

**Evaluation of Capegooseberry (*Physalis peruviana* L.) Under
Humid Agro-climatic condition of Jhalawar**

रसभरी (*फाइसेलिस पेरुवियाना* एल.) का झालावाड़ की आर्द्र कृषि जलवायुवीय
दशा में मूल्यांकन

YOGENDRA KUMAR SHARMA

Thesis

Master of Science in Horticulture
(Fruit Science)



2017

DEPARTMENT OF FRUIT SCIENCE
COLLEGE OF HORTICULTURE AND FORESTRY, JHALAWAR
AGRICULTURE UNIVERSITY, KOTA-324 001 (RAJASTHAN)

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AGRICULTURE UNIVERSITY, KOTA

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Date:

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This is to certify that this thesis entitled “**Evaluation of Capegooseberry (*Physalis peruviana* L.) Under Humid Agro-climatic condition of Jhalawar**” submitted by Mr. Yogendra Kumar Sharma to the Agriculture University, Kota in partial fulfilment of the requirements for the degree of **Master of Science in Horticulture** in the subject of **Fruit Science** after recommendation by the external examiner was defended by the candidate before the following members of examination committee. The performance of the candidate in the oral examination was satisfactory; we therefore, recommended that thesis be approved.

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This is to certify that Mr. Yogendra Kumar Sharma student of **Master of Science in Horticulture** in the Department of **Fruit Science** has made all corrections/modifications in the thesis entitled “**Evaluation of Capegooseberry (*Physalis peruviana* L.) Under Humid Agro-climatic condition of Jhalawar**” which were suggested by the External Examiner and the Advisory Committee in the oral examination held on The final copies of the thesis duly bound and corrected were submitted on

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ACRONYMS

@	:	At the rate of
AM	:	Ante meridiem
°B	:	Degree brix
°C	:	Degree celcius
%	:	Per cent
cc	:	Cubic centimeter
C.D.	:	Critical difference
cm	:	Centimetre
cv	:	Cultivar
CV	:	Coefficient of variance
DW	:	Dry weight
d. f.	:	Degree of freedom
dS	:	Decisiemen
E-W	:	East-West
EC	:	Electrical conductivity:
etc.	:	Etcetera
<i>et al.</i>	:	<i>et allia</i> (and others)
FW	:	Fresh weight
G	:	Gram
GA	:	Genetic advance
GCV	:	Genotypic coefficient of variation
h^2	:	Heritability
ha	:	Hectare
hrs.	:	Hours
i.e.	:	(<i>id est</i>), that is
kg	:	Kilogram
lit.	:	Litre
m	:	Metre
Meq	:	Milliequivalent
mg	:	Milligram
ml:	:	Millilitre

mm	:	Millimetr
PCV	:	Phenotypic coefficient of variation
q	:	Quintal
RH	:	Relative humidity
SEm±	:	Standard error of mean
TSS	:	Total soluble solids
Temp.	:	Temperature
Vit.-C	:	Vitamin-C

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Capegooseberry (*Physalis peruviana* L.) is known by various names like Golden berry (South Africa), Inca berry, Capegooseberry, Giant ground cherry, Peruvian cherry (U.S.), Poha (Hawaii), *Rasbhari*, *Mokai*, *Tipari*, *Bhutka* (India), Aguaymanto (Peru), Uvilla (Ecuador), Uchuva (Colombia) and *Physalis*. It is indigenous to South America but was cultivated in South Africa in the region of the Cape of Good Hope during the 19th century, imparting the common name “Capegooseberry”. Its somatic chromosome number; $2n=24$. It is the only important annual herbaceous, minor tropical fruit crop of India. The crop has potential for use as nutraceutical (Ramadan and Morsel, 2007).

Capegooseberry is a member of solanaceae family. This family has many tribes and contributes many plants which are important to mankind as food or medicine. Solanae tribe of the family has seven genera including *Physalis*. The genus *Physalis*, in its turn, has 80 species, some of which are economically important. The species *peruviana* and *alkekengi* produce edible fruits commonly known as capegooseberry and winter cherry, respectively and these are of commercial importance. Other species like *Physalis pubescence* and *Physalis ixocarpa* are also known as capegooseberry but produce edible fruits of lesser commercial importance and food value (Gupta and Roy, 1980). *Physalis minima* L. another species produces edible fruits and it is known as *Tulatipati* or *Popatan* in Hindi (Singh *et al.* 1990).



Fig. 1 Capegooseberry plant in bearing.

Capegooseberry (*Physalis peruviana* L.) is a herbaceous in nature and reaches 2 to 3 feet in height under favourable growing conditions. It can grow much taller, but will need support. The purplish, spreading branches are ribbed and covered with fine hairs. The heart-shaped leaves around 5 to 15cm long are slightly velvety. The bell-shaped, nodding flowers form in the leaf axils. They are yellow in

colour with dark purple-brown spots in the throat, and cupped by a purplish-green, hairy calyx. Fruit buds are produced after 12 to 13 stem internodes. After the flower falls off, the persistent calyx expands, forming a straw- coloured husk much larger than the fruit enclosed, which take 70 to 80 days to mature. Fruits of capegooseberry are small with 1-3.5cm in diameter. They are very juicy, aromatic yellow orange in colour and round in shape at maturity, fruit contains many tiny seeds and is covered by large acrescent papery epicalyx (Chattopadhyay, 1996), which gives them shape of a bladder. As the fruits ripen, they begin to drop to the ground. The unripe fruit is said to be poisonous to some people. Capegooseberries are self-pollinated, but pollination is enhanced by a gentle shaking of the flowering stems or giving the plants a light spraying with water.

Capegooseberry (*Physalis peruviana* L.) has high significance for diversification of fruit bowl in market. It is usually cultivated as a short cycle (3-4 months), annual crop but in absence of frost it can be perennial. In a region of origin it is grown in a wide altitude range from sea level to 3200m, with an intense solar radiation to humid and cloudy environment (Singh *et al.*, 2012).

Capegooseberry (*Physalis peruviana* L.) plant requires warmer climate and dry weather at the time of fruit development and maturity stages. Its seeds are small and seedlings are planted when they are 15-20cm tall during September-October. Plants raised from cuttings (taken from one year old shoots) flower early and produce more yield but seedling plants are more vigorous (Radha and Mathew, 2007). It is mainly grown in South Africa, Australia and Hawaii. In India capegooseberry is mainly grown in Uttar Pradesh, Punjab and Rajasthan. It can be successfully grown and set fruit without problems if the minimum temperature is above 5⁰C (Chattopadhyay, 1996).

Capegooseberry fruit is tasty, having very good storability and attractive shape. It can be eaten raw, as a dessert, as an appetizer or as dish decorator. It can also be prepared in elaborated dishes in cakes or used in making jams, etc. (Mazumdar, 1979).

Fruits of capegooseberry contain 11.5 per cent carbohydrates, 1.8 per cent protein and 0.2 per cent fat. It also contains 10mg calcium, 60mg phosphorous and 18mg of iron per 100g edible part of fruits. Appreciable quantities of vitamin- A and vitamin- C are also found in fruits. It contains 2380IU vitamin- A and 49mg vitamin- C, and produces 55 calories energy per 100g of fruits. (Khan and Gowder, 1955) moreover, (Hayes, 1966) mentioned that the fruits were thought to be rich in vitamin- P (bioflavonoids). Out of the total carbohydrates content, an appreciable quantity (10 per cent) is available as pectin (Mazumdar and Basu, 1979) which is used by

industries for preparation of preserved fruits like jam, jelly etc. and it is attributed as “jam fruit”. Its fruit can be eaten raw, as a dessert or as an appetizer. It can be prepared in elaborate dishes, in cakes, for making jam or may be used for decoration of dishes (Anonymous, 1969).

Capegooseberry have been shown to provide significant health benefits because of their high antioxidants, vitamins, minerals and fibre contents. They are highly underutilised fruit crop which has potential value as a nutraceutical (Puente *et al.*, 2011; Dinan *et al.*, 2001 and Hassanien, 2011). Major bioactive compounds of *Physalis* spp., physalins (B, D and F) and glycosides (Myricetin-3-Oneohesperidoside), have been shown to possess anticancer activities. It is also used in folk medicine for treating diseases such as malaria, asthma, hepatitis, dermatitis and rheumatism. Many medicinal properties have been attributed to capegooseberry, including antiasthmatic, optic nerve strengthening one, treatment for throat infections and as an aid in elimination of intestinal parasites, amoebas as well as albumin from kidneys. It has anti-ulcer activity besides being effective in reducing cholesterol levels (Branzati and Manaresi, 1980; Sarangi *et al.*, 1989). Capegooseberries are well known for its blood purifying capacity (Singh *et al.* 2011a).

Despite the numerous beneficial aspects of capegooseberry, its cultivation is restricted to a limited area in our country. It may be due to lack of suitable genotype and poorly developed package of practices etc. These are major bottleneck in increasing its yield and economics and consequently in popularizing capegooseberry. By exploring variability potential in the capegooseberry associated bottleneck can be dealt in considerably. It has been reported that variation exists in plants. It can be highlighted following genetic study. Heritability tells us about the additive genetic variance and phenotypic variance. High heritability alone is not enough to make efficient selection in segregating generation, unless the information is accompanied for substantial amount of genetic advance. In all plant species including capegooseberry, the phenotypic expression of a character is governed mainly by the genetic make-up of the plant. Environmental factors in combination with genetic and physiological factors play an important role in determination of plant potential for propagating material. These characters appear to be under strong genetic control. The studies on variability and genetic parameters are of paramount importance for crop improvement programme. Scanty information is available on these aspects. Though, capegooseberry is important in view of its various horticultural utilities, still it is not cultivated commercially. It deserves special attention particularly for its seasonal,

quick growing nature, non-perennial occupation of land and comparatively dwarfs nature of plant (Girapu and Kumar, 2006).

Identifying suitable genotype is very important in order to give capegooseberry a commercial momentum. The present investigation is an attempt to evaluate capegooseberry genotype with a view to identify suitable genotype for cultivation in Jhalawar region.

The investigation entitled, “**Evaluation of Capegooseberry (*Physalis peruviana* L.) Under Humid Agro-climatic condition of Jhalawar**” was carried out with the under mentioned objectives:

1. To estimate genetic variability
2. To study the character association
3. To identify important yield attributing characters
4. To screen out suitable genotype for cultivation under humid Agro-climatic condition of Jhalawar region

There are many genotypes of capegooseberry being grown in various tracts suiting to the specific agro climatic conditions. However, their performance differs considerably under the given set of climatic conditions. This chapter is an attempt to present comprehensive information on the growth, production, quality and variability of capegooseberry to get cognizance of attributes of a suitable genotypes. Various workers have attempted to evaluate capegooseberry under different environmental conditions. To take an account of relevant work undergone in this line suiting to the objective of present study, various available and updated literatures have been gone through. The cohesive findings quoted there from have been presented here under various heads as per context of the study.

Evaluation of genotypes

Growth attributes

Singh *et al.* (2011a) studied the performance of twenty capegooseberry genotypes under temperate condition. The result revealed significant variation for all the growth attributes in various genotypes, whereas, maximum plant height was recorded in CITH-CGB S13.

Mahour *et al.* (2012) conducted an experiment on the performance of various germplasm of guava viz., Dharidar, Chittidar, Apple colour, Rewa-72, Lucknow-49, Allahabad Safeda, Gwalior- 27, Surkhi, Anakapalli, Godhliwala, Chaitpur, Nasik, Dharwar, Lal Guda, Smooth Green, Chitabuwala, Abuwala, Supreme Side Malta, China Red and China White. They found that the plant height was maximum in Dharidar (2.99m) and minimum in China White (1.43m). Canopy spread of the tree in North-South and East-West directions varied from 0.93-1.30m and 0.81-1.20m, respectively. The range of leaf size in terms of length and width varied from 5.13-15.34cm and 1.65- 6.74cm, respectively in different germplasm.

Prasad *et al.* (2012) conducted an experiment for performance evaluation of certain commercially important varieties of pomegranate. The experiment included six varieties viz., Bhagwa, Arakta, Ruby, MHP 7/2, G-137 and Ganesh. The results revealed that the Bhagwa variety of pomegranate was an outstanding for all the characters studied. This variety recorded the maximum length of new shoot (30.93cm), maximum number of leaves per shoot (59.36 leaves per shoot) and higher leaf area per shoot (630.97cm²/shoot).

Singh *et al.* (2013) studied the performance of 10 husk tomato (*Physalis ixocarpa* Brot.) genotypes. The result revealed significant variation for all the morphological and growth attributes in various genotypes. Maximum number of basal shoots was recorded in genotype EC467440 (7.0), whereas, number of prickles/shoot were recorded maximum (8.33) in EC467449. Maximum size of fully developed leaf (147.00mm), plant height (168.33cm) and maximum time taken for bud burst (29.33 days) was recorded in EC467459, whereas, maximum time taken from bud burst to flowering was found in EC467449 (37.67 days). Duration of fruit bloom was recorded maximum in EC467459 and EC467440 (66.0 days in each).

Dubey *et al.* (2014) compared eight sweet orange accessions with the commercial sweet orange varieties Jaffa and Valencia Late. After 10 years of evaluation all strains showed better growth than check cultivars under Delhi conditions. Among the selections, MS-13 showed the lowest and MS-7 the highest canopy volume after 10 years growth. Accessions MS-13 (31.07 kg/tree/year), MS-7 (23.36 kg/tree/year) and MS-3 (20.35 kg/tree/year) and MS-5 (17.51 kg/tree/year) were the most productive selections.

Kumar *et al.* (2014) conducted an experiment to find out the performance of different commercial varieties, viz. Krishna, Kanchan, Chakaiya, NA-6, NA-7, NA-10 and Anand-1 of aonla (*Emblica officinalis* Gaertn). They recorded the plant height was maximum (3.46m) in NA-7 and minimum (2.1m) in Anand 1. Canopy spread of the tree in East-West and North South directions were 2.75-4.0m and 4.20-3.0m, respectively. The maximum plant girth (125cm) was recorded in NA 6. Length of determinate shoot varied from 7.6 to 16.6cm and the range of leaf size was 1.3 to 1.8cm in different varieties.

Thakur *et al.* (2015) conducted an experiment for performance evaluation of certain commercially important varieties viz., Glohavel, Suncrest, Early Elberta and July Elberta of peach. The maximum scion girth (39.33cm) in July Elberta, shoot length (84.77cm) in Glohavel and leaf area (54.09cm²) in Early Elberta were recorded.

Production attributes

Kumar *et al.* (2002) conducted an experiment on strawberry. They revealed that the cultivar Chandler was the best among the three varieties evaluated. The cultivar Sujatha took 96.9 days to mature. The fruit number per plant (4.8) and yield/plot (0.483 kg) were lowest in Sujatha. Labella produced fruits early (88.4 days). Number of fruits per plant (8.3), fruit yield

per plant (32.1g) and yield per plot (0.979 kg) were almost double than that of cultivar Sujatha. The fruits were of desirable shape and colour but the mean weight of fruit was only (3.76g). The Californian cultivar Chandler produced very high yields in Italy. It put forth fruits 67.1 days after planting and the number of fruits per plant was (17.9). The fruit yield per plant (79.3g) was more than double when compared with Labella and it was about five times of the yield of Sujatha.

Bielinski *et al.* (2009) studied the performance of strawberry cultivars Winter Dawn, Florida Elyana, Florida Radiance, Ruby Gem, Strawberry Festival, Treasure, and Camarosa. Strawberry Festival consistently produced the highest early and total fruit numbers among all tested cultivars. Similarly, the same cultivar had the highest early fruit weight. With regard to total fruit weight, Florida Radiance, Treasure and Strawberry Festival resulted in the highest values among all cultivars tested during both seasons. There was no consistency in specific cultivars producing the largest early fruit, while Florida Radiance and Florida Elyana had the largest total weight per fruit.

Doharey *et al.* (2011) evaluated the performance of five kiwifruit cultivars (Allison, Monty, Bruno, Hayward and Abbott) along with one staminate cultivar (Tomuri) with respect to all production attributes. Kiwi cultivars recorded fruit yield in the trend of Bruno>Allison>Monty>Abbott>Hayward. Bruno cultivar performed better as compared to other cultivars of kiwifruit in terms of fruit yield. It produced maximum fruit yield (20.74 kg per plant), fruit weight (73.54g), fruit length (5.82cm), fruit volume (70.5g cm³) and attained fruit maturity within 180 days of flowering. Hayward produced minimum fruit yield (6.44 kg per plant), maximum fruit breadth (4.91cm) and attained fruit maturity in the late by 210 days.

Dwivedi *et al.* (2011) studied eight strawberry cultivars for flowering, fruiting and yield characteristics under subtropical conditions. Results revealed that Cultivar Seascope produced highest (4.736) number of flowers followed by Addie (4.031), Chandler (3.296), Confectura (2.962), Torrey (2.84) and Shasta (2.56). However, lowest (1.880) flower was observed in cultivar Gorell. Cultivars like Seascope and Addie gave highest (5.176 and 4.720, respectively) number of fruit set, whereas cultivar Gorella recorded lowest (1.346) fruit set. Fruit yield was maximum (147.02g) in cultivar Chandler and was followed by cultivar Seascope (100.57g). The lowest fruit yield per plant (42.48g) was recorded in cultivar Confectura. Observation recorded that fruit length and width was maximum (4.18cm and 3.02cm, respectively) in

cultivar Chandler and was minimum (2.36cm and 1.92cm, respectively) in cultivar Confectura.

Herrera *et al.* (2011) evaluated the performance in production attributes of 54 accessions of capegooseberry. They estimated the germination percentage (GP) for 30 seeds per accession and with a random sampling of 20 fruits at 120 days after the beginning of harvest (dah), weight of the fruit with calyx (CFW), percentage of cracked fruit (CF), number of fruits per plant (NFP) and yield (Y) were evaluated. The results suggest the presence of significant variability in the capegooseberry germplasm analyzed that can be incorporated into future conservation and breeding programmes.

Kumar *et al.* (2011a) studied the performance of 11 strawberry varieties in the mid-hills of Sikkim Himalayas. They observed the highest fruiting stalk/plant (11.67) in Chandler followed by Ofra (10.87). Maximum numbers of runners were in Hasta and Etna. Fruits/inflorescence was highest in Seascab (7.67). Fruit diameter was highest in Blackmore (3.30cm) followed by Ofra (3.16cm), whereas, the fruit length was longest in Ofra and Chandler (4.97 and 4.94cm respectively). Maximum fruit weight (20g) was recorded in Ofra. Highest yield (37.2 t/ha) was recorded in Ofra, and the maximum marketable yield and B:C ratio were recorded in Chandler (32.6 t/ha and 2.26 t/ha respectively).

Kumar *et al.* (2011b) evaluated six acid lime cultivar viz., PKM-1, Saisarbati, Pramalini, Vikram, Tenali and Kasipentla for two seasons (July-August and December – February). Among the cultivars, the highest number of flower per shoot in both seasons (10.85 and 12.13), number of fruit per shoot (7.67 and 8.25), number of fruits retained per shoot (4.85-5.35), highest number of fruit per shoot (384.85 and 406.35 fruits/tree) and yield per tree (20.54 and 22.56 kg) was recorded in cultivar Vikram during both seasons. The same genotype Vikram also recorded highest fruit weight (45.53g and 47.33g) and volume of fruit (44.95 and 46.36) during both seasons. The highest fruit length (6.02cm) and fruit diameter (5.86cm) was recorded in cultivar Tenali during first season, and during the second season fruit length (5.78cm) and fruit diameter (6.03cm) were recorded maximum in the cultivar Vikram. The other genotypes PKM-1 followed as the next best performer for yield attributing characters.

Padhiar *et al.* (2011) studied the performance of the six cultivars of mango viz., Alphonso, Dashehari, Kesar, Neelum, Rajapuri, Totapuri. The fruits of cultivar Totapuri recorded the maximum fruit length (cm) at marble and premature stage while, Mallika had

the maximum fruit length (cm) at mature and ripe stages. The maximum fruit diameter (cm) and fruit weight (g) were recorded in Rajapuri at all the stages of growth except Amrapali at marble stage. The maximum average pulp weight (per cent) was recorded in Totapuri at marble stages and in Rajapuri at other stages. The minimum seed weight (per cent) was recorded in Rajapuri at all the stages but, at marble stage it was recorded in Totapuri, Kesar at pre-mature stage, Amrapalli at mature stage and Mallika at ripe stage. The pulp:stone ratio was found higher in Totapuri at marble stage and in Rajapuri at pre-mature ripe stages.

Singh and Mishra (2011) conducted an experiment on the physico-chemical characters of twenty four genotypes of ber. Among the genotype, Chhuhara had highest number of fruits per kg, while Noki had highest fruit size and stone length. Umran was ahead of all cultivars in fruit weight, volume, flesh content and flesh:stone ratio.

Singh *et al.* (2011a) studied the performance of twenty capegooseberry genotypes under temperate condition. The result revealed significant variation for all the yield attributes in various genotypes. Maximum number of fruits per plant was observed in CITH CGB S16 (73), whereas, maximum fruit weight (19.10g) and fruit length (29.82mm) was recorded in CITH CGB S3, however, fruit firmness was estimated maximum in CITH CGB S13. Fruit yield per plant was recorded highest in CITH CGB 20 (1145.03g).

Singh *et al.* (2011b) reported significant variation in the various varieties of mango. On the other hand the width of fruit was maximum in Baneshan and Fazli, followed by Bangallora and Krishnabhog. Whereas, equally minimum width of fruits was obtained from Dashehari, Chhotee, Safeda and Kelam. The highest pulp percentage was noted in the fruits of Baneshan, followed by Aswaniya, Mallika, Langra and then Chausa, while the lowest pulp percentage was obtained in Safeda followed by Bombay Green. The percentage weight of stone was highest in the variety Bangallora followed by Taimuriya and then Safeda and lowest in Baneshan and then in Fazli. The percentage weight of peel was highest in Dashehari followed by Bangallora and lowest in Baneshan and still lower in Shukul, Mallika and Fazli.

