GENETIC EVALUATION AND CHARACTERIZATION OF DIFFERENT GENOTYPES OF ASH GOURD [*Benincasa hispida* (THUNB.) COGN.]

Thesis

submitted to

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in partial fulfillment of requirements for the Degree

of

Doctor of Philosophy

in

HORTICULTURE (VEGETABLE SCIENCE)

by

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Nagaland

2020

DECLARATION

I, Ashwini Ananda 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 Horticulture (Vegetable Science).

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CERTIFICATE – I

This is to certify that the thesis entitled **“Genetic evaluation and characterization of different genotypes of ash gourd [*Benincasa hispida* (Thunb.) Cogn.]”** submitted to Nagaland University in partial fulfillment of the requirements for the award of degree of Doctor of Philosophy in Horticulture (Vegetable Science) is the record of research work carried out by Mr. Ashwini Ananda Registration No. Ph.D./HOR/00124 under 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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CERTIFICATE – II

VIVA VOCE ON THESIS OF DOCTOR OF PHILOSOPHY IN HORTICULTURE

This is to certify that the thesis entitled "**Genetic evaluation and characterization of different genotypes of ash gourd [*Benincasa hispida* (Thunb.) Cogn.]**" submitted by ASHWINI ANANDA Admission No. Ph-227/17 Registration No. Ph.D./HOR/00124 to the NAGALAND UNIVERSITY in partial fulfillment of the requirements for the award of degree of Doctor of Philosophy in Horticulture (Vegetable Science) has been examined by the Advisory Board and External examiner on **12.04.2021.**

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Dedicated

to my beloved parents

and sisters

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LIST OF ABBREVIATIONS

AICRP-VC	: All India Coordinated Research Project- Vegetable crop
ANOVA	: Analysis of Variance
@	: at the rate
CD	: Critical Difference
cm	: centimeter
Df	: Degree of freedom
^{O}C	: Degree Celsius
E	: East
et al.	: Et alilbi and others
FYM	: Farm Yard Manure
GCV	: Genotypic Coefficient of Variation
G	: gram
ha	: Hactare
HP	: Himachal Pradesh
Kg	: Kilogram
MSS	: Mean Sum of Square
Max.	: Maximum
Min.	: Minimum
m	: Meter

mm	: Milimeter
NPK	: Nitrogen Phosphorous Potassium
N	: North
/	: Per
%	: Per cent
PCV	: Phenotypic Coefficient of Variation
RBD	: Randomized Block Design
S	: South
SASRD	: School of Agricultural Sciences and Rural Development
SS	: Sum of Square
t	: tonnes
TSS	: Total Soluble Solute
via.	: through
viz.	: namely
W	: West

CHAPTER I

INTRODUCTION

INTRODUCTION

Ash gourd [*Benincasa hispida* (Thunb.) Cogn.] popularly known as wax gourd or white pumpkin is important cucurbitaceous vegetable grown throughout India mainly in rainy season. Ash gourd belongs to cucurbitaceae family with chromosome number 2n=24. Yawalkar (1985) mentioned that the original home of ash gourd is believed to be Java, where its wild progenitors are still found. However, it is widely distributed throughout the tropical and subtropical Asia (Purseglove, 1987). Though it has been cultivated in China from the ancient period, it is not clearly known from what time this crop is being cultivated in the Indian subcontinent. It is believed that this has originated in Asia. Among the cucurbits, ash gourd is considered a prized vegetable because of its high nutritional value, long storage life and good transport qualities, besides its medicinal properties. The young leaves, flowers and both immature and mature fruits are consumed. It is preferred among the growers and consumers because of long shelf life under ambient conditions, good portability and appreciably good nutritive value. The mature fleshy fruit is either eaten raw or cooked as vegetable marrow or 'candied' as sweet meat popularly known as 'petha'. Ash gourd is considered good for people suffering from nervousness and debility. It is mainly grown in North India especially in Uttar Pradesh where it is used in the preparation of petha sweet. It comes in the market when there is a crisis of vegetables. Among the vegetables under cucurbitaceae family and other creepers usually ash gourd gives the higher economic return for marginal farmers (Chowdhury, 1993). It is a good source of carbohydrate, vitamin A, vitamin C and minerals like iron and zinc (Kanaujia *et al.*, 2020). On compositional basis, petha based sweets contain on average basis of total fat 0.4%, total carbohydrate 65%, dietary fibre 3%, protein 0.6% and sugar content 40%. Its fruits contain a relatively high level of

K and low Na and from the index of nutritional quality value, it has been adjudged as a quality vegetable.

In Korea, ash gourd was used mainly for diabetes and diuresis diseases. One study was carried out for evaluation of anti-angiogenic effect of the seed extract of *Benincasa hispida*. Basic fibroblast growth factor (bFGF) is a potent angiogenic factor found in various tumors. In the study, it was found that the seed extract of *Benincasa hispida*. decreased bFGF-induced endothelial cell proliferation and tube formation in a dose-dependent manner. Besides, *Benincasa hispida* seed extract showed no cytotoxicity on HUVECs and normal fibroblast cells. Furthermore, the seed extract of *Benincasa hispida* showed a potent inhibitory effect on bFGF-induced angiogenesis *in vivo*. These results suggest that the seed extract of *Benincasa hispida* inhibits the proliferation of endothelial cells induced by bFGF, which may explain its anti-angiogenic properties.

Ash gourd is actually a fruit but is referred to as a vegetable because it is cooked and eaten as a vegetable. In India, the ash gourd is offered to the gods in religious ceremonies. Chalky wax on its skin prevents micro-organisms growth and preserves it. It is an excellent source of vitamin B_1 (thiamine), vitamin B_3 (niacin), vitamin C and nutrients i.e., calcium, potassium, iron and zinc (Sureja *et al.*, 2006). It helps in maintaining a healthy blood pressure.

An enzyme extracted from ash gourd juice can be used in place of calf rennet for producing cheddar cheese (Gupta and Eskin, 1977). It is also used to treat a variety of elements in ayurvedic and naturopathy systems of medicine. It also contain different phytonutrients which have immense value in treatment of disease like urinary dysfunction, summer fever, cough and to cure weak nervousness and debility (Nadhiya *et al.,* 2014) Ash gourd is generally a monoecious herb having climbing or trailing habit (Rashid, 1993) and highly cross pollinated crop. Andromonoecious and hermaphrodite flowers are also observed in ash gourd (Rahman, 1996). Two botanical forms of ash gourd have been recognized in Japan, one is called typical, which is characterized by velvety testa and a marginal band around the seeds. While this characteristic is absent in the other form. More frequently vegetables are being sought to be more than just a source of nourishment, consumers are looking for functional and nutritionally active foods. Normally the entire ash gourd plant, including fruit peel, flower, seed, and leaves are used. Biochemical activity of the fruit includes anti-oxidative, anti-inflammatory, anti-angiogenic, detoxificant, and curvative effects in treating various ailments.

This valuable pharmacological plant shows different activities such as anticonvulsant, anxiolytic, gastroprotective, anti-nociceptive, anti-pyretic, anti-histaminic, anti-inflammatory (Chandrababu and Umamaheshwari, 2002), analgesic, anti-oxidant, anti-diarrhoeal, anorectic angiogenic, anthelmentic and anti-ulcer (Grover *et al*., 2001). With the passage of time population has increased manifold and it will continue to increase further. Accurate evaluation of these characters is made more difficult by the genotype by environment interaction. Principal component analysis helps plant breeders to distinguish significant relationship between traits. This is a multivariate analysis method that aims to explain the correlation between a large set of variables in terms of a small number of underlying independent components (Beheshtizadeh *et al*., 2013)

An understanding of the nature and magnitude of variability or genetic diversity among the genetic stocks is of prime importance to the breeder to overcome these production problems. With the passage of time population has increased manifold and it will continue to increase further. So as to keep up with the rising demand of ash gourd production, good initial breeding material is required in the germplasm which can later be utilized for the development of high yielding quality ash gourd varieties. Yield is a complex character controlled by a large number of contributing characters and their interactions. Selection of the appropriate genotypes for the start of the breeding programme depends largely on the primary identification and grouping of genotypes according to the characteristics relevant to the objectives. A study of correlation between different quantitative characters provides an idea of association that could be effectively exploited to formulate selection strategies for improving yield components. Selection may not be effective in population without variability. To meet the diverse goals of plant breeding such as producing cultivars with increased yield, wider adaptation, desirable quality, pest and disease resistance we need to evaluate the existing genotypes at phenotypic and genotypic level. No systematic research was made in the past to evaluate and explore the potentialities of the available germplasms. Therefore, information on its genetic architecture is essential.

For any effective selection programme, it would be desirable to consider the relative magnitude of association of various characters with yield. The path coefficient technique developed by Wright (1921) helps in estimating direct and indirect contribution of various components in building up the total correlation towards yield. It is an important tool for the better understanding of the crop inheritance in respect of yield. It gives specific measures on the direct and indirect effect of each component character on yield. On the basis of these studies the quantum importance of individual character is marked to facilitate the selection programme for better gains.

Ash gourd is grown throughout the country and found in both cultivated and non-cultivated lands and genetic variability in present for fruit shape, size, days to flowering, and other vegetative and qualitative traits. North East has good genetic variability for various traits in ash gourd and no exploration has been taken to tap the diversity till now. So there is need to develop a variety(ies) with good qualitative and yield traits, suitable for cultivation in this region. Therefore, the present investigation entitled “Genetic evaluation and characterization of different genotypes of ash gourd [*Benincasa hispida* (Thunb.) Cogn.]’’ was undertaken with the following objectives:

1. Assemblage of genotypes (open pollinated seed of cultivars, land races, farmers’ varieties, improved varieties, etc.) from different parts of the country.
2. Morpho-physiological characterization of different genotype of ash gourd based on Distinctiveness, Uniformity and Stability (DUS) guidelines.
3. To ascertain the nature and magnitude of genetic variability among different genotypes of ash gourd.
4. To find out character association and degree and direction of relationship among various yield contributing traits in ash gourd genotypes.
5. To work out genetic divergence for fruit yield and quality characters of genotypes of ash gourd.

CHAPTER II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

An attempt has been made to collect and review the relevant literatures available on various aspects of work done so far on horticultural traits, quality attributes, genetic variability, character association and divergence studies in ash gourd for fruit yield and its component characters. As the relevant literature on some of these aspects is scarce in ash gourd, efforts were made to include review of other related cucurbits, wherever it's essential. Literatures on above aspects of the present study are reviewed in this chapter under the following heads.

2.1 Performance of genotypes

2.2 Genetic variability

2.3 Correlation studies and path coefficient analysis

2.4 Genetic divergence

2.1 Performance of genotypes

Sharma and Dhankar (1989) evaluated eighteen accessions of bottle gourd for traits like fruit shape and colour, number of days to production of the first female flower, male/female sex ratio, number of nodes per plant, inter node length, number of fruits/plant and yield per plant and concluded that the accessions HBG3 (round- fruited), HBG2, HBG4 (both bell-shaped), HBG13, HBG14 and HBG18 (all long- fruited) would be best for use in breeding programmes to produce the desired high- yielding type.

Sharma and Dhankar (1990) studied thirty five genotypes of bottle gourd and observed that Hisar Local-3, a round-fruited genotype, was the earliest and highest yielding (4.71 kg/plant). Amongst the long-fruited types, Pusa Summer Prolific Long was most promising for earliness and yield.

Ram *et al.* (2007) evaluated some winter fruited bottle gourd and reported a large genetic variation for characters like days to germination, flowering, edible maturity, number of branches per plant, fruit size (length x width), number of nodes on main vine, vine length, number of fruits per plant, individual fruit weight and yield per plant. Genotypes WVR-7, WVR-15, WVR-10 and WVR-19 were found promising for earliness, fruit size, individual fruit weight and yield.

Mahato *et al.* (2010) studied fifteen lines of bottle gourd for different morphological characters, yield components and fruit yield. The genotypes varied in fruit colour (whitish to deep green with or without patches), shape (globular to elongated) and size. A good amount of variation was noticed in fruit length (10.42-42.33 cm). The inbreds, BCBG-17, BCBG-15, BCBG-33, BCBG-3 and BCBG-6 have emerged as highly promising for developing good quality hybrids.

Kumar and Prasad (2011) evaluated five hybrids and one open pollinated variety of bottle gourd. Among all the hybrids, Vikrant was found to be superior to the others in terms of fruit length, diameter, weight, yield, maximum net return per hectare and cost benefit ratio.

Haque *et al.* (2013) studied that positively significantly correlation for yield of snake gourd with flowering period, number of fruit per plant, total number of fruit / plot and indivisual fruit weight.

Rani (2014) reported the bitter gourd genotypes for their growth and yield so as to select the significant differences among the genotypes for fifteen characters studied. The genotypes viz., IC-044438 followed by IC-033227 and IC-470560 recorded highly significant yield (1.58, 1.38 and 1.36 kg/plant, respectively) and yield related traits like number of fruits/vine (21.6, 20.00 and 22.47, respectively), average fruit weight(73.33, 69.24 and 60.68g, respectively), pulp thickness (3.53, 3.69 and 3.48 cm, respectively) while IC-470560 and IC-044438 were found early as they recorded minimum days to 1st male flower (37.47 and 39.13, respectively), 1st female flower appeared (47.40 and 45.13, respectively) and sex ratio (male to female) (7.16 and 7.38, respectively). Based on the results, genotypes viz., IC-044438, IC-033227 and IC-470560 may be selected as parents in further breeding programme to improve the crop in terms of yield and earliness.

Sahu *et al*. (2015) reported performance of ash gourd genotypes for earliness and yield of 30 genotypes, the genotype IAG 2 was noted for earliness (82 DAT) for days to 50% flowering and the genotype IAG 15 was noted for early male flowering *i.e*. 28.67. The genotype IAG 7 exhibited early fruit setting (68.67 DAT) and the genotype IAG 29 noted for early harvesting *i.e*. 124.33 DAT. Maximum number of fruits per plant (14) was recorded in IAG 10. Studies revealed that the genotypes IAG 2, IAG 15, IAG 7, IAG 29 and IAG 10 were found to be promising for earliness and fruit yield.

Bairwa *et al.* (2017b) reported that among forty six genotypes, the genotype IAG 24 was noted for earliness (82.12) for days to 50% flowering and the genotype IAG 25 was noted for early male flowering i.e. 18.66. The genotype IAG 25 and IAG 35 exhibited early fruit setting (74.25) and the genotype IAG 29 noted for early harvesting i.e. 126.33 days. Maximum number of fruits per plant (13.50) was recorded in IAG 25. Studies revealed that the genotypes IAG 25, IAG 29, IAG 35, IAG 40 and Pusa Ujjawal were found to be promising for earliness and fruit yield.

Tadkal *et al.* (2019) reported that among thirteen genotypes evaluated, G-12 exhibited highest vine length (3.74m), the genotype G-12 (12.13 cm) showed highest internodal length, highest number of internodes was observed in the genotype G12 (51.40), G-9 exhibited highest number of branches (13.20). The genotype G-1 exhibited the lowest node number for first male flower (13.3) on contrast to this the genotype G-2 (15.45) exhibited the lowest node number for first female flower. Earliness in terms of days to appearance of the male and female flower was observed in the genotype G-1 and G-2 (59 and 61.8 days respectively). Days to 50% flowering were earlier in the genotype G-3 (60.5 days). The narrow sex ratio (5.01) was observed in the genotype G-6 under pandal system. The highest fruit weight was recorded in the genotype G-6 (2.60 kg per fruit) and the lowest fruit weight was observed in the genotype G-5 (0.61 kg per fruit) in pandal system. The genotype G-5 recorded the highest number of fruits per vine (6.6) and the genotype G-6 recorded the lowest number of fruits (2.1). The genotype G-12 exhibited the highest yield per plant (6.72 kg per plant), yield per plot (67.2 kg) and yield per hectare (16.8 t per ha) while G-5 exhibited lowest values under pandal system of cultivation.

2.2 Genetic variability

Genetic variability is the raw material on which selection acts to evolve superior genotypes or varieties in plant breeding program. The genetic variability for various characters available in the breeding populations or materials is systematically subjected to selection to change the genetic architecture of plant characters and consequently of the plant as a whole to develop improved genotype having higher economic yield. The variability exploited in breeding programme is derived from the naturally occurring variants and the wild relative of crops as well as artificially developed strains and genetic stocks by human-efforts. The reservoir of variability for different characters of a plant species resulting from available natural or artificially synthesized variants or strains constitutes its germplasm. Thus, germplasm may include improved strains, primitive cultivars, wild relatives, obsolete cultures, special genetic stocks, seeds pollen and vegetative parts etc. Most of the germplasm collections are inadequately evaluated or screened for assessment of genetic variability. Variability in respect of different characters of ash gourd and allied crops is reviewed below. Moreover literatures related to the efficient multivariate techniques for diversity analysis are also reviewed.

Arora *et al.* (1983) found a wide range of variability for number of fruits per plant among the genotypes of sponge gourd (0.3-12.0). They found significant variation for fruit length and diameter in this crop.

Mangal *et al.* (1983) observed significant differences among 21 bitter gourd genotypes for the traits leaf length and leaf width and found low genotypic and phenotypic variances for leaf length (1.83-1.99) and breadth (3.74-4.17). They also reported high heritability as well as high genetic advance for leaf length (91.96% and 41.33%) and breadth (89.69% and 42.55%) and variability for fruits per plant among the genotypes (6.0-17.5) and low value of genotypic and phenotypic variances for fruits per plant in bitter gourd (9.02 and 10.45). Significant variation for fruit length and diameter were also reported in bitter gourd. They observed genotypic and phenotypic variances for seeds per fruit in bitter gourd were 2.49 and 29.70, respectively.

Vashistha *et al.* (1983) found low range of variation (1.37-2.09) for fruits per plant in watermelon. They reported high heritability (76.7%) and considerable genetic advance (21.8) for seeds per fruit in water melon.

Swamy *et al.* (1984) conducted a field experiment on muskmelon and reported genetic diversity for vine length of this crop. They also found a wide range of variability among the genotypes for seed weight per fruit in muskmelon.

Rana *et al.* (1986) evaluated the genetic variability for main vine length in pumpkin. Fruit weight of pumpkin also varied widely.

Hamid *et al.* (1989) studied nine local ash gourd genotypes for two years and observed that the first male flower opened within 41 to 50 and 50 to 66 days and the first female flower opened within 51 to 70 and 60 to 75 days in the 1st and 2 nd year, respectively. They reported that the first male flower appeared within the node order of 10 to 13 (1st year) and 9 to 15 (2nd year) in some ash gourd genotypes but for the remaining test lines of the study, the node order was 22 to 28 in the 1 st year and 23 to 31 in the 2nd year.

Hawlader *et al.* (1999) reported genetic variability in thirteen cultivars of bottle gourd for eight quantitative characters. A wide range of variability was recorded for most of the characters. Heritability was very high for all the eight characters. Number of male flowers, number of female flowers and fruit yield per plant exhibited high heritability coupled with high genetic advance.

Mathew *et al.* (2000) studied twenty eight bottle gourd genotypes for their qualitative and quantitative characters and observed significant difference in accession for quantitative characters, *viz.,* vine length, number of primary branches, days to first female flower opening, nodes to first female flower, sex ratio, number of fruits per plant, length of fruit, girth of fruit, 100 seed weight and number of seeds per fruit. Maximum range of variation was observed for number of seeds per fruit followed by fruit set percent. The highest genotypic and phenotypic coefficient of variation was recorded for number of fruits per plant and the lowest for inter node length.

Lovely (2001) recorded high phenotypic coefficient of variation and genotypic coefficient of variation for the fruit yield and fruit weight in ash gourd.

Singh *et al.* (2002) evaluated that genetic variability and heritability in ridge gourd and reported that high phenotypic coefficient of variation (PCV), genetic coefficient of variation (GCV) and high heritability with high genetic advance was observed for node number at which first male and female flower appeared, length of main axis, number of primary branches, male and female flowers per vine, sex ratio on the whole vine, main axis, number of branches per vine, fruits per vine, fruit set, fruit length, fruit weight, seeds per fruit, 100-seed weight and yield per vine.

Singh and Kumar (2002) studied genetic variability in bottle gourd and reported that the phenotypic coefficient of variation was higher than the genotypic coefficient of variation. Fruit yield per plant, fruit diameter, fruit length, fruit weight, number of nodes to first male flower and vine length were characterized by high genetic variation. High estimates of heritability were recorded for fruit yield per plant, vine length, number of days to first harvest, number of nodes to first male and female flowers, number of primary branches per plant, and fruit length, weight and diameter. High heritability and high genetic advance were recorded for fruit yield per plant, vine length, fruit diameter, fruit length, fruit weight, number of nodes to first male and female flowers, and number of primary branches per plant.

Singh *et al*. (2002) recorded higher phenotypic coefficient of variation (17.08%) than genotypic coefficient of variation (15.69%) for fruit length, a wide range of variability (15.37-88.16) for fruit diameter, high estimates of phenotypic coefficient of variation (50.49%), genotypic coefficient of variation (48.59%) for fruit weight, as well as high estimates of genotypic coefficient of variation (54.70%) and phenotypic coefficient of variation (57.44%) for yield in ash gourd.

Sureja (2003) reported high estimates of genotypic coefficient of variation (31.25%, 34.90% and 39.95%) and phenotypic coefficient of variation (32.46%, 37.36% and 42.84%) for number of seeds per fruit, number of fruits per plant and yield per vine, respectively in ash gourd. A moderate genotypic coefficient of variation (16.61%) and phenotypic coefficient of variation (18.03%) for fruit weight, low genotypic coefficient of variation and phenotypic coefficient of variation for vine length, days to first male flower opening, days to first female flower opening, flesh thickness, for fruit length and fruit girth has been recorded.

Kutty and Dharmatti (2004) reported that genetic variability for 10 quantitative characters in 40 cultivars of bitter gourd and observed large variation in yield and yield components both at the phenotypic and genotypic levels. High heritability coupled with high genetic advance as per cent of mean was observed for number of fruits per vine, fruit weight, total yield per vine, number of seeds per fruit and number of leaves at the 50% flowering stage, indicating the effects of additive gene action for these traits.

Munshi and Acharyya (2005) evaluated twelve genotypes of bottle gourd and observed high genotypic and phenotypic coefficient of variation for vine length, number of primary branches per vine, number of nodes on the main axis, peduncle length, sex ratio, number of fruits per plant, fruit length, girth and weight, crop yield and starch and calcium content. Fruit girth and length, number of days to first fruit harvest and number of days to first female flower anthesis exhibited moderate to high heritability with moderate genetic advance.

Bharathi *et al*. (2006) evaluated genetic variability in 32 genotypes of spine gourd and reported that phenotypic coefficient of variation (PCV) ranged from 15.26% for fruit girth to 34.28% for fruit weight, while genotypic coefficient of variation (GCV) ranged from 14.38% for fruit girth to 33.52% for fruit weight. High heritability coupled with high genetic advance was recorded for fruit weight, fruit volume and number of fruits per vine.

Gayen and Hossain (2006) studied genetic variability and heritability of bottle gourd and observed that magnitude of phenotypic coefficient of variation (PCV) was significantly higher than genotypic coefficient of variation (GCV) for all characters suggesting the effect of environment on expression of these traits. GCV and PCV were high for fruit yield per plant and fruit length. The estimation of heritability ranged from 60.60 to 95.45%. A very high broad sense of heritability (80% and above) was recorded for length of main vine, number of primary branches per plant, number of nodes of first male flower, number of nodes of first female flower, number of days to first male flower anthesis, number of days to first female flower anthesis, sex ration, fruit length, fruit weight, number of fruits per plant, fruit yield per plant, TSS, ascorbic acid, total sugar, seed width, 100-seed weight and number of seeds per fruit. High genetic advance as percentage of mean was recorded for sex ratio, fruit length, fruit yield per plant and TSS. The sex ratio, fruit length, fruit yield per plant and TSS showed high heritability (above 80%) coupled with high genetic advance.

Gangopadhyay *et al.* (2008) at New Delhi studied 26 ash gourd accessions. The accessions showed significant inter-population differences and wide variation for quantitative and qualitative morphological descriptors observed. Low level of difference between the magnitude of PCV and GCV indicated that the descriptors were least influenced by environment and are genetically controlled. High heritability coupled with high genetic advance was observed for descriptors such as primary branches, fruits/ plant and fruit weight/plant.

Parkash (2008) studied 44 germplasms of ash gourd and observed high heritability along with high genetic advance for fruit yield per plant. In his study it has been also revealed that only number of fruits per plant and fruit weight had high genetic advance.

Singh *et al.* (2008) conducted an experiment to determine the genetic variability in bottle gourd, the analysis of variance revealed significant differences among the parents and their F_1 hybrids in both summer and rainy seasons for all the characters studied. The highest genotypic and phenotypic coefficients of variation were recorded for yield per vine in summer and rainy seasons. All the characters under study were highly heritable except number of days for bearing first male and female flowers in both the seasons. High heritability coupled with high genetic advance and genetic coefficient of variation were recorded for number of female flowers per vine, number of primary branches per vine and yield per vine in both the seasons which indicated that these characters are more reliable for effective selection.

Banik *et al.* (2009) reported that variability, heritability and genetic advance for yield and yield contributing characters in 26 genotypes of snake gourd and observed considerable variability for fruit yield per vine, node number at which first male and female flower appeared and main vine length. The highest genotypic and phenotypic coefficients of variations were observed for fruit yield per vine indicating the low impact of environment for expression of this trait. High heritability along with high genetic advance was found for fruit yield per vine, vine length and node number at which first male flower appeared.

Pandit *et al.* (2009) studied fifteen genotype of bottle gourd and reported variability for all traits except fruit/plant. The moderate GCV and genetic advance was observed for fruit length and fruit weight. Thus, improving these characters should be effective and rewarding during selection.

Sharma *et al*. (2010) evaluated on nine diverse genotype of bottle gourd and reported variability for days to first female flower, first female flowering node, fruit diameter, inter node length and fruits per vine. Medium heritability was observed for days to first female flower, first female flowering node, fruit diameter, inter node length, fruits per vine and ascorbic acid content whereas low heritability was observed for days to first picking, fruit length, vine length, branches per vine, average fruit weight, total yield per vine, chlorophyll content and dry matter content of fruit.

Sureja *et al*. (2010**)** observed a wide range of variability along with moderate phenotypic and genotypic coefficients of variation was observed for traits such as days to fruit maturity, number of seeds per fruit,seed weight per fruit, iron and zinc content. High estimates of broad sense heritability were recorded for all traits except rind thickness, TSS and crude fibre with heritability ranging from 44.22% for rind thickness to 99.12% for calcium. High heritability for these traits indicated less influence of environment in their expression. Yield per vine, number of fruits per vine, seed weight per fruit, number of seeds per fruit, vitamin C, iron and copper content showed greater estimates of genetic advance as percentage of mean coupled with high amount of heritability indicating that these traits are governed by additive genes and continued selection would be helpful in modifying the mean performance of the population

Husna *et al*. (2011) studied thirty one genotypes of bottle gourd and observed significant variation for all the characters. High GCV was observed for fruit yield per plant followed by fruit weight whereas low GCV was observed for fruit breadth. In all cases, phenotypic variances were higher than the genotypic variance. High heritability with high GA in percent of mean was observed for fruit yield per plant and days of first male flowering.

Resmi *et al*. (2011) studied twenty five genotypes of ash gourd. Variability, heritability, genetic advance was observed for average fruit weight, yield per plant, fruits per plant, fruit girth and fruit length indicating scope for improvement of these characters through selection. A significant positive correlation was observed for fruit length, fruit girth, average fruit weight, seeds per fruit, 1000 seed weight with yield suggesting that selection for these characters would lead to improvement in yield.

Kumar *et al.* (2012) evaluated genetic variability, heritability and genetic advance in bottle gourd for identifying desirable parents. The experiment comprising 24 hybrids obtained by crossing 11 parents (eight lines viz. C-29, C-37, C-74, C-78, C-4, C-55, C-34, C-26 and three tester viz. C-12 (Azad Harit), C-21 (PSPL) and C-35 (KLG)). Analysis of variance revealed the adequate variability among the all genotypes (Parents and Hybrids) for all characters. It was observed that genotypic and phenotypic coefficient of variations was high for fruit yield per plant followed by fruit length and number of seeds per fruit. Heritability was high for fruit yield per plant, number of seeds per fruit and fruit diameter. Genetic advance was high for fruit yield per plant.

Kumar *et al.* (2013) found that genetic variability, heritability and genetic advance in 20 genotypes of sponge gourd for yield and yield contributing character namely total yield per vine (kg), number of fruits per vine, average weight of fruit (g), average length of fruit (cm), average diameter of fruit (cm), days to anthesis of first male flower, days to anthesis of first female flower, node number at which first female flower appeared, days to maturity, number of primary branches, vine length (cm), specific gravity (g/cc), number of seeds per fruit and total soluble solids (^{0}Brix) and observed significant variations for all the characters in all the genotypes used in experiment. Highest genotypic and phenotypic variations were observed for total yield per vine followed by number of seeds per fruit, average weight of fruit and total soluble solids. Number of seeds per fruit, average weight of fruit and specific gravity showed high heritability with high genetic advance.

Sharma and Sengupta (2013) evaluated sixteen genotypes of bottle gourd and reported that high genotypic co-efficient of variation (GCV) was observed for fruit weight (39.48%). In all cases, phenotypic co-efficient variances were higher than the genotypic co-efficient variance. High heritability with high genetic advance in percent of mean was observed for all characters.

Singh *et al*. (2014) studied that genetic variability, heritability and genetic advance in 36 genotypes of bottle gourd for fruit length (cm) followed by fruit yield per plant, estimated yield, fruit diameter (cm). Fruit per pant and vine length (cm). High heritability (broad sense) along with high genetic advance was found for all the character under study. The high corfficient of variation provides ample scope for selection of desirable type of genotypes whereas; high heritability coupled with high genetic advance suggesting preponderance of additive gene action and indicating that selection will be more effective.

Koppad *et al.* (2015) studied eighteen genotypes of ridge gourd and results revealed that PCV was higher than the GCV for most of the traits. High heritability with moderate to high GCV and PCV was recorded for chlorophyll and proline during 45 DAS and total yield per vine indicated that these characters could be improved by simple selection.

Bairwa *et al.* (2017a) evaluated with sixty genotypes of ash gourd to determine genetic variability, heritability and genetic advance for seventeen contributing characters during the 2015-16. Significant variations were recorded for the various characters studied. Widest range of variation was observed in number of seeds per fruit followed by duration of crop, days to first fruit harvest, days to 50% flowering, days to fruit set and days to first female flower appears. Maximum genotypic and phenotypic coefficient of variation (GCV and PCV) was observed for number of seeds per fruit followed by fruit yield kg/plot. High magnitude of heritability was observed for number of seeds per fruit (95.9%) followed by 100 seed weight, (83.6%), average fruit weight (72.9%) and days to first female flower appears date (70.6%). The maximum genetic advance as percentage of mean was observed high for number of seeds per druit (51.40%), fruit yield per plot (33.32%), 100 seed weight (30.83%). On the basis of this investigation selection criteria are number of seed per fruit bringing out the improvement in ash gourd because they appearance with high value of GCV, PCV, heritability and genetic advance.

Sampath *et al.* (2019a) experiment revealed that there were significant differences for almost all the characters. High genotypic coefficient of variation was observed for, vine length (m), number of fruits per vine, average fruit weight (kg), number of seeds per fruit. Which indicate that there exists high genetic variability and better scope for improvement of these characters through selection. The characters vine length (m), number of primary branches, internodal length (cm), number of male flower, number of female flower, sex ratio, number of fruits per vine, fruit length, fruit circumference, number of seeds per fruit, 100 seed weight (g), fruit yield per vine (kg), TSS, yield/h had high heritability coupled with high genetic advance suggesting improvement of those characters through selection due to additive gene action.

Vaidya *et al.* (2020) conducted an experiment on bottle gourd for genetic variability, concluded that high genotypic and phenotypic coefficient of variation and high heritability estimates associated with high values of genetic advance as a percent mean were observed for number of primary branches per vine, number of fruits per vine, yield per vine, average weight of fruit which indicated additive gene action for these characters, which could be improved by simple selection method.

2.3 Correlation studies and path coefficient analysis

The efficiency of selection can be improved by using correlation between different characters. The phenotypic correlation indicates the extent of observed relationship between two characters and this includes both hereditary and environmental influences, while genotypic correlation coefficient provides a real association between two characters and is most useful in selection (Johnson *et al.* 1955).

The original concept of correlation was presented by Galton (1888) which was further elaborated by Fisher (1918) and Wright (1921). Genetic correlation can result either from pleiotropy or from linkages. While phenotypic value is a non-additive combination of both genetic and environmental correlation. This study merely indicates the nature of association and this alone does not provide the exact insight of the relative effect of each component character. A component character may have no direct effect on considerable economic trait but it may influence it *via.* related characters. Hence knowledge of direct and indirect effects of different characters on desired traits are essential for selection to improve the population. The technique of path coefficient was originally developed by Wright (1921) who defined the path coefficient as the ratio of the standard deviation of the effect to the total standard deviation when all the causes are constant, except the one in question, the variability of which is kept unchanged. The path coefficient divides the correlation into direct and indirect effects and thus determines the nature of association (Falconer, 1960).

Rahman *et al.* (1986) evaluated four lines of bottle gourd and observed that fruit weight per plant had strong positive genotypic correlation with days to first picking, length of main vine and fruit diameter and a negative correlation with fruit length. Path coefficient analysis revealed that fruit diameter and fruit length had high positive direct effect on fruit weight per plant. Number of fruits per plant also had considerable positive direct effect on fruit weight per plant.

Prasad *et al.* (1993) evaluated correlation in thirty genotypes of bottle gourd and reported that fruit yield had significant positive association with number of fruits per vine, average weight of fruit and number of female flowers on primary laterals or per vine.

Narayan *et al*. (1996) studied twenty five diverse genotypes of bottle gourd. Correlation coefficient revealed that fruit yield per plant can be successfully improved by making selection or greater fruit number, higher fruit weight, greater number of primary branches and genotypes with lesser number of days to an thesis of first male flower. Path coefficient analysis revealed that maximum weightage should be given primarily to days to the first harvest followed by average weight of edible fruit, number of fruits per plant and days to anthesis of first female flower.

Kumar and Singh (1998) reported correlation and path coefficient analysis in sixteen parents of bottle gourd and result revealed that yield per plant was positively correlated with average weight of edible fruit and number of fruits per plant at both genotypic and phenotypic levels. Path coefficient analysis revealed that maximum weight should be given to average weight of edible fruit and number of fruits per plant, while formulating selection indices for improvement of yield per plant in bottle gourd.

Hawlader *et al.* (1999) conducted an experiment with thirteen cultivars of bottle gourd and reported that fruit yield per plant showed significant positive associations with number of female flowers and fruits per plant. Path analysis indicated the highest contribution of number of female flowers per plant to fruit yield.

Rao *et al.* (2000) studied correlation in 36 genotypes of ridge gourd and found genotypic correlation coefficients were higher than phenotypic correlation coefficients, indicating a strong inherent association among various characters studied. Yield per vine was significantly and positively correlated with number of fruits per vine, fruits per branch, girth of fruit, weight of fruit and volume of the fruit, but negatively correlated with days to anthesis of first female flower.

Sharma and Bhutani (2001) reported correlation in bitter gourd and observed significant positive correlations for chlorophyll a and b with total chlorophyll content, node at which first female flower appeared and fruit length with fruits per vine, fruit length and fruit diameter with average fruit weight, fruits per vine and average fruit weight with total yield per vine.

Prasanna *et al*. (2002) evaluated correlation in ridge gourd and found fruit yield per hectare was positively associated with vine length at 90 days after sowing (DAS), number of leaves at 90 DAS, number of female flowers, total dry weight of vine, number of fruits, fruit girth and fruit weight. The fruit yield of ridge gourd can be enhanced through the improvement of vine length at 90 DAS, number of female flowers, number of branches, number of fruits per vine, fruit girth and fruit weight.

Umamaheswarappa *et al.* (2004) studied correlation and path analysis in bottle gourd and reported that fruit yield/ha had strong positive association with vine length, number of leaves per vine, number of female flowers per vine, number of branches per vine, vine girth, total chlorophyll content in leaf, total dry weight of plant, number of fruits per vine, fruit weight, fruit length and fruit girth. Path coefficient analysis revealed that number of fruits per vine had maximum direct effect on fruit yield followed by fruit weight.

Ahmed *et al.* (2005) studied correlation and path coefficient in twenty three genotypes of bottle gourd and reported that fruit yield exhibited strong positive and significant correlation both at genotypic and phenotypic levels with number of fruits per plant, average fruit weight and fruit length. The negative significant association with days to first fruit picking and fruit diameter indicate that selection for earliness and increased fruit diameter would not have positive bearing on fruit yield. The path coefficient analysis revealed appreciable amount of direct positive effect of average fruit weight, number of fruits per plant, fruit length, number of female flowers per plant and vine length on fruit yield.

Parvathi and Reddy (2006) reported correlation in bottle gourd and reported that fruit yield per vine showed significant positive correlation with fruit weight, fruit girth, fruit flesh thickness, fruits per vine and 100-seed weight, indicating that selection for these characters may improve fruit yield in bottle gourd.

Singh *et al.* (2006) observed correlation and path coefficient in bottle gourd and study revealed that yield per vine exhibited positive and significant correlation with number of primary branches per vine, number of female flowers per vine, number of nodes on main axis, fruit diameter, fruit length, fruit weight and number of fruits per vine. Path coefficient analysis indicated that characters like female flower per vine, fruit weight, number of fruits per vine and number of nodes on main axis had direct effect on yield of bottle gourd.

Gupta *et al*. (2007) studied path analysis in bitter gourd and found that days to anthesis of first female flower showed highest direct effect followed by number of fruits per vine and average fruit weight towards yield per vine, while days to first fruit harvest exhibited its highest indirect effect via days to anthesis of first female flower followed by fruit length and fruit diameter via days to first fruit harvest.

Gayen and Hossain (2007) conducted an experiment with nine genotypes of bottle gourd and study revealed that the fruit weight and fruit length had significant and positive correlations with fruit yield per plant. The path analysis at phenotypic and genotypic levels revealed that the fruit weight and fruit length had direct effects on yield.

Kumar *et al.* (2007) conducted an experiment on twenty diverse genotypes of bottle gourd and examine that the fruit yield showed positive and significant correlation with number of branches per vine, vine length, node number of first male flower, node number of first female flower, length of edible fruits, number of fruits per vine, number of seeds per fruit and 100 seed weight at genotypic and phenotypic levels.

Yadav *et al.* (2007) conducted an experiment to select the superior genotypes among eighteen strains of bottle gourd by correlation and path coefficient analysis. Yield per plant was positively and significantly associated with the number of fruits per plant, but has a negatively significant correlation with days to first female flowering at both genotypic and phenotypic levels. Studies on path coefficient analysis showed that days to first male flowering, number of nodes first female flowering, days to edible fruit, fruit width, number of fruits per plant and yield per plant had maximum positive direct effect on yield. All the characters except days to first female flowering, number of nodes first male flowering and fruit length had direct effect on yield. For indirect effects, the number of fruits per plant showed highly significant and positive association with yield per plant due to days to first male flowering, number of nodes first female flowering, days to edible fruit, fruit width and number of fruits per plant

Latif *et al.* (2008) study on the variabilities, genetic parameters associations with characters and path coefficients between yield and fourteen important characteristics of ten ash gourd genotypes were observed in node order of first male and female flower anthesis followed by plant height at first male and female flower anthesis, edible fruit yield per plant and number of plant per hectare. Edible fruit yield had high negative r_p and r_g. with plant height for first male and female flower anthesis, days to first male and female flower anthesis and edible fruit yield per plant. Yield had also high negative r_g

with node order of first male and female flower anthesis and positive rg with number of female flower per plant and edible fruit length. Edible fruit length and weight of individual fruit directly contributed to the yield of ash gourd. For increasing yield, selection should be based on plants bearing more fruits with higher length and weight.

Yadav *et al*. (2010) studied path coefficient analysis in bottle gourd and found that length of fruit (cm), weight per fruit (kg) and number of fruits per plant had positive and direct effect on fruit per plant.

Resmi and Sreelathakumary (2012) study of Correlation and path coefficient were worked out for 25 genotypes of ash gourd of different geographical origin. Fruit length, fruit girth, average fruit weight, seeds per fruit and 1000-seed weight had positive and significant correlation with yield. The positive direct effect on yield was revealed by fruit length, average fruit weight and fruits per plant. Therefore, these traits may be considered as the most reliable selection indices for effective improvement in fruit yield in ash gourd.

Kumar *et al*. (2013) studied path coefficient analysis in sponge gourd and reported that average diameter of fruit, number of primary branches, number of fruits per vine, average weight of fruit and total soluble solids showed positive direct effect on total yield per vine. Hence, selection for these traits for improving yield per vine in sponge gourd is suggested.

Dewan *et al.* (2014) evaluated 46 ash gourd to that out the association between yield and contributing characters and result revealed that yield per plant was significantly and positively correlated with average weight per fruit, vine length, number of fruits per plant and also positively correlated with fruit length and diameter, flesh thickness but negatively correlated with sex ratio. Path coefficient analysis indicated that number of fruits per plant had maximum direct and positive effect on yield per plant. The correlation of number of fruits per plant on yield per plant was also shown high and such high correlation with yield per plant was mainly due to the high positive direct effect on number of fruits per plant and considerable indirect effect via average weight per fruit.

Khan *et al.* (2015) studied correlation and path coefficient for 71 genotypes of bitter gourd. The results obtained showed that fruit length showed low direct and positive effect on yield per plant and indirect positive effect on yield per plant via fruit diameter and average fruit weight. Similar result was found for fruit diameter. Average fruit weight and number of fruits per plant showed high direct and positive effect on yield per plant. Path analysis revealed that average fruit weight, number of fruits per plant, days to male flowering and fruit length had positive direct effect on fruit yield.

Manikandan *et al.* (2017) studied association of characters in 15 yield related characters Correlation coefficient indicated that yield per vine had highly significant and positive association with the individual fruit weight (0.840), number of fruits per vine (0.674), fruit length (0.522), fruit girth (0.507) and flesh thickness (0.395). Path analysis revealed that the fruit characters such as flesh thickness, fruit length, fruit weight, fruit girth and number of fruits per vine are considered as important traits which directly and indirectly influences towards yield. This study confirmed that, individual fruit weight, number of fruit per plant, fruit length, fruit girth and flesh thickness were the important characters for varietal selection of ash gourd.

Pradhan *et al.* (2020) studied correlation on ash gourd and concluded that correlation coefficients indicated that yield per vine had significant and positive association with number of branches per vine (0.318, 0.137), number of female flowers per vine (0.078, 0.565) , sex ratio (0.579, 0.322), fruit length (0.604, 0.463), fruit diameter (0.743, 0.565), average fruit weight (0.830, 0.758), number of seeds per fruit(0.387, 0.286), weight of seeds per fruit (0.635, 0.478) and vine length (0.395, 0.340). Negative associations were noticed with node to 1^{st} female flower (-0.279, -0.280) and days to 1st fruit setting (-0.465, -0.189). Number of fruits per vine (0.108) was positively associated with yield per vine at phenotypic level only. Path coefficient analysis revealed that number of female flowers per vine (6.221), vine length (5.727), fruit diameter (5.201), fruit length (0.647), days to 1^{st} fruit setting (3.455), number of branches per vine (1.300) and weight of seeds per fruit (0.892) directly contributed to the yield of ash gourd.

2.4 Genetic divergence

The concept of D^2 statistics was originally developed by Mahalonobis (1936). Then Rao (1952) suggested the application of this technique for the arrangement of genetic diversity in plant breeding. Now, this technique is extensively used in vegetable breeding for the study of genetic divergence in the various breeding material including germplasm. This analysis also helps in the selection of diverse parents for the development of hybrids. Cluster analysis helps to form groups of closely related individuals which help in determining genetic distance between them.

Mathew *et al.* (1986) studied on genetic distance among five botanical varieties of *Cucumis melo.* The genetic distance was calculated for nodes to first female flower, fruit weight, seeds per fruit and fruits per plant. The magnitude of D^2 indicated closeness among the varieties. The character fruits per plant contributed maximum to total divergence (80%). Seeds per fruit did not contribute to the total divergence. Selection of botanical varieties based on fruits per plant would be a logical step in the selection of divergence parents in any hybridization program.

Kadam and Kale (1987) observed highly significant difference between cultivars suggesting considerable divergence among 30 ridge gourd cultivars.

Thirty cultivars were grouped into 20 clusters based on their D^2 values. Cluster A having two cultivars had the lowest intra-cluster D^2 values (8.22) while cluster I which had two cultivars with the highest intra-cluster value of 18.59. The highest inter cluster distance was observed between clusters V and XIII (387.1 1) and it was minimum between cluster IV and VIII (19.79)

Badade *et al*. (2001) studied genetic divergence using Mahalanobis D^2 statistics for seven quantitative characters including yield per vine in a collection of twenty diverse cultivars of bottle gourd. The cultivars differed significantly for almost all the characters and were grouped into ten clusters based on the similarities of D^2 value. Considerable diversity within and between clusters was noted and it was observed for vine length, number of branches, percentage of female flowers, fruits per vine, length and diameter of fruit and yield per vine.

Lovely (2001) studied genetic divergence and the results recorded clustering of 25 genotypes of ash gourd into 8 group constellations. The maximum number of genotypes (8) were included in Cluster III, followed by cluster I (7), cluster II (4) and cluster IV (2). The clusters V, VI, VII and VIII had only one genotype in them. The genetic distance was maximum between II and IV and minimum between VII and VIII. The character seeds per fruit contributed maximum to the total divergence.

Mathew *et al.* (2001) studied genetic divergence in twenty eight accessions of bottle gourd collected from different parts of Kerala, India. Accessions were grouped into eight clusters. Clustering pattern indicated that there was no association between geographical distribution of accessions and genetic divergence for the characters such as number of fruits, average fruit weight, vine length and fruit set percentage, had the greatest contribution to genetic divergence.

