)	-0.139^{NS}	-0.192^{NS}	-0.168^{NS}
100 grain weight (g)	0.208^{NS}	0.180^{NS}	0.195^{NS}

Note: df = (15-2) = 13 $r_{0.05} = 0.514$ $r_{0.01} = 0.64$

* = Significant at 5% level of significance

NS = Non-significant at 5% level of significance

(2023) who reported that the correlation coefficient of *Spodoptera frugiperda* as leaf whorls damage with leaf length, leaf width and number of leaf trichomes showed a significant negative correlation with (r = -0.947), (r = -0.968) and (r = -0.992), respectively. Regarding the leaf area, length of central spike and cob length, the results are also in partial conformity with findings of Paul and Deole (2022a) who reported that the correlation coefficient of *Spodoptera frugiperda* as leaf whorls damage with the leaf area, length of central spike and cob length exhibited a significant positive correlation with (r =0.442), (r =0.447) and (r = 0403), respectively. Regarding the cob height, the results are also in partial conformity with findings of Paul and Deole (2022a) who reported that the correlation coefficient of *Chilo partellus* as leaf whorls damage with the cob height showed a significant negative correlation with (r = -0.412).

Based on the findings by Reddy *et al.* (2020a) and Paul and Deole (2022a) among the seven morphological characteristics of different local maize cultivars in correlation with the leaf whorls damage caused by *Spodoptera frugiperda*, none of the characters are in agreement with the present findings. This might be due to different in the morphological characters of the genotypes, geographical location of the study area and and climatic conditions. Since no literatures or citations were available regarding the stem diameter, number of nodes per plant, plant height and 100 grain weight in correlation with the *Spodoptera frugiperda* as leaf whorls damage, therefore no further comparison could be conducted with the present findings.

4.7. Seasonal incidence of major pests on maize variety, Medziphema Local-1 during April to June 2020 and April to June 2021

In the present investigation maize variety, Medziphema Local-1was found to be infested by a number of insects out of which Maize stem borer, *Chilo partellus* and Fall armyworm, *Spodoptera frugiperda* were the major insect pests during April to June 2020 and April to June 2021. The details of the results pertaining on the seasonal incidence of major insect pests on maize variety, Medziphema Local-1are emphasized under the following heads:

4.7.1. Seasonal incidence of maize stem borer, *Chilo partellus* on maize variety, Medziphema Local-1 during April to June 2020 and April to June 2021

The incidence of maize stem borer, *Chilo partellus* on maize variety, Medziphema Local-1 was observed from 15th standard week (*i.e.*, on 19th April) as evident from the Table 4.33 and Fig. 4.22 which continued upto 23rd standard week (*i.e.*, on 14th June) in both the years. The incidence of *C. partellus* was first observed on the 15th standard week (*i.e.*, 19th April) with 0.87and 0.67 larvae per plant during 2020 and 2021, respectively. On the 16th standard week (*i.e.*, on 26th April), the population of *C. partellus* increased to 1.53 and 1.40 larvae per plant during 2020 and 2021, respectively and reached the peak population on the 22nd standard week (*i.e.*, on 07th June) with 4.29 and 4.07 larvae per plant during 2020 and 2021, respectively. From the 23rd standard week (*i.e.*, on 14th June) onwards, the population decreased to 3.50 and 3.37 larvae per plant during 2020 and 2021, respectively.

Similarly, pooled data also revealed that the incidence of *C. partellus* was first observed on the 15th standard week (*i.e.*, 19th April) with 0.77 larvae per plant. On the 16th standard week (*i.e.*, on 26th April), the population of *C. partellus* increased to 1.47 per plant and reached the peak population on the 22nd standard week (*i.e.*, on 07th June) with 4.18 larvae per plant. From the 23rd standard week (*i.e.*, on 14th June) onwards, the population decreased to 3.43 larvae per plant.

The present results are in conformity with the findings of Krüger*et al.* (2008) who reported that the levels of infestation by *C. partellus* were high and ranged between 0.26 to 4.20 larvae per plant. However, Kumar *et al.* (2017) reported that the levels of infestation by *C. partellus* were low and ranged between 0.20 to 2.40 larvae per plant which was in partial conformity with the

Table 4.33: Seasonal incidence of major pests on maize variety, Medziphema Local-1 recorded during April to June 2020 and April to June 2021