Uddin *et al.* (2011) studied the performance of sixteen grape varieties. The results indicated that all study parameters were significantly different among the varieties except days to fruit setting. Based on berry yield parameters, varieties Cardinal, Exotic, Flam Seedless, Gold, Loose Perlette and King Ruby showed superior performance.

Ahmed *et al.* (2012) conducted an experiment on evaluation of 21 genotypes of Strawberry under open conditions. Out of these only five viz., Camarosa, Blakemore, Chandler, Gorella and Oso Grande were found to be promising in terms of plant growth, flowering and fruit yield.

Choudhary *et al.* (2012) studied four guava cultivars for physico-chemical characters at full maturity. The fresh fruits of cultivar L-49 recorded highest weight of fruit, pulp, peel, pulp:seed ratio. The cultivar Rewa-72 had maximum weight of seed and non-edible wastes followed by L-49, Allahabad Safeda and Apple Colour.

Mahour *et al.* (2012) conducted an experiment on the performance of various germplasm of guava. They concluded significant variation with regard to yield. However, overall performance of cultivars like Allahabad Safeda, Lucknow-49, Rewa-72, Dharidar, Apple Colour and Gwalior-27 were found promising.

Meena *et al.* (2012) conducted an experiment to evaluate five varieties of papaya viz. Pusa Delicious, Pusa Nanha, Pant Papaya-1, Madhu Bindu and hybrid Surya under north Gujarat. Result revealed that on the basis of yield, net return and B:C ratio, Pusa Nanha was found as the best variety but with respect to taste, flavour and overall acceptability, Pusa Delicious was found preferable under North Gujarat agro-climatic condition.

Prasad *et al.* (2012) conducted an experiment for performance evaluation of certain commercially important varieties of pomegranate. The experiment included six varieties viz., Bhagwa, Arakta, Ruby, MHP 7/2, G-137 and Ganesh. The results revealed that the Bhagwa variety of pomegranate was an outstanding for all the characters studied. This variety produced more number of hermaphrodite flowers per shoot (4.03) and it was a high yielder with 147.90 fruits per plant and 18.19 tonnes fruits per hectare.

Tulukcu, Eray (2012) found two kinds of fruit from capegooseberry in the study (big and small). Big sized fruit weighed 6.55g. The average yield per hectare was 317 kg. In both trial years, first flowering was observed 30 days after plantation. Flowering proceeded until the end of harvest. Mature fruits were observed 60 days after flowering.

Kumar and Singh (2013) evaluated the cultivars of aonla viz., Banarasi, Francis, Krishna, Kanchan, Chakaiya, NA6, NA7, NA8, NA9 and NA10 for their physio-chemical constituents. The average value of fruit weight, edible portion, seed and fibre, varied from

29.5 to 46.4g, 92.85 to 94.9 per cent, 4.2 to 6.07 per cent and 0.67 to 1.5 per cent, respectively.

Pandey *et al.* (2013) evaluated a total 48 genotypes of bael (*Aegle marmelos* Corr.). Genotypes showed considerable variation for fruit morphological and physico-chemical traits.

Sahu *et al.* (2013) conducted an experiment on the physical properties of aonla. Result revealed that the fruits are round, ribbed and pale green. The average fruit weight, length, diameter and stone weight were recorded as 33.60g, 3.40cm, 3.99cm and 2.08g, respectively. The average volume, pulp weight and pulp:stone ratios of fruits were obtained as 31.30ml, 29.70g and 14.28, respectively.

Singh *et al.* (2013) studied five cultivars of guava viz., Lalit, Hisar Surkha, Sweta, Allahabad Safeda and L-49. Higher fruit length was observed in Hisar Surkha followed by L-49 and Lalit. They concluded that Hisar Surkha was superior in most of the characters studied and might be one of the promising cultivars.

Singh *et al.* (2013) studied the performance of 10 husk tomato (*Physalis ixocarpa* Brot.) genotypes. The result revealed significant variation for all the morphological, growth, fruiting and yield attributes in various genotypes. Maximum number of fruit/plant (260.67), maximum fruit weight (37.67g), highest fruit husk ratio (1.21), maximum yield/plant (9.69g) and maximum fruit firmness (RI) (44.10) were recorded in EC467459.

Bakshi *et al.* (2014) evaluated *Anardana* (wild pomegranate) or 'Daru' found scattered throughout Doda district of Jammu. The ripe fruits of 12 selected genotypes were analysed for physico-chemical characteristics. Individual fruit weight ranged from 85.64 to 131.60g with fruit length from 5.52 to 7.42cm, fruit breadth 5.17 to 5.99cm, seed weight 34.60 to 56.0g/fruit and peel weight from 49.04 to 68.0g/fruit. A wide variation in physico-chemical characters of wild pomegranate genotypes indicated the scope of individual plant selection based on these characters for its genetic improvement.

Kumar *et al.* (2014) conducted an experiment to find out the performance of different commercial varieties, viz., Krishna, Kanchan, Chakaiya, NA-6, NA-7, NA-10 and Anand-1 of aonla (*Emblica officinalis* Gaertn). They reported overall performance of NA 7, Chakaiya, NA 6 and Krishna promising for cultivation in hot arid ecosystem.

Patel et al. (2014) conducted an experiment on physiological and biochemical changes during fruit growth, development and maturity of six passion fruit genotypes, i.e. three species (*Passiflora edulis* Sims (Meghalaya purple and Nagaland purple), *Passiflora edulis* F. flevicarpa Degener (Kerela yellow, Rcps-1 and Panama yellow) and *Passiflora alata*) were studied at weekly interval after fruit set till maturity. Fruit growth of passion fruit followed a single sigmoid growth curve. Fruit length, diameter and weight increased continuously from the initial stage till maturity, which slightly declined at ripening stage. Fruit developed acceptable physico-chemical qualities with good flavour and colour, when harvested at 83 to 90 days after fruit set in *Passiflora edulis* Sims (Meghalaya purple and Nagaland purple) and at 90 DAF in *Passiflora edulis* F. flevicarpa Degener (Kerela yellow, Rcps-1 and Panama yellow) and *Passiflora alata* passion fruit.

Sahu and Chandel (2014) evaluated the performance of 13 strawberry genotypes viz., Chandler, Camarosa, Confictura, Ofra, Festival, Sweet Charlie, Douglas, Ventana, Selva, Gorella, Pajaro, Eclair and Sequoia. The results revealed that the cultivars Sweet Charlie and Ofra were earliest to flower and the duration of flowering was longest in Camarosa and Sweet Charlie. The cultivars Festival, Chandler, Camarosa and Sweet Charlie stood promising with respect to yield and fruit size. The highest yield of 35.10 and 40.08 MT/ha during 2012 and 2013, respectively was recorded in cv. Chandler followed by cv. Festival (29.76 and 35.24 MT/ha during 2012 and 2013, respectively). The cultivar Festival produced berries of bigger size, weight and had more firmness as compared to cultivar Chandler.

Singh et al. (2014) evaluated nine bael varieties, viz., NB-5, NB-7, NB-9, CISH-B-1, CISH-B-2, Pant Shivani, Pant Urvashi, Pant Aparna and Pant Sujata (10-year-old) for growth, yield and quality parameters. They concluded that the NB-9 and CISHB-2, NB-5 and CISHB-1 could be recommended for commercial cultivation.

Seyie et al. (2015) evaluated twenty five tomato genotypes for low temperature tolerance under open field conditions and further selected tolerant and susceptible genotypes under control conditions (phytotron) for confirmation. They found that the Pusa Sadabahar, Pusa Sheetal and DTR-2 showed tolerance to low temperature (15/8 and 16/10°C) with respect to the vegetative characters studied.

Sharma et al. (2015) evaluated superior tamarind (*Tamarindus indica* L.) genotypes with desirable horticultural traits. A total 12 genotypes having economically important horticultural traits were identified. These genotypes showed considerable variability in

morphological and physico-chemical characters. On the basis of overall assessment they reported that six tamarind genotypes, viz., T1, T2, T5, T10, T11 and T12 were most promising and these might be used as superior trees for clonal multiplication.

Thakur *et al.* (2015) conducted an experiment for performance evaluation of certain commercially important varieties viz., Glohaven, Suncrest, Early Elberta and July Elberta of peach. The highest yield (38.02 Kg per tree) was observed in Early Elberta.

Mer *et al.* (2016) studied the varietal performance of peaches in respect to the all yield attributes in Kumaun region. The varieties F-16-23, Florda King, Nectarine and Red June were evaluated. The study revealed that the size and yield were higher in Red June and the nutritional values were higher in Florda King and Nectarine peaches.

Quality attributes

Dwivedi *et al.* (2011) studied eight strawberry cultivars for flowering, fruiting and yield characteristics under subtropical conditions. Results revealed that the TSS and acidity were higher (12.67 °Brix and 0.77 per cent respectively), in cultivar's Torrey and acidity was least in Confectura (0.53 per cent) but TSS was least (9.73 °Brix) in Confectura. The ascorbic acid was also highest (82mg/100g fresh fruit) in cultivar Torrey while it was minimum (62.00mg/100g fresh fruit) in Seascap.

Singh and Mishra (2011) conducted an experiment on the physico-chemical characters of twenty four genotypes of ber. They found that the maximum stone breadth and titratable acidity was found in Sanaur 3, whereas, Sanaur 5 has maximum stone:breadth ratio. Total soluble solids were higher in Nazuk, while, ZG 3 possessed the maximum TSS:acid ratio. Kala Gola had highest ascorbic acid content of fruit flesh.

Singh *et al.* (2011a) studied the performance of twenty capegooseberry genotypes under temperate condition. The result revealed significant variation for all the quality attributes in various genotypes. Among quality traits maximum total soluble solids was recorded in CITH CGB1 (9.71 °Brix), whereas, acid content was recorded minimum in CITH CGB20 (7.31 per cent). The ascorbic acid was estimated maximum in CITH CGB Sel-6 (24mg/100g). Maximum carotene content was recorded in CITH CGB S10 (1.72mg/100g). CITH CGB S20, CITH CGB S3, CITH CGB S12, CITH CGB S1 and CITH CGB S6 can be used as elite selections for the temperate regions.

Singh *et al.* (2011b) reported significant variation in the various varieties of mango. They found the maximum TSS in Dashehari Chhotee followed by Dashehari and Amrapali, while, the minimum was noted in Bangalora followed by Baneshan and Fazli. The titratable acidity in the fruits was maximum in Amrapali, Kelam and Dashehari Chhotee and lowest in Kakaria, Rumani and Krishnabhog. Looking to the overall qualitative characters of the mango varieties, Baneshan, Mallika and Fazli were found better in physical properties, whereas, Dashehari Chhotee, Dashehari, Langra, Amrapali and Krishnabhog exhibited their superiority in chemical qualities.

Choudhary *et al.* (2012) studied four guava cultivars for physico-chemical characters at full maturity. The fresh fruits of cultivar L-49 recorded highest TSS, total sugar, ascorbic acid, reducing and non-reducing sugar. Maximum acidity was observed in the cultivar Rewa-72, whereas, minimum in Allahabad Safeda. The cultivar Allahabad Safeda recorded high pH followed by L-49, Apple Colour and Rewa-72.

Das (2013) evaluated the performance of Litchi (*Litchi chinensis* Sonn.) cultivars viz., Shahi, Swarna Roopa, China, Elachi, Bombai, Late Bedana, Dehradoon, Mazaffarpur, Early Bedana and Rose scented. Out of all the varieties studied in climatic condition of Tripura in respect to quality parameters, the varieties Shahi, Mazaffarpur, Swarna Roopa, Bombai and Late Bedana were found good. But Shahi variety showed excellent performance in all aspects like taste, flavour, aroma and other quality parameters with good market demand in Tripura conditions.

Kumar *et al.* (2013) evaluated the cultivars of aonla viz., Banarasi, Francis, Krishna, Kanchan, Chakaiya, NA6, NA7, NA8, NA9 and NA10 for their physio-chemical constituents. The average values of TSS, acidity, pectin and total sugars varied from 7.5 to 15 per cent, 1.6 to 2.4 per cent, 2.3 to 3.4 per cent and 3.5 to 4.9 per cent, respectively. The vitamin 'C' ranged from 305.7mg/100g (NA6) to 700mg/100g (Chakaiya). The range of phenol content varied from 162.2 to 175.7mg/100g.

Pandey *et al.* (2013) evaluated a total 48 genotypes of bael having desirable traits. Genotypes showed considerable variation for fruit morphological and physico-chemical traits. With regard to biochemical parameters, TSS ranged from 26.0-44.4⁰Brix, acidity from 0.30-0.56 per cent, total sugars from 13.58-25.53 per cent, reducing sugar from 5.59-11.30 per cent, non reducing sugar from 4.30-17.07 per cent, vitamin-C content from 5.09-18.92mg/100g pulp, tannin content from 2.01-4.53 per cent and total carotenoids from 1.38-

2.72mg/100g pulp among the different genotypes analyzed. On the basis of overall assessment, seven genotypes, viz., T₂, T₁₄, T₁₅, T₂₀, T₃₁, T₄₄ and T₄₇ were found most promising.

Singh *et al.* (2013) studied the performance of 10 husk tomato (*Physalis ixocarpa* Brot.) genotypes. The result revealed significant variation for all the morphological, growth, fruiting and yield attributes in various genotypes. Total soluble solids content ranged from 6.50–11.5 °Brix and highest value was recorded in EC467440 (11.50 °Brix). The value of juice percentage of fruits was recorded maximum (3.49 per cent) in EC467459. The titratable acid content in fruits was estimated the lowest (0.36 per cent) in EC467445. Ascorbic acid content was estimated maximum in EC467459 (24.27mg/100g). The maximum 'L' value indicating brightness was found in EC467439 (64.15), whereas 'a' value indicating redness was recorded highest in EC467435 (−2.44) and 'b' value indicating yellowness was observed.

Sahu *et al.* (2013) conducted an experiment to evaluate chemical properties of aonla. They found that the average specific gravity was 1.07. The average moisture content was recorded as 78.88 per cent. Among chemical composition of fruits the total soluble solids was obtained 10.8 per cent. The acidity of fruit was recorded 1.92 per cent and ascorbic acid content was 535.00mg/100g.

Bakshi *et al.* (2014) evaluated the performance of *Anardana* (wild pomegranate) or 'Daru' found scattered throughout Doda district of Jammu. The ripe fruits of 12 selected genotypes were analysed for physico-chemical characteristics like juice content, total soluble solids (TSS), acidity, total sugars, reducing sugars, and tannins. The chemical characters also showed a wide variation. Total soluble solids varied from 11.0 to 15.5 °Brix, titratable acidity from 5.26 to 6.80 per cent, total sugars from 9.32 to 13.86 per cent and tannins from 121.12 to 149.70mg/100 ml.

Dubey *et al.* (2014) evaluated eight sweet orange accessions compared with the commercial sweet orange varieties Jaffa and Valencia Late. After 10 years of evaluation all strains showed better growth than check cultivars under Delhi conditions. Total soluble solids and acidity among the accessions were very close to check cultivars. All the accessions had more than 40 per cent juice recovery, however, MS- 16, MS-17, MS-2 and MS-1 had the higher juice content. Based on overall performance, MS-5, MS-13, MS-17, and MS-7 were found promising.

Sahu and Chandel (2014) evaluated the performance of 13 strawberry genotypes viz., Chandler, Camarosa, Confictura, Ofra, Festival, Sweet Charlie, Douglas, Ventana, Selva, Gorella, Pajaro, Eclair and Sequoia. They reported that the TSS content was maximum in Sweet Charlie, which also recorded the lowest acid content. Sequoia recorded the highest anthocyanin content, followed by cultivars Camarosa and Festival.

Thakur *et al.* (2015) conducted an experiment for performance evaluation of certain commercially important varieties viz., Glohavel, Suncrest, Early Elberta and July Elberta of peach. The better quality fruits with respect to highest TSS, acidity reducing sugar and ascorbic acid contained were produced by Glohavel.

Mer *et al.* (2016) conducted an experiment on the varietal performance in respect to the quality. They recorded acidity (1.66 per cent), ascorbic acid (440mg/100g), reducing sugar (19.77 per cent) and total sugar (51.73 per cent) and reported that nutritional value were higher in Florida King and Nectarine peach.

Variability, Heritability and Genetic advance

Gupta *et al.* (2004) studied the variability in 25 genotypes of kagzi lime. The result showed that variability was significantly higher for characters like leaf area index, volume of the plant, fruit set percentage, percentage of fruit retained till harvest, number of fruits per plant, yield and juice percentage. The genotypes A-3, A-5, A-10, A-83, A-91, A-134 and A-233 were found to be superior in relation to yield, fruit quality, P^H and reaction to citrus canker.

Rajan *et al.* (2005) examined highly significant variability among sixty eight guava genotypes for all the traits with high GCV and PCV. However, high GCV was noticed for pulp:seed weight ratio (559.84 per cent). The phenotypic coefficient of variation (PCV) varied from 33.85 (average fruit weight) to 609.75 per cent (pulp:seed weight ratio). High PCV was also observed for number of seeds per 100g fruit (48.02), number of seeds per fruit (44.49) and 100 seed weight (39.83).

Baruah *et al.* (2007) assessed the extent of genetic variation among twenty banana cultivars. The growth parameters of local banana cultivars of Assam viz., Bhutmanohar, Bharatmoni and Kachkal were superior as compared to commercial cultivar. Meanwhile, the

yield and yield attributing parameters were most promising in commercial cultivar Barjahaji as compared to local ones. The GCV and PCV were highest for leaf area and finger weight of the banana.

Kour *et al.* (2008) reported high heritability in F1 and F2 generations for fruit per plant and plant height. In F3 highest genetic advance was recorded for fruit yield, primary branches and fruit length while in F2 generation for fruit yield and fruit length. Significant values for phenotypic correlation were observed in 13 out of 21 combinations in F1, generation while for genotypic correlation in 14 combination out of 21 were significant in F2 generation.

Raghava and Tiwari (2008) analyzed heritability for thirteen fruit characters in 15 guava genotypes. Higher estimates of heritability were observed for all the fruit traits which ranged from 90.27 to 99.97 per cent.

Singh and Mishra (2010) studied heritability of the important morphological traits in 15-year-old grafted trees of Bael (*Aegle marmelos*) for genotypes PB-1, PB-2, PB-3, Pant Shivani, Pant Urvashi, PB-7, NB-1, Pant Sujata, PB-13, PB-14, PB-15, PB-16, PB-7B and PB-BB at Pantnagar (Uttarakhand, India). The observations recorded that broad sense heritability was ranged from 48.29 per cent (tree height) to 99.30 per cent (ascorbic acid).

Shukla *et al.* (2012) evaluated 16 genotypes of ber (*Zizyphus mauritiana* Lamp), in which twelve were commercial cultivars viz, Banarasi, Karak, Karali, Shootless, Mehrun, Peundi, Gola, Jaffran, Chhuhara, Khinni, Desi, Kaithali and Illachi ; and four selections – I.e. Ambedkar Ber 1, Ambedkar Ber 2, Ambedkar Ber 3, Ambedkar Ber 4 to correlate 13 physico-chemical characters of fruits i.e. fruit length, fruit width, fruit weight, fruit volume, specific gravity, total soluble solids, acidity, stone length and stone width, stone weight, pulp:stone ratio and fruit pulp. Correlation analysis study showed a high positive and statistically significant ($P < 0.01$) correlation between fruit pulp and fruit weight (0.999). Fruit pulp also had positive and significant correlation with fruit volume (0.874) and fruit width (0.730). Fruit volume indicated negative correlation with specific gravity. Therefore, information on different physico chemical characters of fruit and fruit pulp yield may be of great importance to a breeder in selecting desirable genotype.

Singh *et al.* (2013) reported that PCV were generally higher than their corresponding GCV for all the characters viz., plant height, primary branches per plant, plant spread, days to first flowering, days to first fruit set, days to first harvest, average fruit weight, fruit length,

fruit diameter, fruit index, fruits per plant and yield per plant. PCV and GCV were high (>25 per cent) for fruits per plant, average fruit weight, fruit index, fruit length, fruit diameter, primary branches per plant, whereas, yield per plant, plant spread, plant height, days to first flowering, days to first fruit set and days to first harvest showed moderate PCV (10-25 per cent). The heritability estimates were high for all the characters. Expected genetic advance was observed to be higher for fruits per plant, average fruit weight, fruit index, fruit length, fruit diameter, primary branches per plant, yield per plant, plant spread and plant height where as moderate for days to first flowering, days to first fruit set and days to first harvest.

Jambhale *et al.* (2014) studied the genetic variability, association among the yield component traits and their direct and indirect effects on the yield in papaya. All the genotypes showed considerable amount of variation in their mean performances with respect to the characters studied except TSS (0.267) indicating presence of sufficient variability for breeding of superior desirable genotypes. High heritability with high genetic advance as per cent mean was recorded for characters such as seeds per fruit (98.3, 148.75), pulp to seed ratio (79.70, 91.47), yield per plant (83.5, 37.64), fruit length (84.5, 34.04), distance of first fruiting node from ground level (78.0, 31.66), fruits per plant (71.8, 24.18), fruit cavity, fruit diameter and average fruit weight indicating that these traits are predominantly governed by additive gene action. Yield per plant exhibited highly significant positive correlation with fruit cavity (0.88, 0.68), number of fruits per plant (0.87, 0.85), average fruit weight (0.77, 0.67) and pulp thickness (0.63, 0.54) at both genotypic and phenotypic levels respectively, indicating improvement in these traits correlated to the fruit yield. Number of fruits per plant had the highest direct effect (0.97) on yield per plant followed by average fruit weight (0.56) and length of fruit (0.19) indicating importance of these characters which can be strategically used to improve the yield of papaya.

Nwosu *et al.* (2014) conducted an experiment on the genetic variability among 19 accessions of tomato (*Solanum* sp.). Highly significant differences among the accessions for all attributes were studied. Cluster analysis based on 37 agro-morphological attributes separated accessions into two distinct groups according to the fruit types i.e. cherry and classic fruit types was done. Values for genotypic and phenotypic coefficients of variation showed variability among the accessions. Correlation analysis showed fruit per plant positively correlated to plant height, number of branches per plant and leaf length. Very high genetic advance and heritability estimates for leaf length, leaf width, days to flower, days to 50 per cent flowering, number of fruits per plant, fruit length, fruit diameter, fruit weight and

1000 seed weight suggest simple inheritance system and thus amenability for these attributes to selection in tomato improvement.