Dora *et al.* (2003) studied genetic divergence among eleven characters of pointed gourd genotypes by D^2 Mahalanobis statistic and divided them into four clusters. Clusters I and II comprised four genotypes each, cluster III comprised two genotypes and cluster IV comprised of a single genotype. However, in the case of numerical taxonomic approach, the number of clusters was 3, 4, 6 and 8 at 65, 70, 75 and 80% phenotypic level, respectively. Their study indicated that numerical taxonomic approach was more potent for clustering biological populations over the D^2-statistics.

Islam (2004) reported genetic divergence among forty two bottle gourd accession from Bangladesh. The accessions were grouped into five clusters. No clear relationship was observed between geographic origin and genetic diversity. The maximum inter-cluster distance was between cluster I and cluster IV and the minimum was between cluster III and cluster IV. Primary branches per plant, fruit length and weight, number of fruits and yield per plant contributed the most of the total genetic divergence. The accessions included in the most divergent cluster I and II are promising parents for a hybridization programme.

Lovely and Devi (2004) at Vellyani India, evaluated divergence analysis using 25 genotypes of ash gourd collected from various agro climatic regions. Following the Mahalahobis D^2 statistics, the 25 genotypes were grouped into 4 clusters. Seeds per fruit contributed maximum to the total divergence followed by fruit yield per plant, fruit weight, fruits per plant and flesh thickness. Clustering pattern was not related to the geographical similarities as each cluster contained genotypes from various localities

Bharathi *et al.* (2005) reported the genetic divergence of thirty two genotype of spine gourd. Based on the D^2 values all genotypes were grouped in to seven clusters. The maximum numbers of genotypes (11) were included in cluster III followed by 9 genotypes in cluster IV and 4 genotypes in cluster VI. Three cluster II, V & VII included two genotypes each

Afroze *et al.* (2007) evaluated genetic divergence among 46 ash gourd genotypes from different origins was investigated to select the parents for hybridization using Mahalanobis D^2 statistics. Though the genotypes grouped into seven clusters. Maximum inter-cluster distance between cluster III and IV indicating wide genetic divergence between the genotypes of these two clusters (cluster III and IV followed by cluster IV and VII). However, the intra-cluster distances were smaller than inter-cluster distances. Thus, crossing between the genotypes of these two groups (cluster III and IV) would produce high heterotic progeny and may produce new recombinants with desired traits.

Singh *et al.* (2007) reported twenty eight bottle gourd genotypes for genetic diversity under two environmental conditions and grouped into twelve clusters. Cluster I was the biggest and contained six genotypes. There was no parallelism between the clustering pattern and geographic origin. Maximum genetic diversity was obtained between cluster III and XII. This indicated the potentiality of genotypes for heterosis and spectrum of variability.

Gangopadhyay *et al.* (2008) evaluated genetic diversity, clustering pattern and ordination (principal components) analyses were undertaken in 26 ash gourd accessions. The accessions showed significant inter-population differences and wide variation for quantitative and qualitative morphological descriptors observed.

Singhal *et al.* (2010) reported genetic diversity among twenty three germplasm lines of ash gourd genotypes PAG-50, Pant Petha-1, PAG-64, PAG- 12, PAG-14 and PAG-09 were high yielding lines while considering both the seasons summer and kharif.

Sreelatha (2010) at Trivandrum studied that the genetic diversity of 25 ash gourd genotypes collected from different geographical locations was assessed at the molecular level and compared to morphological traits for degree of divergence. The clustering pattern based on Mahalanobis D^2 statistic indicated that there was no association between geographical distribution of genotypes and genetic divergence.

Narayan *et al.* (2011) conducted an experiment at Jagdalpur (Bastar) reported the genetic diversity in the ash gourd collected from the tribal areas of Bastar (Chhattisgarh). Wide range of variability was recorded in the quantitative traits for fruit, yield and seed characters including days to germination, days to 1^{st} male flower anthesis, days to 1^{st} female flower anthesis, node number of 1^{st} male flower, node no. of 1^{st} female flower, days to 1^{st} fruit harvest, no. of branches per vine, vine length, fruit length, fruit girth, individual edible fruit weight, number of fruits per vine, fruit yield per vine, number of seeds per fruit and 100 seed mass.

Dewan *et al.* (2013) reported genetic divergence for yield and yield contributing characters of 46 ash gourd genotypes at Wide range of variations were found among the ash gourd genotypes in respect of different parameters such as vine length at harvest, fruit length, fruit diameter, sex ratio, number of fruits per plant, average weight per fruit and yield per plant.

Gulshan *et al.* (2014) conducted an experiment to estimate genetic divergence among twenty eight bottle gourd genotypes using D^2 and anonical analysis. The genotypes were grouped into five clusters. The maximum inter cluster distance was between cluster III and cluster I (31.10) and the minimum was between cluster IV and II (6.51). The crosses between the genotypes LS001, LS002, LS007, LS010, LS013, LS016, LS017, LS028 of cluster II and LS018, LS023 in cluster V would exhibit maximum heterosis and produce new recombinants with desired traits in bottle gourd.

Visen *et al.* (2015) studied that the cluster analysis grouped all 31 bottle gourd genotypes into 5 major clusters based on D^2 value. Extreme genetic divergence was estimated among clusters. Maximum number of genotypes were grouped into cluster V included ten genotypes whereas, cluster II included eight genotypes. The cluster I had six genotypes which is followed by cluster IV and cluster III had only three genotypes in each cluster. Fruit length, fruit girth and average fruit weight contributes maximum towards genetic divergence.

Bairwa *et al*. (2017a) studied genetic diversity for yield and its contributing traits in sixty ash gourd genotypes. The cluster analysis grouped all 60 ash gourd genotypes into 5 major clusters based on D^2 value. Extreme genetic divergence was estimated among clusters. Maximum number of genotypes were grouped into cluster I included nineteen genotypes. Average inter cluster distance was found maximum (10.742) between cluster III and cluster II which would be fruitful for developing heterotic cross combination. Cluster III showed highest mean value for number of branches per plant, fruit length, fruit girth, average fruit weight, number of seeds per fruit, number of fruits per plant, total soluble solid, 100 seed weight and fruit yield per plot (kg). The characters like number of seeds per fruit, duration of crop, 100 seed weight contributed maximum to divergence. Hence, ash gourd crop improvement could be tried with the genotypes of divergent clusters for better heterotic effects.

Sampath *et al.* (2019b) studied on genetic divergences was carried out on 45 diverse ash gourd genotypes. Based on D^2 analysis, the genotypes were grouped into four different clusters, where the cluster I possessed higher number of genotypes (37) followed by the cluster II (3), and III, IV, V, VI, VII had only one genotype. The genotypes collected from different location were grouped into different clusters. The maximum intercluster distance was observed between the cluster III and cluster VII. In case of intra-cluster distance, the maximum distance was observed in the cluster II. Among the twenty two traits studied, maximum contribution was made by fruit circumference followed by number of fruits per vine, fruit yield per vine, average fruit weight. Considering cluster mean, the genotypes of cluster VI and cluster VII could be selected for yield and yield attributing characters. The wider genetic diversity was observed in cluster V, VI, VII which indicate the potentiality of this diverse genotype collection for providing basic material for future breeding programmes.

CHAPTER III

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigation entitled "Genetic evaluation and characterization of different genotypes of ash gourd [*Benincasa hispida* (Thunb.) Cogn.]" has been carried out at horticulture farm at School of Agricultural Sciences and Rural Development, Medziphema, Nagaland University. The details of the materials and methods used and followed during the experiment for recording various observations and analysis is presented below.

3.1 Geographical situation

Experimental farm of School of Agricultural Sciences and Rural Development, Medziphema Campus, Nagaland University, Nagaland. It is situated at 25°45'43" N latitude and 93°53'04" E longitude at an elevation of 305 m above the sea level, bringing sub-tropical climate.

3.2 Climatic condition

The area of the experimental farm has subtropical condition with predominantly high humidity of 70-90%, moderate temperature with medium to high rainfall. The average rainfall varies from 2000- 2500 mm. The temperature ranged between 21^0C to 34^0C during summer and during winter from 10^0C to 15^0C. Meteorological data recorded during the period of crop investigation (March to September) for both years 2018 and 2019 have been shown in table 3.1 and fig 3.1.

Table 3.1 Meterological data recorded during the period of crop investigation (March to September) for both years 2018 and 2019.

	Tempreture (°C)				Relative Humidity (%)				Rainfall (mm)		Avg. Sunshine hour (h)	
	Max.		Min:		Max		Min:					
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
March	30.2	29.2	14.5	14.3	95	94	49	46	31.8	79.2	6.1	6.6
April	31.6	30.8	18.1	18.5	94	92	55	58	71.4	73.3	5	5.2
May	31.7	32.2	21.2	21.7	94	90	65	64	135.5	185.8	4.5	5.6
June	33.4	33.5	24.2	24.1	94	91	73	69	354.7	195	3.8	4.5
July	33.2	33	24.9	24.9	92	93	72	72	240	271.3	3.1	3.1
August	33.5	34.1	24.9	24.9	94	93	71	73	302.8	274.5	3.8	4.9
September	33.6	32.7	23.9	23.9	94	94	67	72	115.7	173.4	5.3	4.1

Source: ICAR, Jharnapani, Nagaland.

3.3 Soil of the experimental field

The soil pH of the experimental site was sandy loam, well drained with mean pH of 4.4.

Table 3.2 Initial soil fertility status of the experimental plot.

Parameters	Value	Status	Method employed
pH	4.5	Acidic	Digital pH meter scale (Single electrode meter)
Organic carbon	1.65	High	Walkey and Black Method (Piper, 1966)
Available N (kg ha^{-1})	245.22	Medium	Alakaline potassium permangnate method (Subbiah and Asija, 1956)
Available P_2O_5 (kg ha^{-1})	18.11	Medium	Bray and Kurtz method (1945)
Available K_2O (kg ha^{-1})	222.14	Medium	Flame Photometer (Hanway and Hiedal, 1952)

3.4 Field preparation

The preparation of field was done by tractor-drawn cultivator followed by two cross-harrowing to pulverize the soil and finally the field was leveled with planker. The layout of prepared field was prepared as per the experimental design. Field was divided into small plots according to treatments & replications

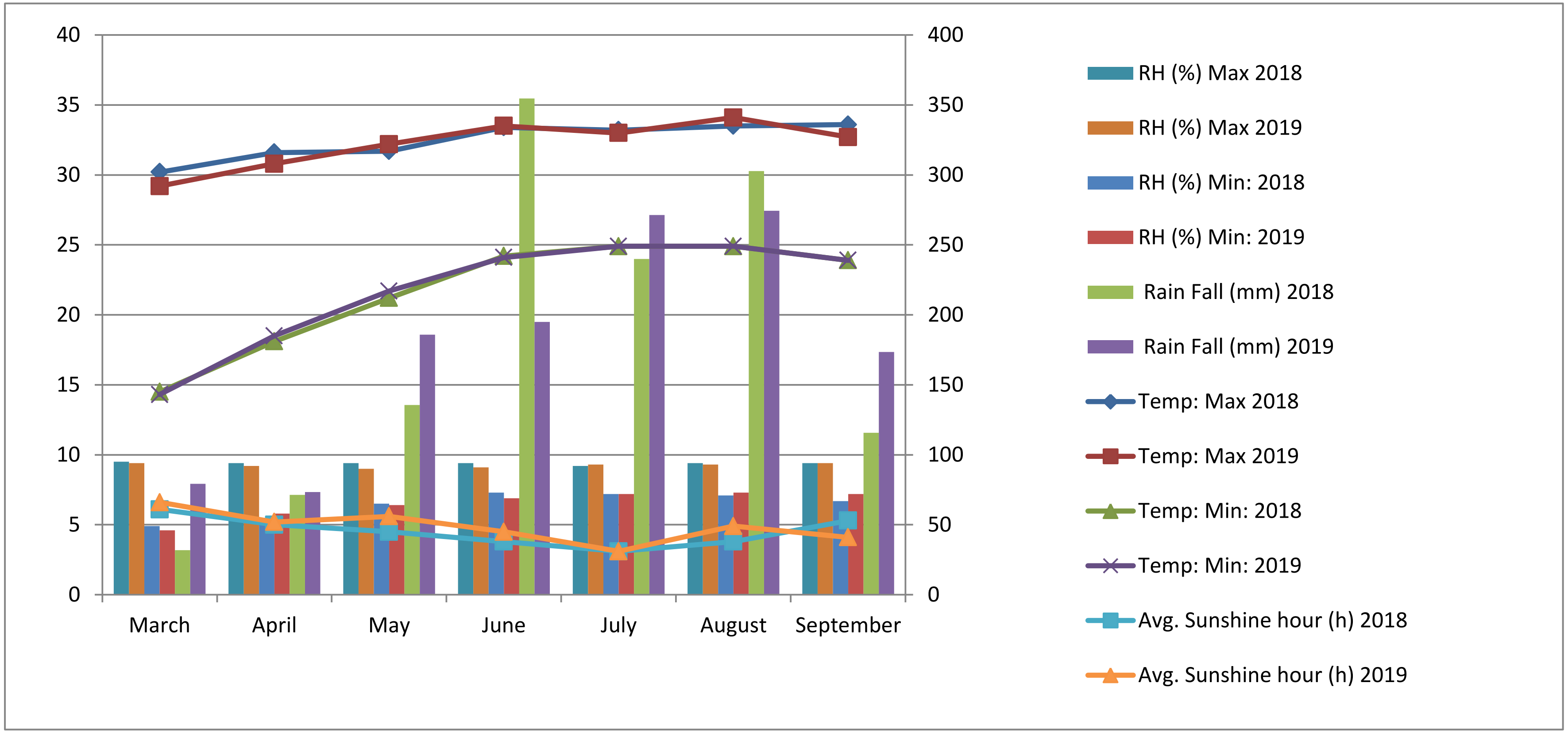

Fig 3.1 Meteorological data recorded during the period of crop investigation (March to September) for both years 2018 and 2019.

with randomized block design. The layout of experimental design is shown in fig 3.2.

3.5 Details of treatments

Thirty seven genotypes of ash gourd from different places of India have been collected to conduct the experiment. Details of treatment are given in table 3.3. Kashi Surbhi, Kashi Ujjwal and Kashi Dhawal were collected from Indian Institute of Vegetable Research (IIVR), Varanasi whereas Pusa Ujjwal, Pusa Sabji Petha was collected form Indian Agricultural Research Institute, New Delhi. Two genotypes i.e. Indu and KAU-Local were collected from Kerela Agricultural University whereas Shakti were collected from Dr. Y S R Horticultural University, Andra Pradesh. Genotype Bux-1 was obtained form Krishi Vigyan Kendra, Buxer. Moreover, ten genotypes viz. TAG-1, TAG-2, TAG-3, TAG-4, TAG-5, TAG-6, TAG-7, TAG-8, TAG-9, TAG-10 were obtained from Indian Council of Agricultural Research Complex, Northeastern Region, Tripura. Four genotypes namely Pundibari Local-1, Pundibari Local-2, Bhagyalaxmi and Basirhat were obtained form Uttar Banga Krishi Vishwavidyalaya (UBKV), Coochbihar. Panji Local, CO-2, KAG-1, PAG-3 and Pant Petha-1 was collected form Indian Council of Agricultural Research Complex, Goa, Tamil Nadu Agricultural University, Coimbatore, Chandra Shekhar Azad Univeristy of Agriculture and Technology, Kanpur, Punjab Agricultural University, Ludhiana and G.B. Pant University of Agriculture and Technology, Pantnagar, respectively. Three genotypes *viz.* Manipur Local-1, Manipur Local-2, Manipur Local-3 collected from Manipur whereas Meghalaya-1, Meghalaya-2 and Meghalaya-3 were colled from different parts of Meghalaya. AS-1 and AS-2 were the two genotypes collected from Majuli district of Assam whereas Nagaland local-1 and Nagaland Local-2 were collected from Dimapur and Kohima district of Nagaland.

R1	R2	R3
Kashi Dhawal	PAG-3	AS-1
Kashi Surbhi	Panji Local	AS-2
Kashi Ujjwal	Pant Petha 1	Basirhat
Pusa Ujjwal	Nagaland Local -1	Bhagyalaxmi
Pusa Sabji Petha	Nagaland Local -2	Bux-1
Pant Petha 1	Pusa Sabji Petha	CO-2
KAG-1	Pusa Ujjwal	Indu
KAU Local	Shakti	KAG-1
PAG-3	TAG-1	Kashi Dhawal
CO-2	TAG-2	Kashi Surbhi
Shakti	TAG-3	Kashi Ujjwal
Indu	TAG-4	KAU Local
Bhagyalaxmi	TAG-5	Manipur-1
Bux-1	TAG-6	Manipur-2
AS-1	TAG-7	Manipur-3
AS-2	TAG-8	Meghalaya-1
Manipur-1	TAG-9	Meghalaya-2
Manipur-2	AS-1	Meghalaya-3
Manipur-3	AS-2	Nagaland Local -1
Meghalaya-1	Basirhat	Nagaland Local -2
Meghalaya-2	Bhagyalaxmi	PAG-3
Meghalaya-3	Bux-1	Panji Local
TAG-1	CO-2	Pant Petha 1
TAG-2	Indu	Pundibari Local-1
TAG-3	KAG-1	Pundibari Local-2
TAG-4	Kashi Dhawal	Pusa Sabji Petha
TAG-5	Kashi Surbhi	Pusa Ujjwal
TAG-6	Kashi Ujjwal	Shakti
TAG-7	KAU Local	TAG-1
TAG-8	Manipur-1	TAG-2
TAG-9	Manipur-2	TAG-3
Pundibari Local-1	Manipur-3	TAG-4
Pundibari Local-2	Meghalaya-1	TAG-5
Panji Local	Meghalaya-2	TAG-6
Basirhat	Meghalaya-3	TAG-7
Nagaland Local -1	Pundibari Local-1	TAG-8
Nagaland Local -2	Pundibari Local-2	TAG-9

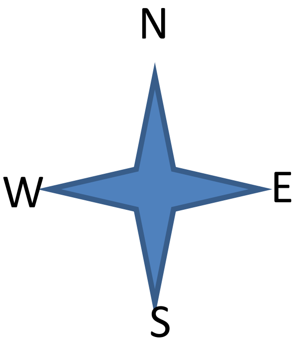

Fig 3.2 Layout plan of experimental field.

Table 3.3 Details of the genotypes.

Sl. No.	Name of the institutes	Name of the varieties	Source of Collecion
1.	Indian Institute of Vegetable Research (IIVR), Varanasi.	i. Kashi Surbhi ii. Kashi Ujjwal iii. Kashi Dhawal	Institute
2.	Indian Agriculture Research Institute (IARI), New Delhi.	i. Pusa Ujjwal ii. Pusa Sabji Petha	Institute
3.	Kerala Agricultural University (KAU), Thrissur.	i. Indu ii. KAU-Local	Institute
4.	Dr. Y S R Horticultural University, A.P.	i. Shakti	Institute
5.	KVK, Buxer	i. Bux-1	Institute
6.	ICAR Research Complex, NER,Tripura	i. TAG-1 ii. TAG -2 iii. TAG -3 iv. TAG -4 v. TAG -5 vi. TAG -6 vii. TAG -7 viii. TAG -8 ix. TAG -9	Institute
7.	Uttar Banga Krishi Vishwavidyalaya (UBKV), Coochbihar	i. Pundibari Local-1 ii. Pundibari Local-2 iii. Basirhat iv. Bhagyalaxmi	Institute
8.	ICAR, Goa	i. Panaji Local	Institute
9.	TNAU, Coimbatore	i. CO-2	Institute
10.	CSAUAT, Kanpur	i. KAG-1	Institute
11.	PAU, Ludhiana	i. PAG-3	Institute
12.	G.B. Pant University of Agriculture and Technology, Pantnagar	i. Pant Petha-1	Institute
13.	Manipur	i. Manipur ii. Manipur iii. Manipur	Imphal, Local Market
14.	Meghalaya	i. Meghalaya-1 ii. Meghalaya-2 iii. Meghalaya-3	Shillong, Local Market
15.	Assam	i. AS-1 ii. AS-2	Majuli, Local Market
16.	Nagaland	i. Nagaland local-1 ii. Nagaland local-2	Dimapur, Local Market

3.6 Technical programme

1. Design : Randomized Block Design (RBD)
2. Genotypes : 37
3. Replication : 3 (three)
4. Spacing : 4 m x 0.6 m
5. Plant/replication : 8

3.7 Experimental material

Thirty seven genotypes of Ash gourd were grown in a randomized block design with three replications. The sowing of experimental material for 1st year was done on 2nd April, 2018 and for second year on 30th March, 2019. The seeds are sowed in direct field at the distance 4 m for row to row and 0.6 m for plant to plant was maintained and the plot size was 19.2 m^2. Two seeds were sown in each hill later on only one plant was allowed to grow in one hill.

3.8 Manures and fertilizer application

FYM was applied to the field @20 tonnes/ha at the time of land preparation. N:P:K was applied @100:60:60 kg/ha. Half quantity of nitrogen was applied at the time field preparation and another half was applied at early vine growth stage.

3.9 Irrigation

The crop was grown during rainy season hence, did not require very frequent irrigation. Field was irrigated than once in 4 to 5 days. The crop during summer season was irrigated at 2-3 days interval. Waterlogging condition was avoided.

3.10 Intercultural operation

2-3 weeding and light hoeing during early stage of vine growth is done. The hill area of the plant was kept clean and weeds free followed by soil pulverization and earthing up.

3.11 Harvesting

The mature fruits were harvested when there is full development of waxy coating on fruit surface. However, for local consumption, fruits were harvested at green stage only, around 7-10 days after anthesis.

Five competitive plants were selected randomly from each plot to record observation on various characters. The average value of each character was calculated on the basis of five plants for each genotype in every replication.

3.12 Growth Parameters recorded at different stage using various method

Observations on quantitative traits were recorded on five randomly selected competitive plants in each genotype from all the three replication and averaged.

3.12.1 Cotyledon length (cm)

The cotyledon length was recorded from five randomly selected plant of each plot at cotyledons completely unfolded by measuring scale.

3.12.2 Cotyledon width (cm)

The cotyledon width was recorded from five randomly selected plant of each plot at cotyledons completely unfolded by measuring scale.

3.12.3 Stem shape

The Stem shape was observed in five randomly selected plant of each plot at vegetative stage.

3.12.4 Stem pubescence

The Stem pubescence was observed in five randomly selected plant of each plot at vegetative stage.

3.12.5 Length of internodes of main stem (between 15^{th} -20^{th} node)

The intermodal length was recorded in between 15^{th} -20^{th} node from main vine of five randomly selected plant of each plot at vegetative stage by measuring scale.

3.12.6 Number of primary branches

The number of primary branches per plant was recorded from five randomly selected plant of each plot at the time of last picking and average was presented as number of primary branches per plant.

3.12.7 Vine length (m)

The vine length of plant was recorded from main vine of five randomly selected plant of each plot at the time of last picking and average was presented as vine length of plant.

3.12.8 Leaf blade margin

The leaf blade margin of leaf was observed at 50 % flowering stage (first pistillate flower appears in 50 % plant).

3.12.9 Leaf shape

The leaf shape of leaf was observed during vegetative stage at 50 % flowering stage (first pistillate flower appears in 50 % plant).

3.12.10 Leaf length between 15th-20th nodes (cm)

The leaf length of leaf was recorded during vegetative stage at 50 % flowering stage (first pistillate flower appears in 50 % plant) using measuring Scale.

3.12.11 Leaf width between 15th-20th nodes (cm)

The leaf width of leaf was recorded during vegetative stage at 50 % flowering stage (first pistillate flower appears in 50 % plant) using measuring Scale.

3.12.12 Leaf pubescence nature (between 15th-20th nodes)

The leaf pubescence was recorded during vegetative stage at 50 % flowering stage (first pistillate flower appears in 50 % plant).

3.12.13 Leaf blade: number of lobes

The number of lobes in leaves was recorded at vegetative stage at 50 % flowering stage (first pistillate flower appears in 50 % plant).

3.12.14 Petiole length between 15th-20th nodes (cm)

The petiole length was recorded between 15th-20th nodes of main vines during vegetative stage at 50 % flowering stage (first pistillate flower appears in 50 % plant) using measuring Scale.

3.12.15 Tendril status

The tendril status was recorded between 15th-20th nodes of main vines during vegetative stage at 50 % flowering stage (first pistillate flower appears in 50 % plant) by visual observation.

3.12.16 Tendril branching

The tendril branching was recorded between 15th-20th nodes of main vines during vegetative stage at 50 % flowering stage (first pistillate flower appears in 50 % plant) by visual observation. .

3.12.17 Tendril type

The tendril type was recorded between 15th-20th nodes of main vines during vegetative stage at 50 % flowering stage (first pistillate flower appears in 50 % plant) by visual observation.

3.12.18 Days to first female flower appears

Days to first female flower appears was recorded as number of days taken from sowing to the opening of first female flower and average value was calculated at initial flowering stage.

3.12.19 Node at which first female flower appears

Node number of first female flower appears was noted as the node number from the base of the plant at which first female flower appeared and average value was calculated at initial flowering stage.

3.12.20 Sex expression

The sex expression was recorded during 50% flowering stage (first pistillate flower appears in 50% plant) of the plant by visual observation.

3.12.21 Male sterility

The male sterility was recorded during 50% flowering stage (first pistillate flower appears in 50 % plant) of the plant by visual observation.

3.12.22 Ovary length on the day of anthesis (cm)

The length of ovary was recorded longitudnaly during 50 % flowering stage (first pistillate flower appears in 50 % plant) by using Vernier Caliper (just after anthesis).

3.12.23 Peduncle length (cm)

Peduncle length of the fruit was measured using Vernier Calliper when fruit attains marketable maturity.

3.12.24 Peduncle shape

Peduncle shape of the fruit was observed when fruit attains marketable maturity.

3.12.25 Fruit length (cm)

Fruit length was recorded in cm for five fruits were selected from five randomly selected plants of each genotype in each replication and average value was calculated. Fruit cut into two halves and length were measured using measuring scale when fruit attains marketable maturity.

3.12.26 Fruit diameter (cm)

Girth of fruits was recorded in cm on five fruits from five randomly selected plants of each genotype in each replication. Girth of fruits was measured at the centre of the fruits and the average value was recorded as fruit girth in cm. Fruit cut into two halves and length were measured using measuring scale when fruit attains marketable maturity

3.12.27 Fruit shape

Fuit shape was observed and recorded when fruit attains marketable maturity.

3.12.28 Fruit skin colour

Fuit skin colour was observed and recorded when fruit attains marketable maturity using RHS color chart.

3.12.29 Fruit shape of base at blossom end

Fruit shape of base at blossom end was visually recorded when fruit attains marketable maturity.

3.12.30 Fruit shape of base at peduncle end

Fruit shape of base at peduncle end was visually recorded when fruit attains marketable maturity.

3.12.31 Fruit pubescence

Fruit pubescence was visually recorded in selected plants at marketable stage of fruits.

3.12.32 Fruit grooves

Fruit grooves was visually recorded in selected plants at marketable stage of fruits

3.12.33 Fruit marbling (Immature stage)

Fruit marbling (Immature stage) was visually recorded in selected plants at marketable stage of fruits.

3.12.34 Flesh texture

Flesh texture was visually recorded in selected plants at marketable stage of fruits by taking the average of feedback of five different persons.

3.12.35 Flesh colour

Flesh colour was visually recorded in selected plants at marketable stage of fruits using RHS color chart.

3.12.36 Fruit waxiness of skin (at mature stage fruit stage)

Fruit waxiness of skin was visually recorded in selected plants at full maturity (seed harvest maturity)

3.12.37 Seediness

Fruit was cut into two halves at full matured stage and seeds were separated from pulp. Seeds for five fruits were counted and taken the mean as observation.

3.12.38 Seed length (cm)

Seed length was recorded from five randomly selected seeds each from 3 different fruits of same genotype but from different replication using Vernier caliper and the mean was calculated at full maturity stage..

3.12.39 Seed width (cm)

Seed width was recorded from five randomly selected seeds each from three different fruits of same genotype but from different replication using Vernier caliper and the mean was calculated at full maturity stage.

3.12.40 Seed coat colour

Seed coat colour was visually observed from five randomly selected seeds each from 3 different fruits of same genotype but from different replication at full maturity stage.

3.12.41 Seed arrangement

Seed arrangement was visually observed from three different fruits of same genotype but from different replication at full maturity stage.

3.12.42 Crop duration

Crop duration was recorded as number of days from sowing to last day of harvesting at fruit marketable stage.

3.13 Yield Parameters

3.13.1 Number of fruits per plant

Number of fruits per plant from five randomly selected plants was recorded throughout the harvest period and their average was worked out.

3.13.2 Average fruit weight (g)

Five randomly fruits selected from different tagged plant of a treatment at marketable maturity and their average was worked out to find average fruit weight.

3.13.3 100 Seed weight (g)

One hundred seeds counted from the bulk produce of each treatment taken for weight. Weight was recorded using electronic balance and expressed in gram.

3.13.4 Yield / plant (kg)

Yield per plant was worked out by multiplying the average weight of the fruit with total number of fruits per plant. The data was represented in kilogram.

3.13.5 Yield/hectare (q)

The fruit yield in q/ha was worked out with the help of the following formula:

$$\text{Fruit yield (q/ha)} = \frac{\text{Weight of fruit (kg per plot)}}{\text{Net plot area (sq. m}^2\text{.)}} \times \frac{10000}{100}$$

3.14 Qualitative characters

3.14.1 TSS (%)

A drop of ash gourd fruit juice was used to determine the TSS with the help of “Erma” (0.32) hand refractometer and the value was noted at room temperature.

3.14.2 Vitamin C (ascorbic acid)

This analysis was performed with composite (composited over 3 replications) samples of 24 genotypes. Ascorbic acid content in fruit was estimated by volumetric method. 5 ml of standard ascorbic acid (100 μ g/ml) was taken in a conical flask containing 10 ml 4% oxalic acid and was titrated against the 2,6-dichlorophenol indophenols dye. The appearance and persistence of pink colour was taken as end point. The amount of dye consumed (V_1 ml) is equivalent to the amount of ascorbic acid. 5 ml of sample (prepared by taking 2.5g of fruit in 100 ml 4% oxalic acid) was taken in a conical flask having 10 ml of 4% oxalic acid and titrated against the dye (V_2 ml).

The amount of ascorbic acid was calculated using the formula,

Ascorbic acid (mg/100 g) = (0.5 mg/V_1ml) × (V_2/5 ml) × (100 ml/Wt. of sample) × 100

3.14.2 Aroma

The presence and absence of Aroma was determined by Panel test for aroma. Five samples were tested for each genotype with Pant petha-1 being included as the sixth sample for each test (Gormely, 1981). Ten people have smelled the fruit and given feedback about the presence and absence of aroma. The maximum feedback was recorded as final status.

3.14 Statistical analysis

3.14.1. Analysis of variance (ANOVA)

The data obtained during the period of investigation will be statistically analyzed. Mean, range of variation, standard error of mean and critical difference for each quantitative characters are worked out by method of analysis of variance using Randomized Block Design (ANOVA by Panse and Sukhatme, 1978).

3.14.2. Estimation of coefficients of variation

The coefficient of variation for different characters was estimated by formula as suggested by Burton and De Vane (1952).

$$\text{GCV (\%)} = \frac{\sqrt{\sigma\ 2g}}{x} \text{ X } 100$$

$$\text{PCV (\%)} = \frac{\sqrt{\sigma\ 2p}}{x} \text{ X } 100$$

Where,

PCV = Phenotypic coefficient of variation

GCV = Genotypic coefficient of variation

$\bar{X}$ = Mean of character

$\sigma^2 g$ = Genotypic variance

$\sigma^2 p$ = Phenotypic variance

The estimates of genotypic and phenotypic coefficient of variance will be classified as low (less than 10%), moderate (10 to 20%) and high (more than 20%).

3.14.3. Genetic advance

Improvement in the mean genotypic value of selected plants over the parental population is known as genetic advance. The expected advance was calculated by the formula given by Johnson *et al.* (1955) as described below.

$$GA = K.h^2.\sigma p$$

Where,

GA = Genetic advance

K = Constant (Standardized selection differential) having value of 2.06 at 5% level of selection intensity.

h^2 = Heritability of the character

σp = Phenotypic standard deviation

The genetic advance as percentage of mean was estimated as per the below formula

$$\text{Genetic advance as percent of mean} = \frac{\text{Genetic advance}}{\text{General mean}} \times 100$$

The magnitude of genetic advance as percent of mean will be categorized as high (more than 20%), moderate (20-10%) and low (less than10%).

3.14.4. Estimation of heritability

Heritability in broad sense $h^2_{(bs)}$ defined as the proportion of the genotypic variance to the total variance (phenotypic) was calculated as per the formula suggested by Burton and De Vane (1952).

$$h^2_{(bs)}\ \% = \frac{\sigma^2_g}{\sigma^2_p} \times 100$$

Where,

$h^2_{(bs)}$ = Heritability in broad sense

σ^2_g = Genotypic variance

σ^2_p = Phenotypic variance

The broad sense heritability estimates were classified as low (<50%), moderate (50-70%) and high (<70%).

3.14.5. Estimation of correlation coefficient

Correlation coefficient analysis measures the mutual relationship between various characters at genotypic (g), phenotypic (p) and environmental levels with the help of formula suggested by Miller *et al.* (1958).

1. Genotypic correlation coefficient character x and y

$$r_{xy}(g) = Cov_{xy}(g) / \sqrt{varx(g) \times vary(g)}$$

2. Phenotypic correlation coefficient between character x and y

$$r_{xy}(p) = Cov_{xy}(p) / \sqrt{varx(p) \times vary(p)}$$

3. Environmental correlation coefficient between characters x and y

$$r_{xy}(e) = Cov_{xy}(e) / \sqrt{varx(e) \times vary(e)}$$

Where,

Cov_{xy} (p), Cov_{xy} (g), Cov_{xy} (e) = Phenotypic, genotypic & environmental co variances between character x and y, respectively.

Var_x (p), var_x (g), var_x (e) = Phenotypic, genotypic & environmental covariance character x, respectively.

$Var_y(p)$, $var_y(g)$, $var_y(e)$ = Phenotypic, genotypic & environmental covariance character y, respectively.

The significance of correlation coefficient (r) was tested by comparing "t" value at (n-2) degree of freedom

$$t = \sqrt{r\,(n - 2\,/\,1 - r2)}$$

If calculated "t" is greater than tabulated "t" at (n-2) degree of freedom at given probability level, the coefficient of correlation is taken as significant.

3.14.6 Path coefficient analysis

The genotypic correlation coefficients were further partitioned into direct and indirect effects with the help of path coefficient analysis as suggested by Wright (1921) and elaborated by Dewey and Lu (1959). Path coefficient analysis is simply a standardized partial regression coefficient which splits the correlation coefficient into the measures of direct and indirect effects.

Path coefficient was estimated using, simultaneous equations, the equations showed a basic relationship between correlation coefficient and path coefficient. These equations were solved by presenting them in matrix notations.

$$A = B.C$$

The solution for the vector "C" may be obtained by multiplying both sides by inverse of "B" matrix i.e. B-1 A = C

After calculation of values of path coefficient i.e. "C" vector, it is possible to obtain path values for residual (R). Residual effect was calculated using formula

$$R = \sqrt{1 - \quad di \times rij}$$

. Where,

D_i = direct effect of i^{th} character

r_{ij} = correlation coefficient of i^{th} character with j^{th} character

A direct and indirect effect of different characters on bulb yield was calculated at genotypic level.

3.14.7 Genetic divergence analysis

The Mahalanobis (1936) D^2 statistic was used to measure the genetic divergence between the populations. The D^2 value was estimated on the basis of "P" character by the formula:

Formula:

$$D^2 P = \sum_{i=1}^{p} = \sum_{j=1}^{p} = (\lambda_{ij})\, \lambda_i\, \lambda_j$$

Where,

(λ , i, j) is the reciprocal or (λ , i, j), the pooled common dispersion matrix (i.e. error matrix)

i = the difference in the mean value for the i^{th} character

j = the difference in the mean value for the j^{th} character

For calculating the D^2 values, the variance and covariance were calculated. The genotypes were grouped into different clusters by Tocher's method. The population was arranged in order of their relative distances from each other. For including a particular population in the clusters, a level of D^2 was fixed by taking the maximum D^2 values between any two populations in the first row of the table where D^2 values were arranged in increasing order of magnitude.

CHAPTER IV

RESULT AND DISCUSSION

RESULTS AND DISCUSSION

The results and discussion of the present investigation, “Genetic evaluation and characterization of different genotypes of ash gourd [*Benincasa hispida* (Thunb.) Cogn.]’’ are presented in this chapter. In order to make the findings more comprehensive, the results obtained from the present studies have been duly supported by respective tables and figures.

4.1 Growth attributes

Performance of growth and growth attributes of various ash gourd genotypes.

4.1.1 Cotyledon length (cm)

The cotyledon length of thirty seven ash gourd genotypes was recorded during unfolded leaf stage by using measuring scale. The results obtained on cotyledon length in different genotypes have been presented in table 4.1 and fig 4.1. Cotyledon length varied significantly among the genotypes and the data obtained from genotypes ranged from 2.30 cm to 4.08 cm. Genotype PAG-3 (4.08 cm) recorded maximum cotyledon length followed by TAG-4 (3.78 cm) and lowest were recoded from TAG-9 (2.30 cm) which was found at par with TAG-2 (2.32 cm), Manipur-2 (2.35 cm), TAG-7 (2.38 cm) and Basirhat (2.38 cm).

4.1.2 Cotyledon width (cm)

The cotyledon width of thirty seven ash gourd genotypes was recorded during unfolded leaf stage by using measuring scale. The results obtained on cotyledon length in different genotypes have been presented in table 4.2 and fig 4.2. Cotyledon width varied significantly among the genotypes and the data obtained from genotypes ranged from 1.15 cm to 2.32 cm. Genotype PAG-3 (2.32 cm) recorded maximum cotyledon width followed by TAG-4 (2.12 cm) and lowest were recoded from Pundibari Local-1 (1.15 cm) which was found at

Table 4.1 Growth attributes of various genotypes of ash gourd on cotyledon length.

	Cotyledon length (cm)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	3.27	3.37	3.32
Kashi Surbhi	2.66	2.71	2.69
Kashi Ujjwal	2.95	3.01	2.98
Pusa Ujjwal	2.84	2.96	2.90
Pusa Sabji Petha	2.86	2.90	2.88
Pant Petha 1	2.58	2.54	2.56
KAG-1	2.62	2.58	2.60
KAU Local	3.13	2.91	3.02
PAG-3	4.16	4.00	4.08
CO-2	2.85	2.79	2.82
Shakti	2.88	2.88	2.88
Indu	3.44	3.20	3.32
Bhagyalaxmi	2.79	2.64	2.72
Bux-1	2.92	2.86	2.89
AS-1	2.62	2.58	2.60
AS-2	3.14	3.02	3.08
Manipur-1	2.76	2.73	2.74
Manipur-2	2.50	2.20	2.35
Manipur-3	2.47	2.53	2.50
Meghalaya-1	2.95	3.01	2.98
Meghalaya-2	2.55	2.61	2.58
Meghalaya-3	2.84	2.92	2.88
TAG-1	2.81	2.83	2.82
TAG-2	2.31	2.33	2.32
TAG-3	3.17	3.10	3.13
TAG-4	3.81	3.75	3.78
TAG-5	3.07	3.04	3.05
TAG-6	3.11	2.97	3.04
TAG-7	2.33	2.43	2.38
TAG-8	2.90	2.70	2.80
TAG-9	2.39	2.21	2.30
Pundibari Local-1	3.01	2.90	2.95
Pundibari Local-2	3.21	3.15	3.18
Panji Local	2.93	2.87	2.90
Basirhat	2.40	2.36	2.38
Nagaland Local -1	3.18	3.14	3.16
Nagaland Local -2	2.78	2.82	2.80
SEm(±)	0.15	0.16	0.05
CD	0.43	0.45	0.15
CV(%)	9.10	9.64	2.59

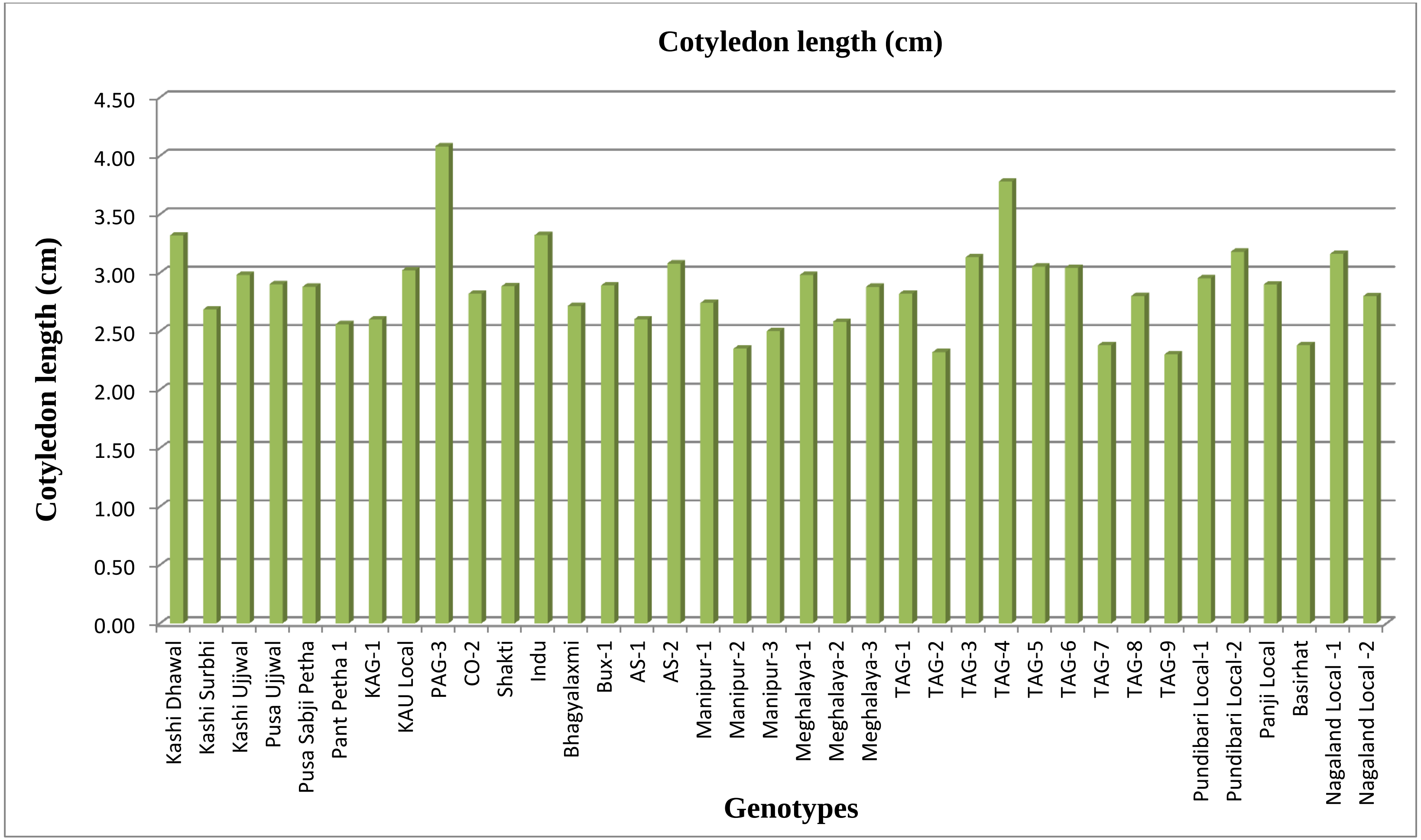

Fig 4.1 Growth attributes of various genotypes of ash gourd on cotyledon length.

Table 4.2 Growth attributes of various genotypes of ash gourd on cotyledon width.