Mean standard week	*Date of observation*	*Seasonal incidence of major pests of maize recorded from ecological plots*					
		Maize stem borer, Chilo partellus			*Fall armyworm, Spodoptera frugiperda*		
		2020	*2021*	*Pooled*	*2020*	*2021*	*Pooled*
14	12 April	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	3.00 (1.87)	2.67 (1.78)	2.84 (1.83)
15	19 April	0.87 (1.17)	0.67 (1.08)	0.77 (1.12)	4.00 (2.11)	3.70 (2.05)	3.85 (2.08)
16	26 April	1.53 (1.43)	1.40 (1.38)	1.47 (1.40)	4.97 (2.34)	4.53 (2.24)	4.75 (2.29)
17	03 May	2.33 (1.68)	2.17 (1.63)	2.25 (1.66)	4.20 (2.17)	4.00 (2.11)	4.10 (2.14)
18	10 May	2.89 (1.84)	2.73 (1.80)	2.81 (1.82)	3.70 (2.05)	3.33 (1.96)	3.52 (2.00)
19	17 May	3.35 (1.96)	3.10 (1.90)	3.23 (1.92)	2.87 (1.81)	2.47 (1.71)	2.67 (1.76)
20	24 May	3.78 (2.06)	3.47 (1.99)	3.62 (2.02)	1.93 (1.56)	1.57 (1.44)	1.75 (1.50)
21	31 May	4.07 (2.13)	3.90 (2.09)	3.98 (2.11)	1.23 (1.32)	1.00 (1.22)	1.12 (1.27)
22	07 June	4.29 (2.19)	4.07 (2.13)	4.18 (2.16)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
23	14 June	3.50 (1.99)	3.37 (1.95)	3.43 (1.97)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
	SEm±	***0.32***	***0.30***	***0.22***	***0.20***	***0.22***	***0.15***
	CD (P= 0.05)	***0.95***	***0.88***	***0.62***	***0.58***	***0.66***	***0.43***

Note: Mean population collected from ten randomly selected plants

Figures in the table are mean values and those in parenthesis are square root transformed values