Singh *et al.* (2014) studied the Genetic variability, heritability and correlation coefficients in 20 genotypes of capegooseberry (*Physalis peruviana* L.). Wide range of variability was observed in a number of fruits/plant (26-73), fruit weight (6.51- 19.1g), fruit length (20.42-29.82mm), fruit diameter (23.06-34.22mm), per cent juice content (56.2-63.17), fruit yield (199.67-1145.03g/plant), total soluble solids (6.92-9.71 °Brix), acidity content (0.28-0.67 per cent), and ascorbic acid content (19.54- 24.36mg/100g edible part). Heritability was recorded in the range of 71.1 per cent (TSS content) to 99.7 per cent (fruit weight). Genetic advance range was recorded between 0.56 (fruit yield per plant) and 454.2 (fruit weight). Genotypic coefficient of variations ranged from 2.99 (TSS content) to 38.27 (weight of fruit) while phenotypic coefficient of variations ranged from 3.54 (TSS content) to 38.28 (weight of fruit). Significant and positive genotypic and phenotypic correlation coefficients were observed in number of fruits/plant and fruit yield/plant. Fruit weight showed high genotypic and phenotypic coefficient of variations with fruit length, diameter and yield/plant. However non significant negative correlation coefficients were observed in number of fruits/plant with fruit weight, fruit length, fruit diameter, and juice percentage. For selecting promising and high-yielding genotypes of capegooseberry emphasis should be given on fruit length, fruit diameter and fruit weight.

Srivastava *et al.* (2014) studied genetic variability and diversity using Mahalanobis D2 statistics in sweet cherry (*Prunus avium* L.). Most of the traits showed low to moderate heritability, while only four traits viz., fruit length, TSS, annual extension growth and trunk girth showed high heritability of 71, 68, 65 and 74 per cent, respectively. The grouping of genotypes using Tocher's method revealed that these cultivars could be grouped into six clusters, with Cluster-I having maximum number of genotypes (9) followed by 8 in Cluster-II. Whereas, rest of the clusters were monogenotypic with one cultivar each. Cluster-II had the maximum intra-cluster distance, while inter-cluster distance was highest between Cluster-III and VI. Maximum contribution towards divergence came from trunk girth (19.52 per cent), while minimum from fruit diameter (1.43). Cluster means indicated that none of the clusters were superior for all the characters studied. Therefore, hybridization between genotypes belonging to different clusters is suggested for development of superior genotypes.

Thapa *et al.* (2014) studied the Genetic divergence in thirty tomato genotypes using Mahalanobis D2 statistics. These genotypes were grouped into five clusters based on nineteen characters. Maximum divergence was recorded between clusters III and IV followed by clusters IV and V. Genotype MT-4 (Oval big) of cluster III was found to be best for yield and related traits, like number of primary branches, fruit length, diameter, weight and yield per plant. Similarly, BT-10 of cluster IV was suitable for quality traits, like TSS, ascorbic acid, juice, β -carotene and lycopene content. Genotypes of cluster III and IV (MT-4, Oval Big and BT-10) can be used for the development of hybrid/variety having higher yield and better quality.

Basavaraj *et al.* (2015) reported wide range of variability for all the character studied. Analysis of variance showed significant variations among the genotype for all tested characters. Phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the characters studied. Days to first fruit maturity showed highest genotypic and phenotypic variation (3427.10 and 6531.93), whereas, TSS ($^{\circ}$ Brix) showed the lowest ones (0.55 and 0.63). High genotypic variation was observed for most of the characters indicating more contribution of genetic component for the total variation. Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were highest for yield per hectare (341.89 and 323.12), whereas, the lowest ones for days to first flowering (5.82 and 7.21). Higher GCV and PCV were recorded for most of the characters. The highest heritability was recorded for yield per hectare (96.34 percent), while the lowest for plant height (45.30 per cent). High heritability estimate were observed for all the tested characters indicating that these characters are controlled by additive gene action which can be improved by simple selection.

Bhat and Dhillon (2015) reported genotypic and phenotypic coefficient of variations, heritability, genetic advance and clustering using D2 analysis with group constellation following Tocher's method. Phenotypic and genotypic coefficients of variation were high for fruit yield (46.58 and 46.55 per cent), fruit length (47.06 and 42.69 per cent), fruit weight (46.53 and 45.17 per cent), pedicel length (38.47 and 37.82 per cent) and TSS (39.62 and 36.1 per cent) and medium to low for other traits. The estimates of heritability and genetic advance were maximum for fruit yield. High heritability estimates accompanied with greater genetic advance were observed for yield, fruit weight, pedicel length and fruit length indicating that these traits may be considered for selecting promising parents. Test genotypes were grouped into four clusters with maximum number of genotypes (6) in cluster I, 2

genotypes in cluster IV and one genotype each in clusters II and III. Highest inter-cluster distance (153.05) was between cluster II and IV, while highest intra-cluster distance was observed in cluster IV (36.24).

Kathayat *et al.* (2015) revealed high genotypic and phenotypic coefficients of variation for number of fruit cluster per plant (49.84 and 51.16, respectively) and lowest for days to first fruit picking (1.51 and 1.41, respectively). Heritability was found low for days to first fruit picking (0.13 per cent) and high for number of fruit cluster per plant (100 per cent). High genetic advance was observed for 1000 seed weight (484.88), whereas, lowest for fruit diameter (0.24). Genotypic correlation coefficient was higher than phenotypic correlation coefficient.

Kumar *et al.* (2015) reported the effect of genetic variability, genetic advance and heritability in papaya and its character association responses to yield under Meerut (UP) condition. The result indicated that for yield improvement, high range of plant height (120 to 185.33cm), flower initiation (212.93 to 228.83 days), flowering (days) (230.83 to 242.27), fruits per plant (19.67 to 60.73), fruit weight (906.90 to 1558.77g) and fruit yield per plant (24.87 to 70.33 kg) were important. High Heritability values obtained for plant height at flowering (99.70 per cent) was followed by fruit weight (97.50 per cent), fruit per plant (96.40 per cent) and flower initiation (94.80 per cent), Fruit yield per plant (93.50 per cent) indicated that these characters were highly influenced by environmental fluctuations. High PCV, GCV and high genetic advance were associated with high heritability. Fruit yield per plant had significant positive association with plant height at flowering, petiole length, number of leaves at flowering, fruit length, fruit girth, central cavity, pulp thickness, TSS and number of fruits per plant both at genotypic and phenotypic levels respectively.

Mishra *et al.* (2015) evaluated Strawberry (*Fragaria × ananassa* Duch.) genotypes to study genetic variation and the relationship between yield and its component. The results showed significant variations among genotypes of all traits. The phenotypic coefficient of variation (PCV) for all the characters was slightly higher than genotypic coefficient of variation (GCV), which signified the presence of environmental influence to some degree in the phenotypic expression of characters. Dry fruit weight had the highest PCV (52.47) and GCV (48.26). The estimates of narrow sense heritability (H^2) were observed to be lower than those of broad sense heritability (H^2) for all characters. Genetic advance was recorded as maximum for fruit yield per plant (76.84), whereas genetic advance as per cent of mean was

highest for dry fruit weight (84.09). Highest heritability (H^2 , 98.44) was coupled with higher genetic advance (76.84) for fruit yield per plant, which indicated that the character is controlled by additive genes and therefore further improvement could be brought by selection. Fruit yield was significantly and positively associated with most of the characters except number of leaves per plant, titratable acidity, and ascorbic acid at both genotypic and phenotypic levels; therefore, these are important prerequisites to formulate a successful improvement programme.

Chapter- 3

MATERIALS AND METHODS

The present investigation entitled “**Evaluation of Capegooseberry (*Physalis peruviana* L.) Under Humid Agro-climatic condition of Jhalawar**” was conducted during the year 2015-16. The details of the experiment in respect to materials used and techniques employed for studies have been described in this chapter.

3.1 EXPERIMENTAL SITE

The present experiment was conducted at the Protected Cultivation Unit, College of Horticulture and Forestry, Jhalrapatan City, Jhalawar.

3.2 LOCATION AND CLIMATE

Jhalawar district is located at 23°4' to 24°52' N-Latitude and 75°29' to 76°56' E-Longitude in South Eastern Rajasthan. Agro-climatically, the district falls in Zone V and is known as Humid South Eastern Plain. About 84.22 per cent population of the district is rural whose main occupation is agriculture. The average rainfall in the region is 954.7mm. Maximum temperature range in the summer is 43- 48°C and minimum 1.0- 2.6°C during winter. Major kharif crops of the district are soybean, maize and pulses. In rabi, wheat, mustard, coriander and garlic are main crops. The detail of weather variables as observed during the experiment period is presented in Table 3.1 and depicted through Figure 3.1.

The daily outside temperature (°C) and relative humidity (per cent) was recorded in the afternoon at 12.00 noon with the help of thermohydrometer.

3.3 SOIL CONDITION

In order to assess the physico-chemical properties of the soil at the experimental site, the soil samples were drawn randomly from different spots in the field at a depth of 0-30cm before the commencement of the experiment. A representative sample was prepared and it was subjected to mechanical, physical and chemical analyses. The detailed study of soil properties as observed is presented ahead.

3.4 EXPERIMENTAL MATERIALS

3.4.1 Seed

Capegooseberry is raised by seeds. Seeds were sown in the month of October. The seed germinated within 1 to 2 week. Seeds of Selection-7, Selection - 9 and Selection-21

were arranged from College of Horticulture, Narsarai, Nalanda (Bihar) and those of Amb. Selection-1, Amb. Selection-2, Amb. Selection-3, Amb. Selection-4, Amb. Selection-5, Amb. Selection-6, Amb. Selection-7, from Bhimrao Ambedkar University, Lucknow (UP).

Seeds were sown in the pro-tray (9 × 7cm size) at the Protected cultivation unit, College of Horticulture and Forestry, Jhalawar. For the study, seeds of Capegooseberry were sown on 14 October, 2015.

The seedlings were transplanted on 15cm raised bed in the field on November 19th 2015. All beds were maintained under uniform cultural management including practices of fertilizer application and plant protection measures. The detail of treatments undertaken and methods followed to carry out the experiment is furnished underneath:

3.5 Experimental details

3.5.1 Treatments

Genotypes

1. Amb. Sel.-1
2. Amb. Sel.-2
3. Amb. Sel.-3
4. Amb. Sel.-4
5. Amb. Sel.-5
6. Amb. Sel.-6
7. Amb. Sel.-7
8. Sel.-7
9. Sel.-9
10. Sel.-21

3.5.2 Other details of experiment

Different genotypes of capegooseberry (*Physalis peruviana* L.) were planted under open field condition. The detail regarding transplanting and the experiment are as under;

- | | |
|--------------------------------|------------|
| 1. Planting system | Raised bed |
| 2. Height of raised bed | 15cm |
| 3. Spacing | 60 x 30cm |

4.	Total no. of treatments	10
5.	Replications	3
6.	Number of plants/treatment	10
7.	Total no. of plants across all treatments	300
8.	Date of sowing seeds	14 th October 2015
9.	Date of transplanting in the field	19 th November 2015
10.	Experimental design	RBD

3.6 EXPERIMENTAL LAYOUT

As per the plan of study, capegooseberry plants were grown over raised beds of 15cm height from ground level prepared independently under open field condition as in context. Between the two beds 0.5m space was left for proper intercultural operations. On each bed two drip lines having inline drippers at 30cm distance were stretched parallel to each other. In all, at the rate of 5 plants each row of the bed, total 10 plants were planted in a bed at 30cm spacing. Plants were transplanted near the drippers. The detailed layout of the field is as under:

3.7 OBSERVATIONS RECORDED

Various parameters of capegooseberry were studied. For recording data five plants in each replication of the treatment were selected randomly and tagged. As per requirement their various parameters were studied to record data. The details of various observations made are as under:

3.7.1 Growth parameters

1. Plant height (cm)
2. Plant spread (cm)
 - East-West
 - North-South
3. Total chlorophyll content of leaves (mg/g)
4. Number of nodes per plant
5. Number of branches per plant

6. Leaf length (cm)
7. Leaf breadth (cm)
8. Root and Shoot ratio (after final harvesting)
9. Leaf perimeter

These parameters were recorded after final harvest of the crop.

3.7.2 Production parameters

1. Days taken to first flower initiation
2. Days taken to fruit set
3. Fruit set (per cent)
4. Days taken to first harvest
5. Duration of harvesting
6. Number of pickings
7. Fruit diameter (mm)
8. Fruit weight (g)
9. Number of fruits per plant
10. Fruit yield per plant
11. Estimated yield (q/ha)

3.7.3 Quality parameters

1. TSS (°Brix)
2. Titratable acidity (per cent)
3. TSS/acid ratio
4. Total sugar (per cent)
5. Juice (per cent)
6. Vitamin C (mg/100g)
7. Carotene (mg/100g)
8. Sensory score

3.7.4 Estimation of genetic variability parameters

1. Genetic variance
2. Phenotypic variance
3. Genotypic coefficient of variation
4. Phenotypic coefficient of variation
5. Heritability
6. Genetic advance

3.8 METHODOLOGY USED FOR RECORDING OBSERVATIONS

3.8.1 PLANT GROWTH PARAMETERS

Five plants were tagged in each replication for taking observations on growth parameter of fruits.

3.8.1.1 Plant height (cm)

The height of plant was measured from the base of soil to the highest tip of the plant with the help of measuring scale.

3.8.1.2 Plant spread (cm)

The spread of the plants was recorded in east-west and north-south directions separately with the help of a meter scale and the average for each direction was calculated.

3.8.1.3 Chlorophyll content of leaves (mg/g)

After completion of harvesting, leaves from plants were analysed for chlorophyll content. Chlorophyll content was measured as per method as suggested by Sadasivam and Manickam (1997). The details of procedure followed are as follows:

One gram of mature finely cut leaves was weighed and ground using 20ml volume of acetone into a clean mortar. The sample was centrifuged (at 5000 rpm for 5 minutes) and the supernatant was transferred to a 100ml volumetric flask. The process of centrifuging was repeated until the appearance of colourless residue. The mortar and pestle were washed thoroughly with 80 per cent acetone to get the clear extract of leaves. The volume was made upto 100ml with 80 per cent acetone. Then the absorbance of the solution was read at 645 and 663nm against the blank solution of 80 per cent acetone. The amount of chlorophyll present in the extract was calculated using the following equations:

$$\text{Chlorophyll (a) mg/g tissue} = 12.7 (A_{663}) - 2.69 (A_{645}) \times V/1000 \times W$$

$$\text{Chlorophyll (b) mg/g tissue} = 22.9 (A_{645}) - 4.68 (A_{663}) \times V/1000 \times W$$

$$\text{Total Chlorophyll mg/g tissue} = 20.2 (A_{645}) + 8.02 (A_{663}) \times V/1000 \times W$$

Where,

A = Absorbance at specific wave length

V = Final volume of chlorophyll extract in 80 per cent acetone

W = Fresh weight of tissue extracted

3.8.1.4 Number of nodes per plant

Number of nodes on the plant in each treatment was counted and average value was recorded.

3.8.1.5 Number of branches of per plant

Number of branches there on the plant in each treatment was counted and average value mass taken.

3.8.1.6 Leaf length (cm)

This was measured selecting ten leaves on each tagged plant by Vernier caliper and average was worked out and expressed in centimeters.

3.8.1.7 Leaf breadth (cm)

The Leaf breadth of the same 10 leaf as used to record length was taken to observe the value of this character. This was measured by Vernier caliper and average was worked out and expressed in centimeters.

3.8.1.8 Root and Shoot ratio (after final harvesting)

The root to shoot ratio was calculated by dividing the root weight by the shoot weight and average was worked out to record the value.

3.8.1.9 Leaf perimeter (cm)

The Leaf perimeter of the same 10 leaf as used to record length and width was taken to observe the value of this character. This was measured by Vernier caliper and average was worked out and expressed in centimeters.

3.8.2 PRODUCTION PARAMETERS

3.8.2.1 Days taken to first flower initiation

It was recorded when 5-6 plants in each replication started to flower. The average number of days from planting date was calculated to make the observation.

3.8.2.2 Days taken to fruit set

The number of days taken to first fruit set was recorded when the swelling of ovary took place and it attained the size equal to fly head. It was recorded when on 5-6 plants in each replication fruit set took place.

3.8.2.3 Fruit set (per cent)

The number of fruits which set in (Flower with swollen ovary) were recorded after initial stage of fruit development. The per cent fruit set was recorded as follows:

$$\text{Fruit set (\%)} = \frac{\text{Number of fruits set}}{\text{Total no. of tagged flowers}} \times 100$$

3.8.2.4 Days taken to first harvest

It was observed when fruits were harvested first in each replication. When persistent calyx and also fruit stalk dried completely, fruits were considered ready for harvesting. The average number of days from planting date was calculated to record the observation.

3.8.2.5 Duration of harvesting

Number of days taken to final harvest was counted from the date of first harvesting to the last harvesting in each treatment. The average was worked out and the data were recorded.

3.8.2.6 Number of pickings

The number of pickings was observed by counting the number of times the fruits were harvested and average was drawn to record the data.

3.8.2.7 Fruit weight (g)

The weight of 10 randomly picked fruits from each sample plant was weighed and noted at first harvesting time with the help of a digital balance. Average fresh fruits weight in grams was then calculated by dividing the weight of fruits with number of fruits weighed.

3.8.2.8 Fruit diameter (mm)

The diameter of the same 10 fruits as used to record length and width was taken to observe the value of this character. This was measured by Vernier caliper and average was worked out.

3.8.2.9 Number of fruits per plant

The number of fruits per plant was recorded on the same five tagged plants on which fruit set was studied. The number of fruits reaching harvestable maturity was counted at each harvest and the value was expressed as number of fruits per plant.

3.8.2.10 Fruit yield per plant (g)

The yield per plant was recorded by adding yield of all the harvest obtained from selected plant. The value was averaged to record the data.

3.8.2.11 Estimated yield (q/ha)

The estimated fruit yield per hectare was calculated on the basis of fruit yield obtained from a unit plot area:

$$\text{Fruit yield (q/ha)} = \frac{\text{Fruit yield per plot (kg)}}{\text{Area of plot (m}^2\text{)}} \times 10000$$

3.8.3QUALITY PARAMETERS

3.8.3.1 Total Soluble Solids (°Brix)

Total soluble solids (TSS) were recorded with the help of hand refractometer. Fully ripe fruits of each treatment were taken. They were squeezed and juice was obtained. A few drops (2-3) of juice from five fruits were taken separately and dropped over the prism of the refractometer. The value as observed was averaged to record the TSS (°Brix).

3.8.3.2 Titratable acidity (per cent)

The titratable acidity was determined by titrating the juice against standard alkali solution (0.1N NaOH). Pulp of sample weighing two gram was taken in distilled water. It was crushed and homogenized. The value of sample was made up to 100ml with distilled water. Aliquot of diluted sample measuring 10 ml was pipetted out and it was transferred in 250ml beaker. Phenolphthalein indicator @ 1-2 drops was added to the solution. The prepared sample was titrated against 0.1N NaOH alkali solution. The alkali was added drop by drop to the conical flask with constant stirring until the end point reached with disappearance of pink colour. The percentage of acidity was calculated following the formula as under:

$$\text{Acidity(\%)} = \frac{\text{Titre volume} \times 0.1 \times 64 \times 10}{\text{Volume of aliquot} \times 10}$$

3.8.3.3 TSS:Acid ratio

TSS/acid ratio was calculated by dividing the value of total soluble solids content by acid content (per cent).

3.8.3.4 Sugars (per cent)

Reducing sugars and total sugars were estimated by Lane and Eynon (1984) copper titration method as explained below:

Reagents

1. **Fehling's solution (A):** 69.28g of copper sulphate was dissolved in water and the volume was made up to 1000ml and filtered through Whatman paper no. 4.
2. **Fehling's solution (B):** 346g of Rochelle salt and 100g NaOH was dissolved in water and volume was made up to 1000ml.
3. **Methylene blue indicator:** 1g of methylene blue was dissolved in 100ml of water.
4. 45 per cent neutral lead acetate solution: 250g of neutral lead acetate was dissolved in water and volume was made up to 500ml.
5. 22 per cent Potassium Oxalate solution: 110g potassium oxalate was dissolved in water and volume was made up to 500ml.
6. Standard invert sugar solution: 100ml of water and 5ml of concentrated HCl was added in 9.5g of AR Sucrose in 1litre volumetric flask. It was allowed to stand for 3 days at 20-25°C and then volume was made up to 1litre with distilled water. Standard invert solution measuring 0.25ml was pipetted out into a 100ml volumetric flask and 50ml distilled water was added. A few drops of phenolphthalein indicator was added and neutralized with 20 per cent NaOH until the solution turned pink and was acidified with 1 N HCl adding it dropwise until one drop caused the pink colour to disappear. Then it was made up to mark with water (1ml=2.5mg of invert sugar).