	Cotyledon width (cm)		
Variety	**2018**	**2019**	**Pooled**
Kashi Dhawal	1.90	1.94	1.92
Kashi Surbhi	2.04	2.08	2.06
Kashi Ujjwal	1.84	1.87	1.86
Pusa Ujjwal	1.48	1.52	1.50
Pusa Sabji Petha	1.89	1.91	1.90
Pant Petha 1	1.59	1.57	1.58
KAG-1	1.91	1.89	1.90
KAU Local	1.77	1.68	1.72
PAG-3	2.35	2.29	2.32
CO-2	1.45	1.43	1.44
Shakti	1.67	1.66	1.67
Indu	1.93	1.83	1.88
Bhagyalaxmi	1.56	1.52	1.54
Bux-1	1.90	1.88	1.89
AS-1	1.37	1.35	1.36
AS-2	1.46	1.42	1.44
Manipur-1	1.53	1.52	1.52
Manipur-2	1.39	1.41	1.40
Manipur-3	1.20	1.24	1.22
Meghalaya-1	1.41	1.43	1.42
Meghalaya-2	1.19	1.21	1.20
Meghalaya-3	1.47	1.50	1.48
TAG-1	1.45	1.46	1.46
TAG-2	1.15	1.16	1.16
TAG-3	1.45	1.42	1.44
TAG-4	2.13	2.11	2.12
TAG-5	1.63	1.62	1.63
TAG-6	1.20	1.14	1.17
TAG-7	1.26	1.29	1.28
TAG-8	1.47	1.40	1.43
TAG-9	1.19	1.13	1.16
Pundibari Local-1	1.16	1.13	1.15
Pundibari Local-2	1.43	1.41	1.42
Panji Local	1.59	1.57	1.58
Basirhat	1.29	1.27	1.28
Nagaland Local -1	1.69	1.68	1.68
Nagaland Local -2	1.53	1.57	1.55
SEm(±)	0.07	0.06	0.02
CD	0.19	0.16	0.05
CV(%)	7.29	6.28	1.72

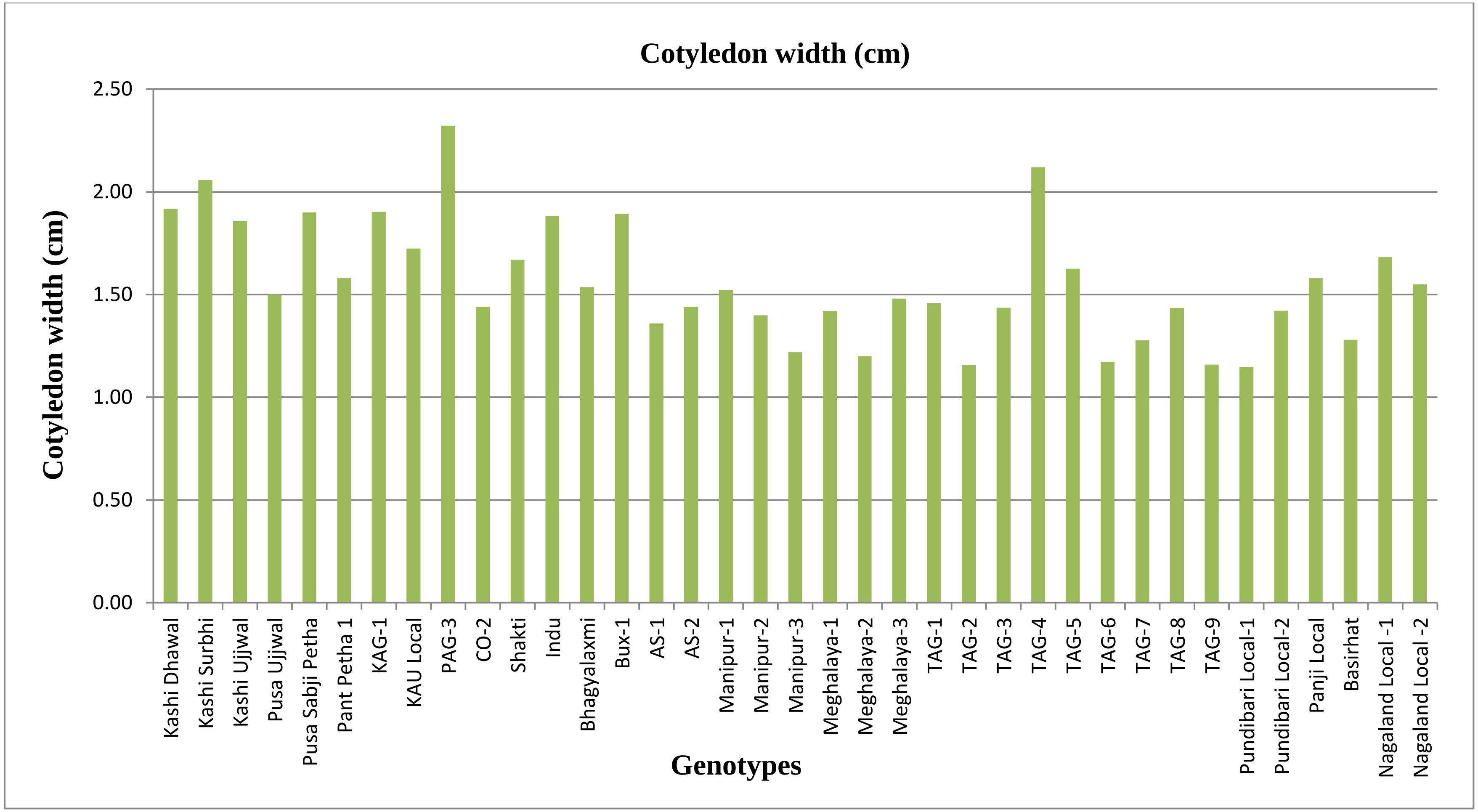

Fig 4.2 Growth attributes of various genotypes of ash gourd on cotyledon width.

par with TAG-2 (1.16 cm), TAG-6 (1.17 cm) and Meghalaya-2 (1.20 cm).

4.1.3 Stem shape

The result obtained by visual observation on the stem shape in different genotypes has been presented in table 4.3. The observation was recorded at active vegetative stage of the plants. Among the thirty seven genotypes, all the genotypes were having angular stem shape. The gene controlling this character may be commonly present in ash gourd plant due to which all the genotypes are having same observation.

4.1.4 Stem pubescence

The result obtained by visual observation on the stem pubescence in different genotypes has been presented in table 4.4. The observation was recorded at 50% flowering stage (first pistillate flower appears in 50% plant) of the plants. Among the thirty seven genotypes, all the genotypes were having stem pubescence. The gene controlling this character may be commonly present in ash gourd plant due to which all the genotypes are having same observation.

4.1.5 Internodal length (cm)

Table 4.5 and Fig 4.3 depicted data on the days when 50% of plants were in flowering stage i.e first 50% flower appears in 50% plants. The depicted data shows that the genotypes differ significantly for the internodal lengths. The genotype Pusa ujjwal (17.95 cm) shown maximum internodal length followed by CO-2 (16.61 cm) whereas the lowest internodal length were recorded from the genotype Manipur - 2 (8.92 cm). However, the internodal length ranged from 8.92 cm to 17.95 cm. This might be due to presence of variation among the ash gourd genotypes that were collected from different location.

4.1.6 Number of primary branches

The data taken for number of primary branches are given in table 4.6

Table 4.3 Growth attributes of various genotypes of ash gourd on stem shape.

Genotypes	Stem shape
Kashi Dhawal	Angular
Kashi Surbhi	Angular
Kashi Ujjwal	Angular
Pusa Ujjwal	Angular
Pusa Sabji Petha	Angular
Pant Petha 1	Angular
KAG-1	Angular
KAU Local	Angular
PAG-3	Angular
CO-2	Angular
Shakti	Angular
Indu	Angular
Bhagyalaxmi	Angular
Bux-1	Angular
AS-1	Angular
AS-2	Angular
Manipur-1	Angular
Manipur-2	Angular
Manipur-3	Angular
Meghalaya-1	Angular
Meghalaya-2	Angular
Meghalaya-3	Angular
TAG-1	Angular
TAG-2	Angular
TAG-3	Angular
TAG-4	Angular
TAG-5	Angular
TAG-6	Angular
TAG-7	Angular
TAG-8	Angular
TAG-9	Angular
Pundibari Local-1	Angular
Pundibari Local-2	Angular
Panji Local	Angular
Basirhat	Angular
Nagaland Local -1	Angular
Nagaland Local -2	Angular

Table 4.4 Growth attributes of various genotypes of ash gourd on stem pubescence.

Genotypes	Stem pubescence
Kashi Dhawal	Pubescence
Kashi Surbhi	Pubescence
Kashi Ujjwal	Pubescence
Pusa Ujjwal	Pubescence
Pusa Sabji Petha	Pubescence
Pant Petha 1	Pubescence
KAG-1	Pubescence
KAU Local	Pubescence
PAG-3	Pubescence
CO-2	Pubescence
Shakti	Pubescence
Indu	Pubescence
Bhagyalaxmi	Pubescence
Bux-1	Pubescence
AS-1	Pubescence
AS-2	Pubescence
Manipur-1	Pubescence
Manipur-2	Pubescence
Manipur-3	Pubescence
Meghalaya-1	Pubescence
Meghalaya-2	Pubescence
Meghalaya-3	Pubescence
TAG-1	Pubescence
TAG-2	Pubescence
TAG-3	Pubescence
TAG-4	Pubescence
TAG-5	Pubescence
TAG-6	Pubescence
TAG-7	Pubescence
TAG-8	Pubescence
TAG-9	Pubescence
Pundibari Local-1	Pubescence
Pundibari Local-2	Pubescence
Panji Local	Pubescence
Basirhat	Pubescence
Nagaland Local -1	Pubescence
Nagaland Local -2	Pubescence

Table 4.5 Growth attributes of various genotypes of ash gourd on internodal length.

	Internodal length (cm)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	14.76	15.20	14.98
Kashi Surbhi	12.29	12.61	12.45
Kashi Ujjwal	11.89	12.13	12.01
Pusa Ujjwal	17.56	18.34	17.95
Pusa Sabji Petha	13.43	13.40	13.41
Pant Petha 1	14.58	14.56	14.57
KAG-1	16.58	16.34	16.46
KAU Local	14.01	13.01	13.51
PAG-3	16.87	16.24	16.56
CO-2	16.76	16.46	16.61
Shakti	14.37	14.21	14.29
Indu	13.10	12.17	12.64
Bhagyalaxmi	15.19	14.62	14.91
Bux-1	15.23	14.96	15.10
AS-1	14.82	14.61	14.72
AS-2	15.70	15.11	15.41
Manipur-1	13.22	13.07	13.14
Manipur-2	8.93	8.91	8.92
Manipur-3	12.34	12.33	12.34
Meghalaya-1	12.00	12.25	12.12
Meghalaya-2	10.04	10.30	10.17
Meghalaya-3	11.16	11.50	11.33
TAG-1	10.56	10.77	10.67
TAG-2	13.56	13.79	13.67
TAG-3	11.47	11.63	11.55
TAG-4	15.72	15.48	15.60
TAG-5	16.03	15.85	15.94
TAG-6	16.10	16.58	16.34
TAG-7	11.17	11.67	11.42
TAG-8	11.68	10.85	11.26
TAG-9	15.25	14.16	14.71
Pundibari Local-1	12.60	12.12	12.36
Pundibari Local-2	10.32	10.14	10.23
Panji Local	13.68	13.43	13.55
Basirhat	11.30	11.13	11.21
Nagaland Local -1	14.13	13.97	14.05
Nagaland Local -2	12.16	12.13	12.15
SEm(±)	0.52	0.51	0.22
CD	1.47	1.44	0.63
CV(%)	6.67	6.59	2.29

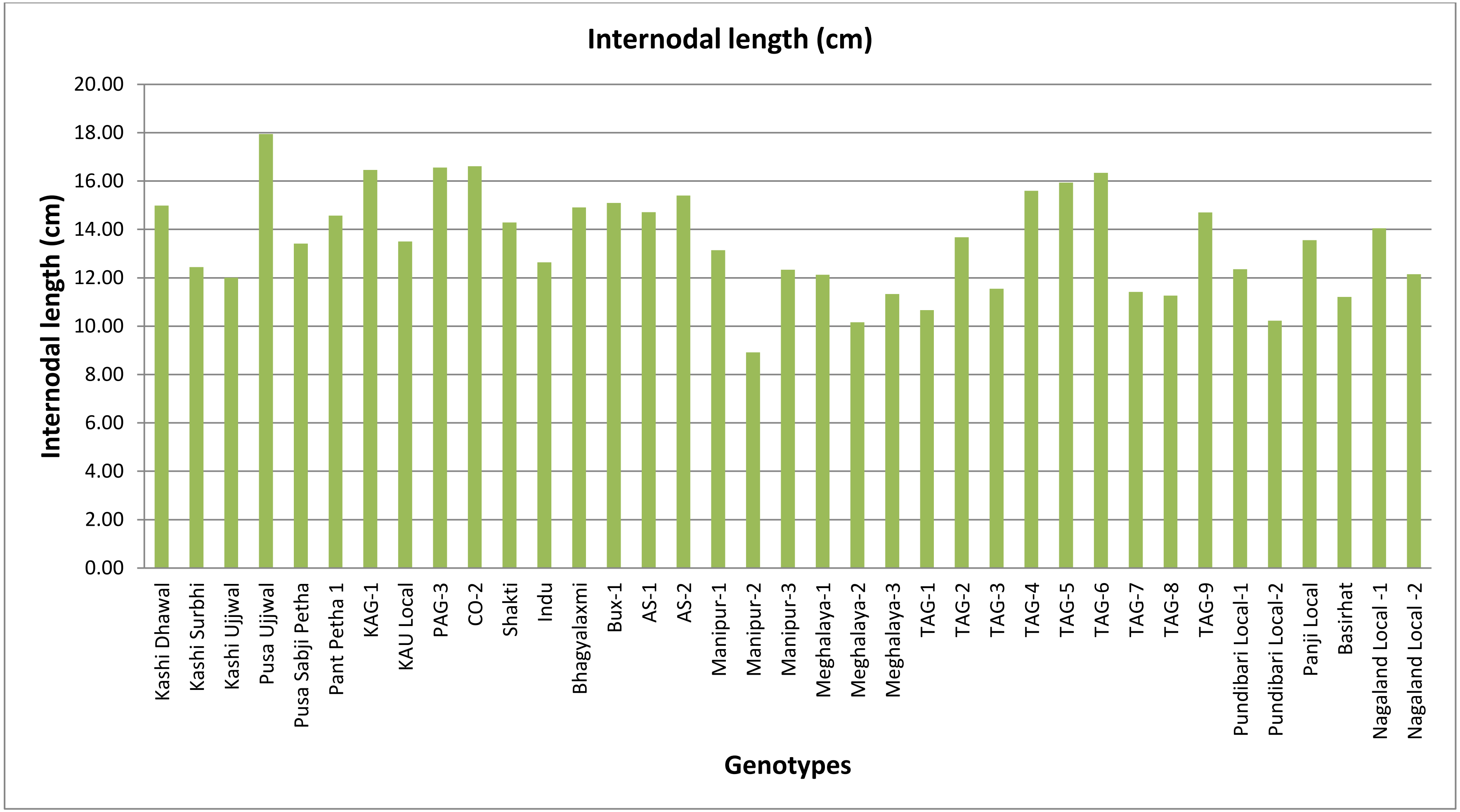

Fig 4.3 Growth attributes of various genotypes of ash gourd on internodal length.

and fig 4.4. The number of primary branches were recorded at the stage when fruit attaining marketable maturity shown significant difference among genotypes. Among the genotypes, PAG-3 (4.00) recorded highest number of primary branches while TAG-1 (3.88), TAG-4 (3.98), CO-2 (3.98), AS-1 (3.98), Panji Local (3.98 and Basirhat (3.98) were found at par with PAG-3. The lowest number of primary branches was recorded from the genotype TAG-6 (2.71) while Bhagyalaxmi (2.81) and Manipur-3 (2.91) were found at par with TAG-6. Number of primary branches depends on genetic makeup of the genotype. Pandey *et al.* (2007) also revealed significant differences among genotypes may be the result of variation in the genetic makeup as well as environmental conditions prevailing during the growth period. Similar variation in number of primary branches was reported by Mohanty (2000) in pumpkin.

4.1.7 Vine length (m)

Vine length of thirty seven ash gourd genotypes were recorded during full maturity stage i.e. seed harvest maturity using measuring tape. The data taken for vine length are given in table 4.7 and fig 4.5. Pusa Ujjwal (7.98 m) recorded maximum vine length which was significantly different from other genotypes except CO-2 (7.83 m) and Indu (7.93 m) which were found at par with Pusa Ujjwal. However, minimum vine length was recorded from TAG-9(3.80 m). Significant variation in vine length of pumpkin genotypes was also reported by Kumaran *et al.* (2000) and Ahamed *et al*. (2011).

4.1.8 Leaf blade margin

Leaf blade margin of thirty seven ash gourd genotypes were visually recorded during 50% flowering stage i.e. first pistillate flower appears in 50% plant. The observations taken for leaf blade margin are given in table 4.8. Among the genotypes, all have shown serrate type leaf blade margin except Shakti, TAG-6 and Nagaland Local-2 which shown multifid type margin.

Table 4.6 Growth attribute of various genotypes of ash gourd on number of primary branches.

	Number of primary branches		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	3.43	3.57	3.50
Kashi Surbhi	2.95	3.00	2.98
Kashi Ujjwal	3.16	3.29	3.22
Pusa Ujjwal	2.91	3.07	2.99
Pusa Sabji Petha	3.85	3.71	3.78
Pant Petha 1	3.53	3.50	3.52
KAG-1	3.03	2.94	2.99
KAU Local	3.57	3.22	3.40
PAG-3	4.10	3.89	4.00
CO-2	4.05	3.90	3.98
Shakti	3.53	3.51	3.52
Indu	3.15	2.80	2.98
Bhagyalaxmi	2.87	2.76	2.81
Bux-1	3.04	2.93	2.98
AS-1	4.04	3.92	3.98
AS-2	3.11	2.94	3.03
Manipur-1	3.02	2.95	2.99
Manipur-2	3.54	3.41	3.48
Manipur-3	2.97	2.85	2.91
Meghalaya-1	3.45	3.53	3.49
Meghalaya-2	2.95	3.00	2.98
Meghalaya-3	2.94	3.02	2.98
TAG-1	3.84	3.92	3.88
TAG-2	2.86	2.91	2.88
TAG-3	3.58	3.63	3.61
TAG-4	4.04	3.92	3.98
TAG-5	3.53	3.51	3.52
TAG-6	2.67	2.75	2.71
TAG-7	2.91	3.07	2.99
TAG-8	3.15	2.80	2.98
TAG-9	3.15	2.80	2.98
Pundibari Local-1	3.59	3.42	3.51
Pundibari Local-2	3.04	2.93	2.98
Panji Local	4.05	3.90	3.98
Basirhat	4.04	3.92	3.98
Nagaland Local -1	3.53	3.48	3.50
Nagaland Local -2	3.03	2.94	2.99
SEm(±)	0.17	0.20	0.07
CD	0.48	0.58	0.20
CV(%)	8.84	10.78	3.02

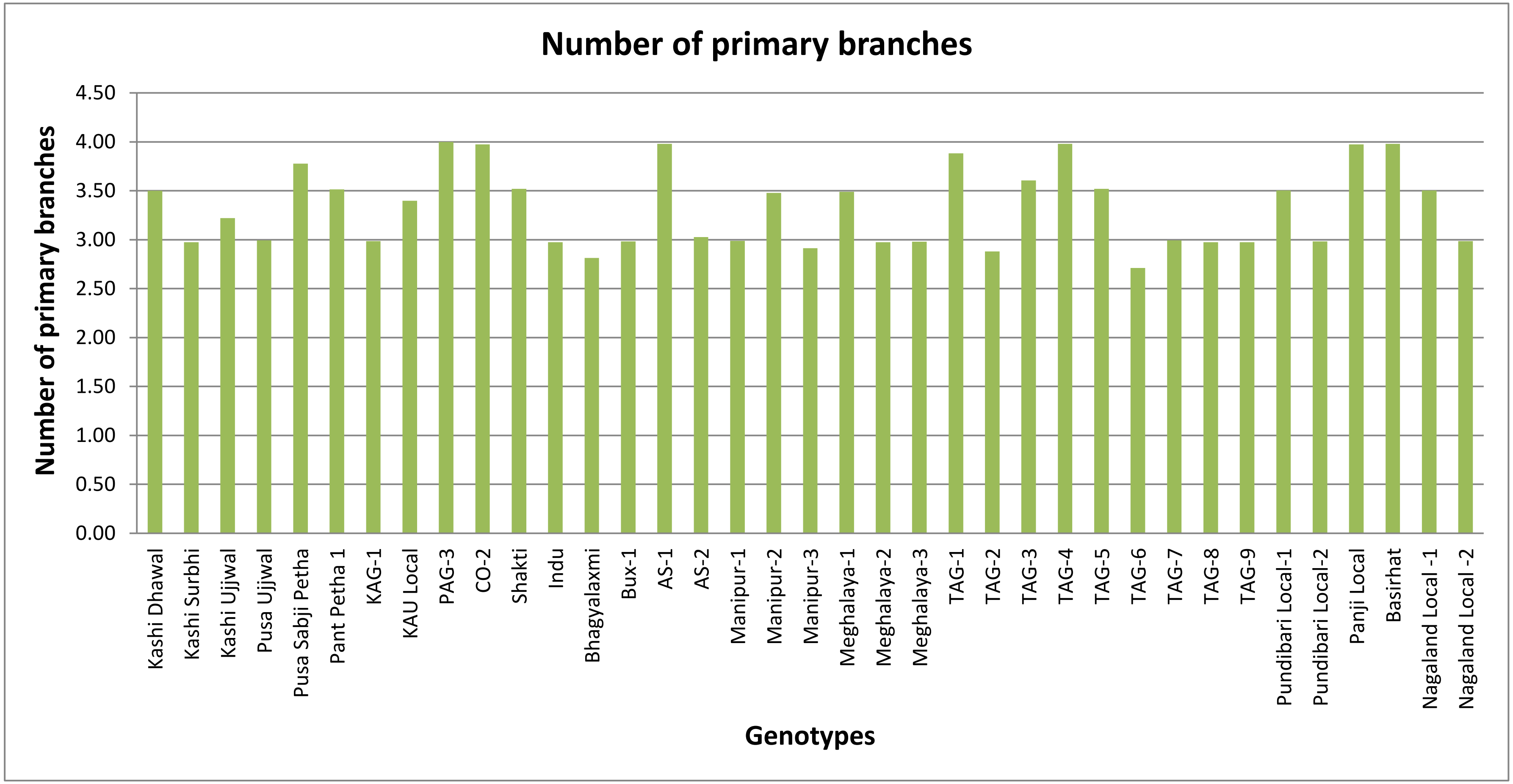

Fig 4.4 Growth attribute of various genotypes of ash gourd on number of primary branches.

Table 4.7 Growth attribute of various genotypes of ash gourd on vine length.

	Vine length (m)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	5.86	6.25	6.05
Kashi Surbhi	5.24	5.16	5.20
Kashi Ujjwal	5.82	5.74	5.78
Pusa Ujjwal	8.04	7.91	7.98
Pusa Sabji Petha	5.46	5.38	5.42
Pant Petha 1	6.26	6.44	6.35
KAG-1	4.66	4.78	4.72
KAU Local	5.54	5.73	5.63
PAG-3	5.36	5.54	5.45
CO-2	7.68	7.98	7.83
Shakti	6.47	6.73	6.60
Indu	7.70	8.15	7.93
Bhagyalaxmi	5.40	5.30	5.35
Bux-1	4.17	4.09	4.13
AS-1	5.35	5.25	5.30
AS-2	5.95	5.65	5.80
Manipur-1	5.77	5.63	5.70
Manipur-2	5.20	5.10	5.15
Manipur-3	5.86	5.74	5.80
Meghalaya-1	6.46	6.34	6.40
Meghalaya-2	7.44	7.26	7.35
Meghalaya-3	6.67	6.51	6.59
TAG-1	5.03	5.08	5.06
TAG-2	5.49	5.53	5.51
TAG-3	6.63	6.47	6.55
TAG-4	5.77	5.22	5.50
TAG-5	6.98	6.32	6.65
TAG-6	7.79	7.43	7.61
TAG-7	7.61	7.43	7.52
TAG-8	7.19	7.02	7.10
TAG-9	3.85	3.75	3.80
Pundibari Local-1	5.03	4.77	4.90
Pundibari Local-2	4.62	4.39	4.50
Panji Local	4.62	4.38	4.50
Basirhat	5.72	5.43	5.57
Nagaland Local -1	7.59	6.87	7.23
Nagaland Local -2	7.68	6.95	7.31
SEm(±)	0.18	0.16	0.14
CD	0.50	0.44	0.39
CV(%)	5.06	4.54	3.23

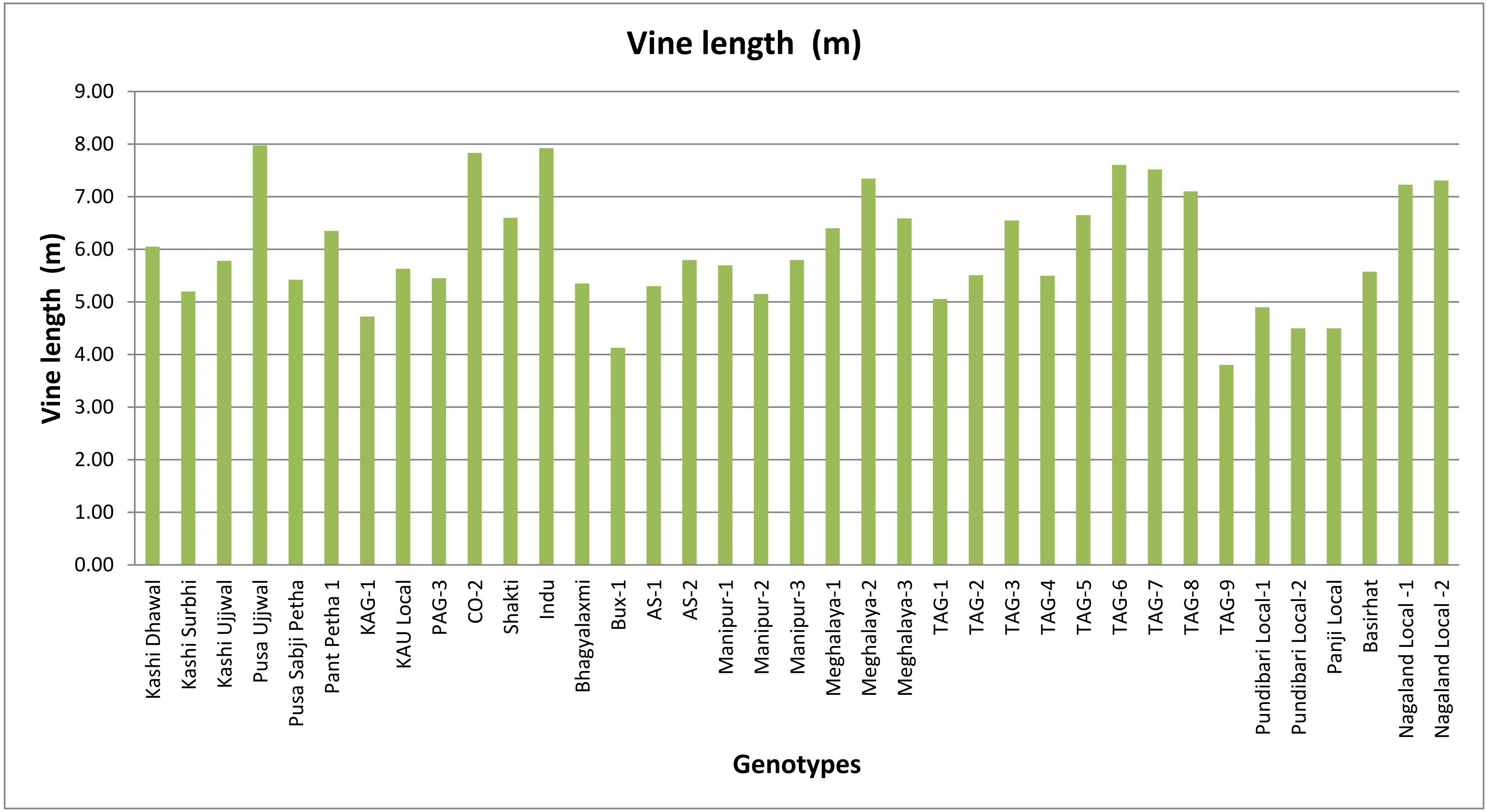

Fig 4.5 Growth attribute of various genotypes of ash gourd on vine length.

Table 4.8 Growth attribute of various genotypes of ash gourd on leaf blade margin.

4.1.9 Leaf shape

Genotypes	Leaf blade margin
Kashi Dhawal	Serrate
Kashi Surbhi	Serrate
Kashi Ujjwal	Serrate
Pusa Ujjwal	Serrate
Pusa Sabji Petha	Serrate
Pant Petha 1	Serrate
KAG-1	Serrate
KAU Local	Serrate
PAG-3	Serrate
CO-2	Serrate
Shakti	Multifid
Indu	Serrate
Bhagyalaxmi	Serrate
Bux-1	Serrate
AS-1	Serrate
AS-2	Serrate
Manipur-1	Serrate
Manipur-2	Serrate
Manipur-3	Serrate
Meghalaya-1	Serrate
Meghalaya-2	Serrate
Meghalaya-3	Serrate
TAG-1	Serrate
TAG-2	Serrate
TAG-3	Serrate
TAG-4	Serrate
TAG-5	Serrate
TAG-6	Multifid
TAG-7	Serrate
TAG-8	Serrate
TAG-9	Serrate
Pundibari Local-1	Serrate
Pundibari Local-2	Serrate
Panji Local	Serrate
Basirhat	Serrate
Nagaland Local -1	Serrate
Nagaland Local -2	Multifid

Leaf shape of thirty seven ash gourd genotypes were visually recorded during 50% flowering stage i.e. first pistillate flower appears in 50% plant. The observations taken for leaf shape are given in table 4.9. Among the genotypes, all have shown cordate type leaf shape. Although there were slight different but more or less all were cordate.

4.1.10 Leaf length (cm)

The data on leaf length of different genotypes are shown in table 4.10 and fig 4.6. Different genotype showed variable behaviour for the leaf length. Leaf length of thirty seven ash gourd genotypes were recorded during 50% flowering stage i.e. first pistillate flower appears in 50% plant. The maximum leaf length was recorded form PAG-3 (17.59 cm) while Shakti (16.80 cm), Kashi Dhawal (16.87 cm), Nagaland Local-1 (17.35 cm) and CO-2 (17.44 cm) were found at par with PAG-3. However, the minimum leaf length was recorded from Manipur-2 (10.37 cm) while TAG-6 (10.43 cm), Meghalaya-3 (10.74 cm), TAG-3 (10.80 cm) and TAG-8 (11.15 cm) were found at par with Manipur-2.

4.1.11 Leaf width (cm)

The data on leaf width of different genotypes are shown in table 4.11 and fig 4.7. Leaf width of thirty seven ash gourd genotypes were recorded during 50% flowering stage i.e. first pistillate flower appears in 50% plant. Different genotypes showed variable behaviour for the leaf width. The maximum leaf width was recorded form CO-2 (23.97 cm) while PAG-3 (23.87 cm), Pusa Ujjawal (23.46 cm) and Kashi Dhawal (23.05 cm) were found at par with each other. However, minimum leaf width were recorded from Manipur-2 (13.41 cm) followed by Meghalaya -3 (14.30 cm).

The variation in leaf length and leaf width may be due to difference in genotypes. In line with the present experimental findings Ahmed *et al.* (2011) also recorded distinct variation in leaf size of pumpkin genotypes.

Table 4.9 Growth attribute of various genotypes of ash gourd on leaf shape.

Genotypes	Leaf shape
Kashi Dhawal	Cordate
Kashi Surbhi	Cordate
Kashi Ujjwal	Cordate
Pusa Ujjwal	Cordate
Pusa Sabji Petha	Cordate
Pant Petha 1	Cordate
KAG-1	Cordate
KAU Local	Cordate
PAG-3	Cordate
CO-2	Cordate
Shakti	Cordate
Indu	Cordate
Bhagyalaxmi	Cordate
Bux-1	Cordate
AS-1	Cordate
AS-2	Cordate
Manipur-1	Cordate
Manipur-2	Cordate
Manipur-3	Cordate
Meghalaya-1	Cordate
Meghalaya-2	Cordate
Meghalaya-3	Cordate
TAG-1	Cordate
TAG-2	Cordate
TAG-3	Cordate
TAG-4	Cordate
TAG-5	Cordate
TAG-6	Cordate
TAG-7	Cordate
TAG-8	Cordate
TAG-9	Cordate
Pundibari Local-1	Cordate
Pundibari Local-2	Cordate
Panji Local	Cordate
Basirhat	Cordate
Nagaland Local -1	Cordate
Nagaland Local -2	Cordate

Table 4.10 Growth attribute of various genotypes of ash gourd on leaf length.

	Leaf length (cm)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	16.39	17.36	16.87
Kashi Surbhi	12.25	12.98	12.61
Kashi Ujjwal	12.82	13.33	13.07
Pusa Ujjwal	16.37	17.03	16.70
Pusa Sabji Petha	13.80	14.28	14.04
Pant Petha 1	14.36	14.86	14.61
KAG-1	13.93	14.32	14.12
KAU Local	13.14	13.50	13.32
PAG-3	17.72	17.45	17.59
CO-2	17.58	17.31	17.44
Shakti	16.93	16.67	16.80
Indu	14.49	14.27	14.38
Bhagyalaxmi	16.80	16.47	16.63
Bux-1	11.74	11.51	11.63
AS-1	11.68	11.48	11.58
AS-2	14.59	13.86	14.23
Manipur-1	12.51	12.27	12.39
Manipur-2	10.48	10.27	10.37
Manipur-3	12.12	11.88	12.00
Meghalaya-1	12.20	11.90	12.05
Meghalaya-2	11.78	11.50	11.64
Meghalaya-3	10.87	10.61	10.74
TAG-1	10.30	10.51	10.41
TAG-2	12.36	12.57	12.46
TAG-3	10.72	10.87	10.80
TAG-4	13.71	12.41	13.06
TAG-5	14.04	12.71	13.38
TAG-6	10.27	10.58	10.43
TAG-7	11.82	11.53	11.67
TAG-8	11.29	11.01	11.15
TAG-9	10.98	10.71	10.85
Pundibari Local-1	13.47	12.79	13.13
Pundibari Local-2	11.92	11.33	11.62
Panji Local	14.00	13.30	13.65
Basirhat	12.87	12.22	12.55
Nagaland Local -1	18.22	16.48	17.35
Nagaland Local -2	13.56	12.27	12.92
SEm(±)	0.40	0.46	0.30
CD	1.12	1.29	0.86
CV(%)	5.17	6.05	3.21

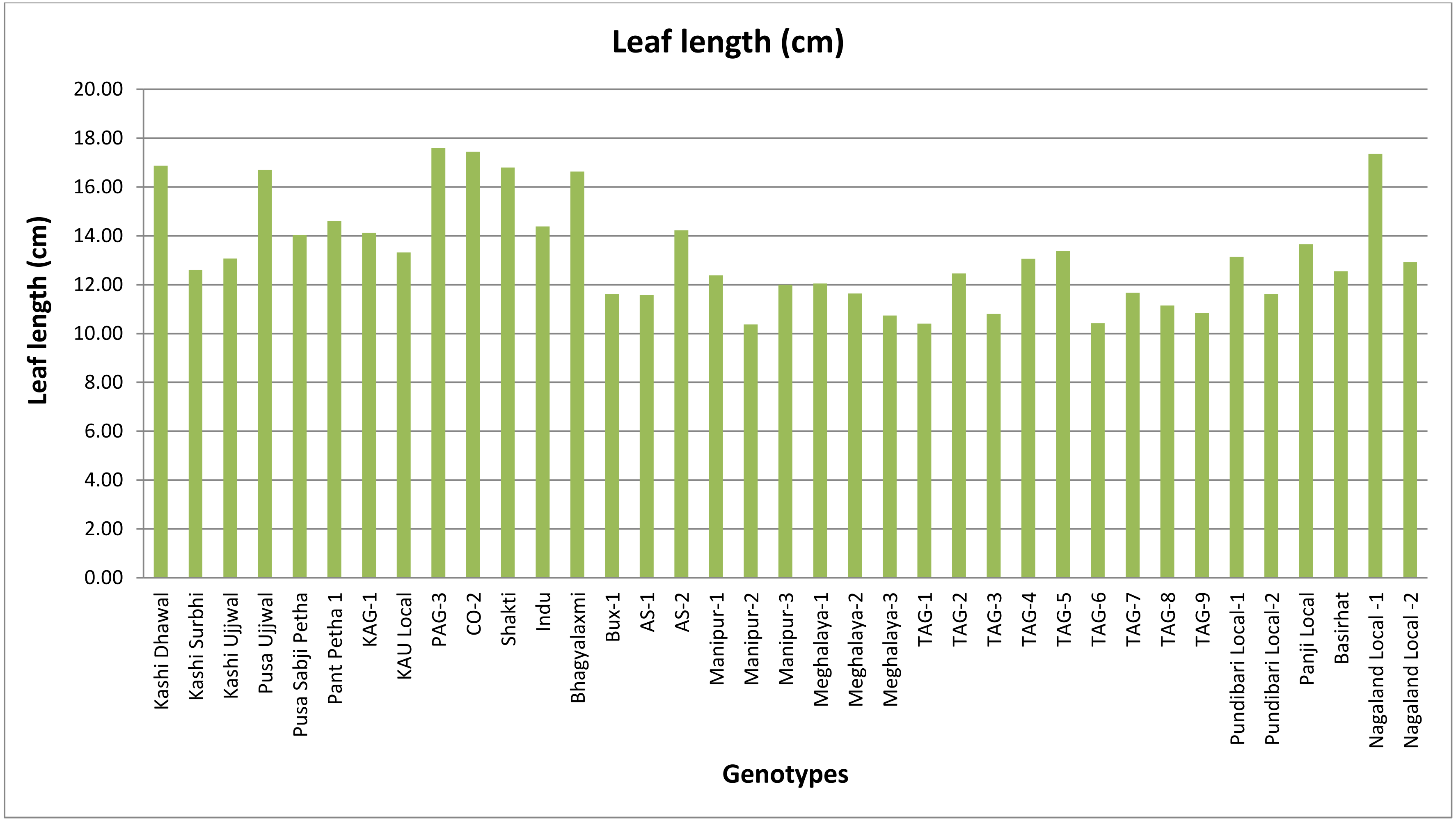

Fig 4.6 Growth attribute of various genotypes of ash gourd on leaf length.

Table 4.11 Growth attribute of various genotypes of ash gourd on leaf width.

	Leaf width (cm)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	22.78	24.14	23.46
Kashi Surbhi	18.43	19.56	18.99
Kashi Ujjwal	17.46	18.16	17.81
Pusa Ujjwal	22.60	23.50	23.05
Pusa Sabji Petha	18.02	18.64	18.33
Pant Petha 1	20.96	21.68	21.32
KAG-1	18.51	19.02	18.76
KAU Local	19.56	20.10	19.83
PAG-3	24.03	23.70	23.87
CO-2	24.15	23.78	23.97
Shakti	22.87	22.53	22.70
Indu	20.61	20.30	20.45
Bhagyalaxmi	21.14	20.72	20.93
Bux-1	17.12	16.79	16.95
AS-1	16.73	16.40	16.56
AS-2	19.81	18.81	19.31
Manipur-1	17.47	17.16	17.32
Manipur-2	13.54	13.28	13.41
Manipur-3	15.09	14.81	14.95
Meghalaya-1	15.85	15.46	15.66
Meghalaya-2	16.15	15.76	15.96
Meghalaya-3	14.47	14.13	14.30
TAG-1	15.14	14.72	14.93
TAG-2	15.58	15.23	15.40
TAG-3	17.70	17.88	17.79
TAG-4	19.52	17.66	18.59
TAG-5	20.55	18.60	19.57
TAG-6	14.93	15.23	15.08
TAG-7	15.08	14.72	14.90
TAG-8	14.94	14.58	14.76
TAG-9	14.88	14.52	14.70
Pundibari Local-1	16.75	15.91	16.33
Pundibari Local-2	16.14	15.33	15.73
Panji Local	19.33	18.36	18.85
Basirhat	18.90	17.95	18.42
Nagaland Local -1	24.20	21.90	23.05
Nagaland Local -2	17.09	15.46	16.27
SEm(±)	0.58	0.53	0.41
CD	1.63	1.50	1.17
CV(%)	5.48	5.14	3.18

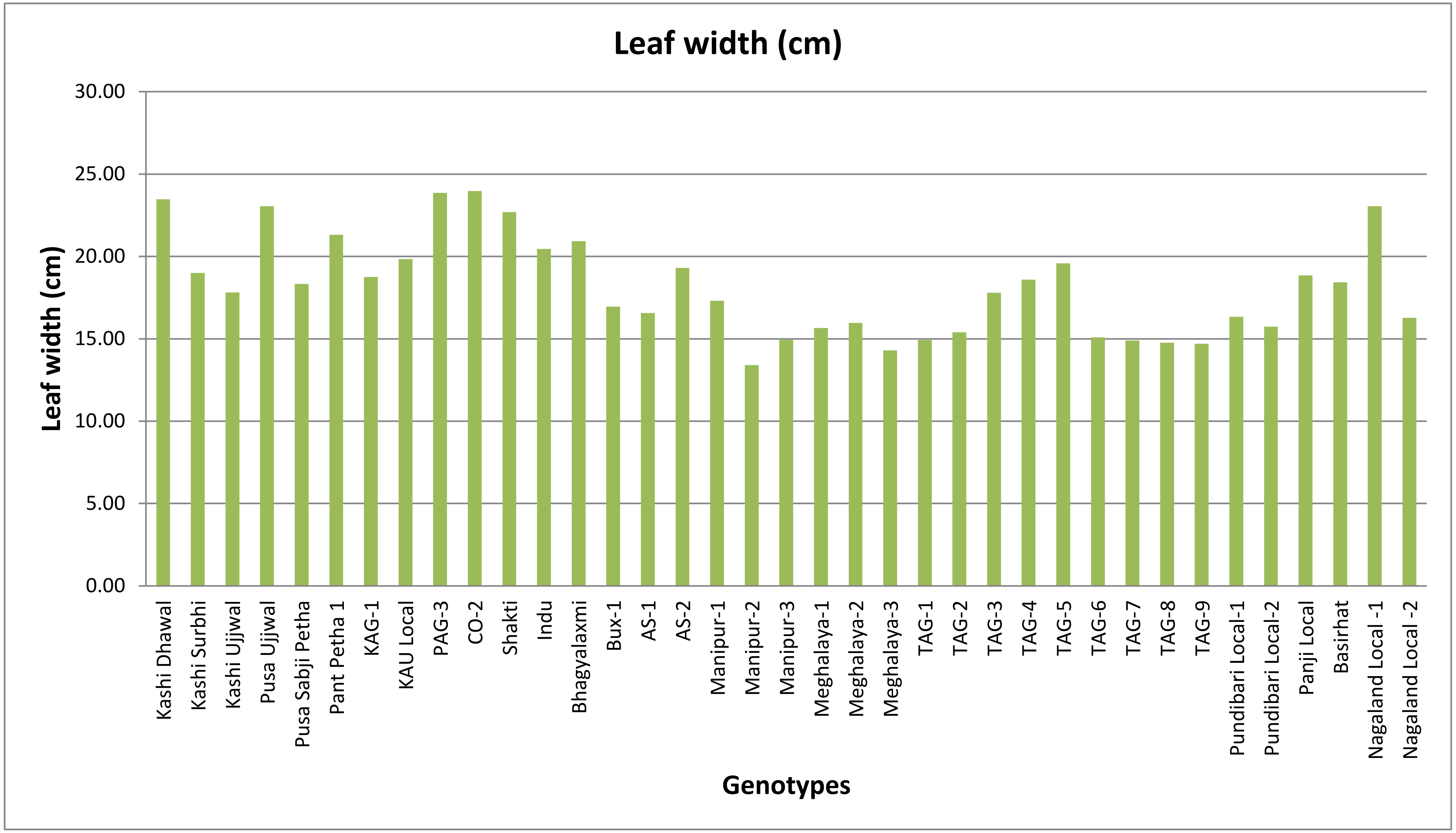

Fig 4.7 Growth attribute of various genotypes of ash gourd on leaf width.

4.1.12 Leaf pubescence

The observations taken for leaf pubescence are given in table 4.12. Leaf pubescence of thirty seven ash gourd genotypes were recorded during 50% flowering stage i.e. first pistillate flower appears in 50% plant. Most of the genotypes were having intermediate type pubescence. However, TAG-6, Basirhat and Nagaland Local-2 shown hard type pubescence and Indu, Bhagyalaxmi, AS-1, TAG-2 and TAG-5 shown soft type pubescence.

4.1.13 Number of lobes

The observations taken for number of lobes are given in table 4.13 and fig 4.8. Number of lobes of thirty seven ash gourd genotypes were visually recorded during 50% flowering stage i.e. first pistillate flower appears in 50% plant. Maximum number of lobes was recorded in Pusa Ujjwal (7.11) and minimum was found in TAG-1 (4.87).

4.1.14 Petiole length (cm)

The observations taken for leaf shape are given in table 4.14 and fig 4.9. Petiole length of thirty seven ash gourd genotypes were visually recorded during 50% flowering stage i.e. first pistillate flower appears in 50% plant. Maximum petiole length was recorded in PAG-3 (20.50 cm) and minimum was found in TAG-7 (6.82 cm).

. **4.1.15 Tendril status**

Tendril status of thirty seven ash gourd genotypes were visually recorded during 50% flowering stage i.e. first pistillate flower appears in 50% plant. It is found that in the entire genotypes tendril were present as shown in table 4.15.

4.1.16 Tendril branching

Tendril branching of thirty seven ash gourd genotypes were visually recorded during 50% flowering stage i.e. first pistillate flower appears in 50 per

Table 4.12 Growth attribute of various genotypes of ash gourd on leaf pubescence.

Genotypes	Leaf pubescence
Kashi Dhawal	Intermediate
Kashi Surbhi	Intermediate
Kashi Ujjwal	Intermediate
Pusa Ujjwal	Intermediate
Pusa Sabji Petha	Intermediate
Pant Petha 1	Intermediate
KAG-1	Intermediate
KAU Local	Intermediate
PAG-3	Intermediate
CO-2	Intermediate
Shakti	Intermediate
Indu	Soft
Bhagyalaxmi	Soft
Bux-1	Intermediate
AS-1	Soft
AS-2	Intermediate
Manipur-1	Intermediate
Manipur-2	Intermediate
Manipur-3	Intermediate
Meghalaya-1	Intermediate
Meghalaya-2	Intermediate
Meghalaya-3	Intermediate
TAG-1	Intermediate
TAG-2	Soft
TAG-3	Intermediate
TAG-4	Intermediate
TAG-5	Soft
TAG-6	Hard
TAG-7	Intermediate
TAG-8	Intermediate
TAG-9	Intermediate
Pundibari Local-1	Intermediate
Pundibari Local-2	Intermediate
Panji Local	Intermediate
Basirhat	Hard
Nagaland Local -1	Intermediate
Nagaland Local -2	Hard

Table 4.13 Growth attribute of various genotypes of ash gourd on number of lobes.