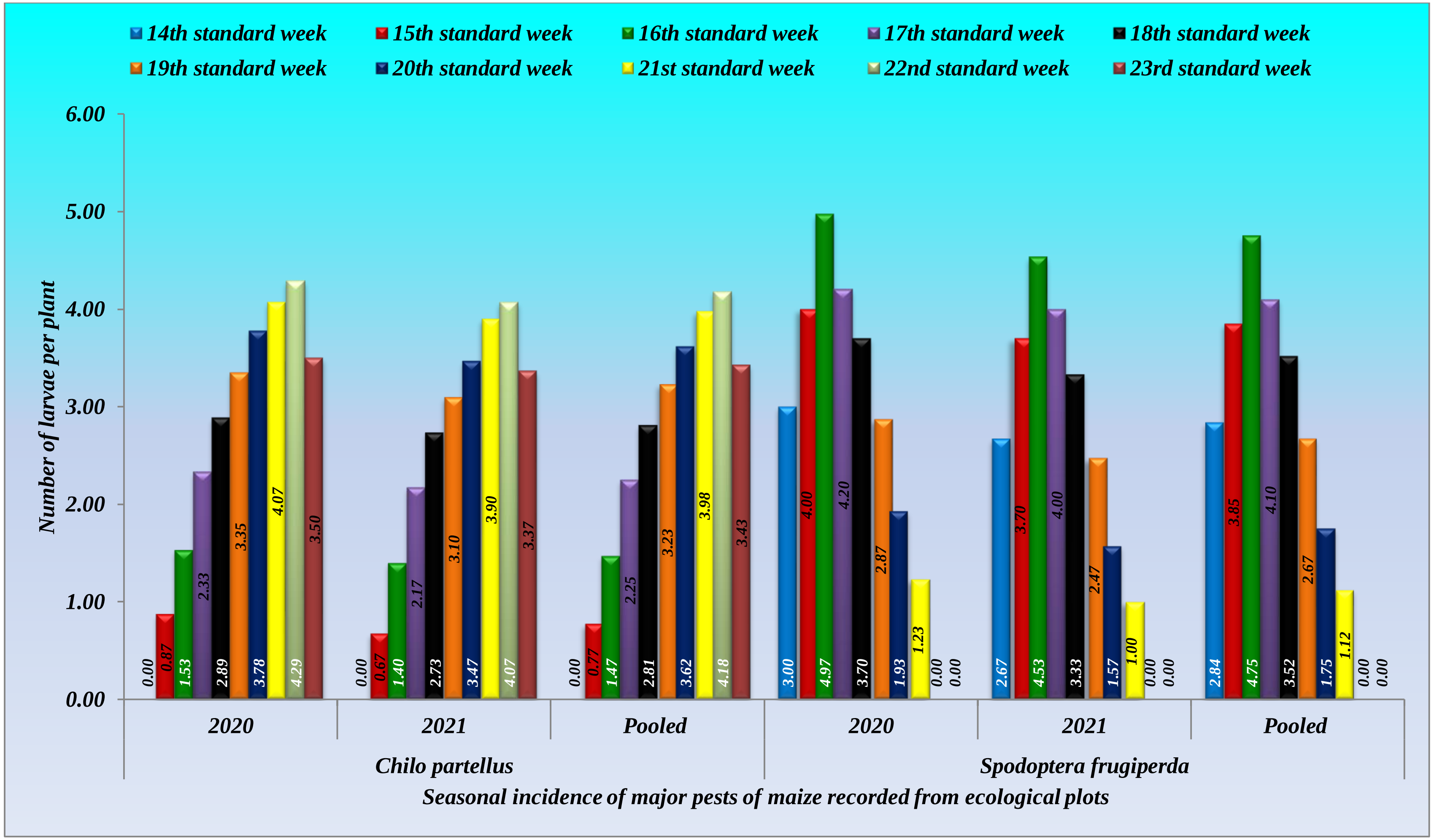

Fig 4.22: Seasonal incidence of major pests on maize variety, Medziphema Local-1 recorded during April to June 2020 and April to June 2021

present findings. This might be due to different in climatic conditions prevailing at different locations, cropping seasons and host preference by the pest.

4.7.2. Seasonal incidence of fall armyworm, *Spodoptera fugiperda* on maize variety, Medziphema Local-1 during April to June 2020 and April to June 2021

The incidence of fall armyworm, *Spodoptera fugiperda*on maize variety, Medziphema Local-1 was observed from 14th standard week (*i.e*., on 12th April) as evident from the 4.33 and Fig. 4.21 which continued upto 21st standard week (*i.e*., on 31st May) in both the years. The incidence of *S.fugiperda* was first observed on the 14th standard week (*i.e*., on 12th April) with 3.00 and 2.67 larvae per plant during 2020 and 2021, respectively. On the 15th standard week (*i.e*., on 19th April) the population of *S.fugiperda* increased to 4.00 and 3.70 larvae per plant during 2020 and 2021, respectively and reached the peak population on the 16th standard week (*i.e*., on 26th April) with 4.97 and 4.53 larvae per plant during 2020 and 2021, respectively. From the 17th standard week (*i.e*., on 3rd May) onwards, the population decreased to 4.20 and 4.00 larvae per plant during 2020 and 2021, respectively. As the plants mature with time, the population of *S.fugiperda* decreased and reached the minimum population on the 21st standard week (*i.e*., on 31st May) with 1.23 and 1.00 larvae per plant during 2020 and 2021, respectively.

Similarly, pooled data also revealed that the incidence of *S. frugiperda* was first observed on the 14th standard week (*i.e*., on 12th April) with 2.84 larvae per plant and reached the peak population on the 16th standard week (*i.e*., on 26th April) with 4.75 larvae per plant. From the 17th standard week (*i.e*., on 3rd May) onwards, the population decreased to 4.10 larvae per plant and as the plants mature with time, the population of *S.fugiperda* decreased and reached the minimum population on the 21st standard week (*i.e*., on 31st May) with 1.12 larvae per plant.

The present results are in agreement with the findings of Mukkun*et al.* 2021) who reported that the population of *S. frugiperda* ranged between 2.20 to 6.60 larvae per plant with a mean population of 4.40 larvae per plant. However, Nivetha*et al.* (2022) reported that the population of *S. frugiperda* ranged between 0.69 to 1.69 larvae per plant with the maximum population was recorded during the 12th standard week and the minimum was in the 8th standard week which was in contradiction with the present findings. The present resultsare also in contradiction with the findings ofAnandhi*et al.* (2020b) who reported that the maximum population of *S. frugiperda* was 3.36 larvae per plant during the first week of July. This might be due to different in climatic conditions prevailing at different locations, cropping seasons and host preference by the pest.

CHAPTER V

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

Studies on "Seasonal incidence of major insect pests and screening of local maize (*Zea mays* L.) cultivars" was carried out during March to July 2020 and March to July 2021 in Experimental Research Farm of Entomology, School of Agricultural Sciences (SAS), Nagaland University. Before conducting the studies, the seeds were collected directly through the farmers from Mon, Kohima, Chumukedima, Phek and Wokha districts during the month of October to December, 2019. For seasonal incidence of major insect pests and their natural enemies in different local maize cultivars, ten (10) randomly plants were selected in each plot at fortnightly intervals. The incidence of insect pests as leaf injuryinfestation, dead hearts infestation caused by maize stem borerand leaf whorls damage caused by fall armywormwere recorded from the infested plants. Randomized Block design (RBD) field layout was used for screening and to study the morphological characteristics of different maize cultivars (14 local and 1 Hybrid) with three replications. Local cultivar Medziphema Local-1 was maintained as the ecological plots to observe the seasonal incidence of major insect pests. The findings of these experiments are summarized below:

5.1. Seasonal incidence of major insect pests and their natural enemies in different local maize cultivars during 2020 and 2021

- In both the years of studies, Maize stem borer (*Chilo partellus*) and Fall armyworm (*Spodoptera frugiperda*) were found the major insect pests in the maize experimental field and the natural enemies which were observed during the present investigation were coccinellid beetles and spiders in both the years.
- The incidence of *C. partellus* as leaf injury damage was observed from 15th standard week (*i.e.*, on 19th April) during April to June 2020 and 16th standard week (*i.e.*, on 26th April) during April to June 2021 which

continued upto 23rd standard week *i.e.*, on 14th June in both the years.