Standardization of the Fehling's Solution

Each Fehling's solution (A and B) measuring 5ml was taken into 250ml conical flask and 25ml of water was added. Prepared standard invert sugar solution was taken in a 50ml burette. 10ml of standard invert sugar solution was added in the conical flask containing mixture of Fehling's solution. Then conical flask containing the mixture was heated and it was boiled for 2-3 minutes on low flame and invert sugar solution was added from the burette rapidly. Then, further quantity of sugar solution was added to the conical flask, which turned the colour of solution light blue. About 2 to 3 drops of methylene blue indicator was added and the titration was completed within 2-3 minutes by adding further quantity of invert sugar solution. At the end point a brick red precipitate developed.

$$\text{Factor for Fehling's solution (g of invert sugar)} = \frac{\text{Titre (Burette Reading)} \times 2.5}{1000}$$

Total sugar (%)

Filtrate volume of 50ml was taken in 100ml conical flask and then hydrolyzed by adding 5ml. of conc. HCl. It was left for 24 hours. After that, two drops of phenolphthalein indicator was added and then it was neutralized by adding 40 per cent NaOH solution. Pink colour appeared due to its neutralization. Then 1N HCL was added drop by drop until pink colour disappeared. Now, it was taken in burette. This solution was then titrated against Fehling's A and B as reducing sugar titration and the percentage of total sugar was worked out.

$$\text{Total sugar (\%)} = \frac{\text{Factor} \times \text{Dilution} \times 100 \times 100}{50 \times \text{Titre value} \times \text{Wt. of Sample}}$$

$$\text{Non-reducing sugar (\%)} = (\% \text{ Total invert sugar} - \% \text{ Reducing sugar originally present}) \times 0.95$$

$$\% \text{ Total Sugar} = (\% \text{ Reducing Sugar} + \% \text{ non-reducing sugar})$$

* (10ml of Fehling solution = 0.05g of sugar)

3.8.3.5 Juice (per cent)

The ripe fruits of capegooseberry were taken in muslin cloth and crushed. It was squeezed firmly to get juice. The juice was weighed with the help of balance and the percentage of juice was worked out on the basis of total weight of fruit taken for juice extraction.

3.8.3.6 Vitamin C (mg/100g fruit)

In estimation, the following reagents were used:

1. Dye solution: 50mg of the sodium salt of 2, 6-dichlorophenol-indophenol was dissolved in approximately 150ml hot distilled water containing 42mg of sodium bicarbonate. The solution was allowed to cool and distilled water was added to make up the volume 200ml.
2. 3 per cent metaphosphoric acid: 30g sticks of HPO_3 were dissolved in distilled water and the volume was made upto 1 liter.
3. Standard ascorbic acid: 100mg of 1-ascorbic acid was added to 3 per cent HPO_3 and volume was made upto 100ml. (1ml = 0.1mg of ascorbic acid). Then 10ml solution was taken from it and the volume was again adjusted to 100ml with 3 per cent

Metaphosphoric acid solution. Now 10ml standard ascorbic acid solution was taken and it was titrated with dye solution.

Procedure

Standardization of Dye

Ascorbic acid solution measuring 5ml was taken and 5ml of HPO_3 was added in a conical flask. A microburette was filled with the dye solution and then the dye solution was titrated till the end point reached with appearance of pink colour which persisted for 15 seconds. The dye factor was determined, i.e. mg of ascorbic acid per ml of dye, using following formula:

$$\text{Dye factor} = \frac{1}{\text{Titre value (burette)}}$$

Crushed sample weighing 2g was taken in a conical flask and the volume was adjusted up to 100ml with 3 per cent HPO_3 solution. This solution was kept for 10-15 minutes and then filtered. The filtrate solution measuring 10ml was titrated with standard dye 2, 6-dichlorophenol-indophenol to a pink end point appearance. It was titrated rapidly and preliminary determination of the titre was made. The ascorbic acid content of the sample was calculated by the following formula :

$$\text{Ascorbic acid (mg/100g pulp)} = \frac{\text{Titre} \times \text{Dye factor} \times \text{Volume made up} \times 100}{\text{Aliquot} \times \text{Vol. of solution taken for estimation}}$$

3.8.3.7 Sensory score

A panel of five judges conducted organoleptic test after getting harvest of fruits of each treatment. The observation were recorded on the basis of flavour, colour, taste and general appearance of fruit and rated on 10.0 scale as under:

Excellent	:	9.1 to 10.0
Very Good	:	8.1 to 9.0
Good	:	6.1 to 8.0
Acceptable	:	5.1 to 6.0
Non-acceptable	:	0 to 5.0

3.8.3.8 Carotene (mg/100g)

The homogenization of fresh, most characteristic fruits, with a typical colour was made in a porcelain mortar with some quartz sand added (a few mg). The pigments were extracted by accurate mixing of the adequate solvent with the formerly crushed fruits. Then

the solution was filtered through the funnel with filter paper (quality, medium) into 10ml volumetric flask. The absorbance was measured with the UV-VIS spectrophotometer in the quartz cuvette (1.0cm) at a wave length adequate for a given pigment.

Carotenoids:

Carotenoids were extracted from the fruits weighing 100mg with concentrated acetone (10ml). The absorbance was measured at the wavelength of 440nm for carotenoids. The concentration of the total carotenoids was calculated according to the method as given by Wettstein, 1957.

$$CK = 4.695 \cdot A_{440} \text{ [mg} \cdot \text{dm}^{-3}]$$

A₄₄₀ – absorbance at $\lambda = 440\text{nm}$

3.8.4 GENOTYPIC PARAMETERS

3.8.4.1 Phenotypic and genotypic variance

Phenotypic and genotypic variances were calculated as per formulae given by Singh and Chaudhary (1979).

$$\text{Genotypic variance } (\sigma_g^2) = \frac{\text{Treatment MSS} - \text{Error MSS}}{\text{Number of replication}}$$

$$\text{Phenotypic variance } (\sigma_p^2) = (\sigma_g^2 + \sigma_e^2)$$

Where,

$$\sigma_e^2 = \text{Error MSS}$$

3.8.4.2 Coefficient of variation

The phenotypic and genotypic coefficients of variation for all characters were calculated by the method as suggested by Singh and Chaudhary (1979).

Phenotypic coefficient of variation (PCV)

$$\text{PCV} = \frac{\sqrt{\sigma_p^2}}{\bar{X}} \times 100$$

Where,

$$\sigma_p^2 = \text{Phenotypic variance}$$

$\bar{X}$ = General mean of the character

Genotypic coefficient of variation (GCV)

$$\text{GCV} = \frac{\sqrt{\sigma_g^2}}{\bar{X}} \times 100$$

Where,

σ_g^2 = Genotypic variance

X = General mean of the character

3.8.4.3 Heritability (h^2)

Heritability in broad sense was estimated as a ratio of genotypic variance (Falconer, 1981).

$$h^2 = \frac{\sigma_g^2}{\sigma_p^2}$$

Where,

σ_g^2 and σ_p^2 are genotypic and phenotypic variances, respectively.

3.8.4.4 Genetic advance

This was calculated by using the formula as given by Johnson *et al.* (1955).

$$GA = \frac{\sigma_g^2}{\sigma_p^2} \times k \cdot 6p$$

Where,

Vg = genotypic variance

Vp = Phenotypic variance

6p = Phenotypic standard deviation

k = Selection of differential at a particular selection intensity the 'k' value is 2.06 at 5 per cent intensity of selection as per Falconer (1981).

As shown by Johnson *et al.* (1955) the genetic advance can also be expressed as percentage of the population mean to show the relationship of the genetic coefficient of variation and heritability.

$$GG = \frac{GA}{\text{General mean}} \times 100$$

3.8.4.5 Correlation studies

Simple correlations between different characters of capegooseberry plant were worked out. Correlation coefficients were tested by referring to correlation values (Fisher and Yates, 1963).

3.8.4.6 Phenotypic and genotypic correlation coefficient

Simple correlation coefficients pertaining to the phenotype and genotype for characters were computed as per method as suggested by Singh and Chaudhary (1979). For growth parameters observations at 160 DAP were considered for correlation studies.

$$\text{Phenotypic correlation } = r_{xy}(p) = \frac{\text{COV}_{xy}(p)}{\sqrt{[V_x(p) V_y(p)]}}$$

$$\text{Genotypic correlation} = r_{xy}(g) = \frac{\text{COV}_{xy}(g)}{\sqrt{[V_x(g) V_y(g)]}}$$

Where,

$\text{COV}_{xy}(g)$ = Genotypic covariance between X and Y characters

$\text{COV}_{xy}(p)$ = Phenotypic covariance between X and Y characters

$V_x(p)$ = Phenotypic variance of x characters

$V_x(g)$ = Genotypic variance of x characters

$V_y(p)$ = Phenotypic variance of y characters

$V_y(g)$ = Genotypic variance of y characters

3.8.4.7 Path coefficient analysis

The direct and indirect effects were estimated through path coefficient analysis as suggested by Wright (1921) and elaborated by Dewey and Lu (1959). The following equations were solved for estimating the various direct and indirect effects.

$$r_{1y} = P_{1y} + r_{12}P_{2y} + \dots + r_{1p}P_{py}$$

$$r_{2y} = r_{21}P_{1y} + P_{2y} + \dots + r_{2p}P_{py}$$

.....

.....

.....

$$R_{py} = r_{p1}P_{1y} + r_{p2}P_{2y} + \dots + P_{py}$$

Where,

$P_{1y}, P_{2y}, \dots, P_{py}$ are direct effect of character 1, 2, ..., p on y and $r_{1y}, r_{2y}, \dots, r_{py}$ denotes correlation coefficient between independent characters 1, 2, ..., p and dependent character 'Y'.

Residual effect was calculated using the following formula :

$$1 = P_{Rg}^2 + \Sigma P_{iy}R_{iy}$$

$$P_{Ry} = \sqrt{1 - (P_{1y}r_{1y}) - (P_{2y}r_{2y}) - \dots - (P_{iy}r_{iy})}$$

Where,

P_{Ry} is the residual effect

Y is the bulb yield

3.9 STATISTICAL ANALYSIS

The mean values of the characters were used for statistical analysis.

Analysis of variance for RBD

Analysis of variance for individual character was made on the basis of mean values as suggested by Panse and Sukhatme (1967). The model of analysis of variance adopted for it is given below:

Source of variation	d. f	Sum of Square (S.S.)	Mean Squares (M.S)	F-cal. Value	F-table value at 5 % level of significance
Treatment	(t-1)	TSS	TMS	F_T	$F(t-1), (t-1)(r-1)$
Replication	(r-1)	RSS	RMS	F_R	$F(r-1), (t-1)(r-1)$
Error	$(t-1)(r-1)$	ESS	EMS		

Standard error of difference between genotype mean was calculated as:

$$SE_d = \sqrt{\frac{2EMS}{r}}$$

Where,

r = Number of replications

t = Number of treatments

TSS = Treatment sum of square

RSS = Replication sum of square

ESS = Error sum of square

TSS = Total sum of square

TMS = Treatment mean square

RMS = Replication mean square

EMS = Error mean square

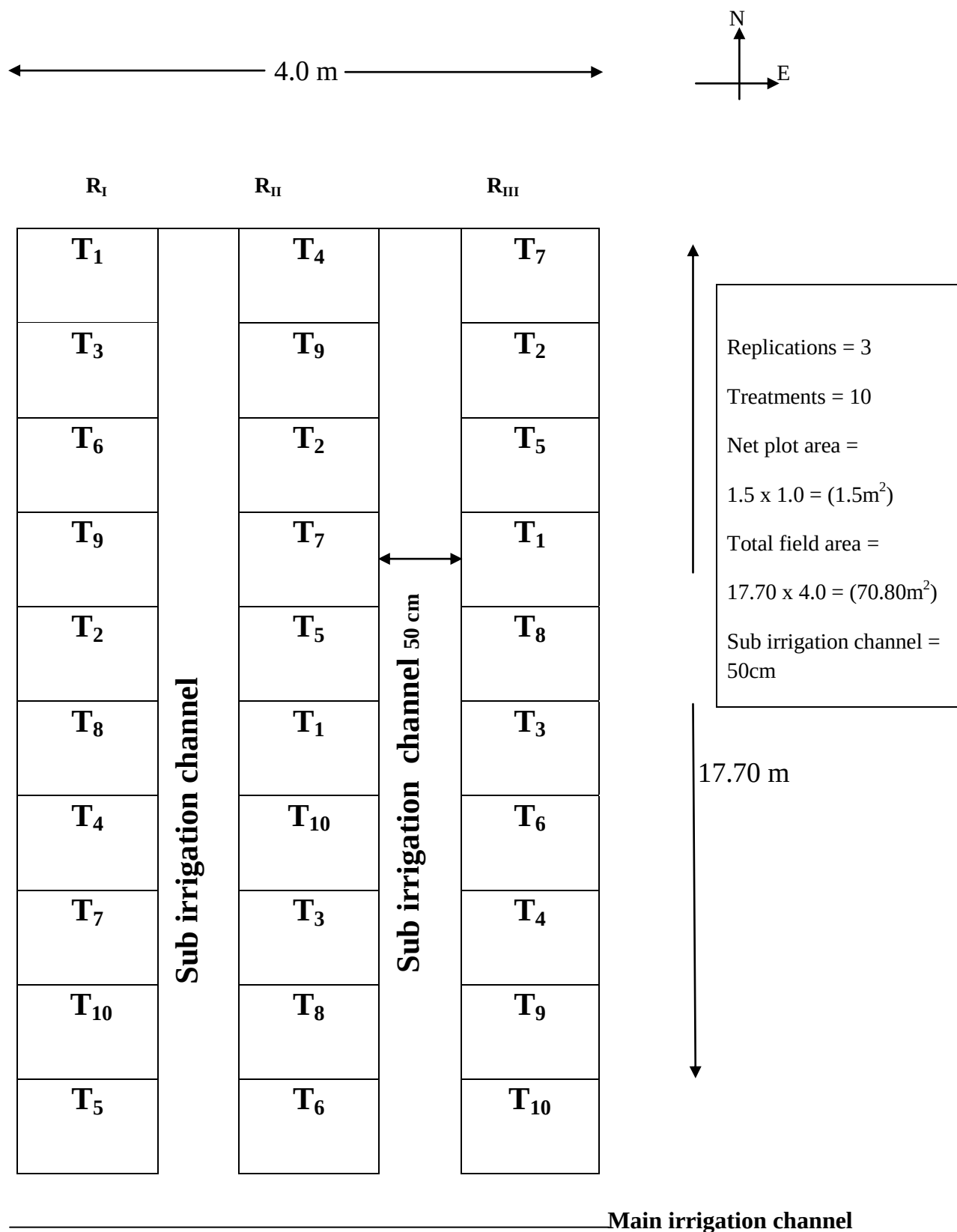


Fig 3.1: Experimental layout of field

Table 3.1: Mean weekly weather data of crop growth period (from October, 2015 to June, 2016).

Standard week number	Duration	Temperature (°C)		Relative humidity (%)	Total rainfall during the week (mm)
		Max.	Min.	Sum.	
41	07-13 Oct., 2015	37.25	19.69	43.85	0.0
42	14-20 Oct., 2015	36.12	18.90	44.42	0.0
43	21-27 Oct., 2015	35.64	19.99	42.00	0.0
44	28 Oct.- 03 Nov., 2015	34.93	16.83	40.42	0.0
45	04-10 Nov., 2015	35.99	15.17	43.71	0.0
46	11-17 Nov., 2015	34.36	13.57	40.28	0.0
47	18-24 Nov., 2015	31.58	13.85	50.42	0.0
48	25 Nov.-01 Dec., 2015	30.93	13.43	48.57	0.0
49	02-08 Dec., 2015	30.66	12.89	52.00	0.0
50	09-15 Dec., 2015	29.04	12.55	53.57	0.0
51	16-22 Dec., 2015	28.60	11.44	57.28	0.0
52	23-29 Dec., 2015	27.78	4.31	52.00	0.0
1	30 Dec., 2015-05 Jan., 2016	26.23	6.26	61.28	0.0
2	06-12 Jan., 2016	25.99	3.34	51.71	0.0
3	13-19 Jan., 2016	25.73	9.13	60.57	0.14
4	20-26 Jan., 2016	24.89	3.92	58.57	0.0
5	27 Jan.-02 Feb., 2016	23.93	4.92	56.57	0.0
6	03- 09 Feb., 2016	22.73	9.13	60.57	0.0
7	10-16 Feb., 2016	24.17	3.91	58.47	0.0
8	17-23 Feb., 2016	26.49	10.50	55.14	0.03
9	24 Feb-02 March, 2016	29.77	13.17	54.28	0.0

10	03-09 March, 2016	29.99	10.50	59.14	0.0
11	10-16 March, 2016	30.77	13.05	50.00	5.14
12	17-23 March, 2016	33.14	15.73	44.57	0.06
13	24-30 March, 2016	34.82	18.90	35.28	0.68
14	31 March-06 April, 2016	33.59	17.71	24.57	0.00
15	06-13 April, 2016	37.66	18.56	32.89	0.00
16	14-20 April, 2016	35.02	19.06	30.65	0.00
17	21-28 April, 2016	36.02	19.67	29.23	0.00
18	29 April-05 May 2016	36.08	20.01	30.05	0.00
19	06-12 May 2016	38.15	18.53	28.92	0.00
20	13-19 May 2016	38.49	19.47	29.13	0.00
21	20-26 May 2016	41.89	20.10	30.29	0.00
22	27 May-02 June 2016	41.10	20.69	29.67	0.00
23	03-09 June 2016	42.89	21.36	28.83	0.00
24	10-16 June 2016	41.13	21.56	32.58	0.00
25	17-23 June 2016	39.55	19.10	31.82	0.00
26	24-30 June 2016	39.12	18.27	32.40	0.00

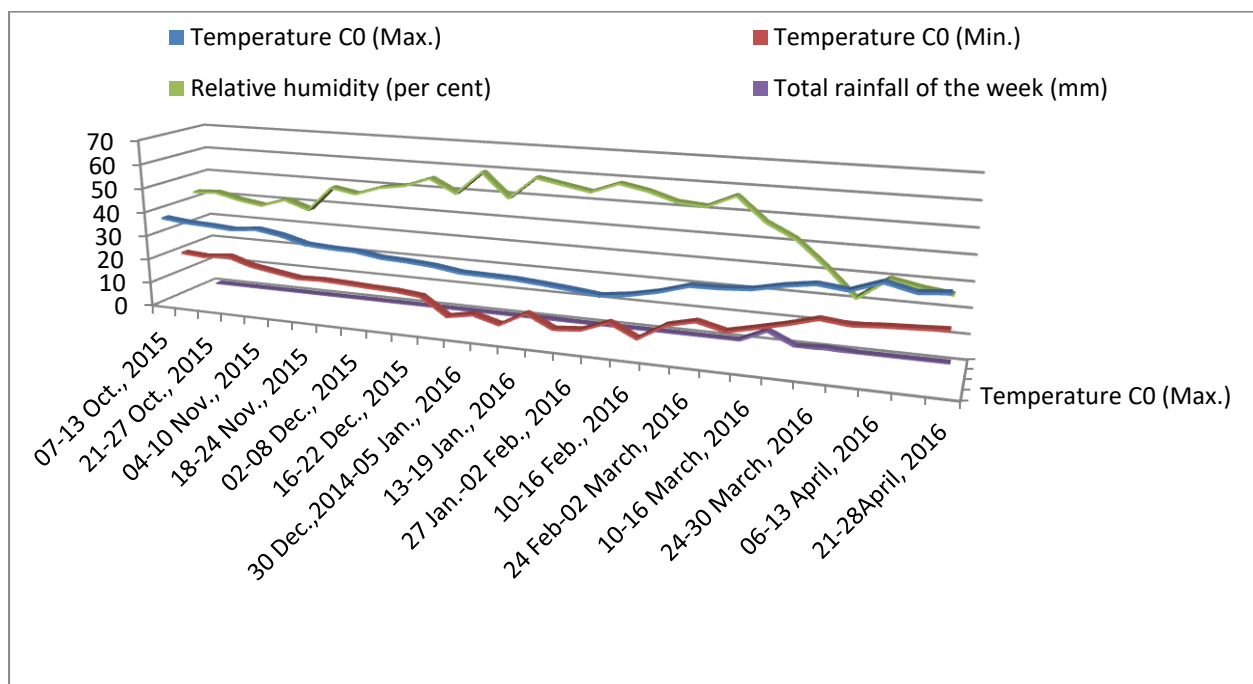


Fig.3.2: Mean weekly data during crop growth period of capegooseberry (From October, 2015 to April, 2016)

The experimental results of the investigation entitled “**Evaluation of Capegooseberry (*Physalis peruviana* L.) Under Humid Agro-climatic condition of Jhalawar**” have been presented in this chapter. The data recorded for various characters under study were subjected to statistical analyses for comparison and interpretation of results. The analyzed data have been presented in tables and with the help of supporting graph for easy comparison and understanding. The results obtained in the present investigation are presented under the following heads:

4.1 Growth attributes

4.2 Production attributes

4.3 Quality attributes

4.4 Variability attributes

4.5 Association analysis, and

4.6 Path coefficient analysis

4.1 Growth attributes

4.1.1 Plant height (cm)

The analyzed data for plant height in different genotypes have been presented in Table 4.1.1 and through Fig. 4.1.1. The variation in height of plants in different genotypes was significant with a range of 64.80 to 127.89cm with an overall mean value of 96.96cm. Amongst all the genotypes, maximum plant height was noted in Amb. Sel.-4 (127.89cm) followed by Amb. Sel.-7 (118.77cm), Amb. Sel.-5 (118.55cm) and Amb. Sel.-2 (109.0cm) whereas, minimum plant height was found in Selection-7 (64.80cm). Genotypes Amb. Sel.-1, Amb. Sel.-2, Amb. Sel.-4 and Amb. Sel.-5 were found at par with each other. Selection-7, Selection-9 and Selection-21 were at par among them.

4.1.2 Plant spread

Data pertaining of plant spread (E-W and N-S) have been presented in Table 4.1.1 and through Fig 4.1.1. The Plant spread (E-W and N-S) ranged from 60.77cm to 146.67cm and 61.78cm to 147cm with a mean value 81.78cm and 86.26cm, respectively. Amongst all the genotypes, maximum plant spread E-W (146.67cm) as well as N-S (147.00cm) was noted in Selection-9 followed by Selection-7. Amb. Sel.-6 had the lowest Plant spread (N-S) (61.78cm).

4.1.3 Total chlorophyll content of leaves (mg/g)

The data pertaining to total chlorophyll content of leaves have been presented in Table 4.1.3 and through Fig. 4.1.3. Total chlorophyll content of leaves varied from 1.94mg/g to 3.36mg/g with an overall mean 2.55mg/g. The maximum total chlorophyll content of leaves were recorded in genotype Selection-7 (3.36mg/g) followed by Selection-9 (3.11mg/g), Selection-21 (2.97mg/g) and Amb. Sel.-3 (2.86mg/g) respectively while, the minimum total chlorophyll content of leaves was recorded in genotype Amb. Sel.-2 (1.94mg/g).