	Number of lobes		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	6.94	7.20	7.07
Kashi Surbhi	4.97	5.12	5.04
Kashi Ujjwal	7.16	6.93	7.05
Pusa Ujjwal	7.34	6.86	7.11
Pusa Sabji Petha	5.02	4.98	5.00
Pant Petha 1	7.14	6.86	7.00
KAG-1	7.16	6.77	6.97
KAU Local	4.94	4.81	4.88
PAG-3	6.91	6.91	6.91
CO-2	5.07	4.87	4.97
Shakti	7.09	6.86	6.97
Indu	4.96	5.14	5.05
Bhagyalaxmi	5.12	5.12	5.12
Bux-1	5.02	4.98	5.00
AS-1	7.16	6.77	6.97
AS-2	5.12	5.12	5.12
Manipur-1	6.91	6.74	6.83
Manipur-2	5.07	4.87	4.97
Manipur-3	5.12	4.95	5.03
Meghalaya-1	5.05	4.98	5.01
Meghalaya-2	5.10	4.90	5.00
Meghalaya-3	4.94	4.93	4.94
TAG-1	4.94	4.81	4.87
TAG-2	5.12	4.95	5.03
TAG-3	5.12	4.88	5.00
TAG-4	6.91	6.91	6.91
TAG-5	7.09	6.86	6.97
TAG-6	5.14	5.80	5.47
TAG-7	4.93	4.95	4.94
TAG-8	5.13	4.93	5.03
TAG-9	5.07	5.06	5.06
Pundibari Local-1	7.16	6.93	7.05
Pundibari Local-2	7.34	6.86	7.10
Panji Local	5.13	4.93	5.03
Basirhat	7.09	7.09	7.09
Nagaland Local -1	5.12	5.12	5.12
Nagaland Local -2	7.02	6.97	7.00
SEm(±)	0.34	0.33	0.09
CD	0.97	0.92	0.24
CV(%)	10.36	9.64	2.09

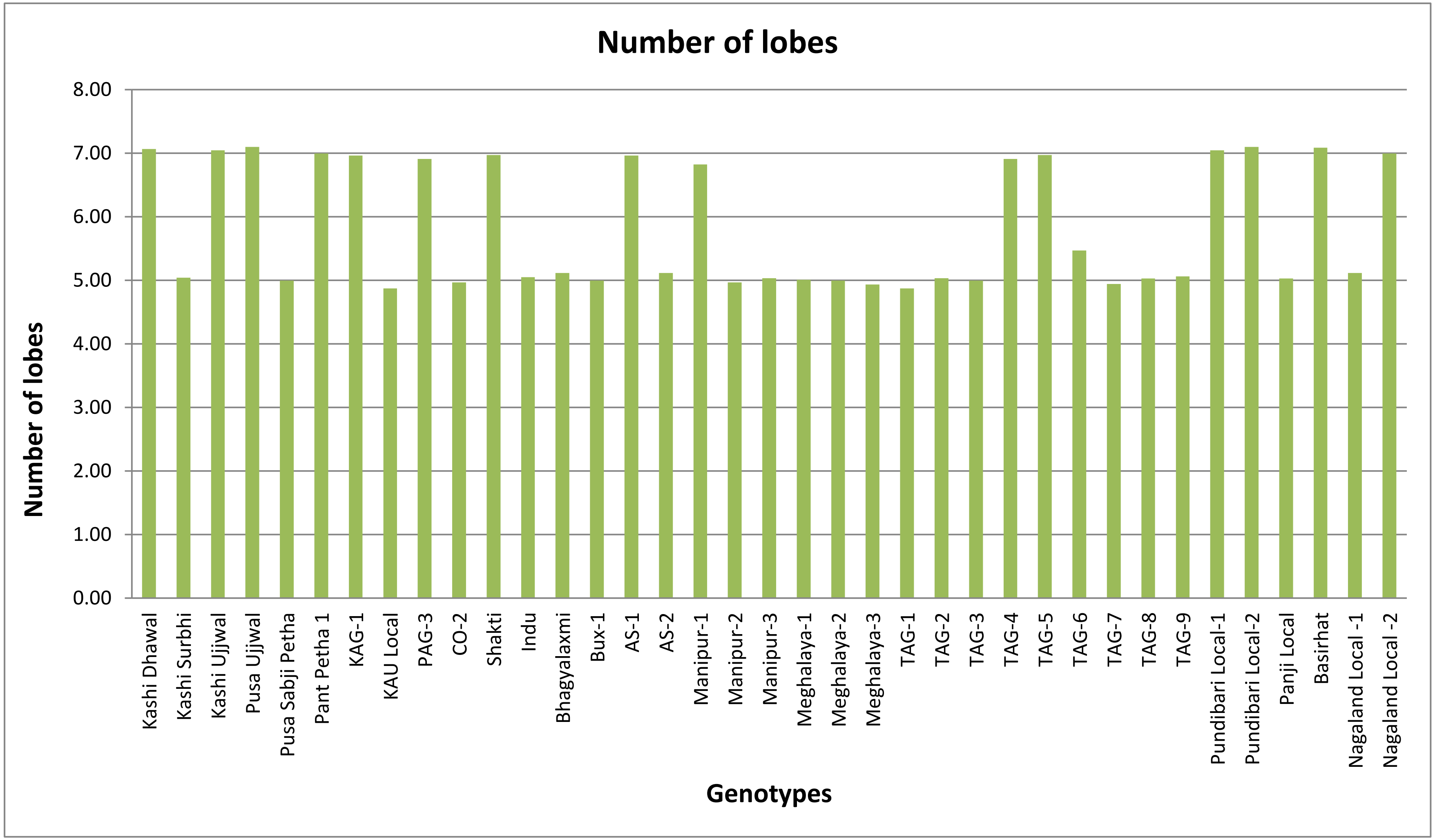

Fig 4.8 Growth attribute of various genotypes of ash gourd on number of lobes.

Table 4.14 Growth attribute of various genotypes of ash gourd on petiole length (cm).

	Petiole length (cm)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	14.67	14.45	14.56
Kashi Surbhi	11.64	11.46	11.55
Kashi Ujjwal	11.42	12.10	11.76
Pusa Ujjwal	14.41	14.19	14.30
Pusa Sabji Petha	12.89	12.69	12.79
Pant Petha 1	14.80	15.21	15.01
KAG-1	10.62	10.92	10.77
KAU Local	14.33	14.82	14.58
PAG-3	19.96	21.03	20.50
CO-2	12.73	13.24	12.99
Shakti	14.17	14.74	14.46
Indu	12.68	12.43	12.55
Bhagyalaxmi	16.12	15.81	15.97
Bux-1	12.11	11.87	11.99
AS-1	10.91	11.56	11.24
AS-2	14.68	14.32	14.50
Manipur-1	10.82	10.56	10.69
Manipur-2	9.32	9.14	9.23
Manipur-3	9.43	9.25	9.34
Meghalaya-1	9.17	8.99	9.08
Meghalaya-2	10.47	10.21	10.34
Meghalaya-3	10.12	9.88	10.00
TAG-1	11.77	12.01	11.89
TAG-2	11.48	11.68	11.58
TAG-3	10.49	10.64	10.56
TAG-4	13.63	12.94	13.29
TAG-5	14.51	13.78	14.15
TAG-6	9.86	10.16	10.01
TAG-7	7.00	6.65	6.82
TAG-8	7.55	7.37	7.46
TAG-9	8.79	8.58	8.69
Pundibari Local-1	9.33	8.87	9.10
Pundibari Local-2	9.51	9.04	9.27
Panji Local	11.89	10.76	11.33
Basirhat	11.38	10.30	10.84
Nagaland Local -1	13.57	12.28	12.92
Nagaland Local -2	10.31	9.33	9.82
SEm(±)	0.48	0.46	0.26
CD	1.36	1.29	0.76
CV(%)	7.08	6.76	3.17

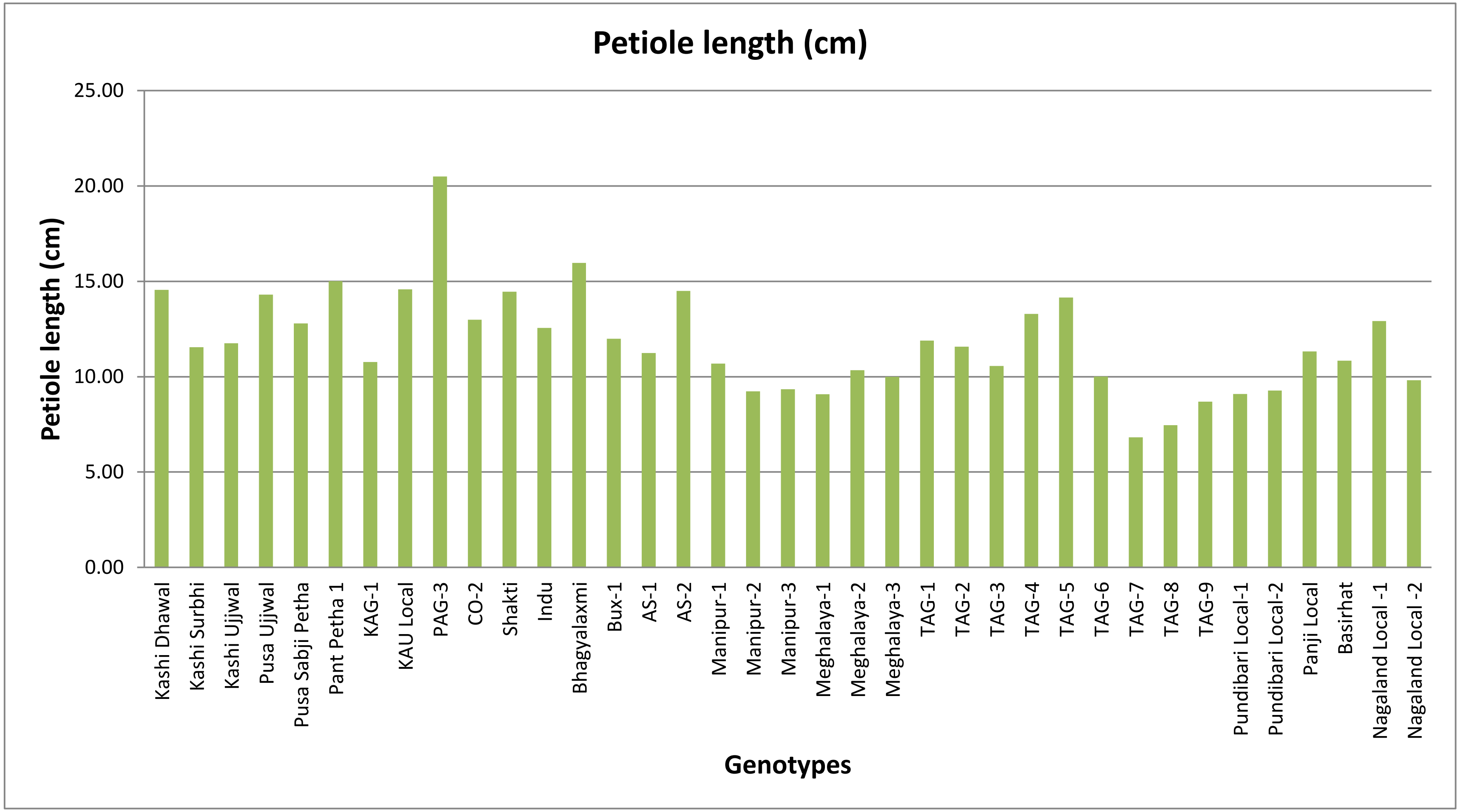

Fig 4.9 Growth attribute of various genotypes of ash gourd on petiole length.

Table 4.15 Growth attribute of various genotypes of ash gourd on tendril status, branching and type.

Genotypes	Tendril status	Tendril branching	Tendril type
Kashi Dhawal	Present	Branched	Coiled
Kashi Surbhi	Present	Branched	Coiled
Kashi Ujjwal	Present	Branched	Coiled
Pusa Ujjwal	Present	Branched	Coiled
Pusa Sabji Petha	Present	Branched	Coiled
Pant Petha 1	Present	Branched	Coiled
KAG-1	Present	Branched	Coiled
KAU Local	Present	Branched	Coiled
PAG-3	Present	Branched	Coiled
CO-2	Present	Branched	Coiled
Shakti	Present	Branched	Coiled
Indu	Present	Branched	Coiled
Bhagyalaxmi	Present	Branched	Coiled
Bux-1	Present	Branched	Coiled
AS-1	Present	Branched	Coiled
AS-2	Present	Branched	Coiled
Manipur-1	Present	Branched	Coiled
Manipur-2	Present	Branched	Coiled
Manipur-3	Present	Branched	Coiled
Meghalaya-1	Present	Branched	Coiled
Meghalaya-2	Present	Branched	Coiled
Meghalaya-3	Present	Branched	Coiled
TAG-1	Present	Branched	Coiled
TAG-2	Present	Branched	Coiled
TAG-3	Present	Branched	Coiled
TAG-4	Present	Branched	Coiled
TAG-5	Present	Branched	Coiled
TAG-6	Present	Branched	Coiled
TAG-7	Present	Branched	Coiled
TAG-8	Present	Branched	Coiled
TAG-9	Present	Branched	Coiled
Pundibari Local-1	Present	Branched	Coiled
Pundibari Local-2	Present	Branched	Coiled
Panji Local	Present	Branched	Coiled
Basirhat	Present	Branched	Coiled
Nagaland Local -1	Present	Branched	Coiled
Nagaland Local -2	Present	Branched	Coiled

cent plant. It is found that in the entire genotypes tendril were branched as shown in table 4.15.

4.1.17 Tendril type

Tendril type of thirty seven ash gourd genotypes were visually recorded during 50% flowering stage i.e. first pistillate flower appears in 50% plant. It is found that in the entire genotypes tendril were coiled as shown in table 4.15.

4.1.18 Days to 1st female flower

The data on the days to 1st female flower of different genotypes are recorded as the number of days taken for initiation of female flower from the date of sowing as shown in table 4.16 and fig 4.10. Different genotypes showed variable behaviour on the days to 1st female flower. The maximum days to 1st female flower was recorded from TAG-7 (91.12) while TAG- 5 (90.44) was found at par with TAG-7 and minimum (61.67) was recoded from Kashi Surbhi while Pundibari Local-1 (61.98) was found at par with Kashi Surbhi. The attainment of maximum and minimum days to 1st female flower by different genotypes may be due to the differences in their genetic makeup which influences the performance of a crop. In line with the present findings, significant variation for days to 1st female flower opening was also reported by Pandey and Singh (2007) in sponge gourd and Samadia (2007) in round melon genotypes.

4.1.19 Node at which 1st female flower appears

The data on the node at which 1st female flower appears of different genotypes were recorded by counting the number of nodes from the ground level on which the first female flower appears as shown in table 4.17 and fig 4.11. Different genotype showed variable behaviour on the days to 1st female flower. The maximum node at which 1st female flower appears was recorded from Manipur-1(29.93) while Meghalaya-2 (29.81) and TAG- 3 (29.55) was found at par with Manipur-1 and minimum was recoded from for AS-1 (9.25).

The attainment of maximum and minimum node at which 1st female flower appears by different genotypes may be due to the differences in their genetic makeup which influence the performance of a crop. This result was in line with experimental findings of Ananthan *et al.* (2005) in ridge gourd and Selvi *et al.* (2012) in pumpkin genotypes.

4.1.20 Sex expression

Sex expression of thirty seven ash gourd genotypes were visually recorded during 50% flowering stage i.e. first pistillate flower appears in 50% plant. It is found that in all the genotypes both male and female flowers were found in same plant which showed all the genotypes are monoecious in nature as shown in table 4.18.

4.1.21 Male sterility

Male sterility of thirty seven ash gourd genotypes were visually recorded during 50% flowering stage i.e. first pistillate flower appears in 50% plant. It is found that in all the genotypes male flowers were producing enough pollen grains which were used during selfing for maintenance breeding which shows that the male sterility were absent in all the genotypes as shown in table 4.18.

4.1.22 Ovary length (cm)

Ovary length of thirty seven ash gourd genotypes was recorded using Vernier calliper just after anthesis of female flower. The data on ovary length was recorded as shown in table 4.19 and fig 4.12. Different genotype show variable behaviour on the ovary length. The maximum ovary length was recorded from AS-1 (4.58 cm) and minimum was recoded from for Manipur-1 (2.12 cm) while TAG-1 (2.29 cm) and TAG-4 (2.25 cm) were found at par with Manipur-1. The attainment of maximum and minimum ovary length appears by different genotypes may be due to the differences in their genetic makeup which influence the performance of a crop.

Table 4.16 Performance of various genotypes of ash gourd on days to 1st female flower.

	Days to first female flower appears		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	79.02	80.60	79.81
Kashi Surbhi	61.15	62.20	61.67
Kashi Ujjwal	64.41	65.30	64.86
Pusa Ujjwal	70.65	72.75	71.70
Pusa Sabji Petha	70.39	70.30	70.34
Pant Petha 1	73.64	73.60	73.62
KAG-1	68.54	68.53	68.54
KAU Local	80.72	77.53	79.13
PAG-3	67.29	65.60	66.44
CO-2	70.96	70.10	70.53
Shakti	75.78	75.20	75.49
Indu	65.98	67.30	66.64
Bhagyalaxmi	65.62	66.53	66.08
Bux-1	62.88	62.80	62.84
AS-1	60.79	60.20	60.50
AS-2	81.88	82.67	82.28
Manipur-1	84.41	80.40	82.41
Manipur-2	79.16	78.20	78.68
Manipur-3	71.42	72.40	71.91
Meghalaya-1	77.40	79.70	78.55
Meghalaya-2	81.25	81.20	81.22
Meghalaya-3	68.21	66.50	67.35
TAG-1	70.61	67.25	68.93
TAG-2	70.28	71.25	70.77
TAG-3	73.79	73.75	73.77
TAG-4	81.67	78.97	80.32
TAG-5	90.79	90.10	90.44
TAG-6	72.63	72.58	72.61
TAG-7	92.00	90.23	91.12
TAG-8	79.10	80.10	79.60
TAG-9	85.28	88.87	87.07
Pundibari Local-1	61.55	62.40	61.98
Pundibari Local-2	71.18	73.30	72.24
Panji Local	75.34	76.30	75.82
Basirhat	71.31	71.83	71.57
Nagaland Local -1	82.88	84.02	83.45
Nagaland Local -2	78.50	78.40	78.45
SEm(±)	0.97	1.16	0.82
CD	2.73	3.27	2.36
CV(%)	2.27	2.72	1.57

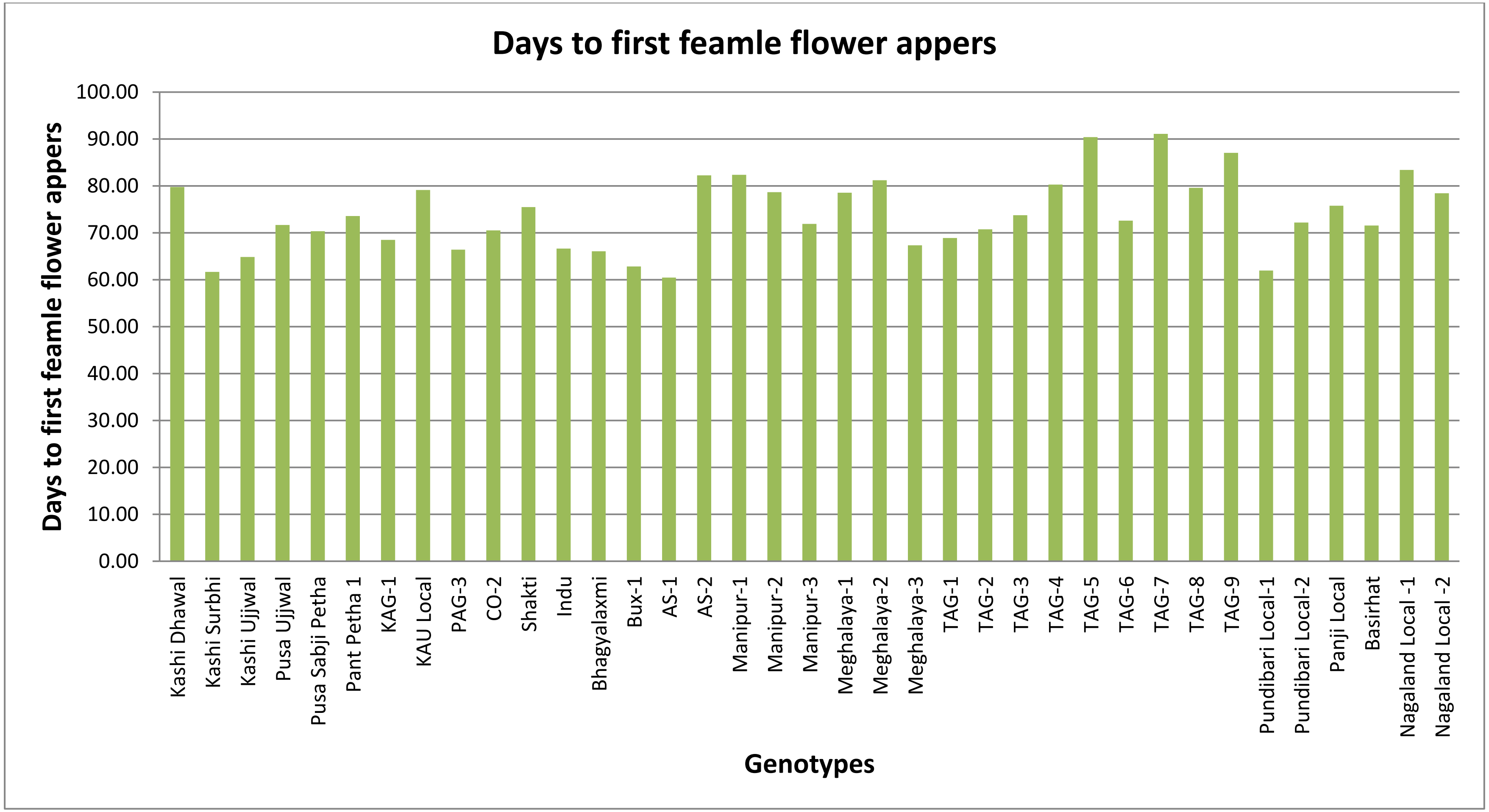

Fig 4.10 Performance of various genotypes of ash gourd on days to 1st female flower.

Table 4.17 Performance of various genotypes of ash gourd on nodes at which first female flower appears.

	Nodes at which first female flower appears		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	17.89	18.25	18.07
Kashi Surbhi	10.23	10.41	10.32
Kashi Ujjwal	17.95	18.20	18.08
Pusa Ujjwal	21.77	22.76	22.26
Pusa Sabji Petha	20.78	20.75	20.76
Pant Petha 1	15.81	15.80	15.80
KAG-1	12.96	12.83	12.89
KAU Local	20.55	19.57	20.06
PAG-3	11.99	11.69	11.84
CO-2	11.04	10.91	10.98
Shakti	13.35	13.25	13.30
Indu	18.60	18.97	18.78
Bhagyalaxmi	18.15	18.40	18.28
Bux-1	15.52	15.50	15.51
AS-1	9.29	9.20	9.25
AS-2	19.25	19.51	19.38
Manipur-1	30.66	29.20	29.93
Manipur-2	20.65	20.40	20.52
Manipur-3	22.00	22.30	22.15
Meghalaya-1	24.57	25.30	24.93
Meghalaya-2	29.82	29.80	29.81
Meghalaya-3	16.92	16.50	16.71
TAG-1	26.71	27.25	26.98
TAG-2	22.28	22.66	22.47
TAG-3	29.35	29.75	29.55
TAG-4	21.03	20.50	20.76
TAG-5	25.29	25.10	25.20
TAG-6	23.06	23.75	23.41
TAG-7	21.59	21.10	21.35
TAG-8	16.00	16.20	16.10
TAG-9	23.58	24.20	23.89
Pundibari Local-1	14.11	14.30	14.20
Pundibari Local-2	16.99	17.50	17.25
Panji Local	16.59	16.80	16.69
Basirhat	15.25	15.65	15.45
Nagaland Local -1	21.04	21.33	21.19
Nagaland Local -2	19.62	19.60	19.61
SEm(±)	0.39	0.40	0.24
CD	1.10	1.12	0.67
CV(%)	3.51	3.57	1.72

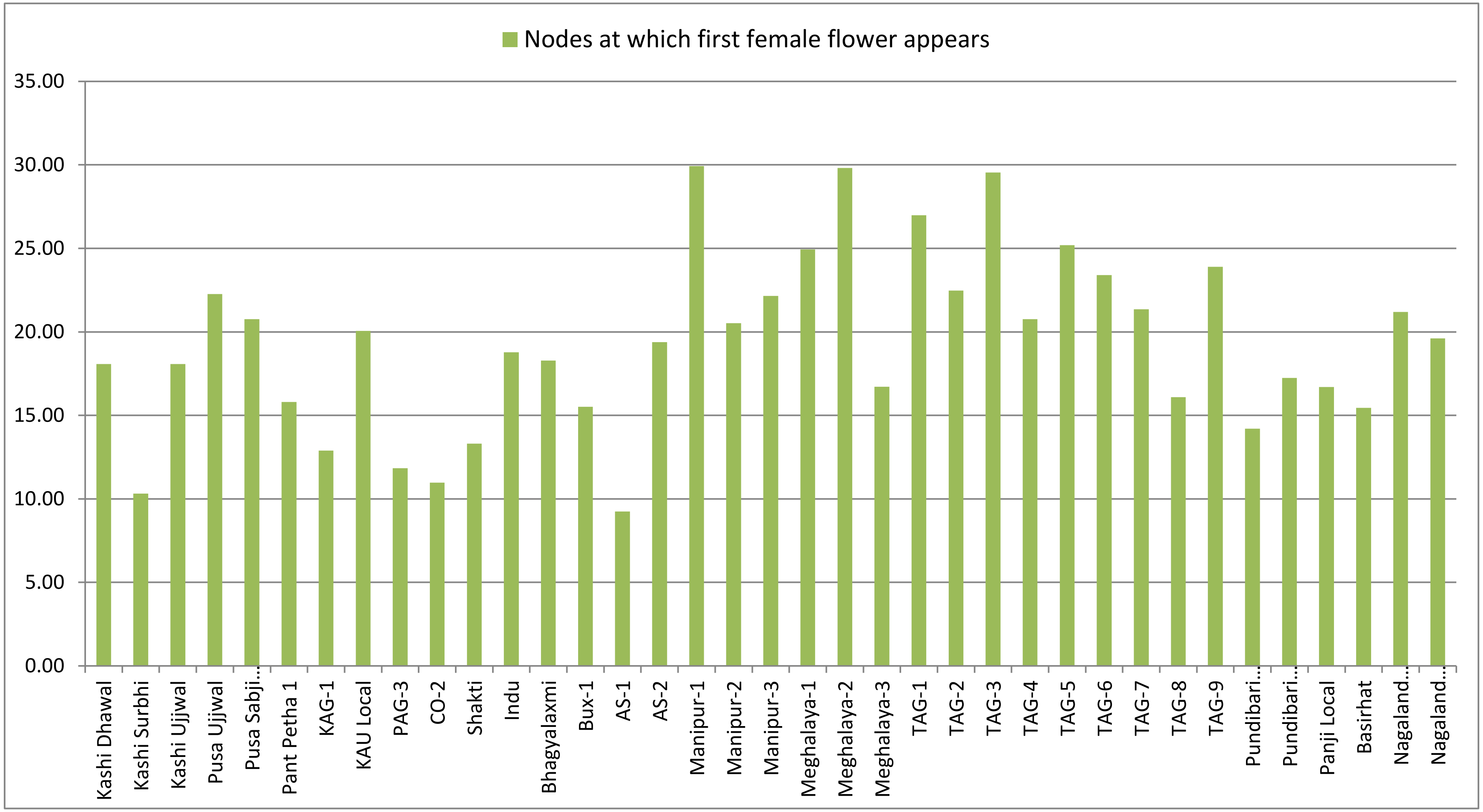

Fig 4.11 Performance of various genotypes of ash gourd on nodes at which first female flower appears.

Table 4.18 Performance of various genotypes of ash gourd on sex expression & male sterility.

Genotypes	Sex expression	Male sterilty
Kashi Dhawal	Monoecious	Absent
Kashi Surbhi	Monoecious	Absent
Kashi Ujjwal	Monoecious	Absent
Pusa Ujjwal	Monoecious	Absent
Pusa Sabji Petha	Monoecious	Absent
Pant Petha 1	Monoecious	Absent
KAG-1	Monoecious	Absent
KAU Local	Monoecious	Absent
PAG-3	Monoecious	Absent
CO-2	Monoecious	Absent
Shakti	Monoecious	Absent
Indu	Monoecious	Absent
Bhagyalaxmi	Monoecious	Absent
Bux-1	Monoecious	Absent
AS-1	Monoecious	Absent
AS-2	Monoecious	Absent
Manipur-1	Monoecious	Absent
Manipur-2	Monoecious	Absent
Manipur-3	Monoecious	Absent
Meghalaya-1	Monoecious	Absent
Meghalaya-2	Monoecious	Absent
Meghalaya-3	Monoecious	Absent
TAG-1	Monoecious	Absent
TAG-2	Monoecious	Absent
TAG-3	Monoecious	Absent
TAG-4	Monoecious	Absent
TAG-5	Monoecious	Absent
TAG-6	Monoecious	Absent
TAG-7	Monoecious	Absent
TAG-8	Monoecious	Absent
TAG-9	Monoecious	Absent
Pundibari Local-1	Monoecious	Absent
Pundibari Local-2	Monoecious	Absent
Panji Local	Monoecious	Absent
Basirhat	Monoecious	Absent
Nagaland Local -1	Monoecious	Absent
Nagaland Local -2	Monoecious	Absent

Table 4.19 Performance of various genotypes of ash gourd on ovary length.

	Ovary length (cm)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	2.66	2.76	2.71
Kashi Surbhi	2.36	2.44	2.40
Kashi Ujjwal	2.80	2.87	2.84
Pusa Ujjwal	2.52	2.67	2.59
Pusa Sabji Petha	3.09	3.02	3.05
Pant Petha 1	2.76	2.71	2.73
KAG-1	2.78	2.73	2.76
KAU Local	3.81	3.45	3.63
PAG-3	3.47	3.30	3.38
CO-2	3.33	3.25	3.29
Shakti	3.03	2.98	3.00
Indu	3.04	2.76	2.90
Bhagyalaxmi	3.14	2.98	3.06
Bux-1	3.54	3.46	3.50
AS-1	4.62	4.53	4.58
AS-2	2.45	2.33	2.39
Manipur-1	2.14	2.10	2.12
Manipur-2	3.17	3.09	3.13
Manipur-3	3.15	3.00	3.08
Meghalaya-1	3.09	3.17	3.13
Meghalaya-2	2.59	2.68	2.63
Meghalaya-3	2.78	2.89	2.83
TAG-1	2.28	2.30	2.29
TAG-2	2.89	2.91	2.90
TAG-3	2.65	2.59	2.62
TAG-4	2.27	2.22	2.25
TAG-5	3.15	3.10	3.12
TAG-6	3.10	2.95	3.02
TAG-7	3.16	3.34	3.25
TAG-8	3.68	3.33	3.50
TAG-9	4.02	3.63	3.83
Pundibari Local-1	2.56	2.47	2.52
Pundibari Local-2	2.71	2.65	2.68
Panji Local	2.69	2.63	2.66
Basirhat	3.05	2.99	3.02
Nagaland Local -1	2.52	2.48	2.50
Nagaland Local -2	2.93	2.87	2.90
SEm(±)	0.14	0.12	0.07
CD	0.38	0.35	0.19
CV(%)	7.91	7.42	3.20

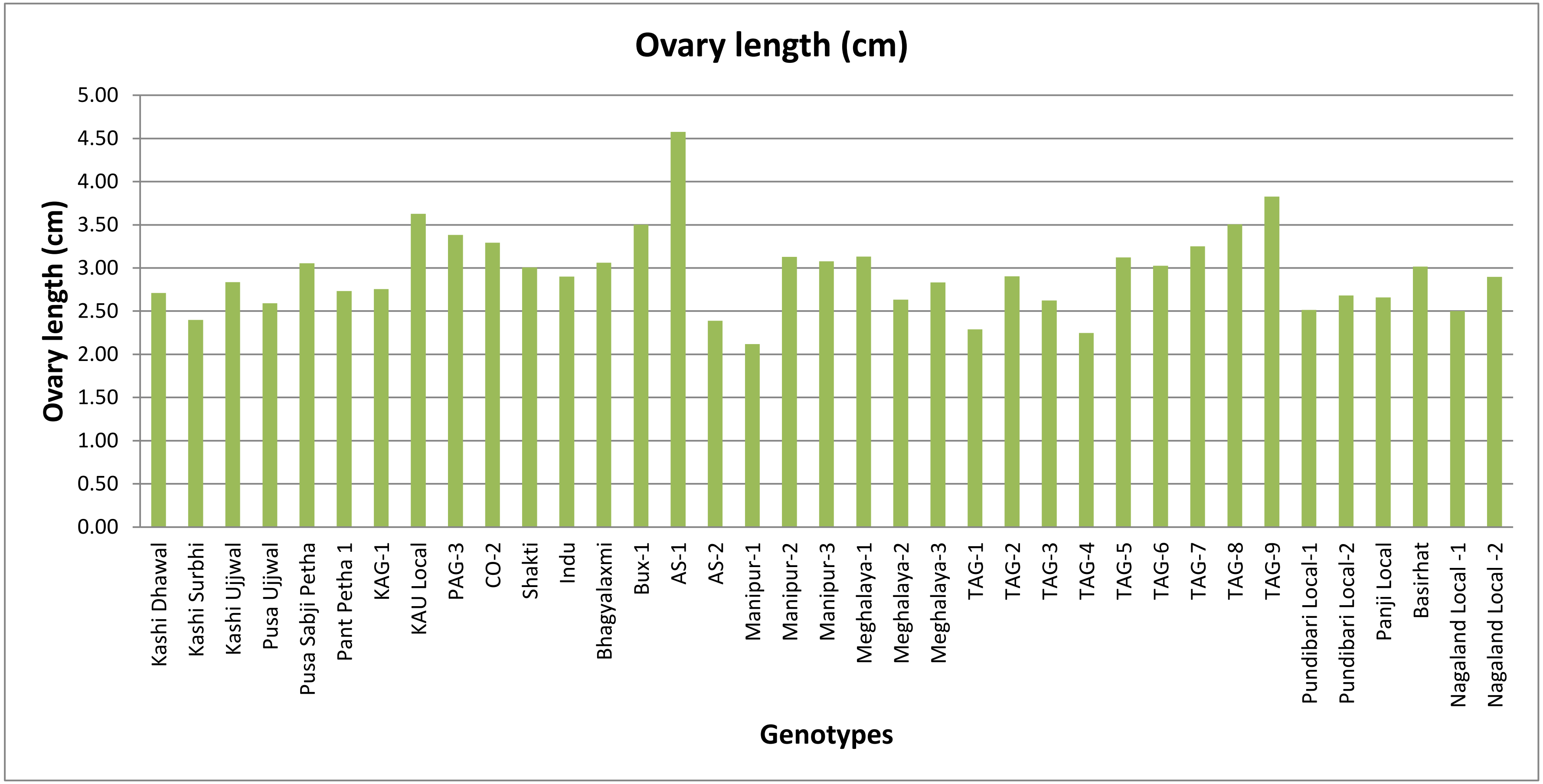

Fig 4.12 Performance of various genotypes of ash gourd on ovary length.

4.1.23 Peduncle length (cm)

The observation on peduncle length was recorded as shown in table 4.20 and fig 4.13. Peduncle length of thirty seven ash gourd genotypes was recorded using Vernier calliper when fruit attain marketable maturity. The maximum peduncle length was recorded from Bux-1 (9.37 cm) while Kashi Dhawal (9.20 cm) was found at par with Bux-1 and minimum (3.30 cm) was recorded from Meghalaya-2 while TAG-6 (3.44 cm) was found at par with Meghalaya -2.

4.1.24 Peduncle shape

Peduncle shape of thirty seven ash gourd genotypes were visually recorded when fruit attains marketable maturity. It is found that in all the genotypes peduncle were found round in shape as shown in table 4.21.

4.1.25 Fruit length (cm)

Fruit length of thirty seven ash gourd genotypes were recorded using Vernier calliper when fruit attain marketable maturity. The fruit cut into two halves and length were measured using measuring scale. The maximum fruit length was recorded from Kashi Dhawal (31.99 cm) while Indu (31.63 cm) was found at par with Kashi Dhawal and minimum was recoded from for Bux-1 (13.65 cm). The data on fruit length was recorded as shown in table 4.22 and fig 4.14. Significant variation in fruit length of pumpkin genotypes was also recorded in Balkaya *et al*. (2010).

4.1.26 Fruit diameter (cm)

Fruit diameter of thirty seven ash gourd genotypes were recorded using Vernier calliper when fruit attain marketable maturity. The fruit cut into two halves and diameter were measured using measuring scale. The maximum fruit diameter was recorded from Indu (36.15 cm) and minimum was recoded from for TAG-8 (8.63 cm) was found at par with TAG-7 (8.63 cm).

Table 4.20 Performance of various genotypes of ash gourd on peduncle length.

	Peduncle length (cm)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	8.93	9.47	9.20
Kashi Surbhi	6.41	6.79	6.60
Kashi Ujjwal	3.73	3.87	3.80
Pusa Ujjwal	7.16	7.44	7.30
Pusa Sabji Petha	8.26	8.54	8.40
Pant Petha 1	8.26	8.54	8.40
KAG-1	4.64	4.76	4.70
KAU Local	4.04	4.15	4.10
PAG-3	4.03	3.94	3.98
CO-2	8.16	8.04	8.10
Shakti	7.15	7.04	7.10
Indu	7.46	7.34	7.40
Bhagyalaxmi	6.77	6.63	6.70
Bux-1	9.30	9.43	9.37
AS-1	6.97	6.83	6.90
AS-2	9.03	8.57	8.80
Manipur-1	5.96	5.84	5.90
Manipur-2	7.57	7.43	7.50
Manipur-3	7.68	7.53	7.60
Meghalaya-1	5.47	5.33	5.40
Meghalaya-2	3.34	3.26	3.30
Meghalaya-3	4.56	4.45	4.50
TAG-1	7.25	7.39	7.32
TAG-2	7.25	7.37	7.31
TAG-3	5.60	5.68	5.64
TAG-4	7.87	7.12	7.50
TAG-5	8.50	7.69	8.10
TAG-6	3.39	3.49	3.44
TAG-7	3.85	3.76	3.80
TAG-8	5.67	5.53	5.60
TAG-9	7.69	7.51	7.60
Pundibari Local-1	6.97	6.62	6.80
Pundibari Local-2	7.39	7.02	7.20
Panji Local	6.56	6.23	6.40
Basirhat	6.36	6.04	6.20
Nagaland Local -1	6.09	5.51	5.80
Nagaland Local -2	6.82	6.18	6.50
SEm(±)	0.20	0.21	0.15
CD	0.57	0.58	0.43
CV(%)	5.40	5.57	3.30

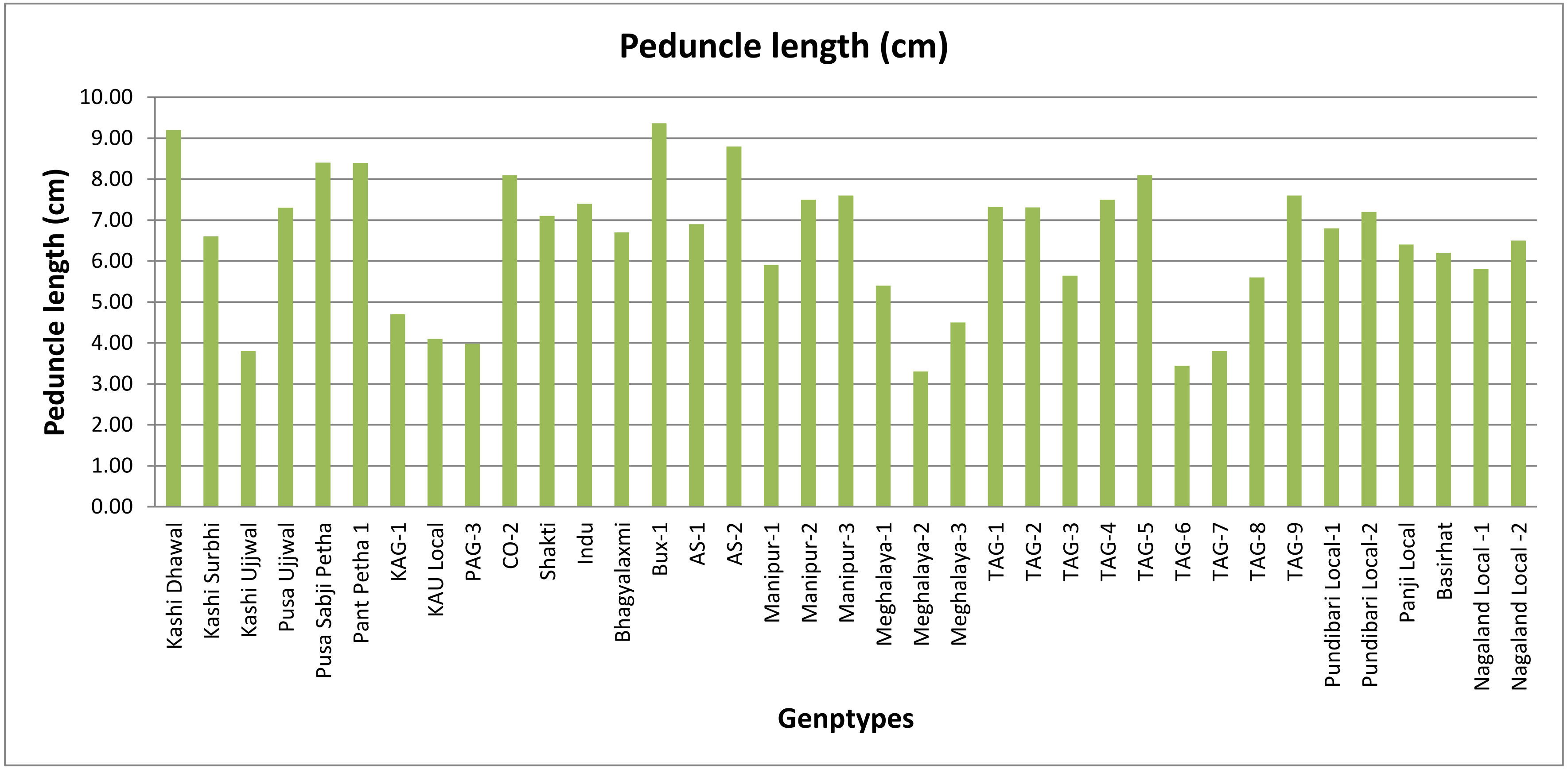

Fig 4.13 Performance of various genotypes of ash gourd on peduncle length.

Table 4.21 Performance of various genotypes of ash gourd on peduncle shape.

Genotypes	Peduncle shape
Kashi Dhawal	Round
Kashi Surbhi	Round
Kashi Ujjwal	Round
Pusa Ujjwal	Round
Pusa Sabji Petha	Round
Pant Petha 1	Round
KAG-1	Round
KAU Local	Round
PAG-3	Round
CO-2	Round
Shakti	Round
Indu	Round
Bhagyalaxmi	Round
Bux-1	Round
AS-1	Round
AS-2	Round
Manipur-1	Round
Manipur-2	Round
Manipur-3	Round
Meghalaya-1	Round
Meghalaya-2	Round
Meghalaya-3	Round
TAG-1	Round
TAG-2	Round
TAG-3	Round
TAG-4	Round
TAG-5	Round
TAG-6	Round
TAG-7	Round
TAG-8	Round
TAG-9	Round
Pundibari Local-1	Round
Pundibari Local-2	Round
Panji Local	Round
Basirhat	Round
Nagaland Local -1	Round
Nagaland Local -2	Round

Table 4.22 Performance of various genotypes of ash gourd on fruit length.