- The maximum leaf injury damage was observed in the cultivars Khonoma Local and Khuzama Local with 20.00% infestation each on the 19th (*i.e.*, on 17th May) and 20th (*i.e.*, on 24th May) standard week during 2020 and 2021, respectively while the minimum leaf injury damage was observed in the cultivars Shiyam Ngangching Local, Yang Leng Ngangching Local, Watak Ngangching Local, Medziphema Local-2, Zarsi Socunoma Local and Wokha Local-2 with 3.33% infestation each in both the years.
- The incidence of *C. partellus* as dead hearts damage was observed from 17th standard week *i.e.*, on 3rd May which continued upto 23rd standard week *i.e.*, on 14th June in both the years.
- Overall the maximum dead hearts damage was observed in the cultivars Khuzama Local and Medziphema Local-1 with 12.23% infestation each and the least dead hearts damage was observed in cultivar Zarsi Socunoma Local with 5.84% infestation during 2020. While during the year 2021, the overall maximum dead hearts damage was observed in cultivar Khuzama Local with 11.69% infestation and the minimum dead hearts damage was observed in cultivar Zarsi Socunoma Local with 5.27% infestation.
- The incidence of *S. frugiperda* as leaf whorls damage was observed from 14th standard week *i.e.*, on 12th April which continued upto 23rd standard week in both the years.
- Overall the maximum leaf whorls damage was observed in cultivar Medziphema Local-1 with 13.83% infestation followed by cultivar Khuzama Local with 11.17% infestation and the least leaf whorls damage was observed in cultivar Zarsi Socunoma Local with 2.83% infestation during 2020. While during the year 2021, the overall maximum leaf whorls damage was observed in cultivar Medziphema Local-1 with 14.00% infestation followed by cultivar Khuzama Local with 13.84%

infestation and the least leaf whorls damage was observed in cultivar Zarsi Socunoma Local with 3.00% infestation during 2021.

- The incidence of coccinellid beetles species was observed from 16th standard week *i.e.*, on 26th April onwards and continued upto 23rd standard week *i.e.*, on 14th June in both the years.
- Overall the maximum coccinellid beetles population was observed in cultivar Zarsi Socunoma Local with 1.06 and 1.07 beetles per plant while the minimumum population was observed in cultivar Khuzama Local with 0.45 and 0.48 beetles per plant during 2020 and 2021, respectively.
- The incidence of spiders was observed from 15th standard week *i.e.*, 19th April onwards and continued upto 23rd standard week*i.e.*, on 14th June in both the years.
- Overall the maximum spiders population was observed in cultivar Zarsi Socunoma Local with 0.93 and 0.97 spiders per plant while the minimumum population was observed in cultivar Medziphema Local-1 with 0.41 and 0.43 spiders per plant during 2020 and 2021, respectively.

5.2. Correlation coefficient (r) on the seasonal incidence of major insect pests and their natural enemies with abiotic factors in different local maize cultivars during 2020 and 2021

- The correlation coefficient on the seasonal incidence of *C. partellus* as leaf injury damage with the minimum temperature revealed a non-significant positive correlation in most of the cultivars but showed a significant positive correlation in the cultivars Chiechama Local (r = 0.653), Khuzama Local (r = 0.680) and Medziphema Local-1 (r = 0.660) during 2020 and cultivars Khuzama Local (r = 0.633) and Medziphema Local-1 (r = 0.632) during 2021.
- The correlation coefficient on the seasonal incidence of *C. partellus* as leaf injury damage revealed a significant positive correlation with the minimum relative humidity in the cultivars Chiechama Local, Khonoma

Local and Khuzama Local with (r = 0.685), (r = 0.632) and (r = 0.677), respectively during 2020 while during 2021 the rest of the cultivars showed a non-significant positive correlation.