4.1.4 Number of nodes per plant

It is obvious from the data shown in Table 4.1.1 and presented through Fig. 4.1.1 that there were significant differences among the genotypes for this trait. The numbers of nodes per plant ranged between 172.0 and 403.67 with a mean value of 237.53. The performance of capegooseberry genotypes with respect to number of nodes per plant was maximum in Selection-21 (403.67) followed by Selection-7 (318.33), Selection-9 (313.33) and Amb. Sel.-2 (223.67) whereas, Amb. Sel.-6 (172.0) had minimum number of nodes per plant.

4.1.5 Number of branches per plant

The genotypes studied under this experiment had significant difference for number of branches per plant (Table 4.1.2 and depicted Fig. 4.1.2). The numbers of branches per plant ranged from 32.67 to 55.0 with an overall mean 42.0 branches. The genotypes which recorded maximum number of branches per plant was Selection-21 (55.0) followed by Selection-7 (50.67), Selection-9 (50.33) and Amb. Sel.-1(47.0) while, minimum was there in Amb. Sel.-4 (32.67) and Amb. Sel.-5 (32.67) amongst all genotypes.

4.1.6 Leaf length (cm)

The different genotypes under study varied significantly with respect to the leaf length (Table 4.1.2 and Fig. 4.1.2). The range of the leaf length varied from 7.05cm to 13.51cm with a mean of 11.31cm. The highest leaf length (13.51cm) was recorded in the Amb. Sel.-3 followed by Amb. Sel.-1 (13.42cm), Amb. Sel.-6 (13.12cm) and Amb. Sel.-2 (12.22cm) whereas, lowest leaf length was found in Selection-21 (7.05cm).

4.1.7 Leaf breadth (cm)

It is evident from the data that the genotypes varied significantly with respect to the breadth of individual leaves as shown in Table 4.1.3 and through Fig. 4.1.3. It ranged between 4.37 and 11.45cm with a mean value of 8.80cm. The higher leaf breadth was noted in the Amb. Sel.-3 (11.45cm) followed by Amb. Sel.-6 (11.13cm), Amb. Sel.-1 (10.75cm)

and Amb. Sel.-2 (10.70cm) whereas, lowest leaf breadth was recorded in Selection-21 (4.37cm).

4.1.8 Root : Shoot ratio

The analyzed data for root : shoot ratio in different genotypes have been presented in Table 4.1.2 and through Fig. 4.1.5. The variation in root : shoot ratio in different genotypes was non-significant with a range of 0.14 to 0.23 with an overall mean 0.17. The maximum root : shoot ratio was recorded in Selection-9 (0.23) followed by Selection-21 (0.20) and Selection-7 (0.19) while, the minimum was recorded in genotypes Amb. Sel.-4 (0.14) and Amb. Sel.-7 (0.14).

4.1.9 Leaf perimeter (cm)

The genotypes studied under experiment had significant difference for leaf perimeter (Table 4.1.2 and Fig. 4.1.2). The analyzed data for leaf perimeter in different genotypes were found significant with a range of 15.11 to 39.93cm and a mean value of 32.59cm. The genotypes Amb. Sel.-6 (39.93cm) presented maximum leaf perimeter followed by Amb. Sel.-3 (39.47cm), Amb. Sel.-1 (38.70cm) and Amb. Sel.-5 (38.54cm) whereas, Selection-21 (15.11cm) had the minimum leaf perimeter amongst all genotypes.

4.2 Production attributes

4.2.1 Days taken to first flower initiation

The data showed significant differences for days taken to first flower initiation (Table 4.2.1 and Fig. 4.2.1). The days taken to first flower initiation ranged between 30.11 and 60.55 days with a mean value of 49.63 days. The minimum number of days taken to first flower initiation (30.11 days) was recorded in Selection-9 followed by Selection-7 (31.28 days), Selection-21 (31.66 days) and Amb. Sel.-4 (55.11 days) while the maximum number of days taken to first flower initiation was observed in the Amb. Sel.-2 (60.55 days) amongst all genotypes.

4.2.2 Days taken to fruit set

It is evident from the Table 4.2.1 and Fig 4.2.1 that there were significant differences among the genotypes with respect to the number of days taken to fruit set. Amongst all the genotypes, days taken to fruit set ranged between 37.77 and 70.59 days with an overall mean 58.27days. The minimum days taken to fruit set was noted in Selection-9 (37.77days)

followed by Selection-7 (39.61 days) and Selection-21 (40.66 days). Genotype Amb. Sel.-2 took 70.59 days which was maximum of all genotypes.

4.2.3 Fruit set (per cent)

The data regarding fruit set are presented in Table 4.2.1 and through Fig. 4.2.1. The fruit set ranged between 68.84 and 93.10 per cent with an overall mean 84.12 per cent. The genotypes which recorded highest fruit set was Amb. Sel.-6 (93.10 per cent) followed by Amb. Sel.-3 (93.13 per cent), Amb. Sel.-5 (91.10 per cent) and Amb. Sel.-7 (91.02 per cent). On the other hand, Selection-7 had the lowest fruit set (68.84 per cent).

4.2.4 Days taken to first harvest

The different genotypes under study varied significantly with respect to the days taken to first harvest (Table 4.2.1 and Fig. 4.2.1). The range of the days taken to first harvest varied from 93.77 to 134.29 days with an overall mean of 118.24 days. The minimum days taken to first harvest was noticed in Selection-9 (93.77 days) followed by Selection-7 (98.61 days), Selection-21 (101.66 days) and Amb. Sel.-4 (119.49 days) whereas, the maximum days taken to first harvest was noted in Amb. Sel.-2 (134.29 days).

4.2.5 Duration of harvesting

The genotypes studied under experiment had significant difference for duration of harvesting (Table 4.2.1 and Fig. 4.2.1). Duration of harvesting varied from 24.66 to 40.64 days with an overall mean 32.75 days. The minimum duration of harvesting was recorded in Selection-21 (24.66 days) followed by Selection-7 (26.66 days), Selection-9 (29.66 days) and Amb. Sel.-2 (28.37 days) while, the maximum duration of harvesting was recorded in Amb. Sel.-5 (40.64 days).

4.2.6 Number of picking

It is obvious from the data shown in Table 4.2.2 and through Fig. 4.2.2 that there were significant differences among the genotypes for this trait. The Number of picking per plant ranged from 3.33 to 7.45 with an overall mean of 5.61. The maximum number of picking per plant was recorded in Amb. Sel.-5 (7.45) followed by Amb. Sel.-6 (7.10), Amb. Sel.-3 (6.55) and Amb. Sel.-1 (6.22) while, the minimum number of picking per plant was recorded in Selection-21 (3.33).

4.2.7 Fruit diameter (mm)

The data on vertical diameter of fruit of capegooseberry are given in Table 4.2.2 and depicted in Fig. 4.2.2. Vertical diameter of fruit ranged from 15.62 to 34.30mm with an overall mean of 21.95mm. The maximum vertical diameter of fruit was recorded in Selection-7 (34.30mm) followed by Selection-9 (30.78mm), Selection-21 (23.74mm) and Amb. Sel.-1 (21.39mm). On the other hand, Amb. Sel.-6 (15.62mm) had the lowest vertical diameter of fruit.

The results regarding horizontal diameter are presented in Table 4.2.2 and depicted in Fig. 4.2.2. Horizontal diameter of fruit ranged from 14.78 to 36.81mm with an overall mean 21.57mm. The maximum horizontal diameter of fruit was recorded in Selection-7 (36.81mm) followed by Selection-9 (33.12mm), Selection-21 (26.04mm) and Amb. Sel.-2 (22.75mm). On the other hand, Amb. Sel.-5 (14.78mm) had the lowest horizontal diameter of fruit.

4.2.8 Fruit weight (g)

The analyzed data for weight of fruit in different genotypes have been presented in Table 4.2.2 and through Fig. 4.2.2. The variations in weight of fruit in different genotypes were significant with a range of 5.63g to 21.75g and a mean value of 9.71g. The fruit weight was recorded maximum in Selection-7 (21.75g) followed by Selection-9 (17.35g), Selection-21 (11.88g) and Amb. Sel.-3 (7.40g) whereas, minimum fruit weight was found in Amb. Sel.-4 (5.63g).

4.2.9 Number of fruits per plant

It is obvious from the data shown in Table 4.2.3 and depicted through Fig. 4.2.3 that there were significant differences among the genotypes for this trait. The number of fruits per plant ranged between 40.11 and 122.33 with an overall mean of 71.71. The performance of capegooseberry genotype with respect to number of fruits per plant was maximum in Selection-9 (122.33) followed by Selection-21 (116.67), Selection-7 (110) and Amb. Sel.-6 (63.89) whereas, Amb. Sel.-2 (40.11) had minimum number of fruits per plant.

4.2.10 Fruits yield per plant (g)

The data presented in Table 4.2.3 and depicted through Fig. 4.2.3 indicate fruit yield varying from 270.70g to 2386.16g with an overall mean 828.57g. The maximum fruit yield per plant was recorded in Selection-7 (2386.16g) followed by Selection-9 (2074.32g), Selection-21 (1399.46g) and Amb. Sel.-6 (415.34g) whereas, minimum fruit yield per plant was recorded in Amb. Sel.-4 (270.70g).

4.2.11 Estimated yield (q/ha)

As evident from the data presented in Table 4.2.3 and depicted through Fig. 4.2.3, that estimated yield ranged from 13.53q/ha to 119.31q/ha with an overall mean 41.43q/ha. The maximum estimated yield per plant was noticed in Selection-7 (119.31q/ha) followed by Selection-9 (103.71q/ha), Selection-21 (69.97q/ha) and Amb. Sel.-6 (20.76q/ha) whereas, minimum estimated yield per plant was recorded in Amb. Sel.-4 (13.53q/ha).

4.3 Quality attributes

4.3.1 Total soluble solids (⁰Brix)

The data regarding total soluble solids are presented in Table 4.3.1 and through Fig. 4.3.1. Total soluble solids varied from 5.07 to 15.73 per cent with an overall mean 11.92 per cent. Maximum TSS was found in Amb. Sel.-3 (15.73 per cent) followed by Amb. Sel.-4 (15.60 per cent), Amb. Sel.-5 (15.36 per cent) and Amb. Sel.-1 (14.02 per cent). On the other hand TSS was found least in Selection-21 (5.07 per cent).

4.3.2 Titratable acidity (%)

The data showed significant differences for Titratable acidity as presented in Table 4.3.3 and depicted through Fig. 4.3.3. Titratable acidity ranged between 0.24 to 0.36 per cent with a mean value of 0.29 per cent. The maximum titratable acidity was recorded in Selection-7 (0.36 per cent) followed by Selection-21 (0.34 per cent), Selection-21 (0.32 per cent) and Amb. Sel.-4 (0.31 per cent) whereas, the minimum titratable acidity was noted in Amb. Sel.-7 (0.24 per cent).

4.3.3 TSS : Acid ratio

The genotypes studied under experiment had significant difference for TSS : Acid ratio as presented in Table 4.3.1 and depicted in Fig. 4.3.1. TSS : Acid ratio varied from 15.06 to 57.86 with an overall mean 49.72. The maximum TSS : Acid ratio was recorded in Amb. Sel.-6 (57.86) followed by Amb. Sel.-1 (57.78), Amb. Sel.-3 (57.58) and Amb. Sel.-5 (55.50) while, the minimum TSS : Acid ratio was recorded in Selection-21 (15.06).

4.3.4 Total sugar (%)

As evident from the data presented in Table 4.3.1 and under reference in Fig. 4.3.1, the per cent total sugar in present study ranged from 3.0 per cent (Selection-21) to 5.10 per cent (Amb. Sel.-3). It was followed by 4.80 per cent in Amb. Sel.-4, 4.40 per cent in Amb. Sel.-5 and 4.20 per cent in Amb. Sel.-6 with an overall mean 3.99 per cent.

4.3.5 Juice (per cent)

The data for juice (per cent) in different genotypes have been presented in Table 4.3.2 and depicted in Fig. 4.3.2. Juice per cent varied from 51.25 to 66.66 per cent with an overall mean 59.43 per cent. The maximum juice per cent was noticed in Amb. Sel.-3 (66.66 per cent) followed by Amb. Sel.-4 (64.70 per cent), Amb. Sel.-7 (63.64 per cent) and Amb. Sel.-6 (62.90 per cent) whereas, the minimum juice per cent was recorded in Selection-7 (51.25 per cent).

4.3.6 Vitamin-C (mg/100g)

It is obvious from the data shown in Table 4.3.2 and depicted in Fig. 4.3.2 that there were significant differences among the genotypes for this trait. Vitamin-C varied from 22.69 to 32.24 (mg/100g) with a mean value of 27.89 (mg/100g). The Amb. Sel.-3 (32.24mg/100g) showed the maximum Vitamin-C followed by Amb. Sel.-1 (31.12mg/100g), Amb. Sel.-2 (30.58mg/100g) and Amb. Sel.-7 (29.78mg/100g). On the other hand, Selection-21 had the lowest Vitamin-C (22.69mg/100g).

4.3.7 Sensory score

Data pertaining of Vitamin-C of capegooseberry genotypes have been presented in Table 4.3.2 and represented in Fig 4.3.2. Sensory score varied from 4.75 to 8.25 with an overall mean 6.79. The genotype Amb. Sel.-3 (8.25) showed the maximum Sensory score followed by Amb. Sel.-1 (8.00), Amb. Sel.-7 (7.75) and Amb. Sel.-2 (7.33). On the other hand, Selection-21 had the minimum Sensory score (4.75).

4.3.8 Carotene (mg/100g)

As evident from the data presented in Table 4.3.3 and manifested through Fig. 4.3.3, that carotene ranged from 1.43 to 1.73 (mg/100g) with an overall mean of (1.61mg/100g). The maximum carotene content in fruits was recorded in Amb. Sel.-3 (1.73mg/100g) followed by Amb. Sel.-1 (1.71mg/100g), Amb. Sel.-2 (1.69mg/100g) and Amb. Sel.-6 (1.66mg/100g) whereas, the minimum carotene content in fruits was found in Selection-21 (1.43mg/100g).

4.4 Variability attributes

4.4.1 Genotypic and Phenotypic coefficients of variation

In the present study, the estimates of phenotypic coefficient correlation of variation (PCV) were higher than their corresponding genotypic coefficient of variation (GCV) for all the characters (Table 4.4.1). However, the difference between GCV and PCV was low for all the characters, except root : shoot ratio and titratable acidity. In the investigation the maximum value of phenotypic coefficient of variation was recorded for fruit yield per plant (102.19) followed by estimated yield (102.14), fruit weight (59.07), number of fruits per plant

(48.04), TSS/Acid ratio (45.40), plant spread E-W (41.57), TSS (38.36), fruit diameter-horizontal (37.83), fruit diameter-vertical (30.49), plant spread N-S (36.54), number of nodes per plant (36.31) and leaf breadth (31.16). Moderate values of PCV were exhibited by leaf perimeter (27.59), days taken to first flower initiation (26.23) followed by number of picking (25.98), root : shoot ratio (25.85), plant height (23.97), number of branches per plant (23.39), days taken to fruit set (22.89), total chlorophyll content of leaves (20.87), leaf length (20.85), titratable acidity (18.95), sensory score (18.90), total sugar (17.31) and duration of harvesting (17.18) while low value of PCV was exhibited by the characters vitamin-C (13.97) followed by days taken to first harvesting (12.48), fruit set (11.71), juice (9.12) and carotene (6.20). The GCV also showed similar trend.

4.4.2 Heritability in broad sense

The estimates of broad sense heritability for different characters are presented in Table 4.4.1. It ranged from 0.00 to 100 per cent. In the present study, the maximum heritability in broad sense was recorded for carotene content in fruit (100%) with high heritability for days taken to first harvesting (99.38%), days taken to fruit set (99.24%), fruit set (98.90%), days taken to first flower initiation (98.72%), duration of harvesting (97.50%), fruit diameter-horizontal (95.14%), TSS (95.06%), leaf breadth (94.40%), leaf perimeter (94.09%), plant height (91.77%), fruit weight (90.96%), leaf length (90.40%), fruit yield per plant (88.50%), estimated yield (88.50%), number of picking (88.30%), TSS/Acid ratio (87.18%), total sugar (85.95%), juice (83.88%) and plant spread N-S (81.80%).

Moderate heritability was observed for total chlorophyll content of leaves (79.60%), plant spread E-W (78.80%), number of nodes per plant (76.90%), fruit diameter-vertical (76.03%), number of fruits per plant (75.31%), number of branches per plant (64.94%), sensory score (60.62%) and vitamin-C (60.10%), while low heritability was recorded for titratable acidity (33.33%) with zero heritability of root : shoot ratio (0.00%).

4.4.3 Genetic advance

The high genetic advance was recorded for the fruit yield per plant (1542.63) followed by number of nodes per plant (136.55), estimated yield (77.18), plant spread E-W (55.20), number of fruits per plant (53.65) and plant spread N-S (53.09). Moderate genetic advance was observed for plant height (43.94), TSS/Acid ratio (35.65), days taken to harvesting (30.21), days taken to fruit set (27.27), days taken to first flower initiation (26.47), whereas, fruit set (20.18), leaf perimeter (17.43), fruit diameter-horizontal (15.99), number of branches per plant (13.14), duration of harvesting (11.30), fruit weight (10.75), fruit

diameter-vertical (10.48), juice (9.46), TSS (8.95), leaf breadth (5.34), vitamin-C (4.82), leaf length (4.39), number of pickings (2.64), sensory score (1.60), total sugar (1.22), total chlorophyll content in leaves (0.87), carotene (0.21), titratable acidity (0.038) and root : shoot ratio (0.00) exhibited low genetic advance.

4.4.4 Genetic advance as per cent of mean

The genetic advance as per cent of mean for different characters is given in Table 4.4.1. It ranged from 0.00 to 186.20 per cent of mean. The highest genetic advance as per cent of mean was recorded for estimated yield (186.20) with high genetic advance as per cent of mean in fruit yield per plant (186.18), fruit weight (110.68), TSS/Acid ratio (81.55), TSS (75.11), number of fruits per plant (74.53), fruit diameter-horizontal (74.15), plant spread E-W (67.49), plant spread N-S (61.54), leaf breadth (60.61), number of nodes per plant (57.49), leaf perimeter (53.47) and days taken to first flower initiation (53.34). Moderate genetic advance mean per cent was observed for fruit diameter-vertical (47.75), number of picking (47.36), days taken to fruit set (46.80), plant height (45.32), leaf length (38.82), duration of harvesting (34.51), total chlorophyll content of leaves (34.22), number of branches per plant (31.29) and total sugar (30.65). On other hand, low genetic advance as mean per cent was noted for days taken to first harvesting (25.55), fruit set (23.99), sensory score (23.60), vitamin-C (17.30), juice (15.91), titratable acidity (13.15), carotene (12.78) and root : shoot ratio (0.00).

4.5 Association analysis

While selecting a suitable plant type, association analysis studies provide reliable information on nature, extent and direction of selection, especially when there is a need to combine high yield potential with desirable agronomic traits and fruit quality characters. In the present investigation, genotype and phenotypic correlation coefficients of different characters with fruit yield and among themselves were estimated and presented in Table 4.5.1-4.5.2. For most of the characters, genotypic correlation coefficient was found to be higher in magnitude than phenotypic correlation coefficient, indicating a strong inherent association among various characters.

The correlation among root : shoot ratio with fruit yield and their correlation with other characters studied were found to be non significant, hence, they have not been described here.

4.5.1 Plant height

This trait showed significant positive correlation at phenotypic level with duration of harvesting (0.75), number of pickings (0.39), TSS, (0.44), TSS/Acid ratio (0.45) and vitamin-C (0.48) and significant negative correlation with total chlorophyll content of leaves (-0.64), number of nodes per plant (-0.39), number of branches per plant (-0.57), number of fruits per plant (-0.44) and estimated yield (-0.36), respectively.

4.5.2 Plant spread (E-W)

Plant spread (E-W) showed significant positive correlation at phenotypic level with plant spread N-S (0.93), total chlorophyll content of leaves (0.74), number of nodes per plant (0.64), number of branches per plant (0.66), root : shoot ratio (0.40), fruit diameter-vertical (0.66), fruit diameter-horizontal (0.81), fruit weight (0.75), number of fruits per plant (0.86), estimated yield (0.84) and titratable acidity (0.65) and had significant negative association with leaf length (-0.81), leaf breadth (-0.83), leaf perimeter (-0.76), days taken to first flower initiation (-0.88), days taken to fruit set (-0.87), fruit set (-0.83), days taken to first harvest (-0.88), duration of harvesting (-0.56), number of pickings (-0.68), TSS (-0.85), TSS/Acid ratio (-0.82), total sugar (-0.67), juice (-0.51), vitamin-C (-0.59), sensory score (-0.70) and carotene (-0.74).

4.5.3 Plant spread (N-S)

This trait showed significant positive correlation at phenotypic level with total chlorophyll content of leaves (0.73), number of nodes per plant (0.77), number of branches per plant (0.58), leaf length (0.82), leaf breadth (0.82), root : shoot ratio (0.48), leaf perimeter (0.75), days taken to first flower initiation (0.88), days taken to fruit set (0.87), fruit set (0.84), days taken to first harvest (0.87), duration of harvesting (0.58), number of pickings (0.75), fruit diameter-vertical (0.71), fruit diameter-horizontal (0.80), fruit weight (0.76), number of fruits per plant (0.87), estimated yield (0.82), TSS (0.86), titratable acidity (0.56), TSS/Acid ratio (0.80), total sugar (0.64), juice (0.54), vitamin-C (0.59), sensory score (0.62) and carotene (0.73).