	Fruit length (cm)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	32.24	31.75	31.99
Kashi Surbhi	25.39	25.01	25.20
Kashi Ujjwal	25.73	27.27	26.50
Pusa Ujjwal	23.88	23.52	23.70
Pusa Sabji Petha	24.08	23.72	23.90
Pant Petha 1	20.96	21.54	21.25
KAG-1	25.84	26.55	26.20
KAU Local	17.75	18.35	18.05
PAG-3	25.07	25.93	25.50
CO-2	23.82	24.78	24.30
Shakti	24.73	25.73	25.23
Indu	31.86	31.41	31.63
Bhagyalaxmi	26.86	26.34	26.60
Bux-1	13.78	13.51	13.65
AS-1	21.46	22.74	22.10
AS-2	19.59	19.12	19.35
Manipur-1	20.75	20.25	20.50
Manipur-2	21.91	21.48	21.70
Manipur-3	19.92	19.54	19.73
Meghalaya-1	28.88	28.32	28.60
Meghalaya-2	24.95	24.35	24.65
Meghalaya-3	23.64	23.07	23.35
TAG-1	18.23	18.50	18.37
TAG-2	25.55	25.05	25.30
TAG-3	25.13	24.58	24.86
TAG-4	29.93	28.43	29.18
TAG-5	30.77	29.23	30.00
TAG-6	28.53	28.53	28.53
TAG-7	25.54	24.26	24.90
TAG-8	30.92	29.69	30.30
TAG-9	15.28	14.91	15.10
Pundibari Local-1	21.95	20.85	21.40
Pundibari Local-2	25.03	23.78	24.40
Panji Local	16.59	15.01	15.80
Basirhat	20.61	18.65	19.63
Nagaland Local -1	22.30	20.18	21.24
Nagaland Local -2	23.31	21.09	22.20
SEm(±)	0.53	0.47	0.47
CD	1.49	1.31	1.33
CV(%)	3.76	3.37	2.72

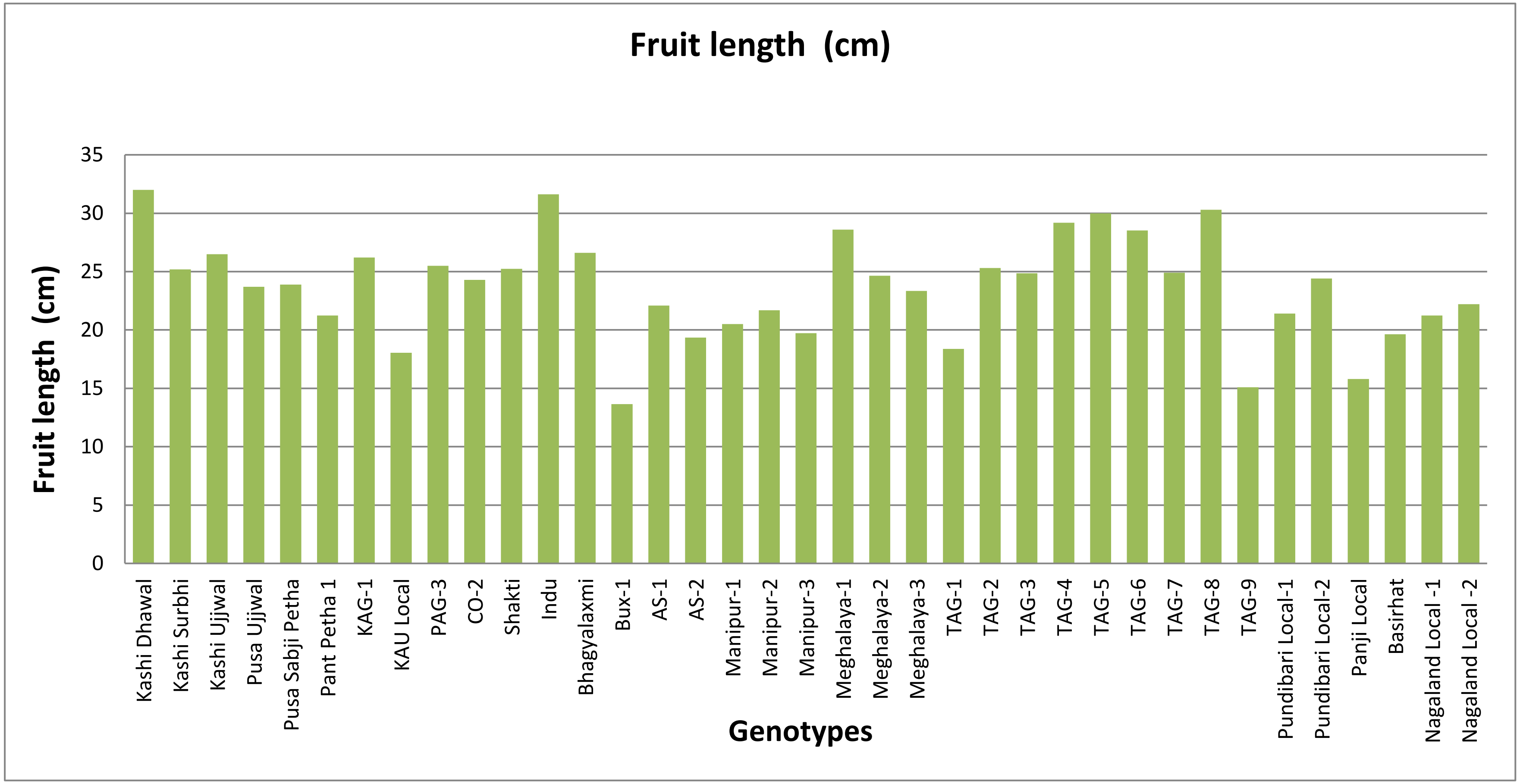

Fig 4.14 Performance of various genotypes of ash gourd on fruit length.

Table 4.23: Performance of various genotypes of ash gourd on fruit diameter.

	Fruit diameter (cm)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	18.61	19.72	19.17
Kashi Surbhi	18.06	19.14	18.60
Kashi Ujjwal	19.61	20.39	20.00
Pusa Ujjwal	15.20	15.81	15.50
Pusa Sabji Petha	17.06	17.65	17.35
Pant Petha 1	19.61	20.28	19.95
KAG-1	18.59	19.10	18.85
KAU Local	11.03	11.33	11.18
PAG-3	19.25	18.95	19.10
CO-2	17.94	17.66	17.80
Shakti	18.68	18.39	18.53
Indu	35.96	36.33	36.15
Bhagyalaxmi	19.44	19.06	19.25
Bux-1	11.77	11.53	11.65
AS-1	16.16	15.84	16.00
AS-2	14.77	14.03	14.40
Manipur-1	15.65	15.35	15.50
Manipur-2	15.55	15.25	15.40
Manipur-3	16.16	15.84	16.00
Meghalaya-1	14.78	14.42	14.60
Meghalaya-2	15.54	15.16	15.35
Meghalaya-3	13.77	13.43	13.60
TAG-1	34.69	35.00	34.85
TAG-2	18.04	17.77	17.90
TAG-3	33.26	32.50	32.88
TAG-4	20.20	18.31	19.26
TAG-5	19.69	17.81	18.75
TAG-6	29.82	27.50	28.66
TAG-7	8.91	8.69	8.80
TAG-8	8.76	8.51	8.63
TAG-9	11.94	11.65	11.80
Pundibari Local-1	14.72	13.98	14.35
Pundibari Local-2	17.23	16.37	16.80
Panji Local	12.00	11.40	11.70
Basirhat	13.27	12.60	12.93
Nagaland Local -1	14.16	12.82	13.49
Nagaland Local -2	15.17	13.73	14.45
SEm(±)	0.37	0.37	0.39
CD	1.04	1.03	1.12
CV(%)	3.40	3.45	2.97

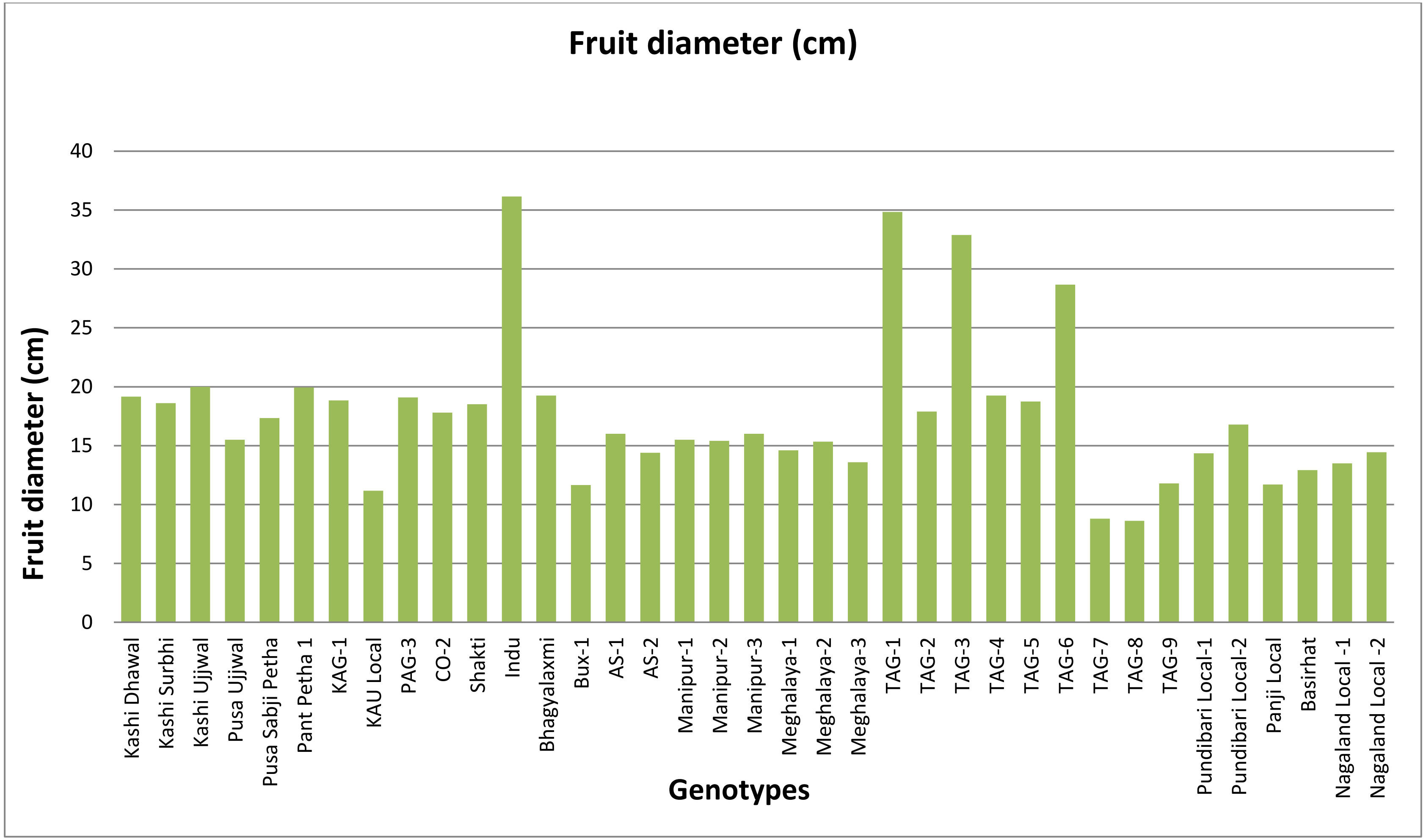

Fig 4.15 Performance of various genotypes of ash gourd on fruit diameter.

The data on fruit diameter was recorded as shown in table 4.23 and fig 4.15. In line with present findings Pandey and Singh (2007) also reported profound variation for the character in sponge guord, respectively.

4.1.27 Flesh thickness (cm)

The data on flesh thickness was recorded as shown in table 4.24 and fig 4.16. Flesh thickness of thirty seven ash gourd genotypes were recorded using measuring scale when fruit attain marketable maturity. The fruit cut into two halves and flesh thickness was measured by measuring scale. The maximum flesh thickness was recorded from Pusa Ujjawal (5.50 cm) and minimum was recoded from for Meghalaya-1 (2.80 cm) was found at par with Nagaland Local-2 (2.89 cm). In line with present findings Singhal *et al.* (2010) also reported profound variation for the character in ash gourd.

4.1.28 Fruit shape

The observations related to fruit shape of ash gourd genotypes have been presented in table 4.25. In the study various fruit shapes specifically oblong, round, cylindrical and pyriform shape have been recorded. Among the ash gourd fruit shapes oblong shape was recorded for twenty two genotypes but round and cylindrical was found shape was observed in three each. Among the genotypes, round shape was found in Kashi Ujjwal, PAG-3 and Indu while cylinderical was found in AS-1, TAG-7 and TAG-8 wheareas pyriform was observed in Meghalaya-1, Meghalaya-2, Meghalaya-3, TAG-9, Pundibari Local-1, Pundibari Local-2, Basirhat and Nagaland Local-2 and rest twenty two showed oblong shape. These findings exhibit the variability in agreement to the findings of Gangopadhyay *et al*. (2008) in ash gourd genotypes.

4.1.29 Fruit skin color

The observations related to fruit skin color of ash gourd genotypes have been presented in table 4.25. The ash gourd genotypes recorded three kinds of fruit skin colour namely, light green, medium green and dark green. Most of the genotypes (17) expressed light green and medium green (17) while dark green (2). These findings exhibit the variability in agreement to the findings of Gangopadhyay *et al*. (2008) in ash gourd genotypes.

4.1.30 Fruit shape at blossom end

The observations related to fruit shape at blossom end of ash gourd genotypes was presented in table 4.25. The ash gourd genotypes recorded four kinds of fruit shape at blossom end namely, flat, slightly depressed, moderately depressed and raised. The number of genotypes expressed flat shape (5), slightly depressed (18), moderately depressed (9) and raised (5). Kashi Ujjawal, KAU local, Meghalaya-1, TAG-3 and Nagaland Local-1 shown flat blossom end. AS-2, Manipur-3, Meghalaya-2, Meghalaya-3, TAG-9, Pundibari Local-1, Pundibari Local-2, Pnaji Local and Basirhat shown moderately depressed blossom end. AS-1, Manipur-1 Manipur-2, TAG-7 and TAG-8 shown raised blossom end. Apart of these genotypes, rest shown slightly depressed blossom end. These findings exhibit the variability in agreement to the findings of Gangopadhyay *et al*. (2008) in ash gourd genotypes.

4.1.31 Fruit shape at peduncle end

The observations related to fruit shape at peduncle end of ash gourd genotypes was presented in table 4.25. The ash gourd genotypes recorded five kinds of fruit shape at blossom end namely, flat, slightly depressed, moderately depressed, depressed and raised. The number of genotypes expressed expressed flat shape (2), slightly depressed (7), moderately depressed (5), depressed (13) and raised (10). Pundibari Local-1 and Pundibari Local-2 have shown flat shape peduncle end. Kashi Ujjwal, Pusa Ujjwal, Bux-1, KAU Local, PAG-3, CO-2 and Shakti had shown slightly depressed peduncle shape. Manipur-1, Manipur-2, TAG-3, Panji Local and Nagaland Local -1 shown moderately depressed peduncle shape. Meghalaya-1, Meghalaya-2, Meghalaya-3, TAG-6, TAG-7, TAG-8, TAG-9, Basirhat and Nagaland Local -2 had shown raised

Table 4.24 Performance of various genotypes of ash gourd on flesh thickness.

	Flesh thickness (cm)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	4.92	5.10	5.01
Kashi Surbhi	3.93	4.07	4.00
Kashi Ujjwal	4.84	5.16	5.00
Pusa Ujjwal	5.34	5.66	5.50
Pusa Sabji Petha	4.05	3.95	4.00
Pant Petha 1	3.28	3.22	3.25
KAG-1	3.94	3.86	3.90
KAU Local	5.04	4.56	4.80
PAG-3	5.13	4.87	5.00
CO-2	3.49	3.41	3.45
Shakti	3.96	3.90	3.93
Indu	5.25	4.75	5.00
Bhagyalaxmi	4.62	4.38	4.50
Bux-1	3.19	3.11	3.15
AS-1	3.53	3.47	3.50
AS-2	3.73	3.67	3.70
Manipur-1	3.64	3.56	3.60
Manipur-2	3.87	3.67	3.77
Manipur-3	3.65	3.75	3.70
Meghalaya-1	2.75	2.85	2.80
Meghalaya-2	3.04	3.16	3.10
Meghalaya-3	3.11	3.29	3.20
TAG-1	3.67	3.33	3.50
TAG-2	3.25	2.94	3.10
TAG-3	3.13	2.97	3.05
TAG-4	4.10	3.90	4.00
TAG-5	3.64	3.56	3.60
TAG-6	3.14	3.06	3.10
TAG-7	3.89	3.81	3.85
TAG-8	4.55	4.45	4.50
TAG-9	4.94	4.86	4.90
Pundibari Local-1	4.23	4.17	4.20
Pundibari Local-2	3.13	3.07	3.10
Panji Local	3.54	3.57	3.56
Basirhat	3.72	3.74	3.73
Nagaland Local -1	3.93	3.84	3.89
Nagaland Local -2	2.96	2.82	2.89
SEm(±)	0.17	0.15	0.09
CD	0.48	0.44	0.25
CV(%)	7.51	7.02	3.18

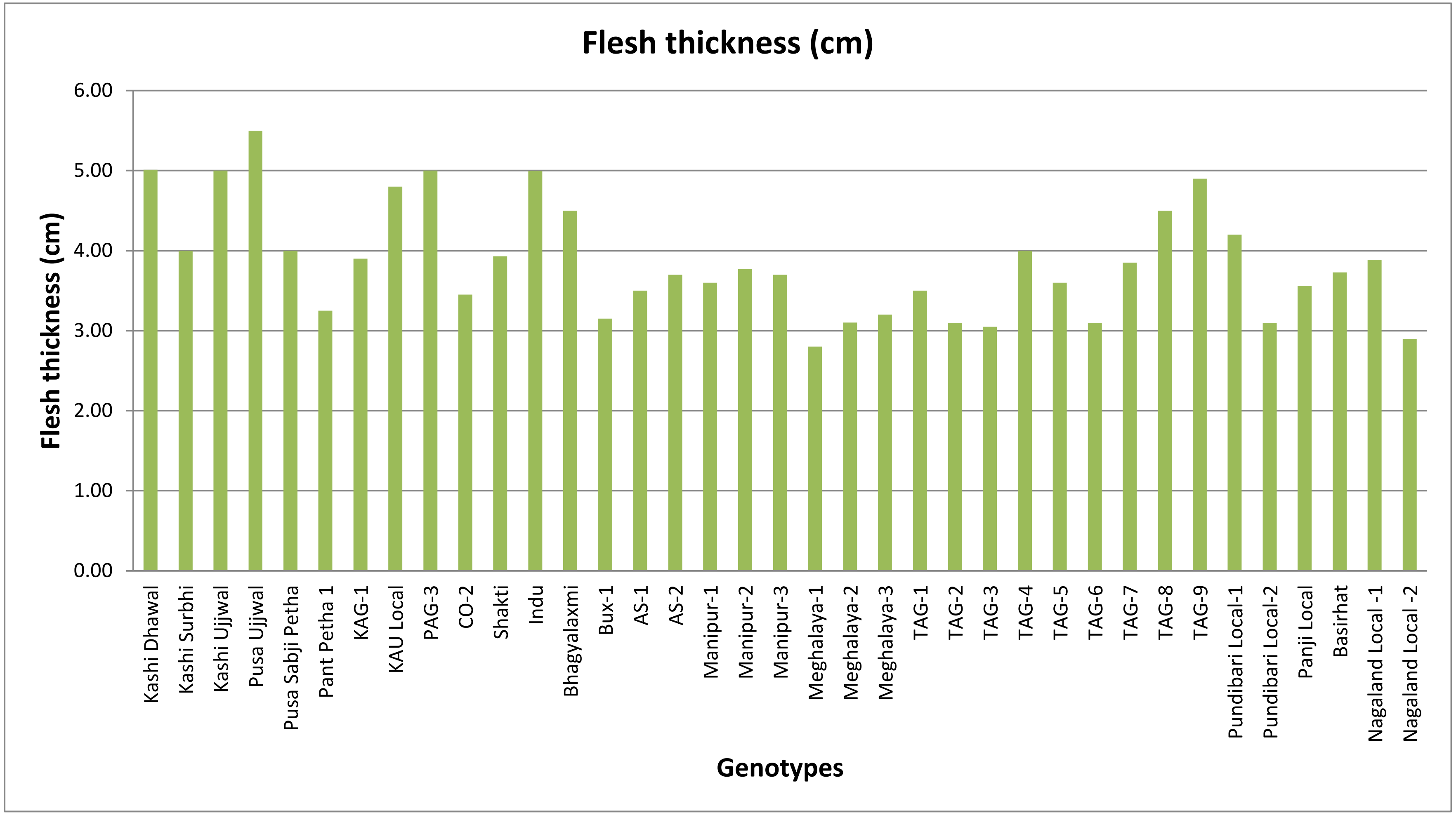

Fig 4.16 Performance of various genotypes of ash gourd on flesh thickness.

Table 4.25 Performance of various genotypes of ash gourd on fruit shape, fruit skin color, fruit shape at blossom end and fruit shape at peduncle end.

Genotypes	Fruit shape	Fruit color of skin	Fruit shape at blossom end	Fruit shape at peduncle end
Kashi Dhawal	Oblong	Light green	Slightly depressed	Depressed
Kashi Surbhi	Oblong	Light green	Slightly depressed	Depressed
Kashi Ujjwal	Round	Light green	Flat	Slightly depressed
Pusa Ujjwal	Oblong	Light green	Slightly depressed	Slightly depressed
Pusa Sabji Petha	Oblong	Medium green	Slightly depressed	Depressed
Pant Petha 1	Oblong	Light green	Slightly depressed	Depressed
KAG-1	Oblong	Light green	Slightly depressed	Depressed
KAU Local	Oblong	Medium green	Flat	Slightly depressed
PAG-3	Round	Medium green	Slightly depressed	Slightly depressed
CO-2	Oblong	Medium green	Slightly depressed	Slightly depressed
Shakti	Oblong	Light green	Slightly depressed	Slightly depressed
Indu	Round	Dark green	Slightly depressed	Depressed
Bhagyalaxmi	Oblong	Medium green	Slightly depressed	Depressed
Bux-1	Oblong	Medium green	Slightly depressed	Slightly depressed
AS-1	Cylindrical	Light green	Raised	Raised
AS-2	Oblong	Medium green	Moderate depressed	Depressed
Manipur-1	Oblong	Medium green	Raised	Moderate depressed
Manipur-2	Oblong	Medium green	Raised	Moderate depressed
Manipur-3	Oblong	Medium green	Moderate depressed	Depressed
Meghalaya-1	Pear	Medium green	Flat	Raised
Meghalaya-2	Pear	Medium green	Moderate depressed	Raised
Meghalaya-3	Pear	Medium green	Moderate depressed	Raised
TAG-1	Oblong	Light green	Slightly depressed	Depressed
TAG-2	Oblong	Light green	Slightly depressed	Depressed
TAG-3	Oblong	Dark green	Flat	Moderate depressed
TAG-4	Oblong	Light green	Slightly depressed	Depressed
TAG-5	Oblong	Light green	Slightly depressed	Depressed
TAG-6	Pear	Light green	Slightly depressed	Raised
TAG-7	Cylindrical	Medium green	Raised	Raised
TAG-8	Cylindrical	Light green	Raised	Raised
TAG-9	Pear	Light green	Moderate depressed	Raised
Pundibari Local-1	Pear	Medium green	Moderate depressed	Flat
Pundibari Local-2	Pear	Medium green	Moderate depressed	Flat
Panji Local	Oblong	Medium green	Moderate depressed	Moderate depressed
Basirhat	Pear	Light green	Moderate depressed	Raised
Nagaland Local -1	Oblong	Dark green	Flat	Moderate depressed
Nagaland Local -2	Pear	Light green	Slightly depressed	Raised

peduncle shape while rest genotypes had shown depressed peduncle shape. These findings exhibit the variability in agreement to the findings of Gangopadhyay *et al*. (2008) in ash gourd genotypes.

4.1.32 Fruit pubescence

The observations for fruit pubescence recorded visually when fruit attain marketable maturity have been presented in table 4.26. It was found that the fruit pubescence was present on the surface of each and every genotype. This may be due to the presence of common gene present ash gourd.

4.1.33 Fruit groves

The observations for fruit groves recorded visually when fruit attain seed harvest maturity have been presented in table 4.26. It was found that among thirty seven genotypes of ash gourd the fruit groves were absent on the surface of genotype Kashi Dhawal, Kashi Surbhi, Pusa Ujjwal, Pusa Sabji Petha, Pant Petha 1, KAG-1, KAU Local, PAG-3, CO-2, Shakti, Indu, AS-1, Manipur-1, Manipur-2, Meghalaya-1, TAG-3, TAG-7, TAG-8, Pundibari Local-2 and Nagaland Local -1 and present on rest of the ash gourd genotypes. This may be due to the presence of different genes present in different ash gourd genotypes.

4.1.34 Fruit marbling

The observations for fruit marbling recorded visually when fruit attain marketable maturity have been presented in table 4.26. It was found that the fruit marbling was absent on the surface of each and every genotype. This may be due to the presence of common gene present ash gourd.

4.1.35 Fruit waxiness

The observations for fruit groves recorded visually when fruit attain seed harvest maturity have been presented in table 4.26. It was found that the fruit wax was present on the surface of each and every genotype. This may be due to the presence of common gene present ash gourd.

4.1.36 Flesh texture

The observations for fruit texture recorded when fruit attain marketable maturity have been presented in Table 4.26. The data on flesh texture depicted spongy type in Meghalaya-2 and Panji Local. Medium hard type flesh texture was observed in Kashi Dhawal, Kashi Surbhi, Pusa Ujjwal, Pusa Sabji Petha, Pant Petha 1, KAG-1, KAU Local, PAG-3, CO-2, Shakti, Bhagyalaxmi, Bux-1, AS-1, Manipur-1, Manipur-2, Manipur-3, Meghalaya-1, Meghalaya-3, TAG-7 and TAG-9 while rest of the genotypes shown hard type flesh texture.

4.1.37 Seediness

The data pertaining to seediness of ash gourd genotypes for the year 2018-19 and 2019-20 is presented in table 4.27 and fig 4.17. The pooled result revealed significant variation for seed per fruit which was ranged from 316.21 seeds to 1478.23 seeds. The data for seediness was recorded at seed harvest maturity by counting the number of seed for five fruits and taken the mean as observation. It can be noticed that there were wide variation in the seediness and the maximum seediness (1478.23) was found in Shakti while minimum seediness (316.21) was found in Indu. In line with the present findings Kumaran *et al.* (2000) and Selvi *et al.* (2012) also reported profound variation for the characters in pumpkin genotypes.

4.1.38 Seed length (cm)

The observation was recorded for seed length at seed harvest maturity by using Vernier caliper. The data pertaining to seed length of ash gourd genotypes pooled data has been presented in table 4.28 and fig 4.18. The pooled result revealed significant variation for seed length

Table 4.26 Performance of various genotypes of ash gourds on fruit pubescence, fruit groves, fruit marbling, fruit waxiness and flesh texture.

Genotypes	Fruit pubescence	Fruit grooves	Fruit marbling	Fruit waxiness	Flesh texture
Kashi Dhawal	Present	Absent	Absent	Present	Medium hard
Kashi Surbhi	Present	Absent	Absent	Present	Medium hard
Kashi Ujjwal	Present	Present	Absent	Present	Hard
Pusa Ujjwal	Present	Absent	Absent	Present	Medium hard
Pusa Sabji Petha	Present	Absent	Absent	Present	Medium hard
Pant Petha 1	Present	Absent	Absent	Present	Medium hard
KAG-1	Present	Absent	Absent	Present	Medium hard
KAU Local	Present	Absent	Absent	Present	Medium hard
PAG-3	Present	Absent	Absent	Present	Medium hard
CO-2	Present	Absent	Absent	Present	Medium hard
Shakti	Present	Absent	Absent	Present	Medium hard
Indu	Present	Absent	Absent	Present	Hard
Bhagyalaxmi	Present	Present	Absent	Present	Medium hard
Bux-1	Present	Present	Absent	Present	Medium hard
AS-1	Present	Absent	Absent	Present	Medium hard
AS-2	Present	Present	Absent	Present	Hard
Manipur-1	Present	Absent	Absent	Present	Medium hard
Manipur-2	Present	Absent	Absent	Present	Medium hard
Manipur-3	Present	Present	Absent	Present	Medium hard
Meghalaya-1	Present	Absent	Absent	Present	Medium hard
Meghalaya-2	Present	Present	Absent	Present	Spongy
Meghalaya-3	Present	Present	Absent	Present	Medium hard
TAG-1	Present	Present	Absent	Present	Hard
TAG-2	Present	Present	Absent	Present	Hard
TAG-3	Present	Absent	Absent	Present	Hard
TAG-4	Present	Present	Absent	Present	Hard
TAG-5	Present	Present	Absent	Present	Hard
TAG-6	Present	Present	Absent	Present	Hard
TAG-7	Present	Absent	Absent	Present	Medium hard
TAG-8	Present	Absent	Absent	Present	Hard
TAG-9	Present	Present	Absent	Present	Medium hard
Pundibari Local-1	Present	Present	Absent	Present	Hard
Pundibari Local-2	Present	Absent	Absent	Present	Hard
Panji Local	Present	Present	Absent	Present	Spongy
Basirhat	Present	Present	Absent	Present	Hard
Nagaland Local -1	Present	Absent	Absent	Present	Hard
Nagaland Local -2	Present	Present	Absent	Present	Hard

Table 4.27 Performance of various genotypes of ash gourd on seediness.

	Seediness		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	503.35	533.29	518.32
Kashi Surbhi	369.60	391.58	380.59
Kashi Ujjwal	603.17	627.35	615.26
Pusa Ujjwal	1372.82	1427.87	1400.35
Pusa Sabji Petha	1127.14	1165.86	1146.50
Pant Petha 1	1242.57	1285.27	1263.92
KAG-1	820.22	842.78	831.50
KAU Local	574.64	590.44	582.54
PAG-3	432.40	425.84	429.12
CO-2	822.11	809.63	815.87
Shakti	1489.54	1466.92	1478.23
Indu	318.63	313.79	316.21
Bhagyalaxmi	1484.08	1455.05	1469.57
Bux-1	438.24	429.67	433.95
AS-1	497.52	487.78	492.65
AS-2	552.47	524.79	538.63
Manipur-1	531.68	521.28	526.48
Manipur-2	1366.01	1339.29	1352.65
Manipur-3	1139.59	1117.30	1128.45
Meghalaya-1	634.32	618.98	626.65
Meghalaya-2	427.00	416.68	421.84
Meghalaya-3	535.22	522.28	528.75
TAG-1	605.22	610.59	607.90
TAG-2	398.17	400.80	399.48
TAG-3	561.16	548.36	554.76
TAG-4	874.12	791.00	832.56
TAG-5	860.85	778.99	819.92
TAG-6	871.89	831.35	851.62
TAG-7	830.60	810.52	820.56
TAG-8	846.87	826.40	836.64
TAG-9	825.51	805.55	815.53
Pundibari Local-1	812.10	771.40	791.75
Pundibari Local-2	408.06	387.62	397.84
Panji Local	447.44	425.02	436.23
Basirhat	443.57	421.35	432.46
Nagaland Local -1	626.02	566.48	596.25
Nagaland Local -2	491.96	445.18	468.57
SEm(±)	18.39	18.53	15.23
CD	51.75	52.15	43.67
CV(%)	4.33	4.44	2.96

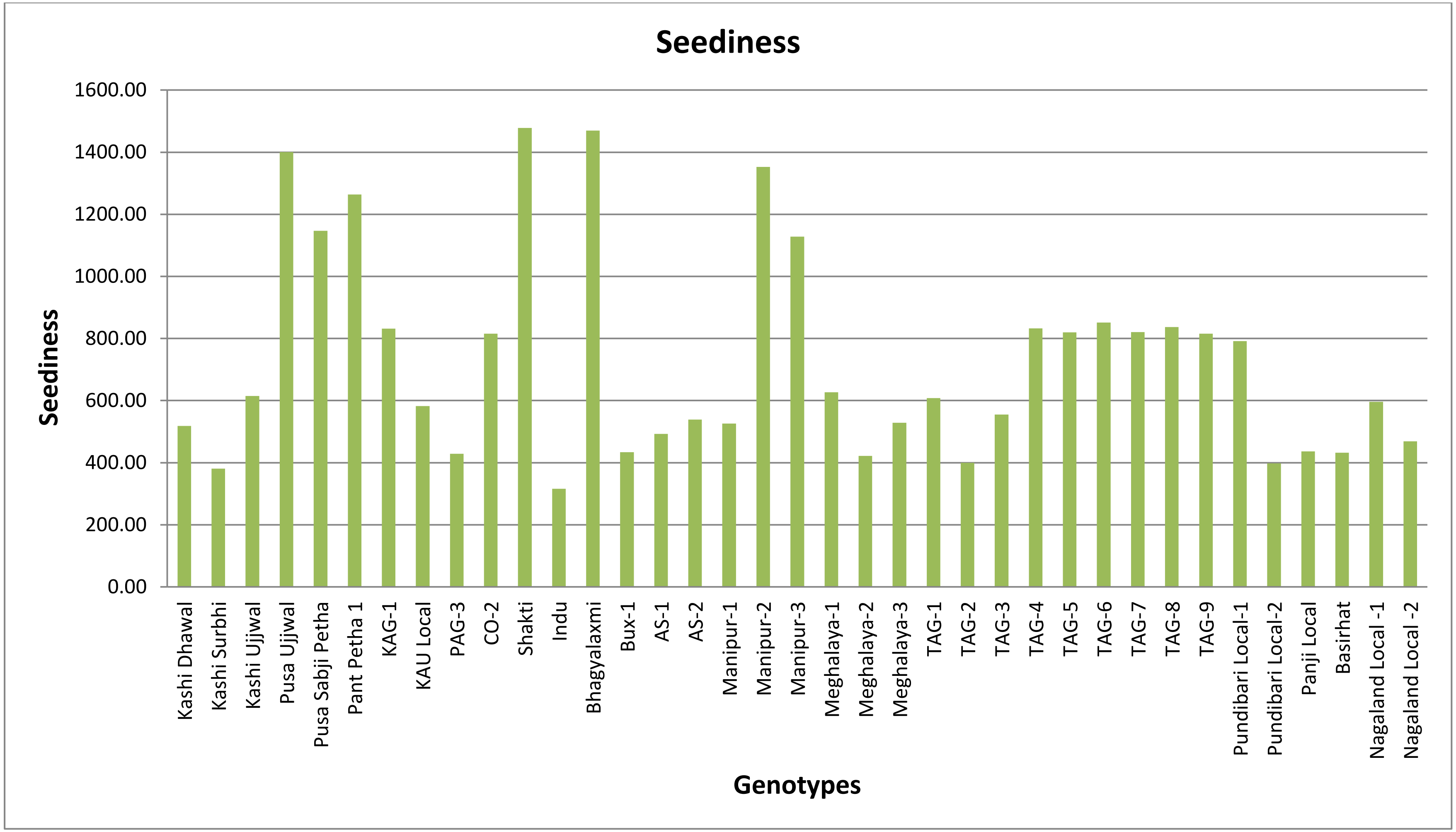

Fig 4.17 Performance of various genotypes of ash gourd on seediness.

which was ranged from 0.68 cm to 1.38 cm. The maximum was recorded by TAG- 4 (1.38 cm) while TAG -1 (1.32 cm) and TAG-5 (1.32 cm) were found at par with TAG-4 whereas the minimum seed length was recorded form TAG-9 (0.68 cm).

4.1.39 Seed width (cm)

The observation was recorded for seed width at seed harvest maturity by using Vernier caliper. The data pertaining to seed width of ash gourd genotypes for the year 2018-19 and 2019-20 has been presented in table 4.28 and fig 4.19. The pooled result revealed significant variation for seed width which was ranged from 0.35 cm to 0.85 cm. The maximum (0.85 cm) was recorded by TAG- 1 while Kashi Dhawal (0.82 cm) was found at par with TAG-1 whereas the minimum seed width (0.35 cm) was recorded form TAG-7 while TAG-8 (0.39 cm) and TAG-9 (0.36 cm) found at par with TAG-7.

4.1.40 Seed coat color

The observation was recorded for seed coat color at seed harvest maturity by using RHS color chart. The variation was found among genotypes for seed coat color. The genotypes were mainly found in yellow white, white, grey white, yellow grey and pale yellow. Kashi Dhawal, Kashi Surbhi, Pusa Ujjwal, Pusa Sabji Petha, KAU Local, PAG-3, CO-2, Bux-1, AS-1, Manipur-3, Meghalaya-1, Meghalaya-2, Meghalaya-3, TAG-1, TAG-2, TAG-4, TAG-5, TAG-7, TAG-8, Panji Local and Basirhat shown yellow white seed coat color. KAG-1, Bhagyalaxmi and AS-2 have shown white seed coat color. Pant Petha 1, Shakti, Indu, TAG-6, Pundibari Local-1, Pundibari Local-2 and Nagaland Local -2 showed grey white color seed coat. Manipur-1, Manipur-2 and TAG-9 shown Yellow grey while TAG-3 and Nagaland Local -1 shown seed coat color as shown in table 4.29.

Table 4.28 Performance of various genotypes of ash gourds on seed length & seed width.

	Seed length (cm)			Seed length (cm)		
Genotypes	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**
Kashi Dhawal	1.24	1.32	1.28	0.80	0.85	0.82
Kashi Surbhi	1.24	1.22	1.23	0.80	0.79	0.79
Kashi Ujjwal	1.09	1.07	1.08	0.54	0.53	0.53
Pusa Ujjwal	1.10	1.09	1.10	0.66	0.65	0.66
Pusa Sabji Petha	1.16	1.15	1.16	0.67	0.65	0.66
Pant Petha 1	1.10	1.13	1.11	0.67	0.69	0.68
KAG-1	1.25	1.28	1.26	0.69	0.71	0.70
KAU Local	1.15	1.19	1.17	0.55	0.57	0.56
PAG-3	1.04	1.08	1.06	0.57	0.59	0.58
CO-2	1.11	1.15	1.13	0.65	0.68	0.66
Shakti	1.17	1.22	1.20	0.65	0.68	0.66
Indu	1.15	1.21	1.18	0.68	0.72	0.70
Bhagyalaxmi	1.18	1.16	1.17	0.64	0.63	0.64
Bux-1	1.05	1.03	1.04	0.45	0.44	0.45
AS-1	0.87	0.85	0.86	0.42	0.42	0.42
AS-2	1.05	0.99	1.02	0.62	0.59	0.61
Manipur-1	1.00	0.97	0.99	0.53	0.52	0.53
Manipur-2	0.88	0.87	0.87	0.40	0.39	0.39
Manipur-3	0.88	0.87	0.87	0.55	0.54	0.54
Meghalaya-1	0.87	0.85	0.86	0.40	0.39	0.39
Meghalaya-2	1.13	1.11	1.12	0.43	0.42	0.42
Meghalaya-3	1.12	1.10	1.11	0.53	0.51	0.52
TAG-1	1.31	1.32	1.32	0.86	0.84	0.85
TAG-2	1.23	1.24	1.24	0.80	0.78	0.79
TAG-3	1.12	1.09	1.11	0.52	0.52	0.52
TAG-4	1.45	1.31	1.38	0.72	0.65	0.69
TAG-5	1.39	1.25	1.32	0.73	0.66	0.70
TAG-6	1.18	1.12	1.15	0.63	0.64	0.63
TAG-7	0.79	0.77	0.78	0.35	0.34	0.35
TAG-8	0.80	0.78	0.79	0.39	0.38	0.39
TAG-9	0.69	0.67	0.68	0.37	0.36	0.36
Pundibari Local-1	1.01	0.96	0.98	0.46	0.44	0.45
Pundibari Local-2	0.97	0.92	0.94	0.40	0.39	0.40
Panji Local	0.93	0.89	0.91	0.55	0.53	0.54
Basirhat	0.90	0.85	0.88	0.41	0.39	0.40
Nagaland Local -1	1.10	1.00	1.05	0.70	0.64	0.67
Nagaland Local -2	0.95	0.87	0.91	0.49	0.44	0.46
SEm(±)	0.05	0.05	0.02	0.02	0.02	0.01
CD	0.15	0.13	0.07	0.05	0.05	0.04
CV(%)	8.37	7.41	3.22	5.53	5.64	3.33

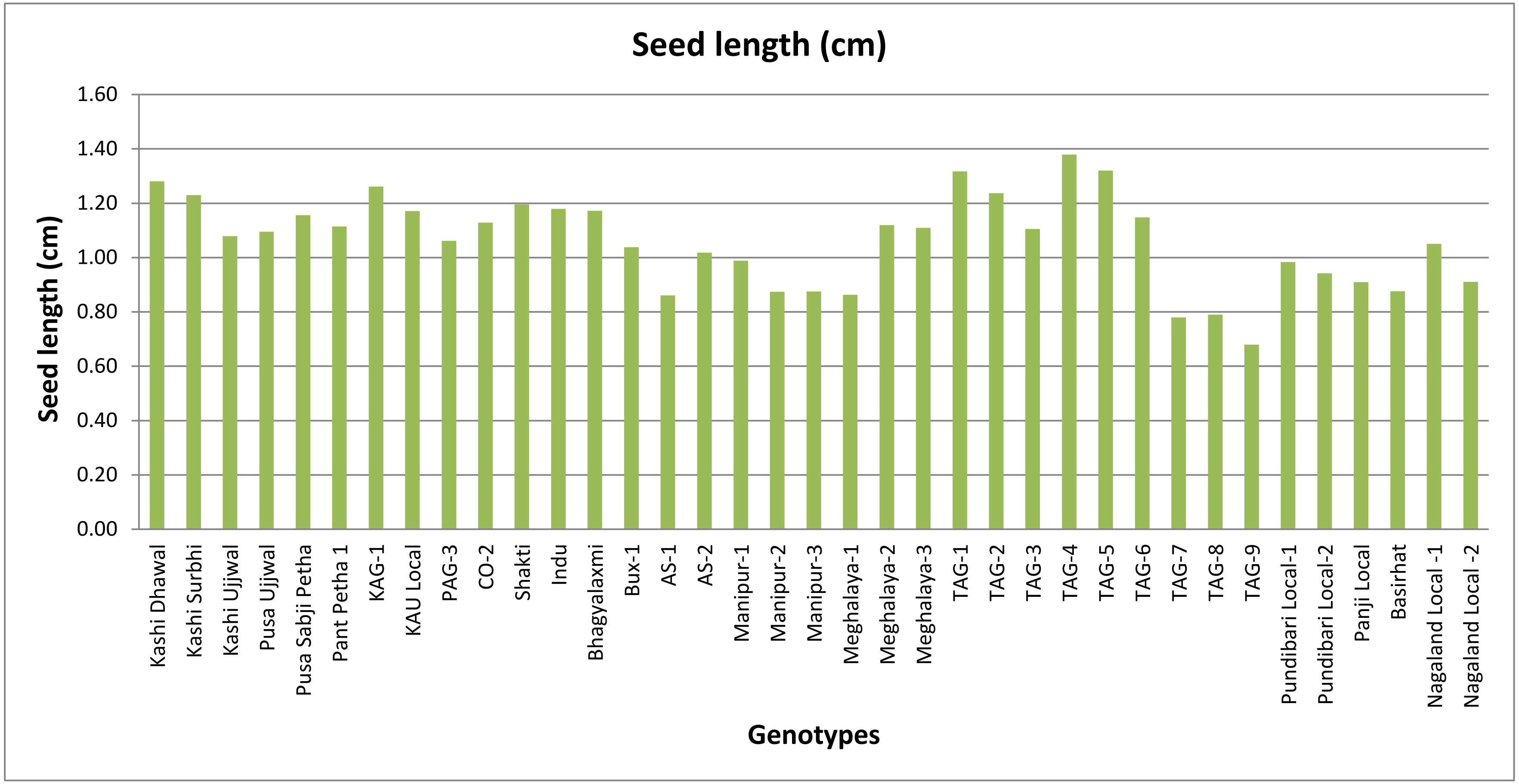

Fig 4.18 Performance of various genotypes of ash gourd on seed length.

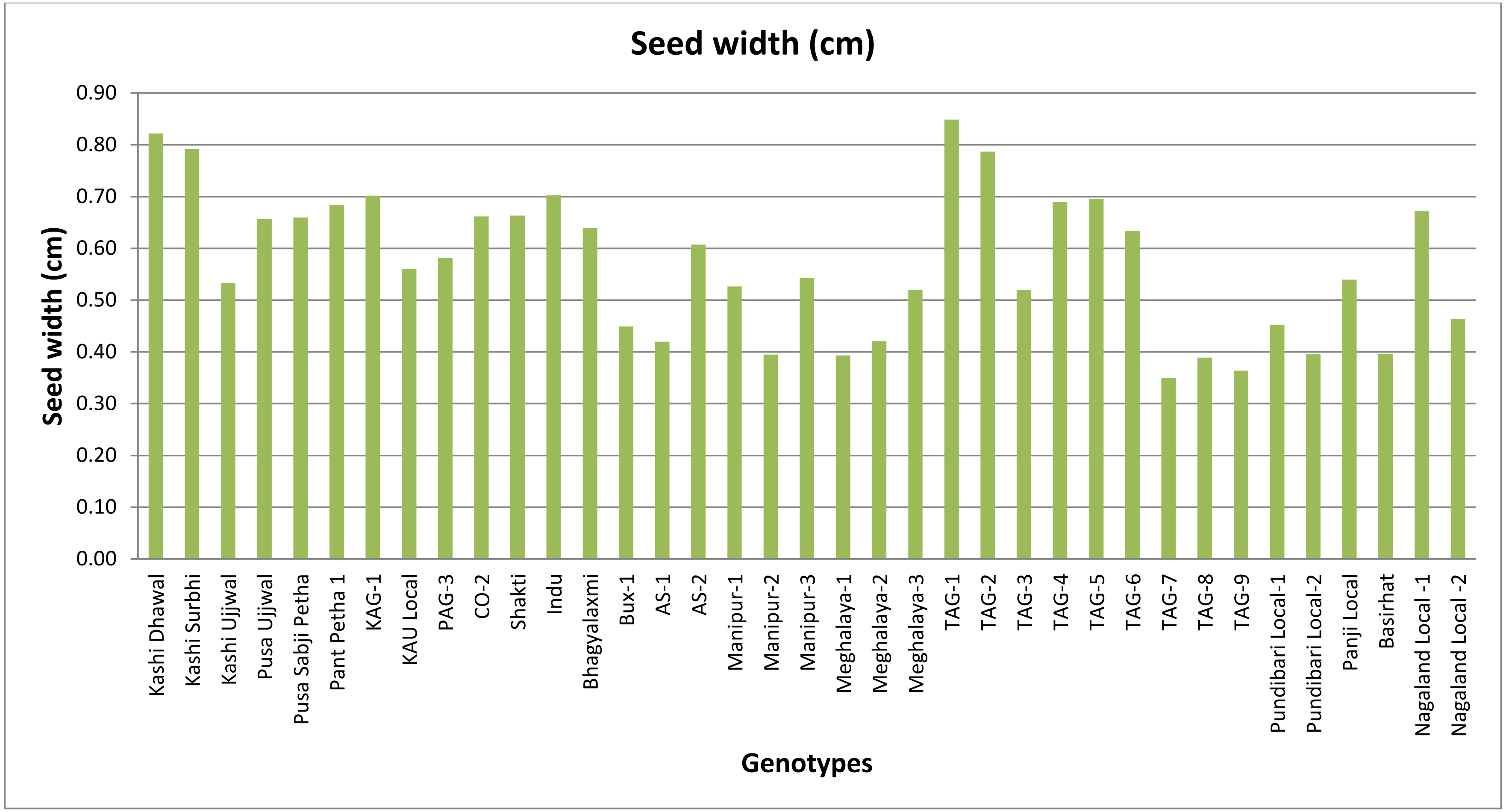

Fig 4.19 Performance of various genotypes of ash gourd on seed width.