- The correlation coefficient on the seasonal incidence of *C. partellus* as dead hearts damage with the minimum temperature abiotic factors showed a significant positive correlation all the cultivars during 2020 but during 2021, it showed a significant positive correlation with the minimum temperature in most of the cultivars except in the cultivars Shiyam Ngangching Local, Yempong Ngangching Local and Chiechama Local which showed a non-significant positive correlation with (r = 0.576), (r = 0.628) and (r = 0.614), respectively.
- The correlation coefficient on the seasonal incidence of *C. partellus* as dead hearts damage with the maximum relative humidity revealed a significant positive correlation and non-significant positive correlation in all the cultivars during 2020 and 2021, respectively.
- The relationship on the seasonal incidence of *C. partellus* as dead hearts damage with rainfall showed a non-significant positive correlation in all the cultivars during 2020 whereas during 2021 it showed a non-significant negative correlation in the cultivars Shiyam Ngangching Local, Zarsi SocunomaLocal and Nmh-8352 with (r = -0.030), (r = -0.063) and (r = -0.014), respectively.
- The correlation coefficient on the seasonal incidence of *S. frugiperda* as leaf whorls damage with the maximum temperature revealed a non-significant negative correlation with the maximum temperature in most ofthe cultivars in both the years.
- The correlation coefficient on the seasonal incidence of *S. frugiperda* as leaf whorls damage with the maximum and minimum temperature showed a non-significant negative correlation with most of the cultivars in both the years.

- The correlation coefficient on the seasonal incidence of *S. frugiperda* as leaf whorls damage with the maximum relative humidity revealed a significant negative correlation in most of the cultivars during 2020 but showed a non-significant negative correlation in most of the cultivars during 2021.
- The relationship on the seasonal incidence of *S. frugiperda* as leaf whorls damage with the rainfall revealed a positive as well as negative non-significant correlation in all the cultivars in both the years.
- The correlation coefficient on the seasonal incidence of coccinellid beetles with the maximum temperature showed a non-significant negative correlation temperature in most of the cultivars during 2020 but showed a non-significant negative correlation in all the cultivars during 2021.
- The correlation coefficient on the seasonal incidence of coccinellid beetles with the minimum temperature revealed a significant positive correlation in all the cultivars in both the years.
- The correlation coefficient on the seasonal incidence of coccinellid beetles with the maximum relative humidity showed a significant positive correlation in all the cultivars during 2020. But during 2021, the correlation coefficient on the seasonal incidence of coccinellid beetles showed a significant positive correlation in most of the cultivars except in cultivar Medziphema Local-1 which revealed a non-significant positivecorrelation with (r = 0.629).
- The correlation coefficient on the seasonal incidence of coccinellid beetles with the minimum relative humidity revealed a significant positivecorrelation in all the cultivars in both the years.
- The correlation coefficient on the seasonal incidence of spiders with the maximum temperature showed a non-significant positive correlation with the maximum temperature in most of the cultivars except in cultivar Shiyam Ngangching during 2010 but it showed a non-

significant negative correlation in all the cultivars during 2021.

- Similarly, the correlation coefficient on the seasonal incidence of spiders with the maximum relative humidity showed a significant positive correlation in all the cultivars in both the years.
- The correlation coefficient on the seasonal incidence of spiders with the minimum relative humidity revealed a significant positive correlation in most of the cultivars except in cultivar Khuzama Local during 2020. But during 2021, the correlation coefficient on the seasonal incidence of spider with the minimum relative humidity showed a non-significant positive correlation in most of the cultivars except in cultivar Yang Leng Ngangching.
- The relationship on the seasonal incidence of spiders with the rainfall revealed a non-significant positive correlation in all the cultivars in both the years.

5.3. Screening of different local cultivars for resistance against the major insect pests of maizeduring 2020 and 2021

- The level of leaf injury caused by *C. partellus* on different local maize cultivars showed a significant difference with respect to leaf injury rating and among the cultivars, the leaf injury rating caused by *C. partellus* ranged between 2.86 to 6.26 and 2.05 to 5.25 during 2020 and 2021, respectively.
- Out of fifteen (15) cultivars, only one cultivar was found resistant; nine (9) cultivars were moderately resistant and five (5) cultivars were observed susceptible to *C. partellus* during 2020but during the year 2021, four (4) cultivars were found resistant, nine (9) cultivars were moderately resistant and two (2) of the cultivars were observed susceptible to *C. partellus* against leaf injury rating.
- The level of dead hearts infestation caused by *C. partellus* on different local maize cultivars showed a significant difference with respect to dead

hearts rating and among the cultivars, the dead hearts rating ranged between 2.83 to 9.27 and 2.27 to 8.67 during 2020 and 2021, respectively.