4.5.4 Total chlorophyll content of leaves

Total chlorophyll content of leaves expressed significant positive correlation at phenotypic level with number of nodes per plant (0.56), number of branches per plant (0.48), leaf perimeter (0.60), fruit diameter-vertical (0.57), fruit diameter-horizontal (0.68), fruit weight (0.73), number of fruits per plant (0.78), estimated yield (0.77) and titratable acidity (0.60) and had significant negative association with leaf length (-0.60), leaf breadth (-0.65), days taken to first flower initiation (-0.75), days taken to fruit set (-0.73), fruit set (-0.66),

days taken to first harvest (-0.72), duration of harvesting (-0.56), number of pickings (-0.60), TSS (-0.69), TSS/Acid ratio (-0.70), total sugar (-0.41), juice (-0.46), vitamin-C (-0.57), sensory score (-0.43) and carotene (-0.54).

4.5.5 Number of nodes per plant

Number of nodes per plant showed significant positive correlation at phenotypic level with number of branches per plant (0.58), fruit diameter-horizontal (0.75), fruit weight (0.63), number of fruits per plant (0.73), estimated yield (0.77) and titratable acidity (0.64) and had significant negative association with leaf length (-0.87), leaf breadth (-0.85), leaf perimeter (-0.89), days taken to first flower initiation (-0.83), days taken to fruit set (-0.82), fruit set (-0.88), days taken to first harvest (-0.77), duration of harvesting (-0.65), number of pickings (-0.85), fruit diameter-vertical (-0.60), TSS (-0.85), TSS/Acid ratio (-0.84), total sugar (-0.70), juice (-0.56), vitamin-C (-0.67), sensory score (-0.55) and carotene (-0.82).

4.5.6 Number of branches per plant

Number of branches per plant showed significant positive correlation at phenotypic level with fruit diameter-vertical (0.36), fruit diameter-horizontal (0.50), number of fruits per plant (0.62), estimated yield (0.46) and titratable acidity (0.48) and had significant negative association with leaf length (-0.69), leaf perimeter (-0.69), days taken to first flower initiation (-0.59), days taken to fruit set (-0.55), fruit set (-0.67), days taken to first harvest (-0.49), duration of harvesting (-0.70), number of pickings (-0.59), TSS (-0.67), TSS/Acid ratio (-0.61), total sugar (-0.67), sensory score (-0.67) and carotene (-0.61).

4.5.7 Leaf length

Leaf length showed significant positive correlation at phenotypic level with leaf breadth (0.96), leaf perimeter (0.94), days taken to first flower initiation (0.90), days taken to fruit set (0.90), fruit set (0.93), days taken to first harvest (0.88), number of pickings (0.85), fruit weight (0.71), number of fruits per plant (0.82), TSS (0.88), titratable acidity (0.62), TSS/Acid ratio (0.83), total sugar (0.74), juice (0.50), vitamin-C (0.65), sensory score (0.81) and carotene (0.93) and manifested significant negative association with fruit diameter-vertical (-0.57), fruit diameter-horizontal (-0.75) and estimated yield (-0.76).

4.5.8 Leaf breadth

Leaf breadth manifested significant positive correlation at phenotypic level with leaf perimeter (0.96), days taken to first flower initiation (0.93), days taken to fruit set (0.93), fruit set (0.94), days taken to first harvest (0.92), duration of harvesting (0.54), number of pickings (0.87), fruit diameter-horizontal (0.79), TSS (0.91), TSS/Acid ratio (0.85), total sugar (0.73), juice (0.53), vitamin-C (0.68), sensory score (0.77) and carotene (0.90) and showed

significant negative association with fruit diameter-vertical (-0.61), fruit weight (-0.76), estimated yield (-0.81) and titratable acidity (-0.60).

4.5.10 Leaf perimeter

This trait showed significant positive correlation at phenotypic level with days taken to first flower initiation (0.92), days taken to fruit set (0.92), fruit set (0.92), days taken to first harvest (0.88), duration of harvesting (0.57), total sugar (0.71), juice (0.51), vitamin-C (0.69), sensory score (0.72) and carotene (0.89) and expressed significant negative association with fruit diameter-vertical (-0.56), fruit diameter-horizontal (-0.74), fruit weight (-0.73), number of fruits per plant (-0.80), estimated yield (-0.77) and titratable acidity (-0.60).

4.5.11 Days taken to first flower initiation

This trait showed significant positive correlation at phenotypic level with days taken to fruit set (0.99), fruit set (0.94), days taken to first harvest (0.97), duration of harvesting (0.58), number of pickings (0.83), TSS (0.94), TSS/Acid ratio (0.91), total sugar (0.68), juice (0.59), vitamin-C (0.72), sensory score (0.72) and carotene (0.90) and had significant negative association with fruit diameter-vertical (-0.68), fruit diameter-horizontal (-0.83), fruit weight (-0.86), number of fruits per plant (-0.89), estimated yield (-0.89) and titratable acidity (-0.68).

4.5.12 Days taken to fruit set

This trait was found having significant positive correlation at phenotypic level with fruit set (0.93), days taken to first harvest (0.98), duration of harvesting (0.53), number of pickings (0.82), TSS (0.93), TSS/Acid ratio (0.89), total sugar (0.65), juice (0.60), vitamin-C (0.74), sensory score (0.71) and carotene (0.90) and had significant negative association with fruit diameter-vertical (-0.66), fruit diameter-horizontal (-0.82), fruit weight (-0.86), number of fruits per plant (-0.88), estimated yield (-0.89) and titratable acidity (-0.67).

4.5.13 Fruit set

It showed significantly positive correlation at phenotypic level with days taken to first harvest (0.88), duration of harvesting (0.72), number of pickings (0.90), TSS (0.94), TSS/Acid ratio (0.89), total sugar (0.72), juice (0.61), vitamin-C (0.72), sensory score (0.70) and carotene (0.89) and had significant negative association with fruit diameter-vertical (-0.71), fruit diameter-horizontal (-0.90), fruit weight (-0.84), number of fruits per plant (-0.81), estimated yield (-0.83) and titratable acidity (-0.64).

4.5.14 Days taken to first harvest

This trait showed significant positive correlation at phenotypic level with duration of harvesting (0.41), number of pickings (0.77), fruit weight (0.83), TSS (0.88), TSS/Acid ratio (0.85), total sugar (0.61), juice (0.55), vitamin-C (0.69), sensory score (0.73) and carotene (0.88) and had significant negative association with fruit diameter-vertical (-0.64), fruit diameter-horizontal (-0.79), number of fruits per plant (-0.86), estimated yield (-0.87) and titratable acidity (-0.67).

4.5.15 Duration of harvesting

This trait had significant positive correlation at phenotypic level with number of pickings (0.68), TSS (0.73), TSS/Acid ratio (0.68), total sugar (0.67), juice (0.56), vitamin-C (0.56) and carotene (0.48) and showed significant negative association with fruit diameter-vertical (-0.59), fruit diameter-horizontal (-0.74), fruit weight (-0.61), number of fruits per plant (-0.59), estimated yield (-0.59) and titratable acidity (-0.64).

4.5.16 Number of pickings

It was observed that number of pickings had significant positive correlation at phenotypic level with TSS (0.86), TSS/Acid ratio (0.75), total sugar (0.69), juice (0.50), vitamin-C (0.62), sensory score (0.57) and carotene (0.73) and marked significant negative association with fruit diameter-vertical (-0.61), fruit diameter-horizontal (-0.82), fruit weight (-0.74), number of fruits per plant (-0.76), estimated yield (-0.77) and titratable acidity (-0.48).

4.5.17 Fruit diameter-vertical

Significant positive correlation at phenotypic level was observed in case of fruit diameter-vertical with fruit diameter-horizontal (0.87), fruit weight (0.79), number of fruits per plant (0.63), estimated yield (0.75) and had significant negative association with TSS (-0.72), TSS/Acid ratio (-0.64), total sugar (-0.55), juice (-0.80), vitamin-C (-0.54) and carotene (-0.51).

4.5.18 Fruit diameter-horizontal

There was significant positive correlation with respect to fruit diameter-horizontal at phenotypic level with fruit weight (0.91), number of fruits per plant (0.77), estimated yield (0.89) and had significant negative association with TSS (-0.87), TSS/Acid ratio (-0.81), total sugar (-0.68), juice (-0.71), vitamin-C (-0.62), sensory score (-0.50) and carotene (-0.69).

4.5.19 Fruit weight

This trait manifested significant positive correlation at phenotypic level with number of fruits per plant (0.77), estimated yield (0.95) and titratable acidity (0.45) and had significant negative association with TSS (-0.84), TSS/Acid ratio (-0.79), total sugar (-0.57), juice (-0.70), vitamin-C (-0.66), sensory score (-0.51) and carotene (-0.70).

4.5.20 Number of fruits per plant

It was noted that number of fruits per plant was having positive correlation at phenotypic level with estimated yield (0.90) and titratable acidity (0.57) and had significant negative association with TSS (-0.87), TSS/Acid ratio (-0.82), total sugar (-0.64), juice (-0.54), vitamin-C (-0.59), sensory score (-0.67) and carotene (-0.78).

4.5.22 Estimated yield

It showed significant positive correlation at phenotypic level with titratable acidity (0.49) and had significant negative association with TSS (-0.88), TSS/Acid ratio (-0.80), total sugar (-0.60), juice (-0.65), vitamin-C (-0.64), sensory score (-0.60) and carotene (-0.74).

4.5.23 TSS

It was found having significant positive correlation of TSS at phenotypic level with TSS/Acid ratio (0.94), total sugar (0.81), juice (0.65), vitamin-C (0.71), sensory score (0.66) and carotene (0.74) and had significant negative association with titratable acidity (-0.58).

4.5.24 Titratable acidity

There was significant negative association of titratable acidity at phenotypic level with TSS/Acid ratio (-0.72), total sugar (-0.28), juice (-0.17), vitamin-C (-0.53), sensory score (-0.52) and carotene (-0.65).

4.5.25 TSS/Acid ratio

It showed significant positive correlation at phenotypic level with total sugar (0.73), juice (0.60), vitamin-C (0.70), sensory score (0.63) and carotene (0.82).

4.5.26 Total sugar

This trait manifested significant positive correlation at phenotypic level with juice (0.57), vitamin-C (0.51), sensory score (0.57) and carotene (0.66).

4.5.27 Juice

There was significant positive correlation of juice at phenotypic level with vitamin-C (0.71) and carotene (0.52).

4.5.28 Vitamin-C

This trait showed significant positive correlation at phenotypic level with sensory score (0.50) and carotene (0.69).

4.5.29 Sensory score

This trait showed significant positive correlation at phenotypic level with carotene (0.86).

4.6 Path coefficient analysis

Path coefficient analysis was worked out using only genotypic correlation for all 30 characters and is presented in Table 4.6.1. The path coefficient of the characters exhibiting significant correlation with fruit yield are described here as under:

4.6.1 Plant spread (E-W)

There was significant positive correlation between plant spread and fruit yield. It was mainly due to indirect effect of fruit set (2.22). However, the value of direct effect was comparatively high (1.18).

4.6.2 Plant spread (N-S)

The significant positive correlation between plant spread and fruit yield was mainly due to the indirect effect of fruit set (2.25). The value of direct effect was comparatively low and in negative direction (-1.89).

4.6.3 Total chlorophyll content of leaves (mg/g)

The significant positive correlation between total chlorophyll content of leaves (mg/g) and fruit yield was mainly due to the direct effect (0.25). The value of indirect effect due to fruit set (1.75) was higher than other indirect effect.

4.6.4 Number of nodes per plant

It exhibited the value of direct effect (0.63), which was the main reason for the significant positive correlation. Among indirect effect, the value of indirect effect due to fruit set (per cent) was higher (2.34).

4.6.5 Number of branches per plant

Significant positive association of it with fruit yield was mainly due to the indirect effect of fruit set (1.79). The value of direct effect was comparatively low and in negative direction (-0.0014).

4.6.6 Leaf length (cm)

Significant positive association between them was mainly due to the indirect effect of fruit diameter (horizontal) (1.80). The value of direct effect was comparatively low and in negative direction (-0.11).

4.6.7 Leaf breadth (cm)

The significant positive correlation between leaf breadth (cm) and fruit yield was mainly due to the direct effect (0.60). The value of indirect effect due to fruit diameter (horizontal) was higher (1.88) than other indirect effect.

4.6.8 Root : shoot ratio

The significant positive correlation with fruit yield was mainly due to indirect effect of fruit diameter-horizontal (1.77). However, the value of direct effect was comparatively higher (1.55).

4.6.9 Days taken to first flower initiation

It exhibited the maximum value of direct effect (1.91), which was the main reason for the significant positive correlation. Among indirect effect the value of indirect effect due to fruit diameter (horizontal) was higher (1.99).

4.6.10 Days taken to fruit set (per cent)

Significant positive correlation between them was mainly due to the indirect effect of fruit diameter-horizontal (1.96). The value of direct effect was comparatively lower and in negative direction (-0.99).

4.6.11 Fruit set (per cent)

Significant positive association with fruit yield was mainly due to the indirect effect of fruit diameter-horizontal (2.14). However, the value of the direct effect was comparatively lower and in negative direction (-1.65).

4.6.12 Days taken to first harvest

It significant positive correlation between them was mainly due to the indirect effect of fruit diameter-horizontal (1.87). The value of direct effect was comparatively low and in negative direction (-1.65).

4.6.13 Duration of harvesting

Significant positive association between them was mainly due to the indirect effect of fruit diameter-horizontal (1.76). However, the value of direct effect was comparatively low and in negative direction (-0.55).

4.6.14 Number of pickings

The significant positive correlation between fruit diameter (horizontal) and fruit yield was mainly due to the indirect effect (1.94). The value of direct effect was comparatively low and in negative direction (-0.30).

4.6.15 Fruit diameter (vertical)

The main reason for the significant positive correlation for this trait is its high value of the direct effect (0.53). Among indirect effect, the value of indirect effect due to fruit set was higher (1.91).

4.6.16 Fruit diameter (horizontal)

Significant positive association between them was mainly due to the indirect effect of fruit set (2.40). However, the value of the direct effect was comparatively low and in negative direction (-2.39).

4.6.17 Fruit weight (g)

It significant positive association between them was mainly due to the indirect effect of fruit set (2.24). However, the value of the direct effect was comparatively higher (0.14).

4.6.18 Number of fruits per plant

The main reason for the significant positive correlation for this trait is its higher value of the direct effect (0.58). Among indirect effect, the value of indirect effect due to fruit set was higher (2.15).

4.6.19 Estimated yield (q/ha)

The significant positive correlation between estimated yield (q/ha) and fruit yield was mainly due to the direct effect (1.13). Estimated yield (q/ha) showed positive indirect effect on fruit yield through fruit set (2.23)

4.6.20 Total soluble solids (⁰Brix)

Significant positive association between them was mainly due to the indirect effect of fruit set (2.07). However, the value of the direct effect was comparatively lower and in negative direction (-0.01).

4.6.21 Titratable acidity (per cent)

The significant positive association between them was mainly due to the indirect effect of fruit set (1.70). The value of the direct effect was comparatively low and in negative direction (-0.36).

4.6.22 TSS/Acid ratio

The chief reason for the significant positive correlation for this trait is its high value of the direct effect (0.34). Among indirect effect, the value of indirect effect due to fruit diameter (horizontal) was higher (1.93).

4.6.23 Total sugar (per cent)

Significant positive association between them was mainly due to the indirect effect of to fruit diameter-horizontal (1.62). However, the value of the direct effect was comparatively lower and in negative direction (-0.18).

4.6.24 Juice (per cent)

The chief reason for the significant positive correlation for this trait is its high value of the direct effect (0.20). Among indirect effect, the value of indirect effect due to fruit diameter (horizontal) was higher (1.70).

4.6.25 Vitamin-C (mg/100g)

The significant positive correlation between vitamin-C (mg/100g) and fruit yield was mainly due to the direct effect (0.025). Vitamin-C (mg/100g) showed positive indirect effect on fruit yield through fruit diameter-horizontal (1.48).

4.6.26 Sensory score

The chief reason for the significant positive correlation for this trait is its high value of the direct effect (0.21). Among indirect effect, the value of indirect effect due to days taken to first flower initiation was higher (1.37).

4.6.27 Carotene (mg/100g)

The chief reason for the significant positive correlation for this trait is its high value of the direct effect (0.33). Among indirect effect, the value of indirect effect due to days taken to first flower initiation was higher (1.71).

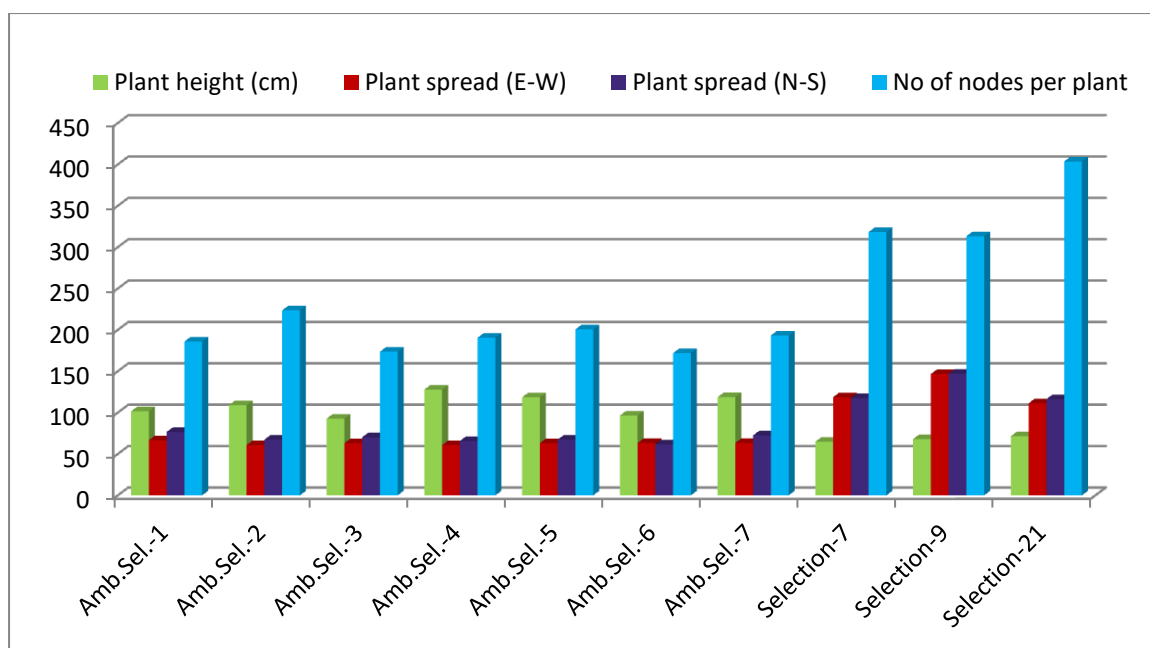


Figure 4.1.1: Performance of capegooseberry genotypes with respect to plant height (cm), plant spread (E-W), plant spread (N-S) and number of nodes per plant

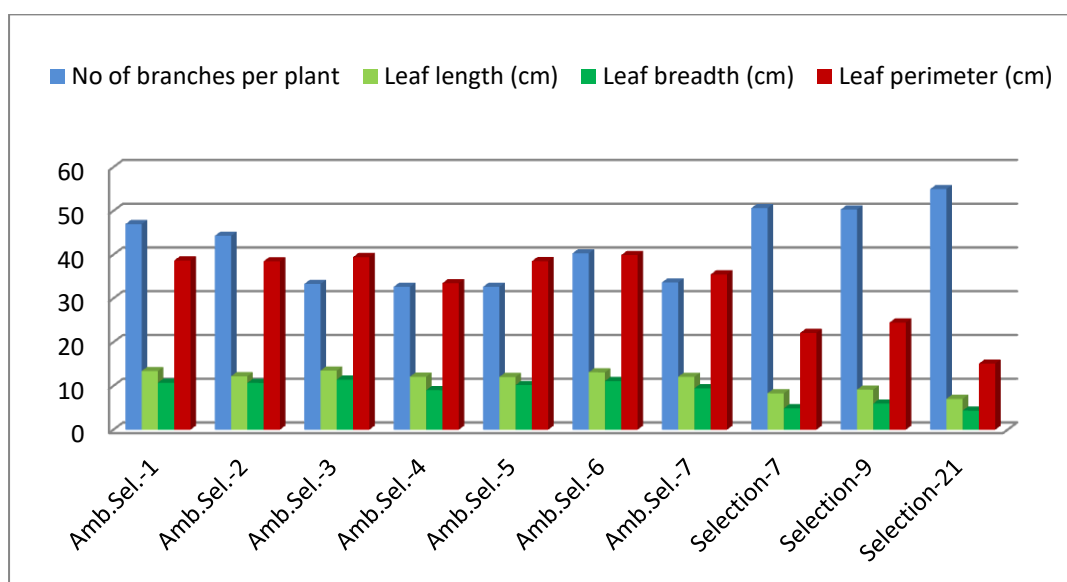


Figure 4.1.2: Performance of capegooseberry genotypes with respect to number of branches per plant, leaf length (cm), leaf breadth (cm) and leaf perimeter (cm)

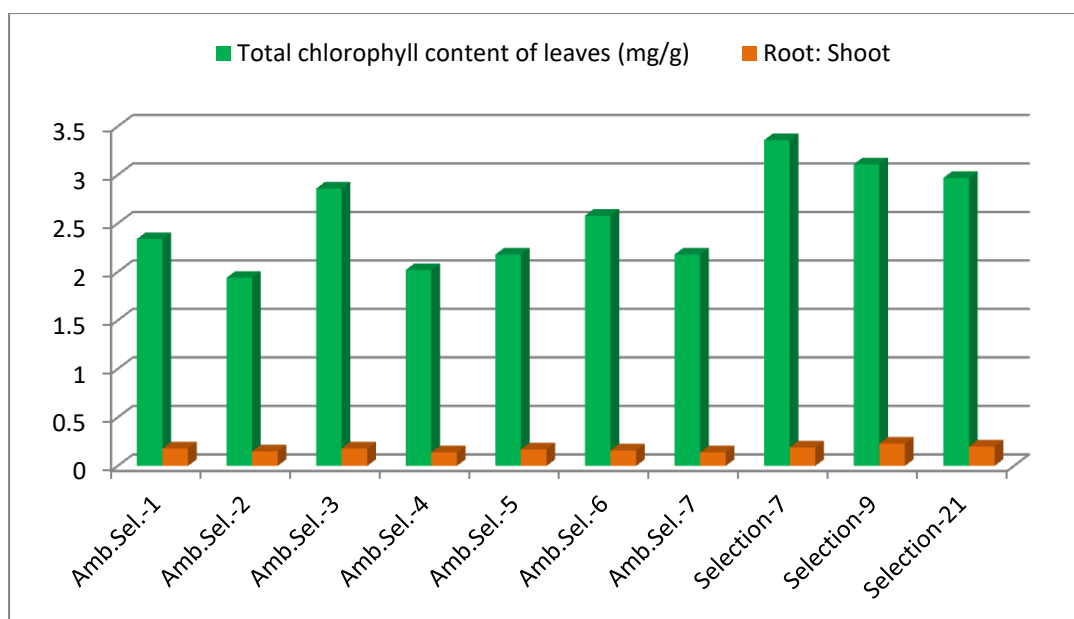


Figure 4.1.3: Performance of capegooseberry genotypes with respect to total chlorophyll content of leaves (mg/g) and root:shoot ratio