4.1.41 Seed arrangement

The observation was visually recorded for seed arrangements by longitudinally cutting the fruits in two equal halves during seed harvest maturity stage. It can be clearly seen from the table 4.29 that all the ash gourd genotypes were found linear seed arrangements. This may be due to the common genes found in all the ash gourd genotypes.

4.1.42 Crop duration

The observation was recorded for crop duration when fruit attained marketable maturity. It was calculated as number of days from sowing to harvest at marketable maturity stage. The table 4.30 and fig 4.20 shows that the maximum crop duration was recorded by TAG-1 (140.40) while TAG-6 (137.33) was fund at par with TAG-1 and the minimum crop duration was found in Meghalaya-1 (103.48) while Nagaland Local-1 (105.44) and Kashi Surbhi (106.10) was found at par with Meghalaya-1.

4.2 Yield Parameters

4.2.1 Number of fruits per plant

The data pertaining to fruits per plant of ash gourd genotypes for the year 2018 and 2019 has been presented in the table 4.31 and fig 4.21. The pooled results recorded significant variation in number of fruits per plant and it was ranged from 3.23 to 7.16. The maximum number of fruits per plant (7.16) was recorded in TAG-6 while TAG-9 (7.01) and TAG-1 (6.98) were found at par with TAG-6 while the minimum (3.23) was recorded form Bhagyalaxmi. Significant variation in number of fruits per plant of ash gourd genotypes was also recorded by Muralidhara (2009) and Aruah *et al*. (2010) in cucurbita species.

Table 4.29 Performance of various genotypes of ash gourd on seed coat color and seed arrangement.

Genotypes	Seed coat color	Seed arrangement
Kashi Dhawal	Yellow white 158A	Linear
Kashi Surbhi	Yellow white 158A	Linear
Kashi Ujjwal	White group 155A	Linear
Pusa Ujjwal	Yellow white 158A	Linear
Pusa Sabji Petha	Yellow white 158C	Linear
Pant Petha 1	Grey white 156 D	Linear
KAG-1	White 155A	Linear
KAU Local	Yellow white 158A	Linear
PAG-3	Yellow white 158A	Linear
CO-2	Yellow white 158A	Linear
Shakti	Grey white 156D	Linear
Indu	Grey white 156D	Linear
Bhagyalaxmi	White NN155A	Linear
Bux-1	Yellow white 158D	Linear
AS-1	Yellow white 158A	Linear
AS-2	White group NN155A	Linear
Manipur-1	Yellow grey 156D	Linear
Manipur-2	Yellow grey 156B	Linear
Manipur-3	Yellow white 158A	Linear
Meghalaya-1	Yellow white 158A	Linear
Meghalaya-2	Yellow white 158A	Linear
Meghalaya-3	Yellow white 158A	Linear
TAG-1	Yellow white 158A	Linear
TAG-2	Yellow white 158A	Linear
TAG-3	Pale yellow 158B	Linear
TAG-4	Yellow white 158A	Linear
TAG-5	Yellow white 158A	Linear
TAG-6	Grey white 156 C	Linear
TAG-7	Yellow white 158A	Linear
TAG-8	Yellow white 158A	Linear
TAG-9	Yellow grey 156B	Linear
Pundibari Local-1	Grey white 156A	Linear
Pundibari Local-2	Grey white 156D	Linear
Panji Local	Yellow white 158A	Linear
Basirhat	Yellow white 158A	Linear
Nagaland Local -1	Pale yellow 158B	Linear
Nagaland Local -2	Grey white 156 C	Linear

Table 4.30 Performance of various genotypes of ash gourd on crop duration.

	Crop Duration (days)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	109.50	110.00	109.75
Kashi Surbhi	105.19	107.00	106.10
Kashi Ujjwal	113.44	115.00	114.22
Pusa Ujjwal	127.22	131.00	129.11
Pusa Sabji Petha	135.17	135.00	135.08
Pant Petha 1	132.08	132.00	132.04
KAG-1	123.20	122.00	122.60
KAU Local	125.99	120.33	123.16
PAG-3	129.90	126.00	127.95
CO-2	130.58	129.00	129.79
Shakti	130.99	130.00	130.50
Indu	129.41	132.00	130.70
Bhagyalaxmi	135.64	137.50	136.57
Bux-1	135.17	135.00	135.08
AS-1	111.09	110.00	110.54
AS-2	117.68	119.30	118.49
Manipur-1	120.74	115.00	117.87
Manipur-2	113.37	112.00	112.69
Manipur-3	112.45	114.00	113.23
Meghalaya-1	101.97	105.00	103.48
Meghalaya-2	108.06	108.00	108.03
Meghalaya-3	112.83	110.00	111.41
TAG-1	143.82	136.98	140.40
TAG-2	133.31	135.14	134.22
TAG-3	136.66	136.58	136.62
TAG-4	128.21	125.00	126.61
TAG-5	128.98	128.00	128.49
TAG-6	138.01	136.66	137.33
TAG-7	117.68	115.00	116.34
TAG-8	116.52	118.00	117.26
TAG-9	109.14	112.00	110.57
Pundibari Local-1	113.44	115.00	114.22
Pundibari Local-2	113.62	117.00	115.31
Panji Local	117.51	119.00	118.25
Basirhat	119.86	123.00	121.43
Nagaland Local -1	104.72	106.16	105.44
Nagaland Local -2	118.15	118.00	118.07
SEm(±)	2.19	1.59	1.32
CD	6.15	4.47	3.77
CV(%)	3.11	2.27	1.53

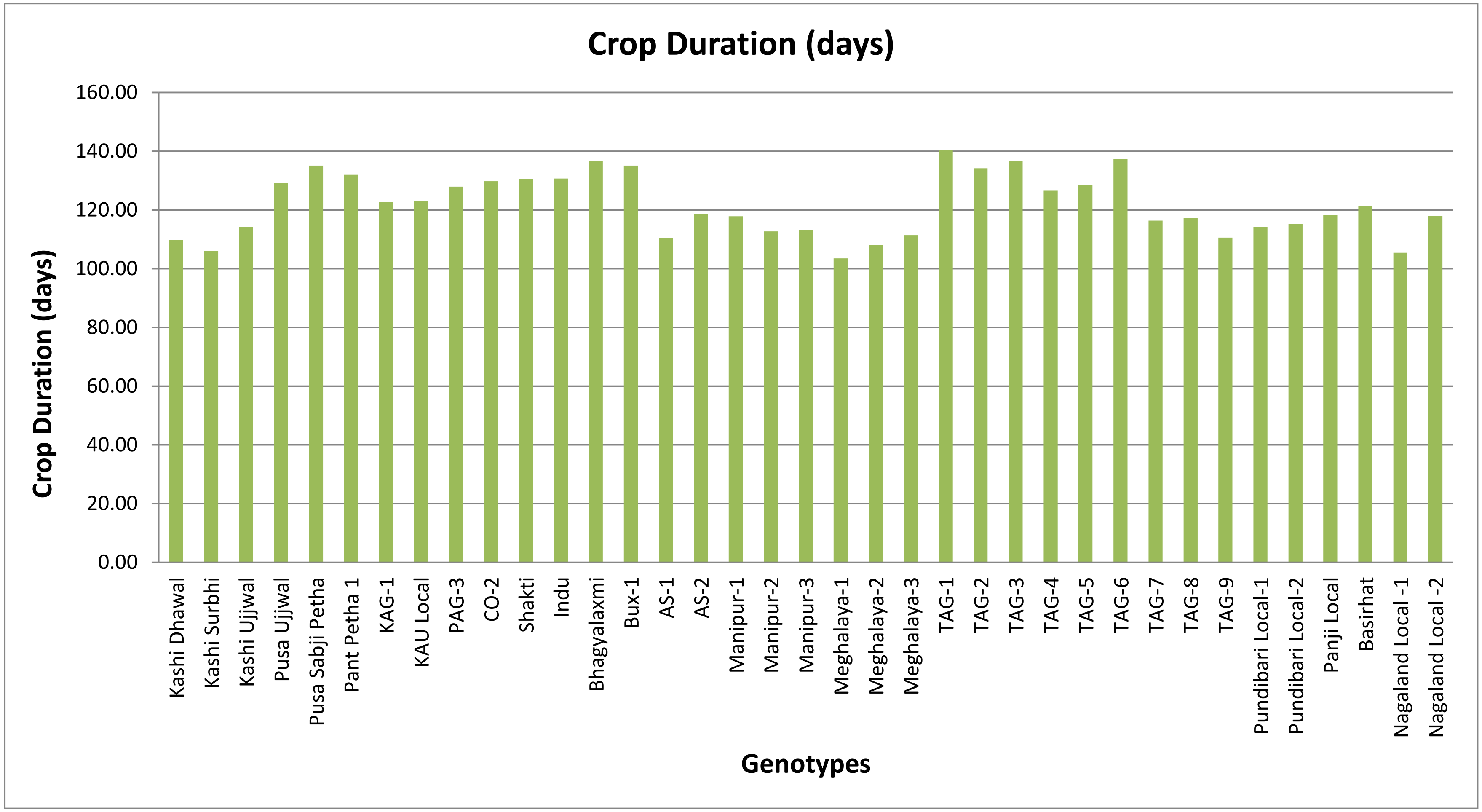

Fig 4.20 Performance of various genotypes of ash gourd on crop duration.

4.2.2 Average fruit weight (g)

The data pertaining to fruits per plant of ash gourd genotypes for the year 2018 and 2019 has been presented in the table 4.32 and fig 4.22. The pooled results recorded significant variation in number of fruits per plant and it was ranged from 1827.36 g to 5762.25 g. The maximum average fruit weight (5762.25 g) was recorded in Indu while the minimum (1827.36 g) was recorded form Bux-1. The average fruit weight was extremely important character for improvement of ash gourd yield. This result was in line with the finding of Mohanty (2000) and Selvi *et. al* (2012) in pumpkin genotypes.

4.2.3 100 seed weight (g)

The observation on test weight of ash gourd genotypes for the year 2018 and 2019 has been presented in table 4.33 and fig 4.23. The pooled results recorded maximum 100 seed weight (5.64) in CO-2 while Shakti (5.62) was found at par with CO-2 and the minimum 100 seed weight (2.87) was recorded from Nagaland Local-1 while Nagaland Local -2 (2.92) was found at par with each other. The significant variation in test weight was also recorded by Balkaya *et al.* (2010a) in cucurbits.

4.2.4 Yield per plant (Kg)

The observation on yield per plant of ash gourd genotypes for the year 2018 and 2019 has been presented in table 4.34 and fig 4.24. The pooled results recorded maximum yield per plant (23.41) in Indu and the minimum yield per plant (8.43) was recorded from AS-1 while Kashi Ujjwal (8.86) and KAG-1 (9.21) was found at par with AS-1. Fruit yield was a complex character

Table 4.31 Performance of various genotypes of ash gourd on number of fruit per plant.

	Number of fruits per plant		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	3.43	3.50	3.47
Kashi Surbhi	4.33	4.40	4.36
Kashi Ujjwal	4.15	4.21	4.18
Pusa Ujjwal	4.06	4.18	4.12
Pusa Sabji Petha	3.62	3.62	3.62
Pant Petha 1	3.65	3.65	3.65
KAG-1	3.79	3.75	3.77
KAU Local	4.48	4.27	4.38
PAG-3	3.99	3.89	3.94
CO-2	4.56	4.50	4.53
Shakti	4.34	4.31	4.33
Indu	4.02	4.10	4.06
Bhagyalaxmi	3.33	3.13	3.23
Bux-1	5.56	5.82	5.69
AS-1	4.47	4.20	4.34
AS-2	5.12	5.26	5.19
Manipur-1	4.92	4.69	4.81
Manipur-2	4.22	4.50	4.36
Manipur-3	4.67	4.80	4.73
Meghalaya-1	4.95	5.10	5.03
Meghalaya-2	4.90	4.90	4.90
Meghalaya-3	5.54	5.31	5.42
TAG-1	7.16	6.79	6.98
TAG-2	5.62	5.70	5.66
TAG-3	6.50	6.50	6.50
TAG-4	3.59	3.50	3.54
TAG-5	3.83	3.80	3.81
TAG-6	7.08	7.23	7.16
TAG-7	6.34	6.20	6.27
TAG-8	6.75	6.80	6.77
TAG-9	6.92	7.10	7.01
Pundibari Local-1	5.36	5.10	5.23
Pundibari Local-2	4.86	5.00	4.93
Panji Local	5.53	5.60	5.56
Basirhat	7.02	7.20	7.11
Nagaland Local -1	4.75	4.85	4.80
Nagaland Local -2	5.44	5.20	5.32
SEm(±)	0.18	0.09	0.08
CD	0.50	0.24	0.23
CV(%)	6.21	2.98	2.32

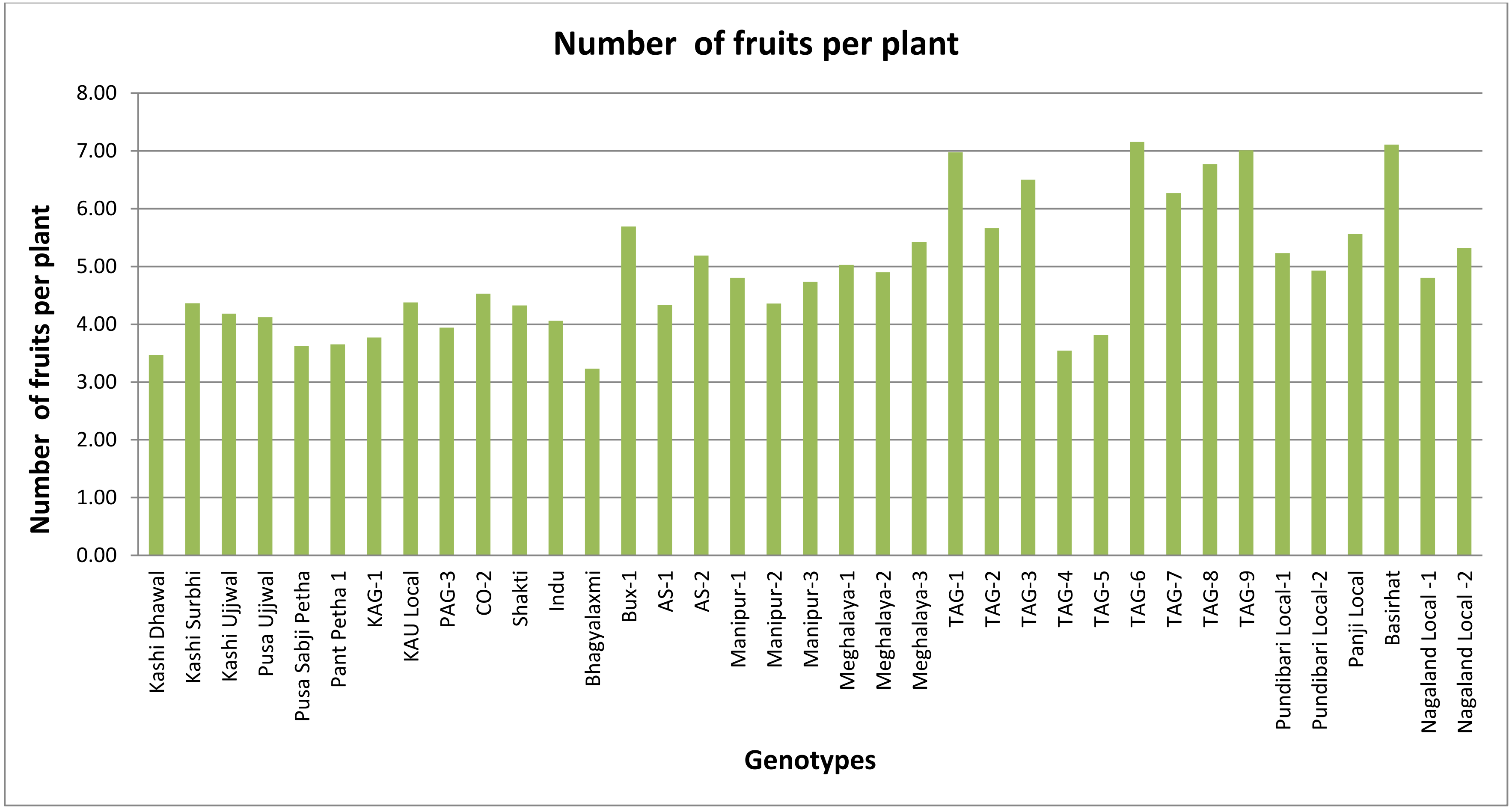

Fig 4.21 Performance of various genotypes of ash gourd on number of fruit per plant.

Table 4.32 Performance of various genotypes of ash gourd on average fruit weight.

	Average fruits weight(g)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	3786.72	3862.65	3824.69
Kashi Surbhi	4484.20	4561.23	4522.71
Kashi Ujjwal	2103.22	2132.15	2117.69
Pusa Ujjwal	3520.59	3625.32	3572.95
Pusa Sabji Petha	3286.36	3282.31	3284.34
Pant Petha 1	3867.83	3865.56	3866.70
KAG-1	2455.37	2431.36	2443.37
KAU Local	3035.80	2891.45	2963.62
PAG-3	5141.45	5012.63	5077.04
CO-2	3859.00	3812.36	3835.68
Shakti	4264.03	4231.66	4247.85
Indu	5705.06	5819.45	5762.25
Bhagyalaxmi	3503.16	3551.34	3527.25
Bux-1	1828.48	1826.23	1827.36
AS-1	1951.20	1932.12	1941.66
AS-2	2514.88	2549.47	2532.17
Manipur-1	2301.80	2192.35	2247.07
Manipur-2	2421.52	2392.26	2406.89
Manipur-3	2390.74	2423.62	2407.18
Meghalaya-1	3324.48	3423.38	3373.93
Meghalaya-2	2654.70	2653.14	2653.92
Meghalaya-3	2611.58	2546.15	2578.87
TAG-1	2995.97	2853.52	2924.75
TAG-2	3212.07	3256.25	3234.16
TAG-3	2755.57	2753.95	2754.76
TAG-4	5711.46	5568.36	5639.91
TAG-5	5024.47	4986.32	5005.39
TAG-6	2593.67	2568.31	2580.99
TAG-7	2816.80	2752.54	2784.67
TAG-8	2511.32	2543.23	2527.28
TAG-9	2098.20	2153.20	2125.70
Pundibari Local-1	2577.79	2613.25	2595.52
Pundibari Local-2	2296.82	2365.15	2330.99
Panji Local	2829.68	2865.63	2847.65
Basirhat	2783.36	2856.32	2819.84
Nagaland Local -1	3136.90	3180.05	3158.47
Nagaland Local -2	2840.03	2836.53	2838.28
SEm(±)	48.47	52.65	35.07
CD	136.41	148.18	100.58
CV(%)	2.65	2.88	1.57

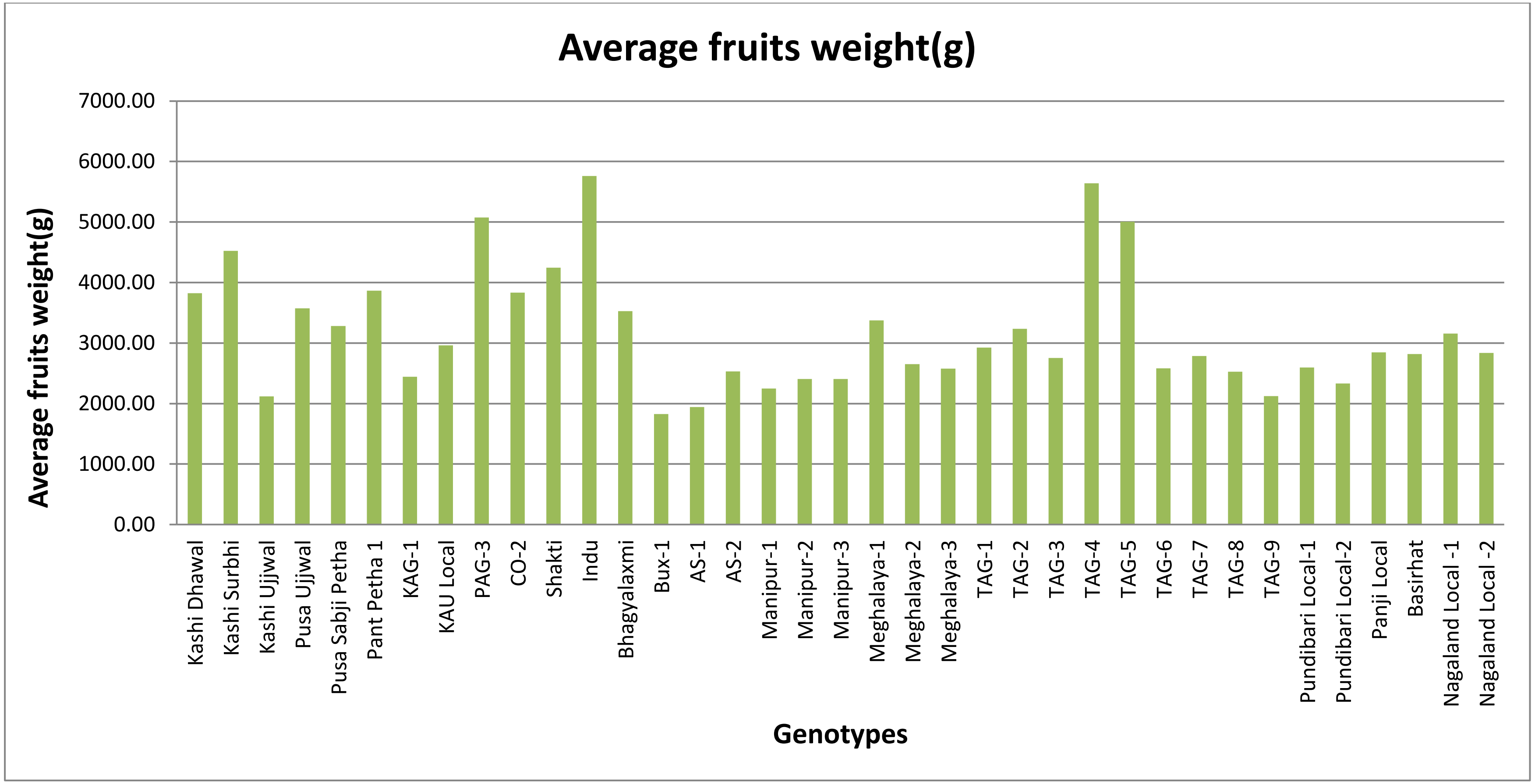

Fig 4.22 Performance of various genotypes of ash gourd on average fruit weight.

Table 4.33 Performance of various genotypes of ash gourds on 100 seed weight.

	100 seed wt. (g)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	4.91	5.19	5.05
Kashi Surbhi	5.18	5.33	5.25
Kashi Ujjwal	4.67	4.52	4.59
Pusa Ujjwal	5.03	4.70	4.87
Pusa Sabji Petha	5.00	4.96	4.98
Pant Petha 1	4.72	4.54	4.63
KAG-1	5.33	5.04	5.18
KAU Local	4.41	4.30	4.36
PAG-3	5.27	5.27	5.27
CO-2	5.75	5.53	5.64
Shakti	5.71	5.53	5.62
Indu	4.29	4.45	4.37
Bhagyalaxmi	4.99	4.99	4.99
Bux-1	4.34	4.31	4.33
AS-1	3.41	3.22	3.31
AS-2	4.08	3.98	4.03
Manipur-1	3.72	3.58	3.65
Manipur-2	4.04	3.91	3.98
Manipur-3	3.20	2.99	3.09
Meghalaya-1	3.98	3.82	3.90
Meghalaya-2	3.82	3.82	3.82
Meghalaya-3	4.04	4.06	4.05
TAG-1	3.33	3.21	3.27
TAG-2	4.08	4.08	4.08
TAG-3	3.53	3.53	3.53
TAG-4	5.45	5.28	5.37
TAG-5	5.30	4.95	5.12
TAG-6	3.72	3.58	3.65
TAG-7	4.41	4.40	4.41
TAG-8	4.77	4.77	4.77
TAG-9	4.89	4.73	4.81
Pundibari Local-1	5.40	5.40	5.40
Pundibari Local-2	5.35	5.31	5.33
Panji Local	4.85	4.73	4.79
Basirhat	5.28	5.11	5.20
Nagaland Local -1	2.93	2.81	2.87
Nagaland Local -2	3.00	2.83	2.92
SEm(±)	0.07	0.06	0.06
CD	0.19	0.18	0.18
CV(%)	2.64	2.54	1.96

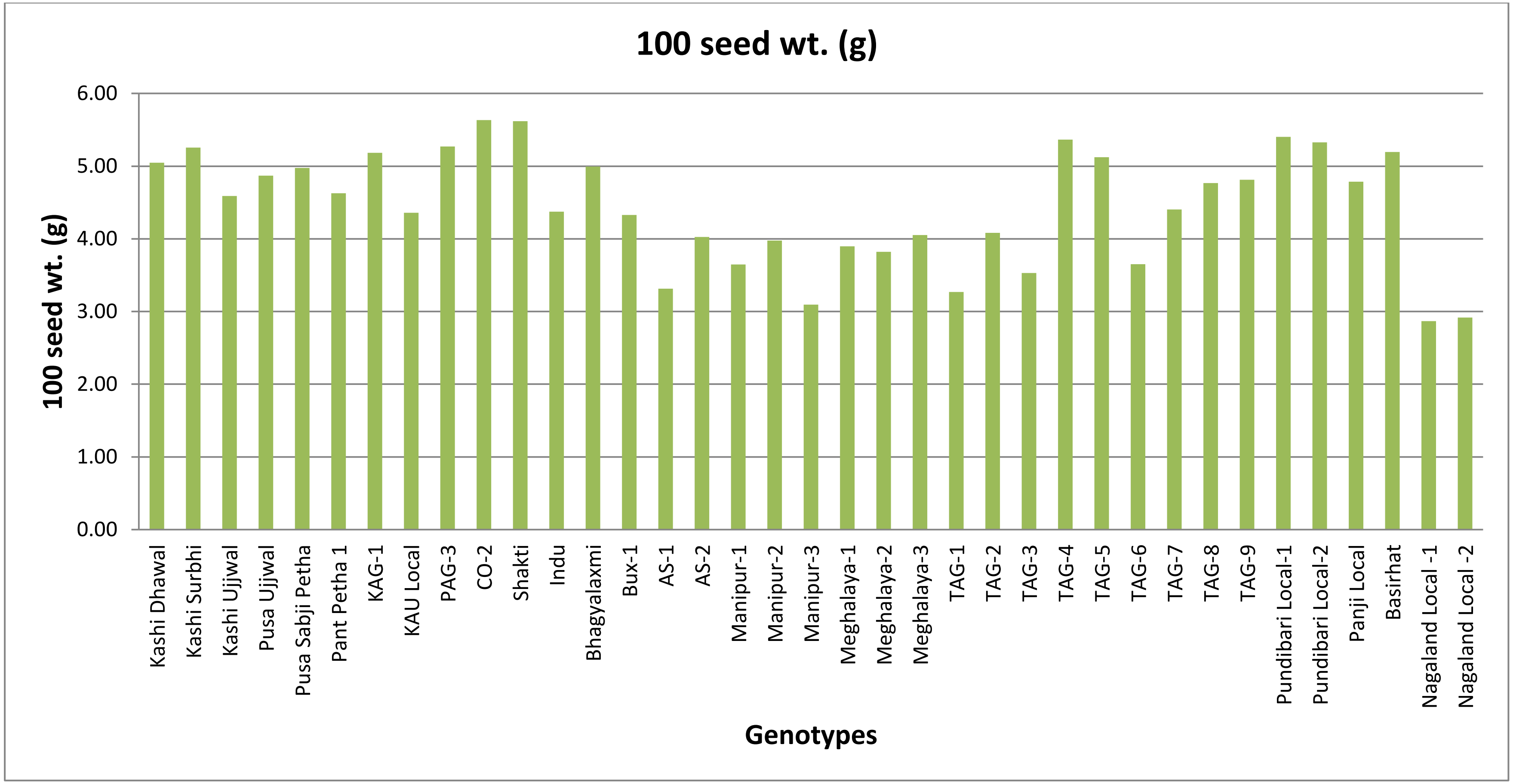

Fig 4.23 Performance of various genotypes of ash gourd on 100 seed weight.

which was shaped through various yield attributing characters. The variation in fruit yield per plant was also documented by Mohanty (2000) in pumpkin genotypes Aruah *et al.* (2010) in cucurbita species.

4.2.5 Yield per hectare (q)

The observation on yield per hectare of ash gourd genotypes for the year 2018 and 2019 has been presented in table 4.35 and fig 4.25. The pooled results recorded maximum yield per plant in Indu (975.22 q) and the minimum was recorded from AS-1 (351.26 q) while Kashi Ujjwal (369.08 q) and KAG-1 (383.83 q) was found at par with AS-1. Fruit yield was a complex character which was shaped through various yield attributing characters. Of which average fruit yield played a pivotal role to harvest high fruit yield. The variation in fruit yield per plant was also documented by Mohanty (2000) in pumpkin genotypes Aruah *et al.* (2010) in cucurbita species.

4.3.1 Qualitative Parameters

4.3.1 TSS (°Brix)

The data pertaining to TSS of ash gourd genotypes for the year 2018 and 2019 has been presented in table 4.36 and fig 4.26. The pooled results recorded maximum TSS (3.00) in Meghalaya-2 and the minimum TSS (1.33 °brix) was recorded from Shakti while Bhagyalaxmi (1.33 °brix) and TAG-9 (1.37 °brix) was found at par with Shakti. TSS content was a important component for sweetness of ash gourd. In the present study, it was recorded with wide variation. The findings were in accordance with Zanish *et al.* (2013) and Niewezas *et al.* (2014) in pumpkin.

4.3.2 Ascorbic acid (mg/100g)

The data pertaining to ascorbic acid of ash gourd genotypes for the year 2018 and 2019 has been presented in table 4.37 and fig 4.27. The pooled results recorded maximum ascorbic acid (45.17mg/100g) in TAG-5 while Pusa Ujjwal (44.35mg/100g), AS-1(44.22mg/100g) and Manipur-1 (44.07 mg/100g)

Table 4.34 Performance of various genotypes of ash gourds on yield per plant.

	Yield/Plant(kg)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	13.00	13.53	13.26
Kashi Surbhi	19.40	20.08	19.74
Kashi Ujjwal	8.74	8.98	8.86
Pusa Ujjwal	14.31	15.17	14.74
Pusa Sabji Petha	11.91	11.88	11.90
Pant Petha 1	14.13	14.12	14.12
KAG-1	9.30	9.12	9.21
KAU Local	13.63	12.36	13.00
PAG-3	20.52	19.52	20.02
CO-2	17.58	17.15	17.37
Shakti	18.52	18.24	18.38
Indu	22.94	23.87	23.41
Bhagyalaxmi	11.66	11.14	11.40
Bux-1	10.17	10.63	10.40
AS-1	8.74	8.12	8.43
AS-2	12.90	13.42	13.16
Manipur-1	11.35	10.30	10.82
Manipur-2	10.22	10.77	10.49
Manipur-3	11.15	11.64	11.40
Meghalaya-1	16.48	17.48	16.98
Meghalaya-2	13.01	13.00	13.01
Meghalaya-3	14.47	13.52	13.99
TAG-1	21.44	19.40	20.42
TAG-2	18.07	18.57	18.32
TAG-3	17.92	17.91	17.91
TAG-4	20.49	19.50	19.99
TAG-5	19.24	18.95	19.09
TAG-6	18.37	18.58	18.47
TAG-7	17.87	17.07	17.47
TAG-8	16.95	17.30	17.13
TAG-9	14.51	15.29	14.90
Pundibari Local-1	13.82	13.33	13.58
Pundibari Local-2	11.17	11.84	11.50
Panji Local	15.65	16.05	15.85
Basirhat	19.53	20.57	20.05
Nagaland Local -1	14.92	15.44	15.18
Nagaland Local -2	15.45	14.75	15.10
SEm(±)	0.60	0.51	0.37
CD	1.68	1.43	1.06
CV(%)	6.85	5.84	3.45

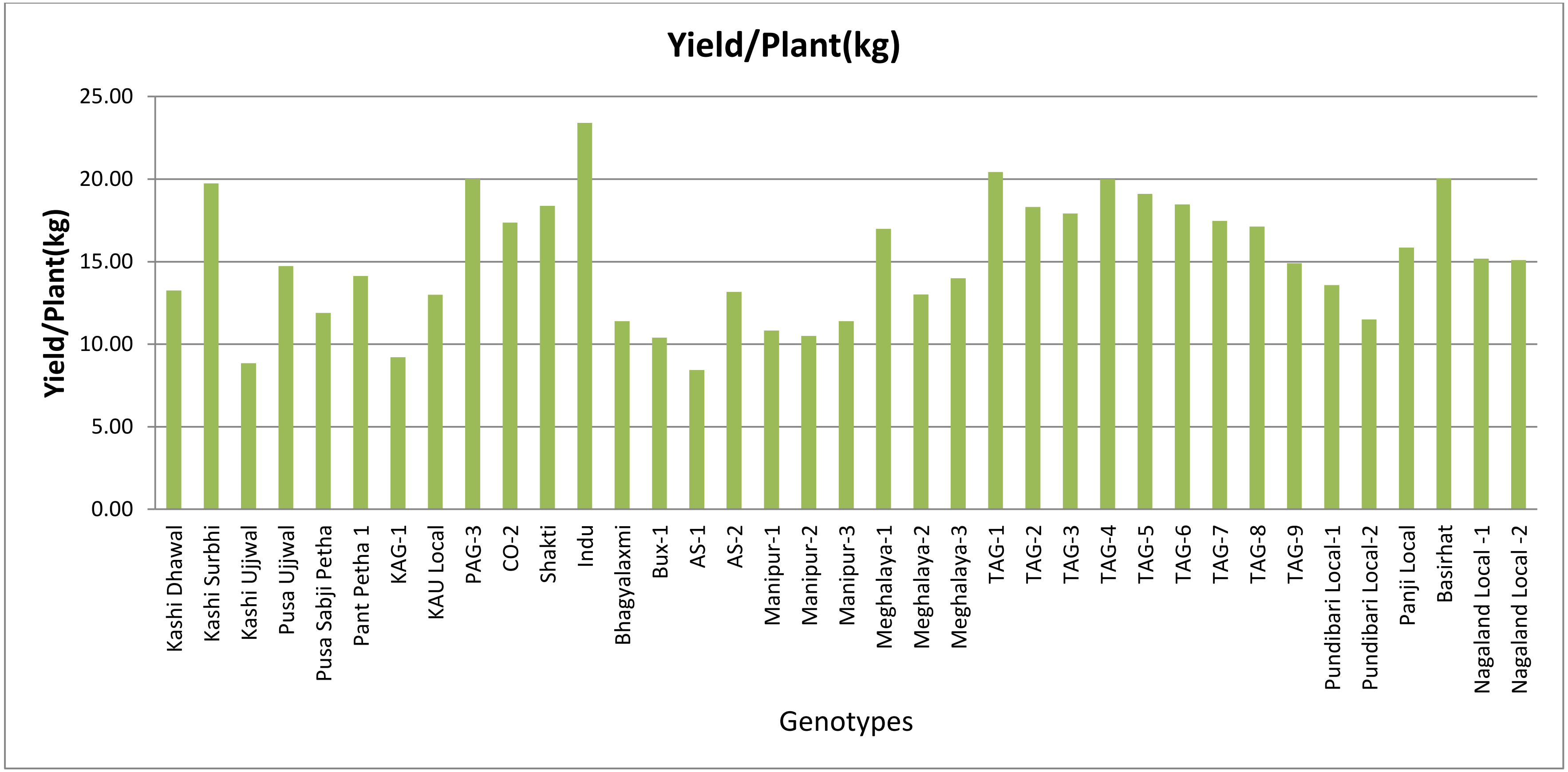

Fig 4.24 Performance of various genotypes of ash gourd on yield per plant.

Table 4.35 Performance of various genotypes of ash gourd on yield per hectare.

	Yield/ha(q)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	541.61	563.54	552.57
Kashi Surbhi	808.46	836.47	822.46
Kashi Ujjwal	364.03	374.12	369.08
Pusa Ujjwal	596.17	632.17	614.17
Pusa Sabji Petha	496.31	495.09	495.70
Pant Petha 1	588.74	588.32	588.53
KAG-1	387.67	380.00	383.83
KAU Local	567.85	515.13	541.49
PAG-3	855.04	813.28	834.16
CO-2	732.65	714.64	723.65
Shakti	771.76	760.09	765.93
Indu	955.86	994.58	975.22
Bhagyalaxmi	485.89	464.19	475.04
Bux-1	423.62	442.87	433.24
AS-1	364.19	338.32	351.26
AS-2	537.56	559.20	548.38
Manipur-1	472.90	429.00	450.95
Manipur-2	425.70	448.70	437.20
Manipur-3	464.75	484.86	474.80
Meghalaya-1	686.87	728.34	707.61
Meghalaya-2	542.17	541.83	542.00
Meghalaya-3	602.90	563.18	583.04
TAG-1	893.24	808.40	850.82
TAG-2	752.79	773.57	763.18
TAG-3	746.59	746.06	746.33
TAG-4	853.87	812.32	833.09
TAG-5	801.59	789.66	795.62
TAG-6	765.31	774.16	769.73
TAG-7	744.59	711.27	727.93
TAG-8	706.29	720.82	713.55
TAG-9	604.77	637.19	620.98
Pundibari Local-1	575.95	555.47	565.71
Pundibari Local-2	465.23	493.33	479.28
Panji Local	652.20	668.87	660.53
Basirhat	813.56	857.18	835.37
Nagaland Local -1	621.83	643.50	632.67
Nagaland Local -2	643.58	614.59	629.09
SEm(±)	24.91	21.22	15.35
CD	70.11	59.72	44.04
CV(%)	6.85	5.84	3.45

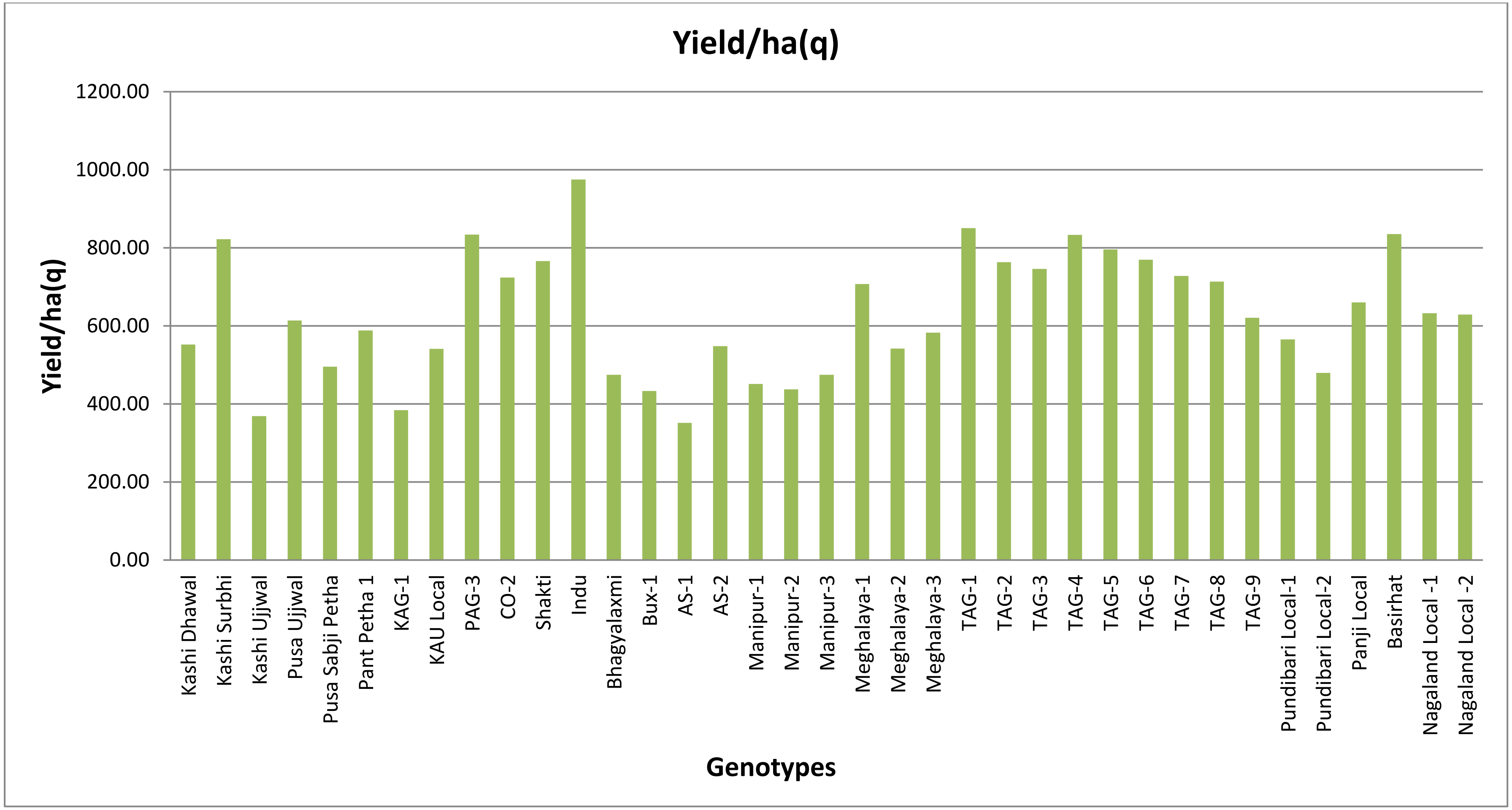

Fig 4.25 Performance of various genotypes of ash gourds on yield per hectare.

was found at par with TAG-5. The minimum (34.13 mg/100g) was recorded from Shakti and TAG-8 (34.78 mg/100g) was found at par with Shakti. The variability in ascorbic acid content was in conformity with the findings of Blessing *et al*. (2011) and Zanish *et al.* (2013) in pumpkin genotype.

4.3.2 Aroma status

The observation recorded for the aroma status in thirty seven ash gourd genotypes. From the table 4.38, it can be clearly seen that aroma was present among all thirty seven ash gourd genotypes AS-1, Meghalaya-2 and Basirhat.

4.4 Estimation of genetic parameters

The analysis of variance indicated highly significant differences among genotypes for all the characters. The results clearly indicated the presence of high amount of variability for the yield components among the genotypes studied. This revealed existence of considerable variability in material studied for improvement for various traits.

4.4.1 Analysis of variance (ANOVA)

Range (minimum and maximum) and mean performance of thirty seven genotypes of ash gourd for all growth characters are presented in table 4.39 and 4.40. Cotyledon length ranged from 2.30 cm to 4.08 cm with mean performance of 2.88 cm, cotyledon width ranged from 1.15 cm to 2.32 cm with mean performance of 1.56 cm, internodal length ranged from 8.92 cm to 17.95 cm with mean performance of 13.42 cm, number of primary branches ranged from 2.71 to 4.00 with mean performance of 3.33, vine length ranged from 3.80 m to 7.98 m with mean performance of 6.01 m, leaf length ranged from 10.37 cm to 17.59 cm with mean performance of 13.14 cm, leaf width ranged from 13.41 cm to 23.97 cm with mean performance of 18.07 cm, number of lobes ranged from 1.01 to 7.10 with mean performance of 5.81, petiole length

Table 4.36 Performance of various genotypes of ash gourd on TSS.