- Out of fifteen (15) cultivars, one cultivar was found resistant; four (4) cultivars were moderately resistant, five (5) cultivars were susceptible and five (5) cultivars were observed highly susceptible to *C. partellus* during 2020 but during the year 2021only one cultivar was found resistant, five (5) cultivars were moderately resistant, five (5) cultivars were susceptible and four (4) cultivars were observed highly susceptible to *C. partellus*against dead hearts rating.
- The level of stem tunneling caused by *C. partellus* on different local maize cultivars showed a significant difference with respect to the length of stem tunnel and among the cultivars, the length of stem tunneling ranged between 3.33 to 13.33 cm and 3.00 to 13.00 cm per plant during 2020 and 2021, respectively.
- Out of fifteen (15) cultivars, four (4) cultivars were found least susceptible, seven (7) cultivars were moderately susceptible and four (4) cultivars were highly susceptible to *C. partellus* against length of stem tunnel in both the years.
- The number of exit holes caused by *C. partellus* on different local maize cultivars showed a significant difference and among the cultivars, the number of exit holes ranged between 2.33 to 4.33 per plant and 2.00 to 4.33 per plant during 2020 and 2021, respectively.
- Out of fifteen (15) cultivars, the minimum number of exit holes were observed in the cultivars Shiyam Ngangching Local, Watak Ngangching Local and Zarsi Socunoma Local whereas, the maximum number of exit holes was observed in the cultivars Medziphema Local-1 in both the years.
- The level of leaf whorls damage caused by fall armyworm, *Spodoptera frugiperda* on different local maize cultivars showed a significant difference with respect to leaf whorls damage rating and among the

cultivars, the leaf whorl damage rating ranged between 2.43 to 7.93 and 2.50 to 8.00 during 2020 and 2021, respectively.

- Out of fifteen (15) cultivars, five (5) cultivars were found resistant; eight (8) cultivars were moderately resistant and two (2) cultivars were observed susceptible to *S. frugiperda* during 2020 but during 2021, six (6) cultivars were found resistant; seven (7) cultivars were moderately resistant, one (1) cultivar was susceptible and one (1) cultivar was found highly susceptible to *S. frugiperda*against leaf whorls damage rating.

5.4. Studies on the morphological characteristics of different local cultivars of maize during 2020 and 2021

- The stem diameter per plant on different local cultivars of maize showed a significant differencein both the years and among the fifteen (15) cultivars, the stem diameter ranged between 3.10 to 3.77 cm per plant and 3.13 to 3.83 cm per plant during 2020 and 2021, respectively.
- The maximum stem diameter was observed in cultivar Yempong Ngangching Local with 3.77 and 3.83 cm per plant during 2020 and 2021, respectively.
- The minimum stem diameter was observed in the cultivars Zarsi Socunoma Local and Nmh-8352 with 3.10 cm each per plant during 2020 but during 2021 the minimum stem diameter wasobserved in cultivar Zarsi Socunoma Local with 3.13 cm per plant.
- The number of nodes per plant on different local cultivars of maize showed a significant differencein both the years and among the fifteen (15) cultivars, the number of nodes per plant ranged between 8.00 to 13.25 and 8.17 to 13.82 cm during 2020 and 2021, respectively.
- The maximum number of nodes per plant was observed in cultivar Yempong Ngangching Local with 13.25 and 13.82 during 2020 and 2021, respectively.

- The minimum number of nodes per plant was observed in the cultivars Zarsi Socunoma Local and Nmh-8352 with 8.00 each during 2020 but during 2021 the minimum number of nodes per plant was observed in cultivar Zarsi Socunoma Local with 8.17.
- The leaf length on different local cultivars of maize showed a significant differencein both the years and among the fifteen (15) cultivars, the leaf length ranged between 56.56 to 88.72 cm and 58.72 to 90.80 cm during 2020 and 2021, respectively.
- The maximum leaf length was observed in cultivar Yempong Ngangching Local with 88.72 and 90.80 cm whereas the minimum leaf length was observed in cultivar Zarsi Socunoma Local with 56.56 and 58.72 cm during 2020 and 2021, respectively.
- The leaf width on different local cultivars of maize showed a significant differencein both the years and among the fifteen (15) cultivars, the leaf width ranged between 7.25 to 8.30 cm and 7.69 to 8.69 cm during 2020 and 2021, respectively.
- The maximum leaf width was observed in cultivar Medziphema Local-1 with 8.30 and 8.69 cm whereas the minimum leaf width was observed in cultivar Medziphema Local-2 with 7.25 and 7.69 cm during 2020 and2021, respectively.
- The leaf area on ondifferent local cultivars of maize showed a significant differencein both the years and among the fifteen (15) cultivars, the leaf area ranged between 420.30 to 692.73 cm^2 and 258.98 to 555.20 cm^2 during 2020 and 2021, respectively.
- Themaximum leaf area was observed in cultivar Yempong Ngangching Local with 692.73 and 755.20 cm^2whereas the minimum leaf area was observed in cultivar Zarsi Socunoma Local with 420.30 and 458.98 cm^2 during 2020 and 2021, respectively.
- The number of leaf trichomes on different local cultivars of maize showed a significant differencein both the years and among the fifteen (15)

cultivars, the number of leaf trichomes ranged between 10.72 to 38.92 and 10.60 to 43.87 during 2020 and 2021, respectively.