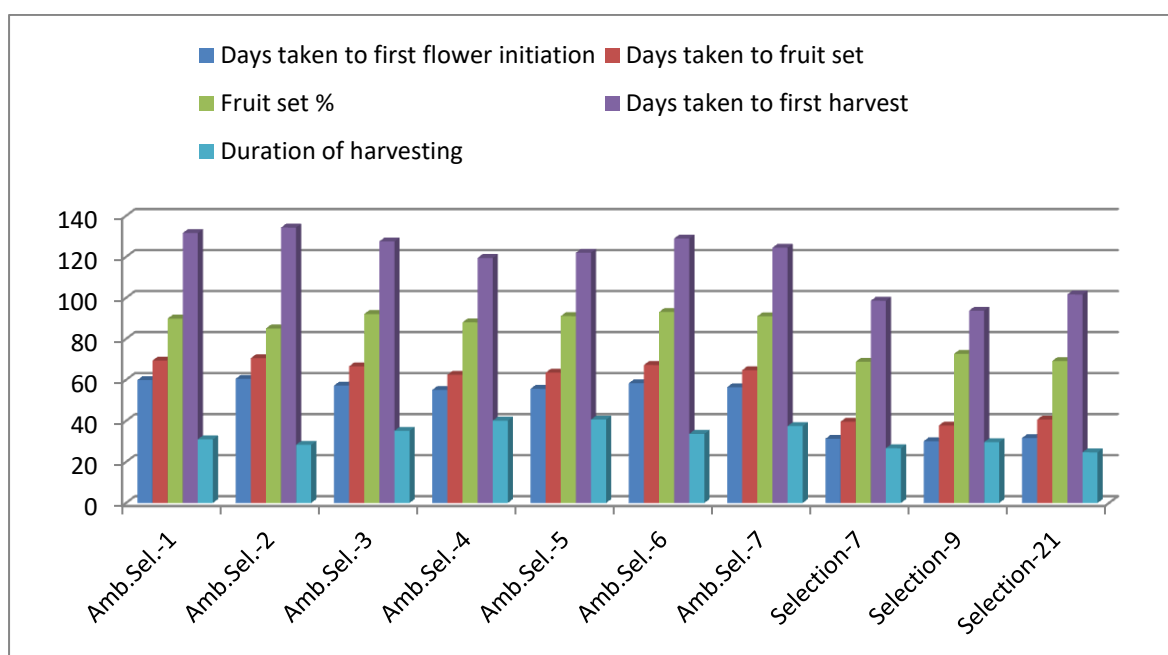


Figure 4.2.1: Performance of capegooseberry genotypes with respect to days taken to first flower initiation, days taken to fruit set, fruit set (%), days taken to first harvest and duration of harvesting

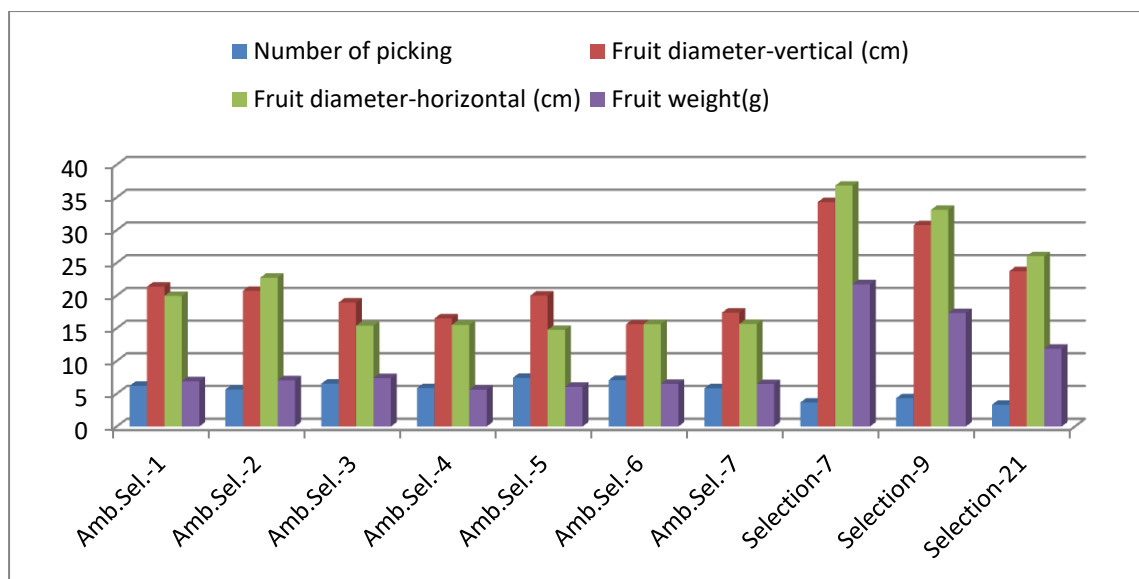


Figure 4.2.2: Performance of capegooseberry genotypes with respect to number of picking, fruit diameter-vertical (mm), fruit diameter-horizontal (mm) and fruit weight (g)

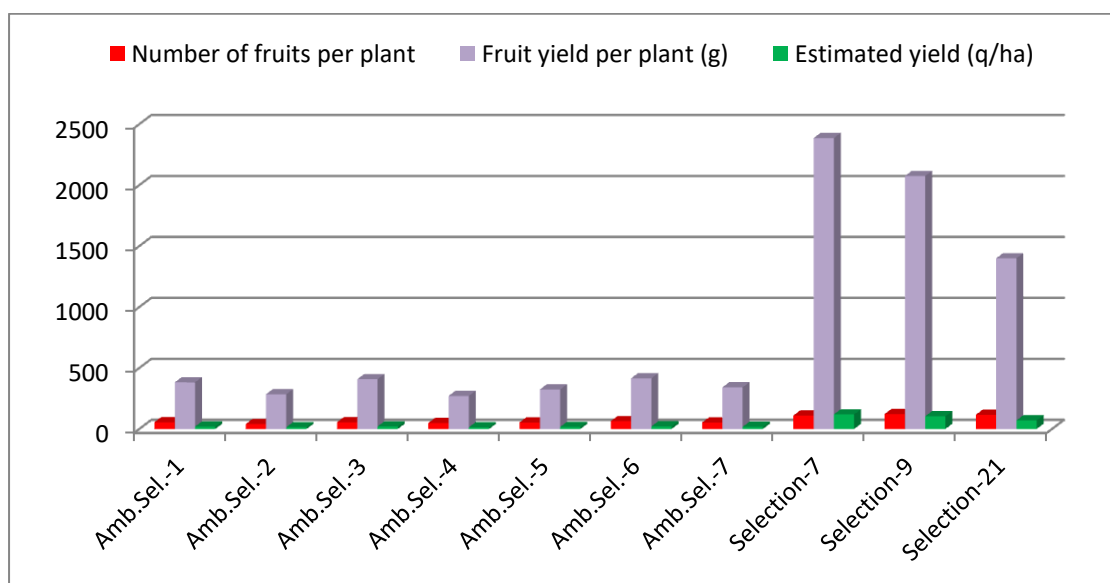


Figure 4.2.3: Performance of capegooseberry genotypes with respect to number of fruits per plant, fruit yield per plant and estimated yield

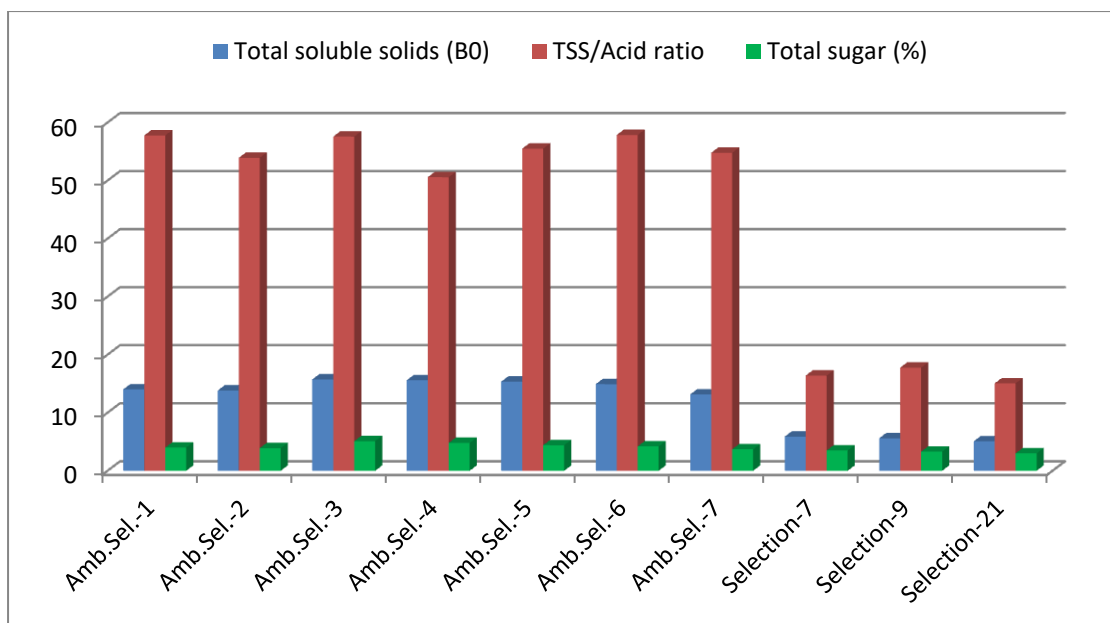


Figure 4.3.1: Performance of capegooseberry genotypes with respect to total soluble solids, TSS/Acid ratio and total sugar

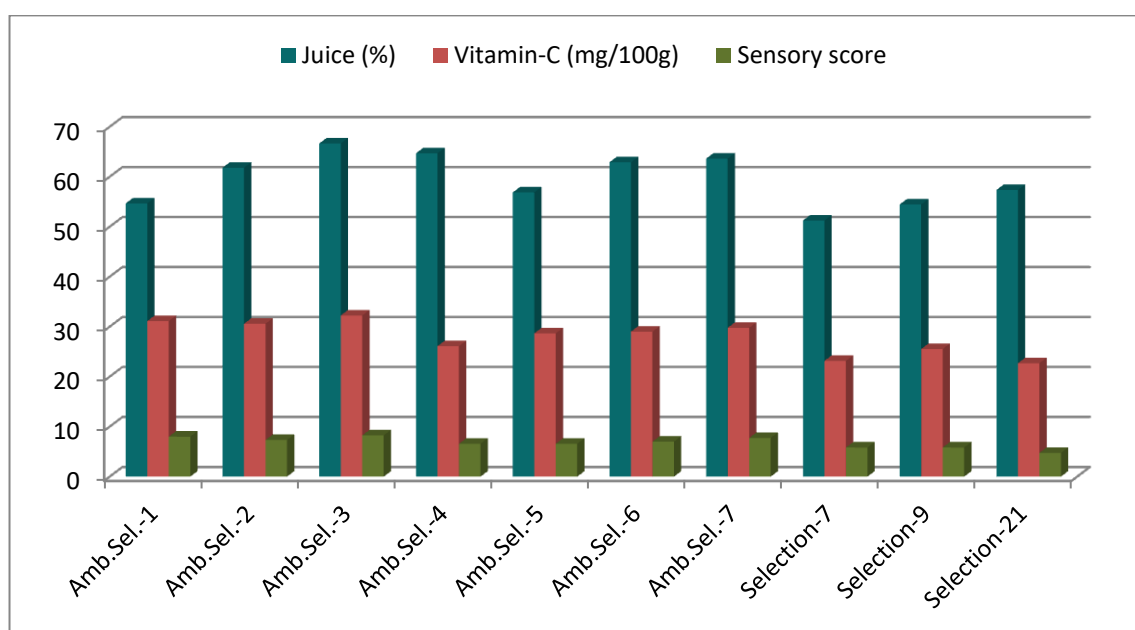


Figure 4.3.2: Performance of capegooseberry genotypes with respect to juice, Vitamin-C and sensory score

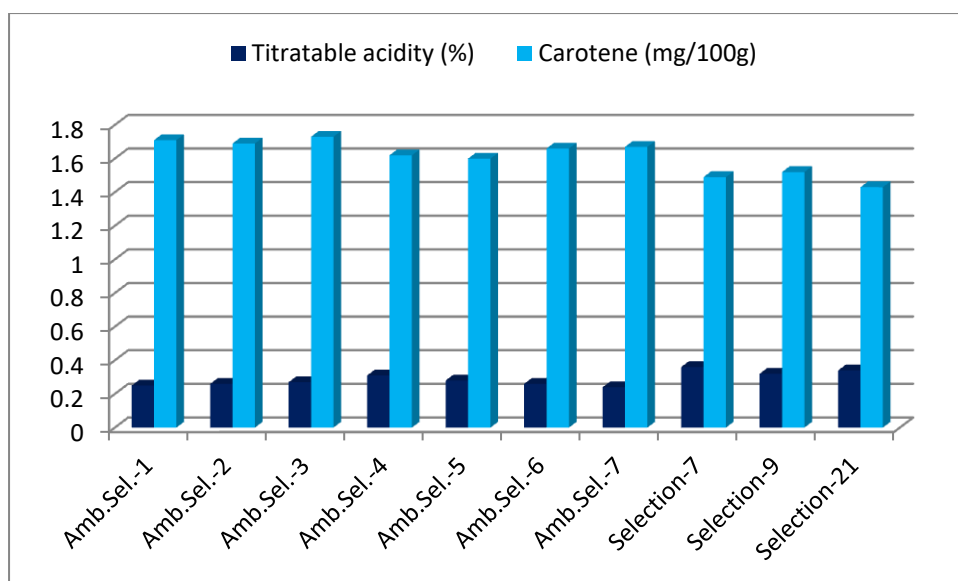


Figure 4.3.3: Performance of capegooseberry genotypes with respect to titratable acidity (%) and carotene (mg/100g)

Table 4.5.1 Phenotypic correlation coefficients for different characters of capegooseberry

[illegible]

X27															
X28															
X29															
X30															
X21															

Significant at p=0.05

Characters															
X1	Plant height (cm)					X11	Days taken to first flower initiation					X21	Fruit yield per plant (g)		
X2	Plant spread (cm) (E-W)					X12	Days taken to fruit set					X22	Estimated yield (q/ha)		
X3	Plant spread (cm) (N-S)					X13	Fruit set (%)					X23	TSS (°Brix)		
X4	Total chlorophyll content of leaves (mg/g)					X14	Days taken to first harvest					X24	Titratable acidity (%)		
X5	No of nodes per plant					X15	Duration of harvesting					X25	TSS/Acid ratio		
X6	No of branches per plant					X16	Number of pickings					X26	Total sugar (%)		
X7	Leaf length (cm)					X17	Fruit diameter (mm) vertical					X27	Juice (%)		
X8	Leaf breadth (cm)					X18	Fruit diameter (mm) horizontal					X28	Vitamin-C (mg/100g)		
X9	Root: Shoot					X19	Fruit weight (g)					X29	Sensory score		
X10	Leaf perimeter (cm)					X20	Number of fruit per plant					X30	Carotene (mg/100g)		

Continued....

Table 4.5.1 Phenotypic correlation coefficients for different characters of capegooseberry

	X16	X17	X18	X19	X20	X22	X23	X24	X25	X26	X27	X28	X29	X30	X21
X1	0.39*	-0.23	-0.34	-0.35	-0.44*	-0.36*	0.44*	-0.33	0.45*	0.32	0.29	0.48*	0.24	0.28	-0.36
X2	-0.68*	0.66*	0.81*	0.78*	0.86*	0.84*	-85*	0.65*	-0.82*	-0.67*	-0.51*	-0.58*	-0.70*	-0.74*	0.84*
X3	0.75*	0.71*	0.80*	0.76*	0.87*	0.82*	0.86*	0.56*	0.80*	0.64*	0.54*	0.59*	0.62*	0.73*	0.82*
X4	-0.60*	0.57*	0.68*	0.73*	0.78*	0.77*	-0.69*	0.60*	-0.70*	-0.41*	-0.46*	-0.57*	-0.43*	-0.54*	0.77*
X5	-0.85*	-0.60*	0.75*	0.63*	0.73*	0.77*	-0.85*	0.64*	-0.84*	-0.70*	-0.56*	-0.67*	-0.55*	-0.82*	0.66*
X6	-0.59*	0.36	0.50*	0.38	0.62*	0.46*	-0.67*	0.48*	-0.61*	-0.67*	-0.29	-0.43	-0.67*	-0.61*	0.46*
X7	0.85*	-0.57*	-0.75*	0.71*	0.82*	-0.77*	0.88*	0.62*	0.83*	0.74*	0.50*	0.65*	0.81*	0.93*	-0.76*
X8	0.87*	-0.61*	0.79*	-0.76*	-0.85	-0.81*	0.91*	-0.61*	0.85*	0.73*	0.53*	0.68*	0.77*	0.90*	-0.81*

X9	-0.11	0.24	0.20	0.21	0.33	0.26	-0.19	0.13	-0.15	0.065	-0.24	-0.33	-0.29	-0.16	0.26
X10	0.89	-0.56*	-0.74*	-0.73*	-0.80*	-0.77*	0.90	-0.61*	0.83	0.71*	0.51*	0.69*	0.72*	0.89*	-0.77*
X11	0.83*	-0.67*	-0.83*	-0.86*	-0.89*	-0.89*	0.94*	-0.68*	0.91*	0.68*	0.59*	0.72*	0.72*	0.90*	-0.89*
X12	0.82*	-0.66*	-0.82*	-0.86*	-0.88*	-0.89*	0.93*	-0.67*	0.89*	0.65*	0.60*	0.74*	0.71*	0.90*	-0.88*
X13	0.90*	-0.71*	-0.90*	-0.84*	-0.81*	-0.83*	0.94*	-0.64*	0.89*	0.72*	0.61*	0.72*	0.70*	0.87*	-0.83*
X14	0.77*	-0.64*	-0.79*	0.83*	-0.86*	-0.87*	0.88*	-0.67*	0.85*	0.61*	0.55*	0.67*	0.73*	0.88*	-0.87*
X15	0.68*	-0.59*	-0.74*	-0.61*	-0.59*	-0.59*	0.73*	-0.34	0.68*	0.67*	0.56*	0.56*	0.34	0.48*	-0.59*
X16	1	-0.61*	-0.82*	-0.74*	-0.76*	-0.77*	0.86*	-0.48*	0.75*	0.67*	0.50*	0.62*	0.57*	0.73*	-0.77*
X17		1	0.87*	0.79*	0.63*	0.75*	-0.72*	0.33	-0.64*	-0.55*	-0.80*	-0.54*	-0.33	-0.51*	0.75*
X18			1	0.91*	0.77*	0.89*	-0.87*	0.49*	-0.81*	-0.68*	-0.71*	-0.62*	-0.50*	-0.69*	0.89*
X19				1	0.77*	0.95*	-0.84*	0.45*	-0.79*	-0.57*	-0.70*	-0.66*	-0.51*	-0.70*	0.95*
X20					1	0.90*	-0.87*	0.57*	-0.82*	-0.64*	-0.54*	-0.59*	-0.67*	-0.78*	0.90*
X22						1	-0.86*	0.49*	-0.80*	-0.60*	-0.65*	-0.64*	-0.60*	-0.74*	1.00*
X23							1	-0.58*	0.94*	0.81*	0.65*	0.71*	0.66*	.83*	-0.86*
X24								1	-0.72*	-0.28	-0.17	-0.53*	-0.52*	-0.65	0.49*
X25									1	0.73*	0.60	0.70*	0.63*	0.82*	-0.80*
X26										1	0.57*	0.51*	0.57*	0.66*	-0.60*
X27											1	0.71*	0.31	0.52*	-0.65*
X28												1	0.50*	0.69*	-0.64*
X29													1	0.86*	-0.60*
X30														1	-0.74*
X21															1

*Significant at p=0.05

Characters					
X1	Plant height (cm)	X11	Days taken to first flower initiation	X21	Fruit yield per plant (g)
X2	Plant spread (cm) (E-W)	X12	Days taken to fruit set	X22	Estimated yield (q/ha)
X3	Plant spread (cm) (N-S)	X13	Fruit set (%)	X23	TSS (^o Brix)
X4	Total chlorophyll content of leaves (mg/g)	X14	Days taken to first harvest	X24	Titrateable acidity (%)
X5	No of nodes per plant	X15	Duration of harvesting	X25	TSS/Acid ratio
X6	No of branches per plant	X16	Number of pickings	X26	Total sugar (%)
X7	Leaf length (cm)	X17	Fruit diameter (mm) vertical	X27	Juice (%)
X8	Leaf breadth (cm)	X18	Fruit diameter (mm) horizontal	X28	Vitamin-C (mg/100g)
X9	Root: Shoot	X19	Fruit weight (g)	X29	Sensory score
X10	Leaf perimeter (cm)	X20	Number of fruit per plant	X30	Carotene (mg/100g)

Table 4.5.2 Genotypic correlation coefficients for different characters of capegooseberry

[illegible]

X22															
X23															
X24															
X25															
X26															
X27															
X28															
X29															
X30															
X21															

*Significant at p=0.05

Characters					
X1	Plant height (cm)	X11	Days taken to first flower initiation	X21	Fruit yield per plant (g)
X2	Plant spread (cm) (E-W)	X12	Days taken to fruit set	X22	Estimated yield (q/ha)
X3	Plant spread (cm) (N-S)	X13	Fruit set (%)	X23	TSS (⁰ Brix)
X4	Total chlorophyll content of leaves (mg/g)	X14	Days taken to first harvest	X24	Titrateable acidity (%)
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X9	Root: Shoot	X19	Fruit weight (g)	X29	Sensory score
X10	Leaf perimeter (cm)	X20	Number of fruit per plant	X30	Carotene (mg/100g)

Continued....