	TSS		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	2.43	2.48	2.46
Kashi Surbhi	2.09	2.13	2.11
Kashi Ujjwal	2.61	2.65	2.63
Pusa Ujjwal	2.86	2.95	2.91
Pusa Sabji Petha	2.00	2.00	2.00
Pant Petha 1	2.00	2.00	2.00
KAG-1	2.34	2.32	2.33
KAU Local	2.70	2.57	2.63
PAG-3	2.15	2.08	2.11
CO-2	1.87	1.85	1.86
Shakti	1.33	1.32	1.33
Indu	2.16	2.20	2.18
Bhagyalaxmi	1.30	1.31	1.31
Bux-1	1.90	1.90	1.90
AS-1	2.12	2.10	2.11
AS-2	1.73	1.72	1.72
Manipur-1	1.89	1.80	1.84
Manipur-2	2.13	2.10	2.11
Manipur-3	2.96	3.00	2.98
Meghalaya-1	2.82	2.90	2.86
Meghalaya-2	3.00	3.00	3.00
Meghalaya-3	2.96	2.90	2.93
TAG-1	2.20	2.10	2.15
TAG-2	2.42	2.45	2.43
TAG-3	2.15	2.15	2.15
TAG-4	2.32	2.30	2.31
TAG-5	2.52	2.50	2.51
TAG-6	2.42	2.40	2.41
TAG-7	1.68	1.62	1.65
TAG-8	1.83	1.85	1.84
TAG-9	1.35	1.40	1.37
Pundibari Local-1	1.78	1.80	1.79
Pundibari Local-2	1.85	1.90	1.87
Panji Local	1.88	1.90	1.89
Basirhat	1.90	2.00	1.95
Nagaland Local -1	2.03	2.02	2.02
Nagaland Local -2	2.10	2.10	2.10
SEm(±)	0.04	0.04	0.03
CD	0.11	0.13	0.07
CV(%)	3.18	3.58	1.68

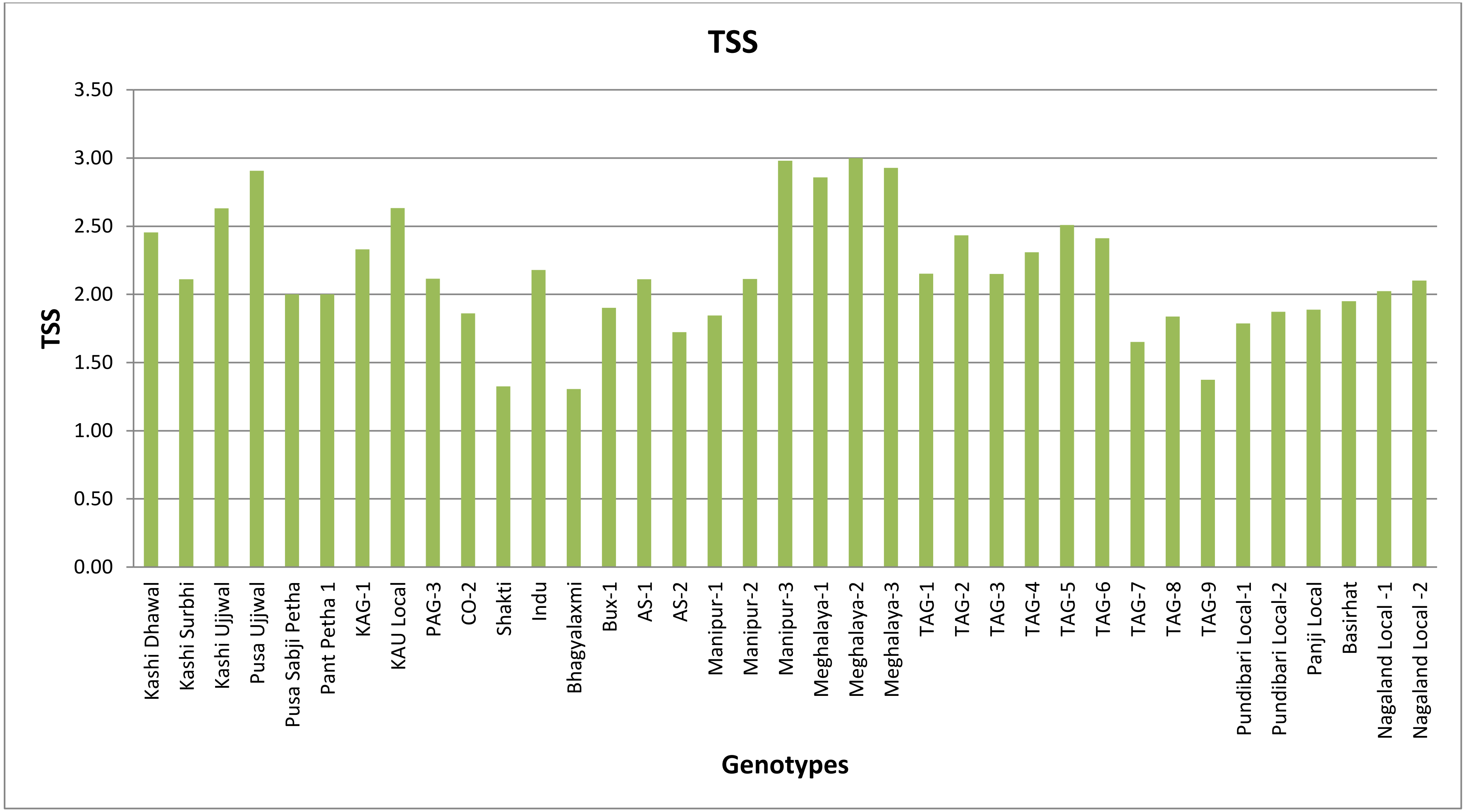

Fig 4.26 Performance of various genotypes of ash gourd on TSS.

Table 4.37 Performance of various genotypes of ash gourd on ascorbic acid.

	Ascorbic acid (mg/100gm)		
Genotypes	**2018**	**2019**	**Pooled**
Kashi Dhawal	37.05	38.54	37.79
Kashi Surbhi	34.12	35.29	34.70
Kashi Ujjwal	40.17	41.27	40.72
Pusa Ujjwal	43.07	45.63	44.35
Pusa Sabji Petha	43.08	42.97	43.03
Pant Petha 1	39.03	38.99	39.01
KAG-1	41.61	40.80	41.20
KAU Local	41.97	37.98	39.97
PAG-3	38.44	36.51	37.48
CO-2	35.64	34.78	35.21
Shakti	34.39	33.87	34.13
Indu	40.77	42.40	41.59
Bhagyalaxmi	35.66	36.64	36.15
Bux-1	38.07	37.98	38.02
AS-1	44.65	43.78	44.22
AS-2	41.12	37.21	39.16
Manipur-1	44.61	43.53	44.07
Manipur-2	41.68	42.83	42.26
Manipur-3	41.47	43.94	42.71
Meghalaya-1	40.43	40.38	40.41
Meghalaya-2	43.09	40.93	42.01
Meghalaya-3	40.59	38.74	39.67
TAG-1	35.42	36.32	35.87
TAG-2	38.23	40.23	39.23
TAG-3	37.50	38.53	38.01
TAG-4	42.96	44.14	43.55
TAG-5	43.87	46.48	45.17
TAG-6	35.23	36.12	35.68
TAG-7	35.49	37.35	36.42
TAG-8	35.67	33.89	34.78
TAG-9	36.81	36.25	36.53
Pundibari Local-1	39.19	40.27	39.73
Pundibari Local-2	40.46	40.36	40.41
Panji Local	38.60	34.93	36.77
Basirhat	37.98	39.02	38.50
Nagaland Local -1	39.19	39.14	39.16
Nagaland Local -2	41.43	40.62	41.03
SEm(±)	0.64	0.67	0.43
CD	1.79	1.88	1.25
CV(%)	2.79	2.94	1.56

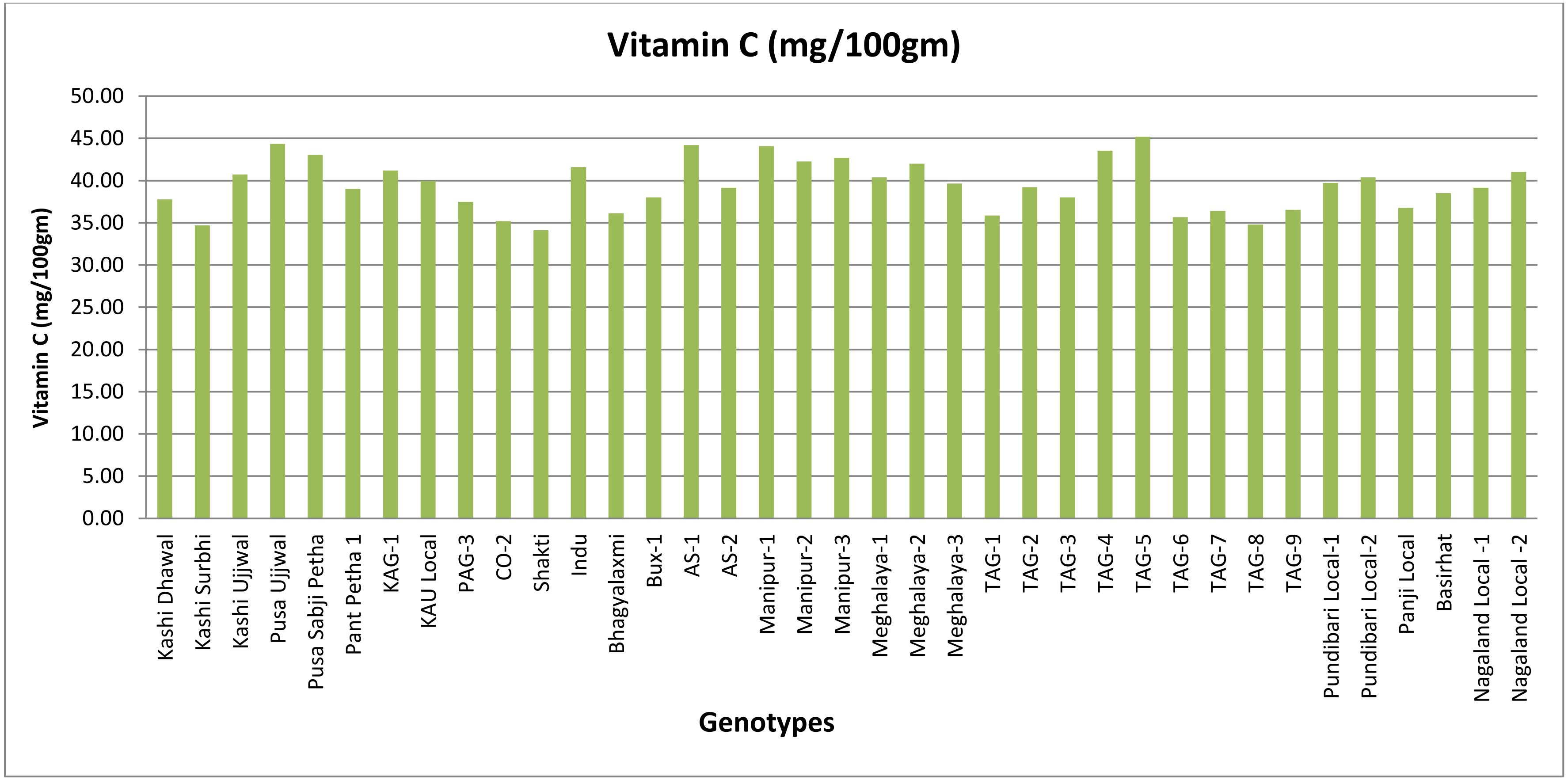

Fig 4.27 Performance of various genotypes of ash gourd on ascorbic acid.

Table 4.38 Performance of various genotypes of ash gourds on aroma status.

Genotypes	Aroma Status
Kashi Dhawal	Absent
Kashi Surbhi	Absent
Kashi Ujjwal	Absent
Pusa Ujjwal	Absent
Pusa Sabji Petha	Absent
Pant Petha 1	Absent
KAG-1	Absent
KAU Local	Absent
PAG-3	Absent
CO-2	Absent
Shakti	Absent
Indu	Absent
Bhagyalaxmi	Absent
Bux-1	Absent
AS-1	Present
AS-2	Absent
Manipur-1	Absent
Manipur-2	Absent
Manipur-3	Absent
Meghalaya-1	Absent
Meghalaya-2	Present
Meghalaya-3	Absent
TAG-1	Absent
TAG-2	Absent
TAG-3	Absent
TAG-4	Absent
TAG-5	Absent
TAG-6	Absent
TAG-7	Absent
TAG-8	Absent
TAG-9	Absent
Pundibari Local-1	Absent
Pundibari Local-2	Absent
Panji Local	Absent
Basirhat	Present
Nagaland Local -1	Absent
Nagaland Local -2	Absent

ranged from 6.82 cm to 20.50 cm with mean performance of 11.64 cm, days to 1st female flower ranged from 60.50 to 91.12 with mean performance of 74.46, nodes at first female flower ranged from 9.25 to 29.93 with mean performance of 19.61, ovary length ranged from 2.12 cm to 4.58 cm with mean performance of 2.92 cm, peduncle length ranged from 3.30 cm to 9.37 cm with mean performance of 6.47 cm, fruit length ranged from 13.65 cm to 50.30 cm with mean performance of 24.02 cm, fruit width ranged from 8.63 cm to 56.15 cm with mean performance of 18.53 cm, flesh thickness ranged from 2.80 cm to 5.50 cm with mean performance of 3.84 cm, seediness ranged from 316.21 to 1478.23 with mean performance of 703.16, seed length ranged from 0.68 cm to 1.38 cm with mean performance of 1.06 cm, seed width ranged from 0.35 cm to 0.85 cm with mean performance of 0.57 cm, crop duration ranged from 103.48 to 140.40 with mean performance of 121.09, number of fruits per plant ranged from 3.23 to 7.16 with mean performance of 4.98, average fruit weight ranged from 1827.36 g cm to 5762.25 g with mean performance of 3132.52 g, 100 seed weight ranged from 2.87 g to 5.64 g with mean performance of 4.42 g, yield per plant ranged from 8.43 kg to 23.41 kg with mean performance of 15.09 kg, yield per hectare ranged from 351.26 q to 975.22 q with mean performance of 628.92 q, TSS ranged from 1.31°brix to 3.00 °brix with mean performance of 2.17 °brix and ascorbic acid content ranged from 34.13 mg/100g to 45.17 mg/100g with mean performance of 39.64 mg/100g.

4.4.2 Estimation of coefficients of variation

The component of variation such as genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) have been computed. It is essential to know about the selection by separating out the environmental influences from total variability. This indicates the accuracy with which a genotype can be identified by its phenotypic performance. Genotypic and phenotypic coefficient of variation are simple measure of variability, these measures are commonly used for the assessment of variability. The relative value of these types of coefficients gives an idea about the magnitude of variability present in a genetic population. Thus, the component of variation such as genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were computed. The phenotypic coefficient of variation was marginally higher than the corresponding genotypic coefficient of variation indicated the influence of environment in the expression of the character under study.

Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are categorized as low (less than 10%), Moderate (10-20 %) and high (more than 20 %) as suggested by Sivasubramanian and Madhavamenon (1973).

Phenotypic and genotypic coefficients of variation of different characters are presented in table 4.39 and 4.40. High magnitude of genotypic as well as phenotypic coefficient of variations were recorded for traits viz., Seediness (44.197 and 44.09), fruit diameter (32.49 and 52.41), average fruits weight (32.308 and 32.27), number of lobes (21.73 and 21.63), peduncle length (25.72 and 25.651), petiole length (22.25 and 22.02), fruit length (25.82 and 25.68), seed width (24.84 and 24.62), number of fruit per plant (21.93 and 21.81), nodes at which first female flower appears (28.54 and 28.48), yield per plant (25.35 and 25.11) and yield per hectare (25.35 and 25.11). This high value of PCV and GCV indicated that maximum variability exists in these traits and there is enough scope for further improvement. These findings are in line with Lakshmi *et al* (2002) in pumpkin.

Moderate PCV and GCV were recorded for suggested existence of considerable variability in the population viz. Cotyledon length (13.12 and 12.88), cotyledon width (18.85 and 18.78), internodal length (15.97 and 15.81), number of primary branches (12.38 and 12.01), vine length (18.55 and 18.28), seed length (18.32 and 18.05), Leaf length (16.32 and 16.00), days to first female flower (10.64 and 10.51), ovary length (17.25 and 16.96), flesh thickness (18.32 and 18.05), 100 seed weight (17.90 and 17.80) and TSS (19.60 and 19.53). Selection for these traits may also be given the importance for improvement programme. In line with present experimental findings high PCV and GCV for various characters also been reported by Yadav *et al.* (2013) in bitter gourd genotypes.

Low PCV and GCV were found in the characters like crop duration (8.51 and 8.36) and Ascorbic acid content (7.88 and 7.71). Selection for these traits may not have significant effect for improvement programme. Similar finding were also reported earlier by Rahman *et al*. (1986), Singh and Kumar (2002), Munshi and Acharyya (2005), Gayen and Hossain (2006) and Pandit *et al.* (2009) in different cucurbitaceous crops.

Phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the traits indicating that environmental factors were influencing the expression of traits. Narrow difference between phenotypic and genotypic coefficient of variations indicated less environmental interference on the expression of these traits. The traits which showed high phenotypic and genotypic coefficient of variations are of economic importance and there is scope for improvement of these traits through selection.

4.2.3 Heritability (h^2_{bs}) and Genetic advance (GA)

Heritability governed the resemblance between parents and their progeny whereas, the genetic advance provide the knowledge about expected gain for a particular character after selection. Heritability suggests the relative role of genetic factors in expression of phenotypes and also act as an index of transmissibility of a particular trait to its off springs. However, the knowledge of heritability alone does not help to formulating concrete breeding programme, genetic advance along with heritability help to ascertain the possible genetic control for any particular trait. The nature and extent of the inherent ability of a genotype for a character is an important parameter determining the extent of improvement of any crop species. Heritability and genetic advance are the important genetic parameters for selecting a genotype that permit greater effectiveness of selection by separating out environmental influence from total variability.

Heritability estimate provide the information regarding the amount of transmissible genetic variation to total variation and determine genetic improvement and response to selection. Heritability estimate along genetic advance are normally more useful in predicting the gain under selection than that of heritability alone. However, it is not necessary that a character showing high heritability will also exhibit high genetic advance. The heritability usually considered to be low if it is less than 30%, moderate between (30-60%) and high f it is more than 60% (Johnson *et al.* 1955). Heritability estimate provide the information regarding the amount of transmissible genetic variation to total variation and determine genetic improvement and response to selection. Heritability estimate along genetic advance are normally more useful in predicting the gain under selection than that of heritability alone.

Among the twenty five characters estimated in this experiment all the characters have shown heritability above 90% in which the highest heritability in broad sense was observed in average fruit weight (99.75 %) and the lowest was observed in number of primary branches (94.01%) as shown in table 4.38 and 4.39.

The heritability value alone however, provides no indication of the amount of genetic improvement that would result from selection of superior genotypes. To facilitate the comparison of progress in various characters of different genotypes, genetic advance was calculated as percentage of mean. The range of genetic advance as percent of mean is classified as low if it is

Table 4.39 Genetic parameters on growth attributes of thirty seven ash gourd genotypes during 2018-19.

Characters	Year	Mean	Range		Coefficient of variance		Heritability (%)	Genetic advance as % of mean
			Min.	Max.	PVC (%)	GCV (%)		
Cotyledon length (cm)	2018	2.89	2.31	4.16	15.235	12.212	64.25	20.164
	2019	2.853	2.20	4.00	15.163	11.714	59.683	18.642
	Pooled	2.88	2.30	4.08	13.12	12.88	96.36	26.04
Cotyledon width (cm)	2018	1.56	1.15	2.35	19.804	18.433	86.636	35.344
	2019	1.55	1.13	2.29	19.495	18.458	89.645	36.002
	Pooled	1.56	1.15	2.32	18.855	18.78	99.20	38.53
Length of internodes (cm)	2018	13.52	8.93	17.56	17.01	15.647	84.616	29.649
	2019	13.406	8.91	18.34	16.806	15.459	84.609	29.292
	Pooled	13.42	8.92	17.95	15.972	15.81	97.99	32.24
Number of primary branches	2018	3.35	2.67	4.10	14.535	11.55	63.143	18.91
	2019	3.287	2.75	3.92	15.828	10.403	43.194	14.084
	Pooled	3.33	2.71	4.00	12.389	12.01	94.01	23.99
Vine length (m)	2018	6.05	3.85	8.04	19.041	18.357	92.946	36.457
	2019	5.938	3.75	8.15	19.071	18.521	94.318	37.054
	Pooled	6.01	3.80	7.98	18.558	18.28	96.99	37.08
Leaf length (cm)	2018	13.35	10.27	18.22	17.164	16.37	90.954	32.16
	2019	13.147	10.27	17.45	17.513	16.435	88.07	31.773
	Pooled	13.14	10.37	17.59	16.322	16.00	96.06	32.30
Leaf width (cm)	2018	18.32	13.54	24.20	17.073	16.167	89.673	31.53
	2019	18.013	13.28	24.14	17.757	16.997	91.622	33.515
	Pooled	18.07	13.41	23.97	16.771	16.46	96.38	33.30

Characters	Year	Mean	Range		Coefficient of variance		Heritability (%)	Genetic advance as % of mean
			Min.	Max.	PVC (%)	GCV (%)		
Number of lobes	2018	5.83	1.05	7.34	22.105	21.969	98.77	44.97
	2019	5.703	0.98	7.20	21.634	21.496	98.725	43.999
	Pooled	5.81	1.01	7.10	21.731	21.63	99.11	44.37
Petiole length (cm)	2018	11.85	7.00	19.96	22.635	21.499	90.217	42.066
	2019	11.709	6.65	21.03	24.227	23.266	92.22	46.026
	Pooled	11.64	6.82	20.50	22.251	22.02	97.92	44.88
Days to first feamle flower appers	2018	74.01	60.79	92.00	10.933	10.695	95.696	21.552
	2019	74.026	60.20	90.23	10.844	10.498	93.712	20.934
	Pooled	74.46	60.50	91.12	10.64	10.51	97.52	21.38
Nodes at which first female flower appears	2018	19.25	9.29	30.66	27.737	27.513	98.395	56.221
	2019	19.329	9.20	29.80	27.716	27.484	98.336	56.145
	Pooled	19.61	9.25	29.93	28.547	28.48	99.55	58.54
Ovary length (cm)	2018	2.97	2.14	4.62	18.454	16.671	81.61	31.024
	2019	2.908	2.10	4.53	16.801	15.077	80.53	27.871
	Pooled	2.92	2.12	4.58	17.25	16.96	96.62	34.33
Peduncle length (cm)	2018	6.54	3.34	9.30	25.853	25.283	95.64	50.935
	2019	6.443	3.26	9.47	26.147	25.545	95.452	51.412
	Pooled	6.47	3.30	9.37	25.724	25.51	98.35	52.12
Fruit length (cm)	2018	24.40	13.78	50.92	25.683	25.406	97.85	51.77
	2019	23.99	13.51	49.69	25.853	25.639	98.34	52.379
	Pooled	24.02	13.65	50.30	25.827	25.68	98.87	52.60

Characters	Year	Mean	Range		Coefficient of variance		Heritability (%)	Genetic advance as % of mean
			Min.	**Max.**	**PVC (%)**	**GCV (%)**		
Fruit diameter (cm)	2018	18.78	8.76	55.96	51.934	51.822	99.57	106.52
	2019	18.468	8.51	56.33	52.51	52.396	99.568	107.704
	Pooled	18.53	8.63	56.15	52.499	52.41	99.68	107.80
Flesh thickness (cm)	2018	3.90	2.75	5.34	18.441	18.265	98.101	37.267
	2019	3.825	2.82	5.66	18.647	18.47	98.114	37.687
	Pooled	3.84	2.80	5.50	18.321	18.05	97.03	36.62
Seediness	2018	734.75	318.63	1489.54	45.393	45.186	99.088	92.657
	2019	722.55	313.79	1466.92	46.494	46.281	99.087	94.903
	Pooled	703.16	316.21	1478.23	44.197	44.09	99.52	90.61
Seed length (cm)	2018	1.07	0.69	1.45	17.083	14.89	75.968	26.734
	2019	1.052	0.67	1.32	17.615	15.982	82.313	29.869
	Pooled	1.06	0.68	1.38	18.321	18.05	97.03	36.62
Seed width (cm)	2018	0.57	0.35	0.86	24.64	24.011	94.922	48.19
	2019	0.567	0.34	0.85	25.756	25.13	95.203	50.512
	Pooled	0.57	0.35	0.85	24.845	24.62	98.20	50.26
Crop Duration (days)	2018	121.65	101.97	143.82	9.337	8.803	88.894	17.09
	2019	121.531	105.00	137.50	8.632	8.329	93.109	16.556
	Pooled	121.09	103.48	140.40	8.515	8.36	96.41	16.91

Table 4.40 Genetic parameters on yield and qualitative attributes of thirty seven ash gourd genotypes during 2018-19.

Characters	Year	Mean	Range		Coefficient of variance		Heritability (%)	Genetic advance as % of mean
			Min.	Max.	PVC (%)	GCV (%)		
Number of fruits per plant	2018	4.94	3.33	7.16	23.228	22.382	92.854	44.42
	2019	4.937	3.13	7.23	23.195	23.002	98.348	46.992
	Pooled	4.98	3.23	7.16	21.931	21.81	98.89	44.68
Average fruits weight(g)	2018	3167.46	1828.48	5711.46	31.802	31.691	99.305	65.057
	2019	3,166.78	1826.23	5819.45	31.681	31.55	99.174	64.723
	Pooled	3132.52	1827.36	5762.25	32.308	32.27	99.75	66.39
100 seed wt (g)	2018	4.49	2.93	5.75	17.739	17.574	98.156	35.86
	2019	4.403	2.81	5.53	18.3	18.141	98.265	37.045
	Pooled	4.42	2.87	5.64	17.905	17.80	98.82	36.45
TSS	2018	2.15	1.30	3.00	20.802	20.558	97.67	41.85
	2019	2.156	1.31	3.00	20.932	20.625	97.092	41.866
	Pooled	2.17	1.31	3.00	19.607	19.53	99.24	40.08
Vitamin C (mg/100gm)	2018	39.45	34.12	44.65	7.865	7.474	90.29	14.63
	2019	39.458	33.87	46.48	8.607	8.257	92.031	16.318
	Pooled	39.64	34.13	45.17	7.888	7.71	95.55	15.53
Yield/Plant(kg)	2018	15.12	8.74	22.94	25.83	24.906	92.977	49.47
	2019	15.097	8.12	23.87	25.664	24.991	94.821	50.131
	Pooled	15.09	8.43	23.41	25.358	25.11	98.07	51.23
Yield/ha(q)	2018	630.11	364.03	955.86	25.832	24.907	92.97	49.474
	2019	626.965	338.32	994.58	25.43	25.306	99.023	51.875
	Pooled	628.92	351.26	975.22	25.359	25.11	98.07	51.23

less than 10%, moderate between (10-20%) and high if more than 20% (Johnson *et al.,* 1955).

Genetic advance as percentage of mean was observed highest for seediness (90.61%) whereas cotyledon length (26.04%), cotyledon width (38.53%), intermodal length (32.24%), number of primary branches (23.99%), vine length (37.08), leaf length (32.30%), leaf width (33.30%), number of lobes (44.37%), petiole length (44.88%), days to first female flower appears (21.38%), nodes at which first female flower appears (58.54%), ovary length (34.33%), peduncle length (52.12%), fruit length (52.60%), fruit diameter (107.80%), flesh thickness (36.62%), seed length (36.62%), seed width (50.26%), number of fruits per plant (44.68%), average fruit weight (66.39%), 100 seed weight (36.45 %), yield/ plant (51.23%), yield/hectare(51.23%) and TSS (40.08%) have shown high genetic advance. Moreover, crop duration (16.91%) and vitamin C (15.53%) have shown moderate genetic advance. The high value of genetic advance for these traits showed that these characters are governed by additive genes and selection will be rewarding for the further improvement of these traits. Moderate genetic advance for the traits suggest that both the additive and non-additive variance are operating in these traits. The results are in conformity with Singh *et al*. (2002) and Kumar *et al.* (2011) in bottle gourd genotypes.

Heritability estimates along with genetic advance are more useful than the heritability value alone for selecting the best individual. In present experiment it is found that almost all the characters are showing high heritability and also high genetic advance except crop duration and ascorbic acid content. However, among these few most suitable character for selection with high heritability coupled with high genetic advance as percentage of mean was observed for traits like seediness (99.52% and 90.61%), fruit diameter (99.68% and 107.80%), fruit length (98.87% and 52.60%), peduncle length (98.35 % and 52.12%), seed width (98.20% and 50.26%), average fruit weight (99.75% and 66.39%), nodes of 1st female flower (99.55% and

58.54%), yield per plant (98.07% and 51.23%) indicating that most likely the heritability is due to additive gene effects and selection may be effective.

4.2.4 Correlation analysis

Association analysis is an important approach in a crop improvement programme. It gives an idea about relationship among the various characters and determines the component characters, on which selection can be used for genetic improvement in the fruit yield. The degree of association also affects the effectiveness of selection process. The degree of association between independent and dependent variables was first suggested by Galton (1888) and its theory was developed by Pearson (1904) and their mathematical utilization at phenotypic, genotypic and environmental levels was described by Searle (1961).

The major causes underlying association are either due to pleiotropic gene action or linkage or both. The phenotypic correlation includes a genotypic and environmental effect, which provides information about total association between the observable characters. Genotypic correlation provided a measure of genetic association between the characters and normally used in selection, while environmental as well as genetic architecture of a genotype plays a great role in achieving higher yield combined with better quality.

The phenotypic and genotypic correlation for fruit yield and its component in ash gourd are presented in table 4.41 and 4.42, respectively and only significant correlations are discussed here.

Cotyledon length exhibited significant positive correlation with cotyledon width (0.649 and 0.650), intermodal length (0.347 and 0.336), number of primary branches (0.324 and 0.302), leaf length (0.434 and 0.444), leaf width (0.490 and 0.502), petiole length (0.595 and 0.616), flesh thickness (0.522 and 0.512), seed length (0.406 and 0.424), seed width (0.276 and 0.288), average fruit weight (0.557 and 0.567) and yield per plant (0.295 and 0.305) at both phenotypic and genotypic levels, respectively. Cotyledon length exhibited significant negative correlation with number of fruit per plant (-0.353 and -00.358) at both phenotypic and genotypic levels, respectively.

Cotyledon width exhibited significant positive correlation with internodal length (0.338 and 0.333), number of primary branches (0.271 and 0.264), leaf length (0.487 and 0.496), leaf width (0.560 and 0.571), petiole length (0.635 and 0.646), flesh thickness (0.561 and 0.559), seed length (0.494 and 0.509), seed width (0.437 and 0.446), average fruit weight (0.563 and 0.565) and 100 seed weight (0.353 and 0.358) at both phenotypic and genotypic levels, respectively. Cotyledon width exhibited significant negative correlation with nodes at first female flower (-0.341 and -0.344) and number of fruit per plant (-0.616 and -0.622) at both phenotypic and genotypic levels, respectively.

Internodal length exhibited significant positive correlation with leaf length (0.596 and 0.605), leaf width (0.623 and 0.633), number of lobes (0.281 and 0.287), petiole length (0.594 and 0.607), flesh thickness (0.316 and 0.302), seed length (0.339 and 0.351), seed width (0.434 and 0. 444), crop duration (0.340 and 0.349), average fruit weight (0.332 and 0.335) and 100 seed weight (0.301 and 0.306) at both phenotypic and genotypic levels, respectively. Internodal length exhibited significant negative correlation with nodes at first female flower (-0.244 and -0.249) and number of fruit per plant (-0.333 and -0.339) at both phenotypic and genotypic levels, respectively.

Number of primary branches exhibited significant positive correlation with leaf length (0.323.and 0.325), leaf width (0.386 and 0.393), petiole length (0.416 and 0.432), average fruit weight (0.318 and 0.327) and 100 seed weight (0.250 and (0.259) at both phenotypic and genotypic levels, respectively. Number of primary branches exhibited significant negative correlation with nodes at first female flower (-0.270 and -0.283) at both phenotypic and genotypic levels, respectively.

Vine length exhibited significant positive correlation with leaf length (0.290.and 0.276), leaf width (0.279 and 0.265), days to first female flower (0.231 and 0.238), fruit length (0.408 and 0.404), average fruit weight (0.318

and 0.323), TSS (0.276 and 0.282) and yield per plant (0.359 and 0.368) at both phenotypic and genotypic levels, respectively. Vine length exhibited significant negative correlation with peduncle length (-0.245 and -0.266) at both phenotypic and genotypic levels, respectively.

Leaf length exhibited significant positive correlation with leaf width (0.941 and 0.940), number of lobes (0.263 and 0.271), petiole length (0.729 and 0.733), flesh thickness (0.530 and 0.540), seed length (0.336 and 0.320), seed width (0.473 and 0.468), average fruit weight (0.522 and 0.532) and 100 seed weight (0.396 and (0.400) at both phenotypic and genotypic levels, respectively. Leaf length exhibited significant negative correlation with nodes at first female flower (-0.369 and -0.379) and number of fruit per plant (-0.579 and -0.596) at both phenotypic and genotypic levels, respectively.

Leaf width exhibited significant positive correlation with number of lobes (0.315 and 0.324), petiole length (0.805 and 0.812), flesh thickness (0.570 and 0.582), seed length (0.427 and 0.351), seed width (0.522 and 0. 444), average fruit weight (0.589 and 0.335) and 100 seed weight (0.416 and 0.306) at both phenotypic and genotypic levels, respectively. Leaf width exhibited significant negative correlation with nodes at first female flower (-0.332 and -0.340) and number of fruit per plant (-0.549 and -0.564) at both phenotypic and genotypic levels, respectively.

Number of lobes exhibited significant positive correlation with petiole length (0.300 and 0.308), flesh thickness (0.307 and 0.314) and 100 seed weight (0.291 and 0.288) at both phenotypic and genotypic levels, respectively whereas vitamin C content (0.235) also exhibited positive correlation with number of lobes at genotypic level only. Number of lobes exhibited significant negative correlation with number of fruit per plant (-0.262 and -0.265) at both phenotypic and genotypic levels, respectively.

Petiole length exhibited significant positive correlation with flesh thickness (0.542 and 0.558), seed length (0.553 and 0.552), seed width (0.571 and 0. 570), crop duration (0.364 and 0.383), average fruit weight (0.583 and 0.592) and 100 seed weight (0.288 and 0.293) at both phenotypic and genotypic levels, respectively. Petiole length exhibited significant negative correlation with nodes at first female flower (-0.245 and -0.248) and number of fruit per plant (-0.553 and -0.559) at both phenotypic and genotypic levels, respectively.

Days to first female flower significant positive correlation with nodes at first female flower (0.573 and 0.573) at both phenotypic and genotypic levels, respectively.

Nodes at first female flower exhibited significant positive correlation with fruit diameter (0.235 and 0.236), number of fruit per plant (0.259 and 0.257), TSS (0.246 and 0.243), ascorbic acid content (0.349 and 0.346) at both phenotypic and genotypic levels, respectively. Nodes at first female flower exhibited significant negative correlation with ovary length (-0.390 and -0.399) and 100 seed weight (-0.497 and -0.502) at both phenotypic and genotypic levels, respectively.

Ovary length exhibited significant negative correlation with seed length (-0.404 and -0.416), seed width (-0.403 and -0.409) at both phenotypic and genotypic levels, respectively.

Peduncle length exhibited significant positive correlation with seed width (0.308 and 0.301) at both phenotypic and genotypic levels, respectively. Peduncle length exhibited significant negative correlation with number of fruit per plant (-0.229 and -0.234) and TSS (-0.292 and -0.296) at both phenotypic and genotypic levels, respectively.

Fruit length exhibited significant positive correlation with average fruit weight (0.243 and 0.276) and yield per plant (0.266 and 0.274) at both phenotypic and genotypic levels, respectively.

Fruit diameter exhibited significant positive correlation with seed length (0.465 and 0.466), seed width (0.503 and 0. 504), crop duration (0.534 and 0.545), and yield per plant (0.304 and 0.307) at both phenotypic and genotypic levels, respectively.

Flesh thickness exhibited significant positive correlation with seed length (0.418 and 0.436), seed width (0.404 and 0.417), average fruit weight (0.553 and 0.560) and 100 seed weight (0.331 and 0.339), TSS (0.292 and 0.295) and ascorbic acid content (0.302 and 0.310) both phenotypic and genotypic levels, respectively. Flesh thickness exhibited significant negative correlation with number of fruit per plant (-0.556 and -0.568) at both phenotypic and genotypic levels, respectively.

Seed length exhibited significant positive correlation with seed width (0.850 and 0.851), crop duration (0.472 and 0.494), average fruit weight (0.563 and 0.575), 100 seed weight (0.232 and 0.230), TSS (0.305 and 0.313) and yield per plant (0.277 and 0.286) at both phenotypic and genotypic levels, respectively. Seed length exhibited significant negative correlation with number of fruit per plant (-0.443 and -0.454) at both phenotypic and genotypic levels, respectively.

Seed width exhibited significant positive correlation with crop duration (0.423 and 0.436), average fruit weight (0.559 and 0.564) and yield per plant (0.337 and 0.342) at both phenotypic and genotypic levels, respectively. Seed width exhibited significant negative correlation with number of fruit per plant (-0.383 and -0.389) at both phenotypic and genotypic levels, respectively

Table 4.41 Phenotypic correlation coefficient between fruit yield and its component characters in ash gourd.

	CL	CW	LOI	NPB	VL	LL	LW	NOL	PL	DFFF	NFFF	OL	PEDL	FL	FD	FT	SEE	SL	SW	CD	NFP	AFW	SEW	TSS	VC	YIP
CL																										
CW	0.649**																									
LOI	0.347**	0.338**																								
NPB	0.324**	0.271*	0.122^{NS}																							
VL	0.101^{NS}	-0.125^{NS}	0.086^{NS}	-0.167^{NS}																						
LL	0.434**	0.487**	0.596**	0.323**	0.290*																					
LW	0.490**	0.561**	0.623**	0.386**	0.279*	0.941**																				
NOL	0.177^{NS}	0.194^{NS}	0.281*	0.089^{NS}	-0.064^{NS}	0.263*	0.315**																			
PL	0.595**	0.635**	0.594**	0.416**	0.044^{NS}	0.729**	0.805**	0.300**																		
DFFF	-0.093^{NS}	-0.220^{NS}	-0.033^{NS}	-0.132^{NS}	0.231*	-0.023^{NS}	-0.048^{NS}	-0.118^{NS}	-0.148^{NS}																	
NFFF	-0.098^{NS}	-0.341**	-0.244*	-0.270*	0.166^{NS}	-0.369**	-0.332**	-0.201^{NS}	-0.245*	0.573**																
OL	-0.173^{NS}	-0.117^{NS}	0.133^{NS}	0.155^{NS}	-0.068^{NS}	-0.104^{NS}	-0.112^{NS}	-0.160^{NS}	-0.053^{NS}	-0.117^{NS}	-0.390**															
PEDL	-0.036^{NS}	0.081^{NS}	0.227^{NS}	0.189^{NS}	-0.245*	0.220^{NS}	0.224^{NS}	0.075^{NS}	0.206^{NS}	-0.048^{NS}	-0.151^{NS}	-0.023^{NS}														
FL	0.184^{NS}	0.076^{NS}	-0.016^{NS}	-0.121^{NS}	0.408**	0.038^{NS}	-0.006^{NS}	-0.000^{NS}	-0.090^{NS}	0.104^{NS}	-0.064^{NS}	0.051^{NS}	-0.163^{NS}													
FD	0.005^{NS}	-0.179^{NS}	0.123^{NS}	-0.091^{NS}	0.069^{NS}	-0.151^{NS}	-0.115^{NS}	0.034^{NS}	0.086^{NS}	-0.213^{NS}	0.235*	-0.163^{NS}	-0.043^{NS}	0.195^{NS}												
FT	0.522**	0.561**	0.316**	0.232*	0.122^{NS}	0.530**	0.570**	0.307**	0.542**	-0.112^{NS}	-0.076^{NS}	-0.066^{NS}	0.059^{NS}	0.209^{NS}	-0.030^{NS}											
SEE	-0.214^{NS}	-0.111^{NS}	0.194^{NS}	0.053^{NS}	0.172^{NS}	0.181^{NS}	0.107^{NS}	0.103^{NS}	0.038^{NS}	0.146^{NS}	-0.025^{NS}	0.069^{NS}	0.218^{NS}	0.076^{NS}	-0.061^{NS}	0.090^{NS}										
SL	0.406**	0.494**	0.339**	0.142^{NS}	0.135^{NS}	0.336**	0.438**	0.219^{NS}	0.553**	-0.191^{NS}	0.007^{NS}	-0.404**	0.133^{NS}	0.156^{NS}	0.465**	0.418**	0.002^{NS}									
SW	0.276*	0.437**	0.434**	0.125^{NS}	0.126^{NS}	0.473**	0.526**	0.145^{NS}	0.571**	-0.179^{NS}	-0.059^{NS}	-0.403**	0.308**	0.117^{NS}	0.503**	0.404**	0.064^{NS}	0.850**								
CD	0.182^{NS}	0.136^{NS}	0.340**	0.161^{NS}	0.097^{NS}	0.088^{NS}	0.196^{NS}	0.200^{NS}	0.364**	-0.182^{NS}	0.079^{NS}	-0.043^{NS}	0.212^{NS}	-0.014^{NS}	0.534**	0.108^{NS}	0.207^{NS}	0.472**	0.423**							
NFP	-0.353**	-0.616**	-0.333**	-0.189^{NS}	-0.039^{NS}	-0.579**	-0.549**	-0.262*	-0.553**	0.114^{NS}	0.259*	0.103^{NS}	-0.229*	-0.046^{NS}	0.222^{NS}	-0.556**	-0.225^{NS}	-0.443**	-0.383**	0.100^{NS}						
AFW	0.557**	0.563**	0.332**	0.318**	0.318**	0.522**	0.579**	0.075^{NS}	0.583**	0.022^{NS}	-0.166^{NS}	-0.159^{NS}	0.185^{NS}	0.273*	0.088^{NS}	0.553**	0.068^{NS}	0.563**	0.559**	0.273*	-0.482**					
SEW	0.215^{NS}	0.353**	0.301**	0.250*	-0.186^{NS}	0.396**	0.412**	0.291*	0.288*	-0.124^{NS}	-0.497**	0.011^{NS}	0.185^{NS}	0.207^{NS}	-0.189^{NS}	0.331**	0.196^{NS}	0.232*	0.138^{NS}	0.133^{NS}	-0.300**	0.425**				
TSS	0.098^{NS}	0.017^{NS}	-0.026^{NS}	-0.155^{NS}	0.276*	-0.085^{NS}	-0.081^{NS}	-0.197^{NS}	0.055^{NS}	-0.131^{NS}	0.246*	-0.062^{NS}	-0.292*	0.164^{NS}	0.181^{NS}	0.292*	-0.049^{NS}	0.305**	0.162^{NS}	-0.120^{NS}	-0.249*	0.075^{NS}	-0.276*			
VC	0.028^{NS}	0.034^{NS}	0.039^{NS}	-0.047^{NS}	-0.005^{NS}	-0.058^{NS}	-0.083^{NS}	0.228^{NS}	0.026^{NS}	0.115^{NS}	0.349**	-0.109^{NS}	0.086^{NS}	-0.123^{NS}	-0.152^{NS}	0.302**	0.065^{NS}	0.059^{NS}	-0.087^{NS}	-0.100^{NS}	-0.487**	-0.009^{NS}	-0.220^{NS}	0.430**		
YIP	0.295*	0.102^{NS}	0.060^{NS}	0.211^{NS}	0.359**	0.137^{NS}	0.213^{NS}	-0.160^{NS}	0.195^{NS}	0.084^{NS}	0.013^{NS}	-0.118^{NS}	-0.018^{NS}	0.266*	0.304**	0.167^{NS}	-0.114^{NS}	0.277*	0.337**	0.370**	0.264*	0.708**	0.200^{NS}	-0.087^{NS}	-0.412**	
YPH	0.295*	0.102^{NS}	0.060^{NS}	0.211^{NS}	0.359**	0.137^{NS}	0.213^{NS}	-0.160^{NS}	0.195^{NS}	0.085^{NS}	0.013^{NS}	-0.118^{NS}	-0.018^{NS}	0.266*	0.304**	0.167^{NS}	-0.113^{NS}	0.277*	0.337**	0.370**	0.264*	0.708**	0.200^{NS}	-0.087^{NS}	-0.412**	1.000**

CL-Cotyledon length, CW: Cotyledon width, LOI: Internodal length, NPB: number of primary branches, VL: Vine length, LL: Leaf length, LW: Leaf width, NOL Number of Lobes, PL: Petiole length , DFFF: Days to first female flower, NFFF: Nodes of first female flower, OL: Ovary length, PEDL: Peduncle length, FL: Fruit length, FD: Fruit diameter, FT: Flesh thickness, SEE: Seediness, SL: Seed length, SW: Seed width, CD: Crop duration, NFP : Number of fruit per plant, AFW: Average fruit weight,SEW: 100 seed weight, TSS: TSS, VC: Ascorbic acid content.

Table 4.42 Genotypic correlation coefficient between fruit yield and its component characters in ash gourd.