- The maximum number of leaf trichomes was observed in cultivar Chiechama Local with 38.92 and 43.87 whereas the minimum number of leaf trichomes was observed in cultivar Yang Leng Ngangching Local with 10.72 and 10.60 during 2020 and 2021, respectively.
- The plant height on different local cultivars of maize showed a significant difference in both the years and among the fifteen (15) cultivars, the plant height ranged between 130.00 to 265.00 cm and 133.33 to 276.67 cm during 2020 and 2021, respectively.
- The maximum plant height was observed in cultivar Yempong Ngangching Local with 265.00 and 276.67 cm whereas the minimum was observed in cultivar Zarsi Socunoma Local with 130.00 and 133.33 cm during 2020 and 2021, respectively.
- The cob length on different local cultivars of maize showed a significant difference in both the years and among the fifteen (15) cultivars, the cob length ranged between 16.67 to 27.67 cm and 18.77 to 30.20 cm during2020 and 2021, respectively.
- The maximum cob length was observed in cultivar Phek Local-1 with 27.67 and 30.20 cm whereas the minimum cob length was observed in cultivar Medziphema Local-1 with 16.67 and 18.77 cm during 2020 and 2021, respectively.
- The cob height on different local cultivars of maize showed a significant difference in both the years and among the fifteen (15) cultivars, the cob height ranged between 70.00 to 162.33 cm and 73.33 to 171.67 cm during 2020 and 2021, respectively.
- The maximum cob height was observed in cultivarYempong Ngangching Local with 162.33 and 171.67 cm whereas the minimum cob height was observed in cultivar Zarsi Socunoma Local with 70.00 and 73.33 cm during 2020 and 2021, respectively.

- The length of central spike on different local cultivars of maize showed a significant difference in both the years and among the fifteen (15) cultivars, the length of central spike ranged between 21.60 to 42.27 cm and 23.38 to 44.20 cm during 2020 and 2021, respectively.
- The maximum length of central spike was observed in cultivar Wokha Local-2 with 42.27 and 44.20 cm whereas the minimum length of central spike was observed in cultivar Medziphema Local-1 with 21.60 and 23.38 cm during 2020 and 2021, respectively.
- The 100 grain weight on different local cultivars of maize showed asignificant difference in both the years and among the fifteen (15) cultivars, the 100 grain weight ranged between 17.77 to 30.78 g and 18.23 to 33.90 g during 2020 and 2021, respectively.
- The maximum 100 grain weight was observed in cultivar Phek Local-1 with 30.78 and 33.90 g whereas the minimum 100 grain weight was observed in cultivar Zarsi Socunoma Local with 17.77 and 18.23 g during2020 and 2021, respectively.

5.5. Correlation coefficient (r) on the seasonal incidence of major insect pests in relation to morphological characteristics of different local maize cultivarsduring 2020 and 2021

- The correlation coefficient on the seasonal incidence of *Chilo partellus* as leaf injury damage with the morphological characteristics of different local maize cultivars showed a non-significant positive correlation in most of the characters in both the years except with the cob length and length of central spike which showed a non-significant negative correlation with (r = -0.165 &r = -0.198) and (r = -0.067 & r = -0.065) during 2020 and 2021, respectively.
- The correlation coefficient on the seasonal incidence of *C. partellus* as leaf injury damage with the morphological characteristics of different local maize cultivars revealed a significant positive correlation with the

leaf width with (r = 0.529) and (r = 0.553) during 2020 and 2021, respectively.

- The correlation coefficient on the seasonal incidence of *C. partellus* as dead hearts infestation with the morphological characteristics of different local maize cultivars showed a non-significant positive correlation in most of the characters in both the years except with cob length which showed a non-significant negative correlation with (r = -0.149) and (r = -0.024) during 2020 and 2021, respectively.
- The correlation coefficient on the seasonal incidence of *C. partellus* as dead hearts infestation with the morphological characteristics of different local maize cultivars revealed a significant positive correlation with 100 grain weight which showed a significant positive correlation with (r = 0.520) and (r = 0.528) during 2020 and 2021, respectively.
- The correlation coefficient on the seasonal incidence of *C. partellus* as stem tunneling with the morphological characteristics of different local maize cultivars showed a non-significant positive correlation in most of the characters except with the leaf length and cob length which revealed a non-significant negative correlation with (r = -0.058) and (r = -0.266), respectively during 2020 and (r = -0.068) and (r = -0.294), respectively during 2021.
- The correlation coefficient on the seasonal incidence of *C. partellus* as stem tunneling with the morphological characteristics of different local maize cultivars revealed a significant positive correlation with 100 grain weight with (r = 0.524) and (r = 0.531) during 2020 and 2021, respectively.
- The correlation coefficient on the seasonal incidence of *C. partellus* as number of exit holes with the morphological characteristics of different local maize cultivars showed a non-significant positive correlation with the stem diameter, number of nodes, leaf width, number of leaf trichomes and plant height in both the years.