	CL	CW	LOI	NPB	VL	LL	LW	NOL	PL	DFFF	NFFF	OL	PEDL	FL	FD	FT	SEE	SL	SW	CD	NFP	AFW	SEW	TSS	VC	YIP
CL																										
CW	0.650**																									
LOI	0.336**	0.333**																								
NPB	0.302**	0.264*	0.093^{NS}																							
VL	0.108^{NS}	-0.124 ^{NS}	0.092^{NS}	-0.171^{NS}																						
LL	0.444**	0.496**	0.605**	0.325**	0.276*																					
LW	0.502**	0.571**	0.633**	0.393**	0.265*	0.940**																				
NOL	0.181^{NS}	0.196^{NS}	0.287*	0.095^{NS}	-0.067^{NS}	0.271*	0.324**																			
PL	0.616**	0.646**	0.607**	0.432**	0.028NS	0.733**	0.812**	0.308**																		
DFFF	-0.097^{NS}	-0.224 ^{NS}	-0.033^{NS}	-0.137 ^{NS}	0.238*	-0.025^{NS}	-0.052^{NS}	-0.120^{NS}	-0.147^{NS}																	
NFFF	-0.102^{NS}	-0.344**	-0.249*	-0.283*	0.169^{NS}	-0.379**	-0.340**	-0.202^{NS}	-0.248*	0.573**																
OL	-0.209^{NS}	-0.134^{NS}	0.113^{NS}	0.120^{NS}	-0.067^{NS}	-0.114^{NS}	-0.121^{NS}	-0.163^{NS}	-0.051^{NS}	-0.118^{NS}	-0.399**															
PEDL	-0.043^{NS}	0.080^{NS}	0.225^{NS}	0.186^{NS}	-0.266*	0.201^{NS}	0.207^{NS}	0.076^{NS}	0.199^{NS}	-0.050^{NS}	-0.154^{NS}	-0.029^{NS}														
FL	0.189^{NS}	0.078^{NS}	-0.016^{NS}	-0.127^{NS}	0.404**	0.025^{NS}	-0.019^{NS}	0.002^{NS}	-0.107^{NS}	0.109^{NS}	-0.064^{NS}	0.054^{NS}	-0.173^{NS}													
FD	0.002^{NS}	-0.181^{NS}	0.123^{NS}	-0.096^{NS}	0.063^{NS}	-0.164^{NS}	-0.126^{NS}	0.033^{NS}	0.084^{NS}	-0.216^{NS}	0.236*	-0.168^{NS}	-0.050^{NS}	0.193^{NS}												
FT	0.512**	0.559**	0.302**	0.203^{NS}	0.129^{NS}	0.540**	0.582**	0.314**	0.558**	-0.117^{NS}	-0.079^{NS}	-0.099^{NS}	0.054^{NS}	0.214^{NS}	-0.033^{NS}											
SEE	-0.222^{NS}	-0.113^{NS}	0.194^{NS}	0.052^{NS}	0.167^{NS}	0.173^{NS}	0.097^{NS}	0.104^{NS}	0.033^{NS}	0.147^{NS}	-0.026^{NS}	0.068^{NS}	0.213^{NS}	0.072^{NS}	-0.065^{NS}	0.089^{NS}										
SL	0.424**	0.509**	0.351**	0.153^{NS}	0.106^{NS}	0.320**	0.427**	0.222^{NS}	0.552**	-0.198^{NS}	0.007^{NS}	-0.416**	0.117^{NS}	0.146^{NS}	0.466**	0.436**	-0.008^{NS}									
SW	0.288*	0.446**	0.444**	0.133 ^{NS}	0.108 ^{NS}	0.468**	0.522**	0.147^{NS}	0.570**	-0.184 ^{NS}	-0.060 ^{NS}	-0.409**	0.301**	0.109 ^{NS}	0.504**	0.417**	0.059 ^{NS}	0.851**								
CD	0.185 ^{NS}	0.137 ^{NS}	0.349**	0.170 ^{NS}	0.104 ^{NS}	0.093 ^{NS}	0.203 ^{NS}	0.205 ^{NS}	0.383**	-0.217 ^{NS}	0.071 ^{NS}	-0.045 ^{NS}	0.218 ^{NS}	-0.009 ^{NS}	0.545**	0.109 ^{NS}	0.210 ^{NS}	0.494**	0.436**							
NFP	-0.358**	-0.622**	-0.339**	-0.195^{NS}	-0.039^{NS}	-0.596**	-0.564**	-0.265*	-0.559**	0.104^{NS}	0.257*	0.107^{NS}	-0.234*	-0.045^{NS}	0.223^{NS}	-0.568**	-0.227 ^{NS}	-0.454**	-0.389**	0.088 ^{NS}						
AFW	0.567**	0.565**	0.335**	0.327**	0.323**	0.532**	0.589**	0.075^{NS}	0.592**	0.015^{NS}	-0.170^{NS}	-0.163^{NS}	0.186^{NS}	0.276*	0.087^{NS}	0.560**	0.068^{NS}	0.575**	0.564**	0.269*	-0.489**					
SEW	0.221^{NS}	0.358**	0.306**	0.259*	-0.197^{NS}	0.400**	0.416**	0.288*	0.293*	-0.129^{NS}	-0.502**	0.011^{NS}	0.182^{NS}	0.211^{NS}	-0.193^{NS}	0.339**	0.196^{NS}	0.230*	0.135^{NS}	0.135^{NS}	-0.304**	0.428**				
TSS	0.096^{NS}	0.016^{NS}	-0.029^{NS}	-0.163^{NS}	0.282*	-0.088^{NS}	-0.084^{NS}	-0.199^{NS}	0.060^{NS}	-0.146^{NS}	0.243*	-0.065^{NS}	-0.296*	0.168^{NS}	0.182^{NS}	0.295*	-0.050^{NS}	0.313**	0.164^{NS}	-0.138^{NS}	-0.257*	0.072^{NS}	-0.279*			
VC	0.026^{NS}	0.034^{NS}	0.038^{NS}	-0.050^{NS}	-0.002^{NS}	-0.060^{NS}	-0.088^{NS}	0.235*	0.036^{NS}	0.086^{NS}	0.346**	-0.114^{NS}	0.089^{NS}	-0.120^{NS}	-0.156^{NS}	0.310**	0.065^{NS}	0.063^{NS}	-0.090^{NS}	-0.146^{NS}	-0.517**	-0.019^{NS}	-0.229*	0.424**		
YIP	0.305**	0.103^{NS}	0.060^{NS}	0.221^{NS}	0.368**	0.139^{NS}	0.216^{NS}	-0.163^{NS}	0.205^{NS}	0.067^{NS}	0.007^{NS}	-0.120^{NS}	-0.021^{NS}	0.274*	0.307**	0.170^{NS}	-0.116^{NS}	0.286*	0.342**	0.356**	0.255*	0.709**	0.201^{NS}	-0.099^{NS}	-0.453**	
YPH	0.305**	0.103^{NS}	0.060^{NS}	0.221^{NS}	0.368**	0.139^{NS}	0.216^{NS}	-0.164^{NS}	0.205^{NS}	0.067^{NS}	0.007^{NS}	-0.120^{NS}	-0.021^{NS}	0.274*	0.306**	0.170^{NS}	-0.116^{NS}	0.286*	0.342**	0.356**	0.255*	0.709**	0.201^{NS}	-0.099^{NS}	-0.453**	1.000**

CL-Cotyledon length, CW: Cotyledon width, LOI: Internodal length, NPB: number of primary branches, VL: Vine length, LL: Leaf length, LW: Leaf width, NOL Number of Lobes, PL: Petiole length , DFFF: Days to first female flower, NFFF: Nodes of first female flower, OL: Ovary length, PEDL: Peduncle length, FL: Fruit length, FD: Fruit diameter, FT: Flesh thickness, SEE: Seediness, SL: Seed length, SW: Seed width, CD: Crop duration, NFP : Number of fruit per plant, AFW: Average fruit weight,SEW: 100 seed weight, TSS: TSS, VC: Ascorbic acid content..

Crop duration exhibited significant positive correlation with average fruit weight (0.273 and 0.269) and yield per plant (0.370 and 0.356) at both phenotypic and genotypic levels, respectively.

Number of fruit per plant exhibited significant positive correlation with yield per plant (0.264 and 0.255) at both phenotypic and genotypic levels, respectively. Number of fruit per plant exhibited significant negative correlation with average fruit weight (-0.482 and -0.489), 100 seed weight (-0.300 and -0.304), TSS (-0.249 and -0.257) and ascorbic acid content (-0.487 and -0.517) at both phenotypic and genotypic levels, respectively.

Average fruit weight exhibited significant positive correlation with 100 seed weight (0.425 and 0.428) and yield per plant (0.708 and 0.709) at both phenotypic and genotypic levels, respectively.

100 seed weight exhibited significant negative correlation with TSS (-0.276 and -0.279) at both phenotypic and genotypic levels, respectively. 100 seed weight also exhibited significant negative correlation with ascorbic acid content (-0.290) at genotypic level only.

TSS exhibited significant positive correlation with ascorbic acid content (0.430 and 0.424) at both phenotypic and genotypic levels, respectively.

Ascorbic acid content exhibited significant negative correlation with yield per plant (-0.412 and -0.453) at both phenotypic and genotypic levels, respectively.

The findings clearly indicated that genotypic correlations were of higher magnitude to the corresponding phenotypic ones, thereby establishing strong inherent relationship among the characters studied. The low phenotypic value might be due to appreciable interaction of the genotypes with the environments. Overall observation of correlation coefficient analysis revealed that cotyledon length, vine length, fruit length, fruit diameter, seed length, seed width, crop duration, number of fruit per plant, avg. fruit wt., exhibited the significant positive correlation with yield/ha while ascorbic acid content shown negative correlation. Hence, direct selection for these traits may lead to development of high yielding genotypes of ash gourd. Hence, direct selection for these traits may lead to the development of high yielding genotypes of ash gourd.

The present findings are in conformity with Umamaheswarappa *et al.* (2004) who reported that fruit yield per ha had strong positive association with number of fruits per vine, fruit weight, fruit length and fruit girth. Similar results were also reported by Ahmed *et al*. (2005), Kumar *et al.* (2007), Ram *et al.* (2007), Wani *et al.* (2008) and Bhardwaj *et al*. (2013) in different cucurbits.

4.2.5 Path coefficient analysis

Path coefficient analysis is an important tool for partitioning the correlation coefficients into the direct and indirect effects of independent variables on a dependent variable. With the inclusion of more variables in correlation study, their indirect association becomes more complex. Two characters may show correlation, just because they are correlated with a common third one. In such circumstances, path coefficient analysis provides an effective means of a critical examination of specific forces action to produce a given correlation and measure the relative importance of each factor. In this analysis, fruit yield was taken as dependent variable and the rest of the characters were considered as independent variables.

The path coefficient analysis which splits total correlation coefficient of different characters into direct and indirect effects on fruit yield per plant in such a manner that the sum of direct and indirect effects is equal to total genotypic correlation as presented in table 4.43.

The data revealed that average fruit weight shown the highest positive effect (1.034) on fruit yield followed by number of fruit/plant(0.738), vine length (0.062), flesh thickness (0.056), petiole leaf (0.054), seed width (0.048), number of primary branch (0.040), fruit diameter (0.040), 100 seed wt. (0.026),

Table 4.43 Direct and indirect effect of component character on fruit yield in ash gourd.

	CL	CW	LOI	NPB	VL	LL	LW	NOL	PL	DFFF	NFFF	OL	PEDL	FL	FD	FT	SEE	SL	SW	CD	NFP	AFW	SEW	TSS	VC
CL	**-0.062**	-0.039	-0.016	0.012	0.007	-0.011	0.009	-0.016	0.033	0.000	0.009	0.015	0.003	0.001	0.000	0.028	0.007	-0.019	0.014	0.004	-0.264	0.587	0.005	-0.003	0.000
CW	-0.040	**-0.059**	-0.015	0.010	-0.008	-0.012	0.010	-0.017	0.035	-0.001	0.029	0.010	-0.005	0.000	-0.007	0.031	0.004	-0.023	0.021	0.003	-0.459	0.585	0.011	0.000	0.001
LOI	-0.021	-0.020	**-0.046**	0.004	0.006	-0.015	0.011	-0.025	0.033	0.000	0.021	-0.008	-0.014	0.000	0.005	0.017	-0.006	-0.016	0.021	0.008	-0.250	0.347	0.007	0.001	0.001
NPB	-0.019	-0.016	-0.004	**0.040**	-0.011	-0.008	0.007	-0.008	0.023	0.000	0.024	-0.009	-0.012	0.000	-0.004	0.011	-0.002	-0.007	0.006	0.004	-0.144	0.339	0.005	0.005	-0.001
VL	-0.007	0.007	-0.004	-0.007	**0.062**	-0.007	0.005	0.006	0.002	0.001	-0.014	0.005	0.017	0.002	0.003	0.007	-0.006	-0.005	0.005	0.003	-0.029	0.334	-0.001	-0.009	0.000
LL	-0.027	-0.029	-0.028	0.013	0.017	**-0.025**	0.017	-0.024	0.040	0.000	0.032	0.008	-0.012	0.000	-0.007	0.030	-0.006	-0.015	0.022	0.002	-0.439	0.550	0.017	0.003	-0.001
LW	-0.031	-0.034	-0.029	0.016	0.016	-0.023	**0.018**	-0.028	0.044	0.000	0.029	0.009	-0.013	0.000	-0.005	0.032	-0.003	-0.019	0.025	0.005	-0.416	0.609	0.014	0.003	-0.002
NOL	-0.011	-0.012	-0.013	0.004	-0.004	-0.007	0.006	**-0.087**	0.017	0.000	0.017	0.012	-0.005	0.000	0.001	0.017	-0.003	-0.010	0.007	0.005	-0.196	0.078	0.010	0.006	0.004
PL	-0.038	-0.038	-0.028	0.017	0.002	-0.018	0.014	-0.027	**0.054**	0.000	0.021	0.004	-0.012	0.000	0.003	0.031	-0.001	-0.025	0.027	0.009	-0.413	0.613	0.011	-0.002	0.001
DFFF	0.006	0.013	0.002	-0.005	0.015	0.001	-0.001	0.010	-0.008	**0.003**	-0.049	0.009	0.003	0.000	-0.009	-0.007	-0.005	0.009	-0.009	-0.005	0.077	0.016	-0.005	0.005	0.002
NFFF	0.006	0.020	0.012	-0.011	0.011	0.009	-0.006	0.018	-0.013	0.002	**-0.085**	0.029	0.010	0.000	0.010	-0.004	0.001	0.000	-0.003	0.002	0.190	-0.175	-0.010	-0.008	0.006
OL	0.013	0.008	-0.005	0.005	-0.004	0.003	-0.002	0.014	-0.003	0.000	0.034	**-0.073**	0.002	0.000	-0.007	-0.006	-0.002	0.019	-0.020	-0.001	0.079	-0.168	-0.006	0.002	-0.002
PEDL	0.003	-0.005	-0.010	0.007	-0.017	-0.005	0.004	-0.007	0.011	0.000	0.013	0.002	**-0.062**	-0.001	-0.002	0.003	-0.007	-0.005	0.014	0.005	-0.172	0.192	0.007	0.009	0.002
FL	-0.012	-0.005	0.001	-0.005	0.025	-0.001	0.000	0.000	-0.006	0.000	0.005	-0.004	0.011	**0.004**	0.008	0.012	-0.002	-0.007	0.005	0.000	-0.033	0.286	-0.001	-0.005	-0.002
FD	0.000	0.011	-0.006	-0.004	0.004	0.004	-0.002	-0.003	0.005	-0.001	-0.020	0.012	0.003	0.001	**0.040**	-0.002	0.002	-0.021	0.024	0.013	0.165	0.090	0.000	-0.006	-0.003
FT	-0.032	-0.033	-0.014	0.008	0.008	-0.013	0.010	-0.027	0.030	0.000	0.007	0.007	-0.003	0.001	-0.001	**0.056**	-0.003	-0.020	0.020	0.003	-0.419	0.580	0.010	-0.009	0.006
SEE	0.014	0.007	-0.009	0.002	0.010	-0.004	0.002	-0.009	0.002	0.000	0.002	-0.005	-0.013	0.000	-0.003	0.005	**-0.033**	0.000	0.003	0.005	-0.167	0.070	0.002	0.002	0.001
SL	-0.026	-0.030	-0.016	0.006	0.007	-0.008	0.008	-0.019	0.030	-0.001	-0.001	0.030	-0.007	0.001	0.019	0.024	0.000	**-0.045**	0.041	0.012	-0.335	0.595	0.011	-0.010	0.001
SW	-0.018	-0.026	-0.020	0.005	0.007	-0.012	0.009	-0.013	0.031	-0.001	0.005	0.030	-0.019	0.000	0.020	0.023	-0.002	-0.039	**0.048**	0.010	-0.287	0.583	0.013	-0.005	-0.002
CD	-0.011	-0.008	-0.016	0.007	0.006	-0.002	0.004	-0.018	0.021	-0.001	-0.006	0.003	-0.014	0.000	0.022	0.006	-0.007	-0.022	0.021	**0.024**	0.065	0.278	0.004	0.004	-0.003
NFP	0.022	0.037	0.016	-0.008	-0.002	0.015	-0.010	0.023	-0.030	0.000	-0.022	-0.008	0.014	0.000	0.009	-0.032	0.008	0.021	-0.019	0.002	**0.738**	-0.506	-0.012	0.008	-0.010
AFW	-0.035	-0.034	-0.015	0.013	0.020	-0.013	0.010	-0.007	0.032	0.000	0.014	0.012	-0.012	0.001	0.004	0.031	-0.002	-0.026	0.027	0.006	-0.361	**1.034**	0.011	-0.002	0.000
SEW	-0.011	-0.024	-0.012	0.007	-0.003	-0.016	0.010	-0.033	0.024	-0.001	0.033	0.015	-0.017	0.000	0.000	0.022	-0.003	-0.020	0.023	0.003	-0.331	0.431	**0.026**	0.005	-0.001
TSS	-0.006	-0.001	0.001	-0.006	0.018	0.002	-0.001	0.017	0.003	0.000	-0.021	0.005	0.018	0.001	0.007	0.016	0.002	-0.014	0.008	-0.003	-0.190	0.074	-0.004	**-0.031**	0.008
VC	-0.002	-0.002	-0.002	-0.002	0.000	0.001	-0.002	-0.020	0.002	0.000	-0.030	0.008	-0.006	0.000	-0.006	0.017	-0.002	-0.003	-0.004	-0.004	-0.381	-0.020	-0.002	-0.013	**0.019**

Residual are 0.00288

Diagonal and bold underline figures shows direct effect on fruit yield

CL-Cotyledon length, CW: Cotyledon width, LOI: Internodal length, NPB: number of primary branches, VL: Vine length, LL: Leaf length, LW: Leaf width, NOL Number of Lobes, PL: Petiole length , DFFF: Days to first female flower, NFFF: Nodes of first female flower, OL: Ovary length, PEDL: Peduncle length, FL: Fruit length, FD: Fruit diameter, FT: Flesh thickness, SEE: Seediness, SL: Seed length, SW: Seed width, CD: Crop duration, NFP : Number of fruit per plant, AFW: Average fruit weight, SEW: 100 seed weight, TSS: TSS, VC: Ascorbic acid content.

crop duration (0.024), ascorbic acid content (0.019), Leaf width (0.018), fruit length (0.004) and day to 1st female flower (0.003). In similarity to present findings, importance of these characters to promote fruit yield also reported by Mandal (2005) and Harzra *et al.* (2003) in pointed gourd.

Whereas, number of lobes (-0.087) shown highest negative direct effect followed by ovary length (-0.073), cotyledon width (-0.059), length of internodes (-0.046), seed length (-0.045), seediness (-0.035), TSS (-0.031) and leaf length (-0.025).

Cotyledon length showed positive indirect effect on fruit yield via number of primary branches (0.012), vine length (0.007),leaf width(0.009), petiole length (0.033), nodes at first female flower(0.009), ovary length (0.015), peduncle length (0.003), flesh thickness (0.028), seediness (0.007), seed width (0.014), crop duration (0.004), average fruit weight (0.587) and 100gm seed weight (0.005).

Cotyledon width showed positive indirect effect on fruit yield via number of primary branches (0.010), leaf width(0.010), petiole length (0.035), nodes at first female flower(0.029), ovary length (0.010), flesh thickness (0.031), seediness (0.004), seed width (0.021), crop duration (0.003), average fruit weight (0.585), 100gm seed weight (0.011) and ascorbic acid content (0.001).

Internodal length showed positive indirect effect on fruit yield via number of primary branches (0.004), vine length (0.006), leaf width(0.011), petiole length (0.033), nodes at first female flower(0.021), fruit diameter (0.005), flesh thickness (0.017), seed width (0.021), crop duration (0.008), average fruit weight (0.347), 100gm seed weight (0.007), TSS (0.001) and ascorbic acid content (0.001).

Number of primary branches showed positive indirect effect on fruit yield via leaf width (0.017), petiole length (0.023), nodes at first female flower(0.024), flesh thickness (0.011), seed width (0.006), crop duration

(0.004), average fruit weight (0.339), 100gm seed weight (0.005) and TSS (0.005).

Vine length showed positive indirect effect on fruit yield via cotyledon width (0.007), leaf width(0.005), number of lobes (0.006), petiole length (0.002), days to first female flower (0.001), ovary length (0.005), peduncle length (0.017), fruit length (0.002) fruit diameter (0.003), flesh thickness (0.007), seed width (0.005), crop duration (0.003) and average fruit weight (0.334).

Leaf length showed positive indirect effect on fruit yield via number of primary branches (0.013), vine length (0.017), leaf width(0.017), petiole length (0.040), nodes at first female flower (0.032), ovary length (0.008), flesh thickness (0.030), seed width (0.022), crop duration (0.002), average fruit weight (0.550), 100gm seed weight (0.017) and TSS (0.003).

Leaf width showed positive indirect effect on fruit yield via number of primary branches (0.016), vine length (0.016), petiole length (0.044), nodes at 1^{st} female flower (0.029), ovary length (0.009), flesh thickness (0.032), seed width (0.025), crop duration (0.005), average fruit weight (0.609), 100gm seed weight (0.014) and TSS (0.003).

Number of lobes showed positive indirect effect on fruit yield via number of primary branches (0.004), leaf width (0.006), petiole length (0.017), nodes at 1^{st} female flower (0.017), ovary length (0.012), flesh thickness (0.017), seed width (0.007), crop duration (0.005), average fruit weight (0.078), 100gm seed weight (0.010) and TSS (0.006).

Petiole length showed positive indirect effect on fruit yield via number of primary branches (0.017), vine length (0.002), leaf width (0.014), nodes at 1^{st} female flower (0.021), ovary length (0.004), fruit diameter (0.003), flesh thickness (0.031), seed width (0.027), crop duration (0.009), average fruit weight (0.613), 100gm seed weight (0.011) and ascorbic acid content (0.001).

Days to first female flower showed positive indirect effect on fruit yield via cotyledon width (0.006), cotyledon width (0.013), internodal length (0.002), vine length (0.015), Leaf length (0.001), number of lobes (0.010), ovary length (0.009), peduncle length (0.003), seed length (0.009), number of fruit per plant (0.077), average fruit weight (0.016), TSS(0.005) and ascorbic acid content(0.002).

Nodes at first female flower showed positive indirect effect on fruit yield via cotyledon width (0.006), cotyledon width (0.020), internodal length (0.012), vine length (0.011), Leaf length (0.009), number of lobes (0.018), ovary length (0.029), fruit diameter (0.010), crop duration (0.002), number of fruit per plant (0.190) and ascorbic acid content (0.006).

Ovary length showed positive indirect effect on fruit yield via cotyledon length (0.013), cotyledon width (0.008), number of primary branches (0.005), Leaf length (0.003), number of lobes (0.014), nodes at first female flower (0.034), peduncle length (0.002), seed length (0.019, number of fruit per plant (0.190) and TSS (0.002).

Peduncle length showed positive indirect effect on fruit yield via cotyledon length (0.003), number of primary branches (0.007), Leaf width (0.004), petiole length (0.011), nodes at first female flower (0.013), flesh thickness (0.003), seed width (0.019, crop duration (0.005), average fruit weight (0.192), 100seed weight (0.007), TSS (0.009) and ascorbic acid content(0.002).

Fruit length showed positive indirect effect on fruit yield via intermodal length (0.001), vine length (0.025), nodes at first female flower (0.005), peduncle length (0.011), fruit diameter (0.008), flesh thickness (0.012), seed width (0.014), crop duration (0.005), average fruit weight (0.192), 100gm seed weight (0.007), TSS (0.009) and ascorbic acid content (0.002).

Fruit diameter length showed positive indirect effect on fruit yield via cotyledon width (0.11), vine length (0.004), Leaf length (0.004), petiole length (0.005), ovary length (0.012), peduncle length (0.003), seed width (0.024), crop duration (0.013), number of fruit per plant (0.165) and average fruit weight (0.090).

Flesh thickness length showed positive indirect effect on fruit yield via number of primary branch (0.008), vine length (0.008), Leaf width (0.010), petiole length (0.030), nodes at first female flower (0.007), ovary length (0.012), peduncle length (0.003), seed width (0.020), crop duration (0.003), average fruit weight (0.090) and 100 seed weight (0.010).

Seediness showed positive indirect effect on fruit yield via cotyledon length (0.014), cotyledon width (0.007), number of primary branches (0.002), vine length (0.010), leaf width (0.002), petiole length (0.002), nodes at first female flower (0.002), flesh thickness (0.005), average fruit weight (0.070), 100 seed weight (0.010) and TSS (0.002).

Seed length showed positive indirect effect on fruit yield via number of primary branches (0.006), vine length (0.007), leaf width (0.008), petiole length (0.030), ovary length (0.030), nodes at first female flower (0.002), fruit length (0.001), fruit diameter (0.019), flesh thickness (0.024), seed weight (0.041), crop duration (0.012), average fruit weight (0.595) and 100 seed weight (0.011).

Crop duration showed positive indirect effect on fruit yield via number of primary branches (0.007), vine length (0.006), leaf width (0.004), petiole length (0.021), ovary length (0.003), fruit diameter (0.022), flesh thickness (0.006), seed width (0.021), number of fruit per plant (0.065), average fruit weight (0.278), 100 seed weight (0.004) and TSS (0.004).

Number of fruit per plant showed positive indirect effect on fruit yield via cotyledon length (0.022), cotyledon width (0.037), internodal length (0.016), number of lobes (0.023), peduncle length (0.014), fruit diameter (0.009), seediness (0.008), seed length (0.021), crop duration (0.002) and TSS (0.004).

Average fruit weight showed positive indirect effect on fruit yield via number of primary branches (0.013), vine length (0.020), leaf width (0.010), petiole length (0.032), nodes at first female flower (0.014), ovary length (0.012), fruit diameter (0.004), flesh thickness (0.031), seed width (0.027) and 100 seed weight (0.004).

100 seed weight showed positive indirect effect on fruit yield via number of primary branches (0.007), leaf width (0.010), petiole length (0.024), nodes at first female flower (0.033), ovary length (0.015), flesh thickness (0.022), seed width (0.023), average fruit weight (0.431) and TSS (0.005).

TSS showed positive indirect effect on fruit yield via intermodal length (0.001), vine length (0.018), number of lobes (0.017), petiole length (0.003), ovary length (0.005), peduncle length (0.018), fruit length (0.001), fruit diameter (0.007), flesh thickness (0.016), seediness (0.002), average fruit weight (0.074) and ascorbic acid content (0.008).

Ascorbic acid content showed positive indirect effect on fruit yield via leaf length (0.001), petiole length (0.002), ovary length (0.008) and flesh thickness (0.017).

The effect of residual factor (0.00288) on fruit yield per plot was negligible, thereby, suggested that no other major yield contributing component is left over.

The present study suggested that more emphasis should be given to selecting genotypes having maximum average fruit weight and number fruits per plant and vine length. Directly or indirectly all characters showed positive effect on fruit yield per plant, which is in confirmation to the finding of Umamaheswarappa *et al.* (2004) who also reported that number of fruits per vine had maximum direct effect on fruit yield followed by fruit weight. Ahmed *et al*. (2005) also reported that fruit weight, number of fruits per plant, fruit length had positive direct effect on fruit yield of bottle gourd. Similar results were obtained by Singh *et al.* (2006), Gayen and Hossain (2007) and Muralidharan *et al.* (2013).

Overall path analysis confined that direct effects of average fruit weight number of fruit/plant, vine length, flesh thickness, petiole leaf , seed width, number of primary branch, fruit diameter, 100 seed wt., crop duration, ascorbic acid content, leaf width, fruit length and day to 1st female flower appears whereas indirect effects number of lobes, ovary length, cotyledon width, length of internodes, seed length, seediness, TSS and leaf length should be considered simultaneously for amenability in fruit yield of ash gourd.

4.2.6 Divergence analysis

The concept of D2 statistics was originally developed by Mahalonobis (1936). Then Rao (1952) suggested the application of this technique for the arrangement of genetic diversity in plant breeding. Now, this technique is being extensively used in vegetable breeding also to study the selection of different parents. Genetic variability and selection of parents from diverse breeding material including germplasm and there diverse parents, can be used for the development of hybrids in ash gourd.

On the basis of D^2 analysis, thirty seven genotypes were grouped into seven clusters as shown in table 4.44. Maximum number of genotypes was grouped into cluster VI (AS-2, Meghalaya-2, Meghalaya-3, TAG-1, TAG-3, TAG-6, TAG-7, TAG-8, Pundibari Local-1, Panji Local, Basirhat, Nagaland Local-2 and Indu) including thirteen genotypes followed by cluster III (Kashi Ujjwal, KAG-1, Bux-1, AS-1, Manipur-1, TAG-9, and Pundibari Local-2) including seven genotypes. Cluster I (Kashi Dhawal, KAU Local, CO-2, Meghalaya-1, TAG-2 and Nagaland Local-1) including six genotypes whereas cluster IV (Pusa Ujjwal, Pusa Sabji Petha, Pant Petha-1, Shakti and Bhagyalaxmi) includes five genotypes. Cluster II (Kashi Surbhi, PAG-3 and TAG-5) includes three genotypes whereas cluster VII (Manipur-2 and Manipur-3) includes two genotypes and cluster V includes only one genotype i.e. TAG-4.

Table 4.44 Composition of clusters for yield and its components.

Cluster number	Number of genotypes included	Name of genotypes
I	6	Kashi Dhawal, KAU Local, CO-2, Meghalaya-1, TAG-2, Nagaland Local-1
II	3	Kashi Surbhi, PAG-3, TAG-5
III	7	Kashi Ujjwal, KAG-1, Bux-1, AS-1, Manipur-1, TAG-9, Pundibari Local-2,
IV	5	Pusa Ujjwal, Pusa Sabji Petha, Pant Petha-1, Shakti, Bhagyalaxmi,
V	1	TAG-4
VI	13	AS-2, Meghalaya-2, Meghalaya-3, TAG-1, TAG-3, TAG-6, TAG-7, TAG-8, Pundibari Local-1, Panji Local, Basirhat, Nagaland Local-2, Indu
VII	2	Manipur-2, Manipur-3

From the table 4.45 it can be seen that Maximum inter-cluster distance was observed between cluster III and cluster VII (3568.03) followed by cluster I and cluster VII (3249.87), cluster II and cluster III (2730.91), cluster VII and cluster IV (2668.36), cluster I and cluster II (2426.08), cluster III and cluster VI (2306.11), cluster V and cluster VII (2293.16), cluster II and cluster IV (1831.38), cluster VI and cluster VII (1717.00), cluster III and cluster V (1606.03), cluster II and cluster V (1543.82), cluster IV and cluster VI (1519.26), cluster I and cluster V (1126.77), cluster II and cluster VI (1123.44), cluster IV and cluster V (932.90), cluster III and cluster IV (907.62), cluster II and cluster VII (837.85), cluster V and cluster VI (737.55), cluster I and cluster IV (694.27) and cluster I and cluster III (543.91).

Among the seven clusters, minimum inter-cluster distance was observed between cluster I and cluster III (543.91). The higher distance indicated greater genetic divergence between the genotypes of those cluster, while lower inter-cluster values between the clusters suggested that the genotypes of the cluster were not much genetically diverse from each other.

Table 4.45 Inter cluster distances values in ash gourd.

Cluster number	I	II	III	IV	V	VI	VII
I							
II	2426.08						
III	543.91	2730.91					
IV	694.27	1831.38	907.62				
V	1126.77	1543.82	1604.03	932.90			
VI	1839.66	1123.44	2306.11	1519.26	737.55		
VII	3249.87	837.85	3568.03	2668.36	2293.16	1717.00	

The critical perusal of the result obtained from thr present investigation also revealed interesting feature that expression of cluster distance was not according to the geographical location. For instance, Kashi Ujjawal (Varanasi, Uttar Pradesh) and Manipur-1 were collected from diverse locations but grouped into same cluster (IV) whereas both genotypes collected from Manipur region i.e. Manipur -1 and Manipur -2 shared diverse cluster namely cluster II and cluster VII, respectively.

From the table 4.46, it can be seen that the mean performance for different clusters of genotypes for fruit yield and its components. The data of cluster means for all the characters showed appreciable differences. The cluster mean for various traits shown that different cluster respond differently for various traits. cluster VII shown highest mean value for cotyledon length (3.55), cotyledon width (2.00), vine length (6.72), peduncle length (7.45), average fruit weight (5701.08), vit. C (42.57), yield/plant (21.70) and yield/ha (904.16). cluster VI shown highest mean value for number of primary branches (3.52), leaf length (16.80), length width (22.70), number of lobes(6.97), seediness(1478.23), seed weight (5.62) whereas cluster I and III shown lowest mean value for most of the traits. The better genotypes can be selected for most characters on the basis of mean performance in the cluster.

The higher inter-cluster distances in present investigation reflecting the wider diversity among the breeding lines of the distant group. Hence, it is suggested that intercrossing of genotypes from diverse clusters showing high mean performance will be helpful in obtaining better recombinants with higher genetic variability.

Genetic divergence is one of the useful tools for selection and efficient use of parents for hybridization to develop high yielding potential cultivars/hybrids. Inclusion of more diverse parents in hybridization is believed to increase the chances of obtaining stronger heterosis and gives broad spectrum of variability in segregating generations.

This implied that there was no parallelism between genetic divergence and geographical divergence. This has been observed that diverse the parents within its overall limits of fitness, the greater are the chances of heterotic expression in F_1's and a broad spectrum of variability in segregating generations.

In this study, group constellation showed that cluster VII (Manipur-2 and Manipur-3) were highly divergent from all other genotypes and may be used as parents in transgenic breeding programme and may directly be used as a pure line variety for fruit yield and it's component characters in ash gourd [*Benincasa hispida* (Thunb.) Cogn.] for Nagaland condition.

Table: 4.46 Mean Performance of genotypes in individual cluster for yield and its components in ash gourd

CL-Cotyledon length, CW: Cotyledon width, LOI: Internodal length, NPB: number of primary branches, VL: Vine length, LL: Leaf length, LW: Leaf width, NOL Number of Lobes, PL: Petiole length , DFFF: Days to first female flower, NFFF: Nodes of first female flower, OL: Ovary length, PEDL: Peduncle length,

	I	II	III	IV	V	VI	VII
CL	2.71	3.27	2.82	2.82	2.77	2.88	3.55
CW	1.38	2.00	1.52	1.47	1.63	1.67	2.00
LOI	12.95	14.98	13.62	12.64	15.21	14.29	14.12
NPB	3.10	3.50	3.17	3.44	3.28	3.52	3.48
VL	5.88	5.77	5.00	6.36	6.28	6.60	6.72
LL	11.87	14.53	12.20	13.13	15.50	16.80	13.72
LW	15.55	20.81	16.91	18.06	20.91	22.70	19.52
NOL	5.84	6.31	6.16	5.21	6.06	6.97	5.98
PL	9.32	15.40	11.16	11.24	14.52	14.46	12.92
DFFF	72.22	72.85	73.17	76.46	70.44	75.49	73.48
NFFF	18.21	15.79	19.04	20.99	19.28	13.30	19.77
OL	3.00	2.97	3.13	2.88	2.86	3.00	2.58
PEDL	5.94	6.23	7.08	5.97	7.70	7.10	7.45
FL	27.98	26.90	20.23	23.54	23.86	25.23	27.24
FD	20.32	18.82	15.16	19.78	18.01	18.53	18.58
FT	3.86	4.20	3.85	3.57	4.31	3.93	4.50
SEE	965.44	543.21	545.76	557.87	1320.09	1478.23	574.38
SL	0.99	1.20	0.94	1.06	1.14	1.20	1.28
SW	0.52	0.69	0.47	0.57	0.66	0.66	0.70
CD	119.56	120.85	117.44	119.74	133.20	130.50	128.66
NFP	5.34	4.04	5.16	5.42	3.66	4.33	3.80
AFW	2493.54	4868.38	2160.38	3042.38	3562.81	4247.85	5701.08
SEW	4.35	5.21	4.29	4.14	4.87	5.62	4.87
TSS	2.24	2.24	1.92	2.29	2.06	1.33	2.24
VC	39.39	39.12	40.45	38.58	40.64	34.13	42.57
YIP	13.38	19.62	11.15	16.28	13.04	18.38	21.70
YIH	557.47	817.41	464.74	678.31	543.36	765.93	904.16

FL: Fruit length, FD: Fruit diameter, FT: Flesh thickness, SEE: Seediness, SL: Seed length, SW: Seed width, CD: Crop duration, NFP: Number of fruit per plant, AFW: Average fruit weight, SEW: 100 seed weight, TSS: TSS, VC: Ascorbic acid content.

CHAPTER V

SUMMARY & CONCLUSION

SUMMARY AND CONCLUSION

The present investigation entitled "**Genetic evaluation and characterization of different genotypes of ash gourd [*Benincasa hispida* (Thunb.) Cogn.]**" has been carried out at horticulture farm at School of Agricultural Sciences and Rural Development, Medziphema, Nagaland University during *Kharif* season in the year 2018 & 2019. The experiment was conducted in Randomized Block Design (RBD) with thirty seven treatments in three replication of ash gourd collected from different places of the country to estimate growth, yield and quality parameters alongwith genetic variability, correlation coefficient, path analysis and genetic divergence.

Five randomly selected plants were considered for observations of different characters *viz.,* cotyledon length, cotyledon width, stem shape, stem pubescence, internodal length, number of primary branches, vine length, leaf blade margin, leaf shape, leaf length, leaf width, leaf pubescence, leaf blade, petiole length, tendril status, tendril branching, tendril type, days to 1st female flower appears, sex expression, male sterility, ovary length, peduncle length, fruit length, fruit shape, skin color, fruit shape at blossom end, fruit shape at peduncle end, fruit pubescence, fruit groves, fruit marbling, flesh texture, fruit waxiness, seed length, seed width, seed coat color, seed arrangement, crop duration, number of fruits per plant, average fruit weight, 100 seed weight, yield per plant, yield per hectare, TSS, vitamin C and aroma status.

The analysis of variance indicated that the mean sum of square due to genotypes were highly significant for all the characters. Significant mean sum of squares due to fruit yield and attributing characters revealed existence of considerable variability in material studied for improvement of various traits.

The details of the materials and methods used and followed during the experiment for recording various observations and analysis is presented below.

Growth parameters

Growth attributes with respect to cotyledon length (4.08 cm), cotyledon width (2.32 cm), number of primary ches (4.00), leaf length (17.59 cm), leaf width (23.97 cm), number of lobes (7.11), petiole length (20.50 cm) and intermodal length (16.56 cm) were recorded maximum in PAG-3 whereas TAG-9 exhibited least cotyledon length (2.30), cotyledon width (1.16), vine length (3.80 m), seed length (0.68), seed width (0.36 cm).

Yield parameters

Yield attributes with respect to average fruit weight (5762.25 g), yield per plant (23.41 kg), yield per hectare (975.22 q) is found highest in Indu. Highest number of fruit per plant was recorder in TAG-6 (7.16) at par with TAG-1(6.98).

Quality parameters

Quality attributes with respect to TSS is found in Meghalaya-2 (3.10) and for vitamin C is found in TAG-5 (45.17 mg/100g) while lowest TSS (1.33) and vitamin content (34.13 mg/100g) were found in Shakti.

Genetic parameters

Highest phenotypic and genotypic coefficient of variation was observed in seediness (44.19 and 44.09), respectively for growth attributes, average fruit weight (32.30 and 32.27), respectively for yield attributes and TSS (19.84 and 19.17), respectively for quality attributes. High heritability coupled with high genetic advance as percentage of mean was observed for traits like seediness (99.52% and 90.61%), fruit diameter (99.23% and 74.41%), fruit length (98.87% and 52.60%), peduncle length(98.35% and 52.12%), seed width

(98.20 and 50.26%), average fruit weight (99.75% and 66.39%), nodes of 1st female flower (99.55 % and 58.54%) and yield per plant (98.07% and 51.23%).

Correlation studies revealed that yield per plant showed highly significant positive phenotypic and genotypic correlation coefficients with cotyledon length (0.295 and 0.305), vine length (0.359 and 0.368), fruit length (0.266 and 0.274), fruit diameter (0.304 and 0.307), seed length (0.277 and 0.286), seed width (0.337 and 0.342), crop duration (0.370 and 0.356), number of fruit per plant (0.264 and 0.255) and avg. fruit weight (0.708 and 0.709), respectively.

Path coefficient analysis revealed that on yield there is direct effects of average fruit weight (1.034), number of fruit/plant(0.738), vine length (0.062), flesh thickness (0.056), petiole leaf (0.054), seed width (0.048), number of primary branch (0.040), fruit diameter (0.040), 100 seed wt. (0.026), crop duration (0.024), ascorbic acid content (0.019), Leaf width (0.018), fruit length (0.004) and day to 1st female flower (0.003) whereas number of lobes (-0.087) shown highest negative direct effect followed by ovary length (-0.062), cotyledon width (-0.059), length of internodes (-0.046), seed length (-0.045), seediness (-0.035), TSS (-0.031) and leaf length (-0.025).

D^2 values recorded on fruit yield and its components for thirty seven genotypes, which were grouped into seven clusters based on relative magnitude of D^2 values. The data showed that cluster VII were highly divergent from all other genotypes and may be used as parents, to exploit heterotic expression for fruit yield and its component characters in ash gourd for Nagaland condition.

Divergence Analysis divided the total genotypes divided into 7 clusters in which maximum inter-cluster distance was observed between cluster III and cluster VII (3568.03) and Cluster VII shown highest mean value for cotyledon length (3.55), cotyledon width (2.00), vine length (6.72), peduncle length

(7.45), average fruit weight(5701.08), vit. C (42.57), yield/plant (21.70) and yield/ha (904.16). cluster VI shown highest mean value for number of primary branches (3.52), leaf length (16.80), length width (22.70), number of lobes(6.97), seediness(1478.23), seed weight (5.62).

Thus, while planning hybridization programme or the development of heterotic hybrids and better transgressive segregants one should select genotypes cluster VII for cotyledon length, cotyledon width, vine length, flesh thickness, seed length, seed width, average fruit weight, vitamin C and more yield. Similarly, for crop duration or earliness, genotypes from cluster V should be selected and for fruit length and diameter, genotypes from cluster I should be selected. For more number of fruits per plant and TSS, genotypes from cluster IV should be selected and for more number of seeds, genotypes from cluster VI should be selected for breeding programme.

Conclusion

The analysis of variance showed that considerable variability existed among the genotypes for most of the traits showing possibilities of further genetic improvement in ash gourd.

- Assemblage of thirty seven different genotypes (open pollinated seed of cultivars, land races, farmers' varieties, improved varieties, etc.) from sixteen different places of the country was done.
- The mean performance for yield per hectare of Indu was superior among all genotypes. High heritability coupled with high genetic advance as percentage of mean was observed for traits like seediness, fruit diameter, fruit length, peduncle length, seed width, average fruit weight, nodes of 1st female flower and yield per plant.
- Correlation studies revealed that yield per plant showed highly significant positive phenotypic and genotypic correlation coefficients with cotyledon length, vine length, fruit length, fruit diameter, seed

length, seed width, crop duration, number of fruit per plant and avg. fruit weight.

- The D^2 values recorded for thirty seven genotypes indicated the presence of appreciable amount of genetic diversity among the genotypes. In this study, observed that genotype of cluster VII were highly divergent from all other genotypes. This indicated that crossing programme with Indu will be planned by using this desirable useful trangressive genotype for fruit yield in ash gourd for Nagaland condition.
- Based on the mean performance of the thirty seven genotypes of ash gourd and high yield potential exhibited by genotype Indu confirmed that it is the best ash gourd genotype under existing agro-climatic condition.

Suggestion for future works

Ash gourd is very potential crop. Hence, needs deeper works like molecular work for further characterization with the help of different DNA markers. Along with that more germplasm can be collected from other north-eastern states for further studies. Parameters like Fibre content, Disease resistant and pest resistant can be included for future works.

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Appendix

Appendix I

Diagrammatic representation of Leaf and Fruit shape as per DUS guidelines

Ch.8: Leaf blade: margin

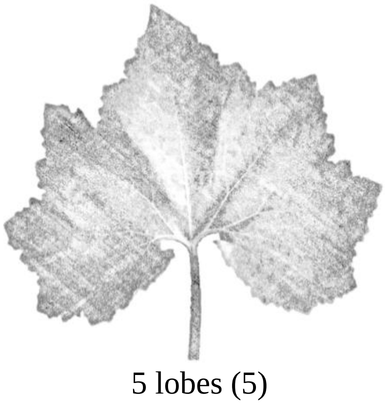
Serrate (2)

Mutifid (3)

Ch.9: Leaf:shape

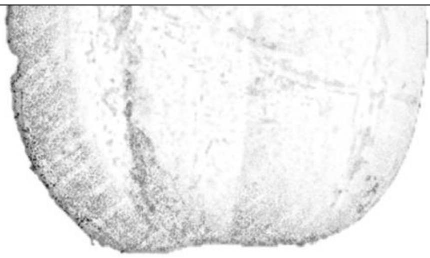
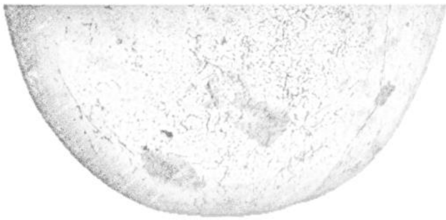
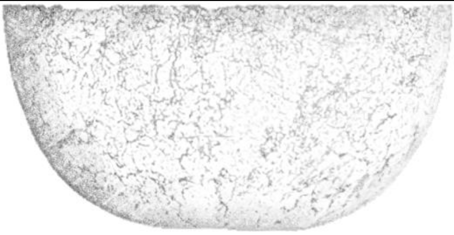
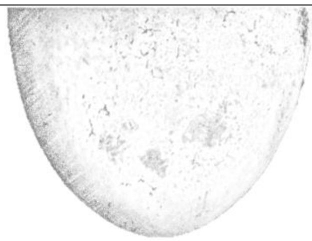
Cordate (1)

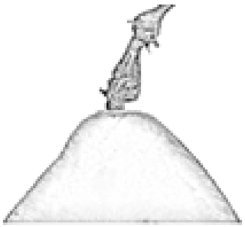
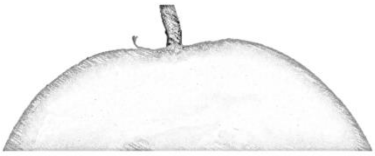
Ch.13: Leaf blade: number of lobes



5 lobes (5)

7 lobes (7)

Ch. 27:	Fruit: shape	
		
	Round (2)	Oval (3)
		
	Pear (6)	Cylindrical (8)
Ch. 29:	Fruit: shape of blossom end	
		
	Slightly depressed (2)	Moderately depressed (3)
		
	Flat (4)	Raised (5)

Ch. 30:	Fruit: shape at peduncle end		
			
	Raised (1)	Flat (2)	Depressed (3)
			
	Slightly depressed (4)	Moderately depressed (5)	