- The seasonal incidence of *C. partellus*as number of exit holes with the morphological characteristics of different local maize cultivars showed a non-significant negative correlation with the leaf length, leaf area, cob length, cob height and length of central spike in both the years.
- The correlation coefficient on the seasonal incidence of *S. frugiperda* as leaf whorls damage with the morphological characteristics of different local maize cultivars showed a non-significant positive correlation in most of the characters except with the leaf length, cob length and length of central spike which showed a non-significant negative correlation in both the years.

5.6. Seasonal incidence of major pests on maize variety, Medziphema Local-1 during 2020 and 2021

- The incidence of *C. partellus*on maize variety, Medziphema Local-1 was observed from 15th standard week (*i.e.*, on 19th April) which continued upto 23rd standard week (*i.e.*, on 14th June) in both the years.
- The incidence of *C. partellus* was first observed on the 15th standard week (*i.e.*, 19th April) with 0.87 and 0.67 larvae per plant and reached the peak population on the 22nd standard week (*i.e.*, on 07th June) with 4.29 and 4.07larvae per plant during 2020 and 2021, respectively.
- The incidence of *S. fugiperda* on maize variety, Medziphema Local-1 was observed from 14th standard week (*i.e.*, on 12thApril which continued upto 21st standard week (*i.e.*, on 31st May) in both the years.
- The incidence of *S. fugiperda* was first observed on the 14th standard week (*i.e.*, on 12th April) with 3.00 and 2.67 larvae per plant and reached the peak population on the 16th standard week (*i.e.*, on 26th April) with 4.97 and 4.53 larvae per plant during 2020 and 2021, respectively.

Conclusions:

Based on the present studies, the following conclusions have been drawn from the findings given above

1. The maximum leaf injury damage due to maize stem borer was observed in cultivar Medziphema Local-1in both the years of studies.
2. The maximum dead heart damage due to maize stem borer were observed in the cultivars Khuzama Local and Medziphema Local-1 during 2020 and Khuzama Local during 2021.
3. The maximum leaf whorls damage due to fall armyworm was observed in cultivar Medziphema Local-1in both the years of studies.
4. The correlation coefficient on the seasonal incidence of maize stem borer as leaf damage with minimum relative humidity revealed a significant positive correlation in most of the cultivars in both the years.
5. The correlation coefficient on the seasonal incidence of maize stem borer as dead heart damage with minimum temperature and maximum relative humidity showed a significant positive correlation in all the cultivars in both the years.
6. The correlation coefficient on the seasonal incidence of fall armyworm as leaf whorl damage wih the rainfall revealed a positive as well as negative non – significant correlation in all the cutivars in both the years,
7. The correlation coefficient on the seasonal incidence of coccenilid beetles with minimum temperature and minimum and maximum relative humidity showed a positive significant correlation in almost all the cultivars in both the years,
8. The correlation coefficient on the seasonal incidence of spiders with the maximum and minimum relative humidity showed a significant positive correlation in almost all the cultivars in both the years.
9. Five (5) cultivars were found resistant; ten (10) cultivars were moderately resistant and none of the cultivar was observed susceptible to leaf injury caused by *C. partellus.*

10. Two (2) cultivars were found resistant, five (5) cultivars were moderately resistant, four (4) cultivars were susceptible and four (4) cultivars were highly susceptible to the dead heart caused by *C. partellus.*
11. Four (4) cultivars were found least susceptible, seven (7) cultivars were moderately susceptible and four (4) cultivars were highly susceptible to stem tunneling by *C. partellus.*
12. Five (5) cultivars were found resistant and eight (8) cultivars were moderately resistant and two (2) cultivars were observed susceptible to leaf whorls damage by *S. frugiperda.*

Future line of work

Insecticides have become indispensible to control insect pests in maize because of its rapid effect and ease of application. Screening of varieties and the morphological characteristics of the host plant in the present study has proven to be very efficient and has immense potential for pest management in field conditions.

Invasive species such as fall armyworm can cause devastating outcome but the use of readily available management *i.e*., different planting dates and use of resistant varieties has immense potential to avoid such conditions arising from invasive species. Hence such methods of pest management against fall armyworm can encourage the farmers to take up for future pest management.

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