Table 4.5.2 Genotypic correlation coefficients for different characters of capegooseberry

	X16	X17	X18	X19	X20	X22	X23	X24	X25	X26	X27	X28	X29	X30	X21
X1	0.44	-0.43	-0.42	-0.42	-0.60	-0.45	0.53	-0.62	0.57	0.42	0.40	0.63	0.30	0.36	-0.45
X2	-0.89	0.89	0.94	0.97	1.02	0.99	-0.99	0.87	-1.00	-0.76	-0.79	-1.06	-0.75	-0.84	0.99
X3	-0.88	0.88	0.93	0.94	0.99	0.97	-0.99	0.92	-1.00	-0.80	-0.78	-1.06	-0.76	-0.81	0.97
X4	-0.69	0.77	0.76	0.91	0.94	0.92	-0.80	0.87	-0.84	-0.47	-0.66	-0.97	-0.55	-0.65	0.92
X5	-0.96	0.65	0.80	0.80	0.98	0.87	-1.00	0.96	-1.01	-0.87	-0.60	-1.05	-1.12	-0.99	0.87

X6	-0.93	0.59	0.68	0.57	0.80	0.63	-0.90	0.73	-0.89	-0.87	-0.66	-1.08	-0.77	-0.85	0.63
X7	0.95	-0.66	-0.81	-0.82	-0.95	-0.88	0.98	-0.96	1.01	0.81	0.62	1.04	0.99	0.98	-0.88
X8	0.95	-0.71	-0.83	-0.85	-0.96	-0.90	0.97	-0.92	0.96	0.78	0.62	1.01	0.96	0.96	-0.91
X9	-0.27	1.24	1.00	0.95	0.93	0.92	-0.87	1.22	-1.03	-0.55	-1.05	-0.66	-0.04	-0.44	0.92
X10	0.96	-0.64	-0.77	-0.76	-0.96	-0.84	0.95	-0.99	0.95	0.77	0.52	0.99	0.99	0.95	-0.84
X11	0.90	-0.78	-0.87	-0.90	-1.04	-0.97	0.97	-0.100	0.99	0.73	0.66	1.04	0.93	0.92	-0.97
X12	0.88	-0.76	-0.85	-0.90	1.03	-0.96	0.95	-0.100	0.98	0.72	0.64	1.01	0.95	0.92	-0.96
X13	0.98	-0.81	-0.93	-0.90	-0.97	-0.95	0.97	-0.91	0.98	0.78	0.68	1.03	0.93	0.91	-0.95
X14	0.83	-0.72	-0.80	-0.87	-0.99	-0.94	0.91	-0.98	0.93	0.65	0.61	0.99	0.91	0.90	-0.94
X15	0.73	-0.70	-0.77	-0.65	-0.68	-0.65	0.75	-0.51	0.76	0.75	0.63	0.76	0.49	0.52	-0.65
X16	1	-0.73	-0.87	-0.82	-0.88	-0.85	0.96	-0.88	0.92	0.81	0.50	0.90	0.82	0.83	-0.85
X17		1	0.94	0.94	0.82	0.93	-0.80	0.53	-0.78	-0.65	-0.97	-1.07	-0.51	-0.60	0.93
X18			1	0.98	0.89	0.98	-0.91	0.69	-0.91	-0.73	-0.79	-0.97	-0.70	-0.74	0.98
X19				1	0.96	1.02	-0.89	0.82	-0.92	-0.64	-0.76	-0.96	-0.68	-0.74	1.02
X20					1	0.96	-1.01	0.99	-1.04	-0.82	-0.76	-1.15	-0.86	-0.92	0.96
X22						1	-0.95	0.89	-0.97	-0.70	-0.79	-1.05	-0.75	-0.82	1.00
X23							1	-0.86	1.00	0.89	0.71	1.03	0.88	0.89	-0.95
X24								1	-0.86	-0.42	-0.44	-0.99	-1.02	-0.94	0.89
X25									1	0.87	0.72	1.04	0.94	0.92	-0.97
X26										1	0.71	0.80	0.70	0.72	-0.70
X27											1	0.94	0.57	0.61	-0.79
X28												1	1.03	1.01	-1.05
X29													1	1.07	-0.75
X30														1	-0.82
X21															1

*Significant at p=0.05

Characters					
X1	Plant height (cm)	X11	Days taken to first flower initiation	X21	Fruit yield per plant (g)
X2	Plant spread (cm) (E-W)	X12	Days taken to fruit set	X22	Estimated yield (q/ha)
X3	Plant spread (cm) (N-S)	X13	Fruit set (%)	X23	TSS (⁰ Brix)
X4	Total chlorophyll content of leaves (mg/g)	X14	Days taken to first harvest	X24	Titrateable acidity (%)
X5	No of nodes per plant	X15	Duration of harvesting	X25	TSS/Acid ratio
X6	No of branches per plant	X16	Number of pickings	X26	Total sugar (%)

X7	Leaf length (cm)	X17	Fruit diameter (mm) vertical	X27	Juice (%)
X8	Leaf breadth (cm)	X18	Fruit diameter (mm) horizontal	X28	Vitamin-C (mg/100g)
X9	Root: Shoot	X19	Fruit weight (g)	X29	Sensory score
X10	Leaf perimeter (cm)	X20	Number of fruit per plant	X30	Carotene (mg/100g)

Table 4.6.1 Phenotypic direct (diagonal) and indirect effects (non-diagonal) of different characters on fruit yield of capegooseberry

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
X1	<u>0.3473</u>	-0.4094	0.6143	-0.1606	-0.2456	0.0008	-0.0359	0.1814	-0.0238	0.5699	0.7539	-0.3487	-1.0751	-0.4007	-0.4173
X2	-0.1205	<u>1.1799</u>	-1.7527	0.1866	0.4007	-0.0009	0.0929	-0.5004	0.0541	-1.1733	-1.685	0.8628	2.223	1.4559	0.3139
X3	-0.1127	1.0929	<u>-1.8923</u>	0.1835	0.4356	-0.0008	0.0943	-0.4949	0.0648	-1.1596	-1.6821	0.8685	2.2542	1.4416	0.3263
X4	-0.2213	0.8731	-1.3772	<u>0.2522</u>	0.3527	-0.0007	0.0694	-0.3885	0.0315	-0.927	-1.44	0.7295	1.7599	1.1846	0.3144
X5	-0.1364	0.7563	-1.3185	0.1423	<u>0.6251</u>	-0.0008	0.0998	-0.51	0.0064	-1.3754	-1.591	0.8215	2.3454	1.28	0.3654
X6	-0.1986	0.7794	-1.0912	0.1218	0.3603	<u>-0.0014</u>	0.0798	-0.4012	0.0099	-1.0625	-1.1312	0.5465	1.7962	0.814	0.3881
X7	0.1085	-0.9536	1.5523	-0.1523	-0.5427	0.0009	<u>-0.1149</u>	0.5789	-0.0226	1.4535	1.725	-0.8963	-2.4784	-1.4566	-0.3209
X8	0.1051	-0.9839	1.5606	-0.1632	-0.5312	0.0009	-0.1109	<u>0.6001</u>	-0.0197	1.4907	1.786	-0.9314	-2.5046	-1.5299	-0.3007
X9	-0.0611	0.4723	-0.9069	0.0588	0.0296	-0.0001	0.0192	-0.0875	<u>0.1352</u>	-0.0982	-0.4415	0.2561	0.4144	0.4404	0.0908
X10	0.1277	-0.8931	1.4156	-0.1508	-0.5547	0.0009	-0.1077	0.5771	-0.0086	<u>1.55</u>	1.7526	-0.915	-2.4675	-1.4637	-0.3208
X11	0.1368	-1.0388	1.6631	-0.1897	-0.5197	0.0008	-0.1036	0.56	-0.0312	1.4194	<u>1.9139</u>	-0.9882	-2.5202	-1.6137	-0.3234
X12	0.1215	-1.0217	1.6494	-0.1846	-0.5154	0.0007	-0.1034	0.5609	-0.0347	1.4234	1.8982	<u>-0.9964</u>	-2.4883	-1.6285	-0.2985
X13	0.1395	-0.9797	1.5932	-0.1657	-0.5476	0.0009	-0.1064	0.5613	-0.0209	1.4285	1.8015	-0.926	<u>-2.6775</u>	-1.4628	-0.4006
X14	0.0841	-1.0377	1.6478	-0.1804	-0.4833	0.0007	-0.1011	0.5546	-0.036	1.3705	1.8656	-0.9802	-2.3658	<u>-1.6555</u>	-0.2303
X15	0.2596	-0.6634	1.1058	-0.142	-0.4091	0.0009	-0.0661	0.3232	-0.022	0.8906	1.1088	-0.5328	-1.9212	-0.6828	-0.5583
X16	0.1366	-0.8047	1.4127	-0.1518	-0.5312	0.0008	-0.0973	0.5246	-0.0154	1.3759	1.5909	-0.82	-2.4093	-1.2813	-0.3813
X17	-0.0799	0.7803	-1.3418	0.1434	0.3732	-0.0005	0.0657	-0.3652	0.032	-0.8605	-1.277	0.6578	1.9104	1.0565	0.3314

X18	-0.1197	0.9523	-1.5123	0.1706	0.4689	-0.0007	0.0865	-0.473	0.0277	-1.1476	-1.5978	0.8208	2.4012	1.3003	0.4111
X19	-0.123	0.9258	-1.4425	0.1851	0.3934	-0.0005	0.0813	-0.4573	0.0287	-1.136	-1.6485	0.8563	2.2488	1.3744	0.3398
X20	-0.1515	1.0185	-1.6539	0.1963	0.4553	-0.0008	0.0943	-0.5072	0.0452	-1.2429	-1.697	0.8722	2.1558	1.4306	0.3306
X22	-0.1265	0.9895	-1.557	0.195	0.4163	-0.0006	0.0879	-0.4888	0.0357	-1.1912	-1.6973	0.8752	2.2316	1.4336	0.3321
X23	0.1521	-0.9996	1.6357	-0.1752	-0.5316	0.0009	-0.1008	0.5434	-0.026	1.3914	1.8055	-0.9244	-2.5249	-1.4629	-0.4055
X24	-0.1157	0.7673	-1.0541	0.1502	0.4003	-0.0007	0.0714	-0.3633	0.0183	-0.9399	-1.2991	0.6662	1.7028	1.1084	0.1923
X25	0.1553	-0.9714	1.5063	-0.1767	-0.5259	0.0008	-0.0959	0.5095	-0.0199	1.285	1.7346	-0.8852	-2.3932	-1.4073	-0.3802
X26	0.1097	-0.7921	1.2187	-0.1043	-0.4379	0.0009	-0.0845	0.4406	-0.0089	1.105	1.2953	-0.6517	-1.9258	-1.011	-0.3713
X27	0.1009	-0.6072	1.0295	-0.1154	-0.3485	0.0004	-0.0576	0.3172	-0.0323	0.7863	1.1368	-0.5951	-1.6303	-0.91	-0.3142
X28	0.1651	-0.6917	1.1144	-0.1442	-0.4189	0.0006	-0.0748	0.4082	-0.0446	1.0736	1.3849	-0.7338	-1.9316	-1.107	-0.3139
X29	0.0822	-0.8244	1.1775	-0.1085	-0.3441	0.0009	-0.0933	0.4641	-0.0387	1.1196	1.3713	-0.7101	-1.8659	-1.2092	-0.1903
X30	0.0961	-0.8755	1.3848	-0.1352	-0.5117	0.0008	-0.1069	0.5398	-0.0211	1.3818	1.7185	-0.8953	-2.3704	-1.4563	-0.2695

Significant at p=0.05 or at 5 %, Residual effect at Phenotypic level 0.0011

Characters					
X1	Plant height (cm)	X11	Days taken to first flower initiation	X21	Fruit yield per plant (g)
X2	Plant spread (cm) (E-W)	X12	Days taken to fruit set	X22	Estimated yield (q/ha)
X3	Plant spread (cm) (N-S)	X13	Fruit set (%)	X23	TSS (°Brix)
X4	Total chlorophyll content of leaves (mg/g)	X14	Days taken to first harvest	X24	Titrateable acidity (%)
X5	No of nodes per plant	X15	Duration of harvesting	X25	TSS/Acid ratio
X6	No of branches per plant	X16	Number of pickings	X26	Total sugar (%)
X7	Leaf length (cm)	X17	Fruit diameter (mm) vertical	X27	Juice (%)
X8	Leaf breadth (cm)	X18	Fruit diameter (mm) horizontal	X28	Vitamin-C (mg/100g)
X9	Leaf perimeter (cm)	X19	Fruit weight (g)	X29	Sensory score
X10	Root: Shoot	X20	Number of fruit per plant	X30	Carotene (mg/100g)

Continued....

Table 4.6.1 Phenotypic direct (diagonal) and indirect effects (non-diagonal) of different characters on fruit yield of capegooseberry

	X16	X17	X18	X19	X20	X22	X23	X24	X25	X26	X27	X28	X29	X30	Correlation with fruit yield
X1	-0.1197	-0.1225	0.8237	-0.0511	-0.2546	-0.4146	-0.0076	0.1211	0.1537	-0.0574	0.0586	0.0122	0.052	0.0917	-0.364
X2	0.2075	0.3521	-1.929	0.1133	0.504	0.9551	0.0147	-0.2365	-0.2831	0.1219	-0.1038	-0.0151	-0.1537	-0.2458	0.838**
X3	0.2271	0.3776	-1.9101	0.11	0.5103	0.937	0.015	-0.2025	-0.2737	0.1169	-0.1097	-0.0152	-0.1368	-0.2424	0.822**
X4	0.1831	0.3028	-1.6168	0.1059	0.4545	0.8807	0.0121	-0.2167	-0.2409	0.0751	-0.0923	-0.0147	-0.0946	-0.1776	0.773**

X5	0.2586	0.3178	-1.7929	0.0908	0.4253	0.7585	0.0148	-0.2329	-0.2893	0.1272	-0.1124	-0.0173	-0.121	-0.2712	0.666**
X6	0.181	0.1901	-1.189	0.0548	0.3609	0.5264	0.0117	-0.1758	-0.2085	0.1222	-0.0592	-0.0111	-0.1474	-0.2036	0.462**
X7	-0.2575	-0.3043	1.8002	-0.1021	-0.4794	-0.8708	-0.015	0.2258	0.2869	-0.1335	0.1012	0.0168	0.1786	0.3082	-0.764**
X8	-0.266	-0.324	1.8837	-0.11	-0.4935	-0.9277	-0.016	0.2201	0.292	-0.1333	0.1066	0.0175	0.1701	0.298	-0.814**
X9	0.0346	0.126	-0.4889	0.0306	0.1952	0.3006	0.0033	-0.0491	-0.0506	0.0119	-0.0482	-0.0085	-0.063	-0.0516	0.264
X10	-0.2701	-0.2956	1.7695	-0.1058	-0.4682	-0.8752	-0.016	0.2205	0.2851	-0.1294	0.1023	0.0178	0.1588	0.2953	-0.768**
X11	-0.2529	-0.3553	1.9953	-0.1243	-0.5177	-1.01	-0.016	0.2468	0.3117	-0.1229	0.1198	0.0186	0.1576	0.2974	-0.886**
X12	-0.2504	-0.3515	1.9688	-0.124	-0.5111	-1.0002	-0.016	0.2431	0.3055	-0.1188	0.1204	0.019	0.1567	0.2976	-0.878**
X13	-0.2738	-0.3799	2.1435	-0.1212	-0.4701	-0.9492	-0.016	0.2313	0.3074	-0.1306	0.1228	0.0186	0.1533	0.2933	-0.833**
X14	-0.2355	-0.3398	1.8773	-0.1198	-0.5046	-0.9862	-0.015	0.2434	0.2923	-0.1109	0.1109	0.0172	0.1606	0.2914	-0.866**
X15	-0.2078	-0.3161	1.76	-0.0878	-0.3458	-0.6775	-0.013	0.1252	0.2342	-0.1207	0.1135	0.0145	0.0749	0.1599	-0.594**
X16	-0.3043	-0.3233	1.9489	-0.1061	-0.4415	-0.876	-0.015	0.1757	0.2594	-0.1214	0.0998	0.0159	0.1262	0.2431	-0.769**
X17	0.1848	0.5325	-2.0828	0.1143	0.3666	0.8532	0.0126	-0.1211	-0.2198	0.0994	-0.1612	-0.0139	-0.0718	-0.1692	0.749**
X18	0.2481	0.464	-2.3901	0.1314	0.4505	1.008	0.0151	-0.1778	-0.2782	0.1236	-0.1441	-0.016	-0.1099	-0.2281	0.885**
X19	0.2236	0.4218	-2.1759	0.1443	0.4478	1.0764	0.0146	-0.1624	-0.2702	0.1026	-0.1417	-0.017	-0.1128	-0.2312	0.945**
X20	0.2301	0.3343	-1.8441	0.1107	0.5839	1.0305	0.015	-0.2073	-0.2825	0.1171	-0.1086	-0.0152	-0.1474	-0.2572	0.904**
X22	0.234	0.3989	-2.1156	0.1364	0.5284	1.1388	0.0149	-0.1789	-0.2764	0.1086	-0.1301	-0.0164	-0.1328	-0.2455	1.00**
X23	-0.2631	-0.3852	2.078	-0.1212	-0.5054	-0.9761	-0.017	0.2112	0.3219	-0.1476	0.1313	0.0182	0.1453	0.275	-0.857**
X24	0.147	0.1773	-1.1685	0.0645	0.3328	0.5602	0.0101	-0.3636	-0.247	0.0508	-0.0343	-0.0135	-0.1139	-0.2144	0.491**
X25	-0.2295	-0.3404	1.9336	-0.1136	-0.4797	-0.9154	-0.016	0.2612	0.3439	-0.1321	0.1208	0.0179	0.1386	0.2713	-0.803**
X26	-0.2035	-0.2916	1.6268	-0.0816	-0.3766	-0.6814	-0.014	0.1018	0.2502	-0.1816	0.1155	0.0132	0.1248	0.217	-0.598**
X27	-0.1506	-0.4257	1.7076	-0.1014	-0.3145	-0.7348	-0.011	0.0619	0.206	-0.104	0.2017	0.0184	0.0691	0.1721	-0.645**
X28	-0.1874	-0.2873	1.483	-0.0952	-0.3436	-0.7232	-0.012	0.1909	0.2396	-0.0932	0.1441	0.0257	0.109	0.2282	-0.635**
X29	-0.1746	-0.1739	1.1947	-0.0741	-0.3941	-0.6876	-0.012	0.1883	0.2167	-0.103	0.0634	0.0128	0.2199	0.2855	-0.603**
X30	-0.2233	-0.2721	1.6455	-0.1007	-0.4534	-0.8439	-0.014	0.2354	0.2816	-0.119	0.1048	0.0177	0.1895	0.3312	-0.741**

Significant at p=0.05 or at 5 %, Residual effect at Phenotypic level 0.0011

Characters					
X1	Plant height (cm)			X11	Days taken to first flower initiation
X2	Plant spread (cm) (E-W)			X12	Days taken to fruit set
X3	Plant spread (cm) (N-S)			X13	Fruit set (%)
X4	Total chlorophyll content of leaves (mg/g)			X14	Days taken to first harvest
X5	No of nodes per plant			X15	Duration of harvesting
				X21	Fruit yield per plant (g)
				X22	Estimated yield (q/ha)
				X23	TSS (°Brix)
				X24	Titratable acidity (%)
				X25	TSS/Acid ratio

X6	No of branches per plant	X16	Number of pickings	X26	Total sugar (%)
X7	Leaf length (cm)	X17	Fruit diameter (mm) vertical	X27	Juice (%)
X8	Leaf breadth (cm)	X18	Fruit diameter (mm) horizontal	X28	Vitamin-C (mg/100g)
X9	Leaf perimeter (cm)	X19	Fruit weight (g)	X29	Sensory score
X10	Root: Shoot	X20	Number of fruit per plant	X30	Carotene (mg/100g)

Table 4.6.2 Genotypic direct (diagonal) and indirect effects (non-diagonal) of different characters on fruit yield of capegooseberry

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
X1	<u>-0.0949</u>	0.2643	-0.2239	0.0956	0.1672	-0.1542	-0.0572	-0.0291	0.0002	-0.1668	-0.1515	0.3974	0.523	-0.2429	-0.0156
X2	0.0412	<u>-0.6084</u>	0.5247	-0.1069	-0.2704	0.1168	0.1111	0.0729	-0.0011	0.3161	0.3417	-1.0054	-1.0534	0.813	0.0125
X3	0.0419	-0.6298	<u>0.5069</u>	-0.1029	-0.2641	0.1352	0.1097	0.0732	-0.001	0.3212	0.3365	-0.9831	-1.0443	0.799	0.0125
X4	0.0717	-0.5137	0.412	<u>-0.1266</u>	-0.1985	0.1071	0.0876	0.0572	-0.0009	0.2584	0.2908	-0.8422	-0.835	0.6623	0.0123
X5	0.0563	-0.5836	0.4747	-0.0891	<u>-0.282</u>	0.2164	0.134	0.0813	-0.0006	0.3616	0.3294	-0.9448	-1.1301	0.7394	0.0146
X6	0.0763	-0.3704	0.3573	-0.0707	-0.318	<u>0.1918</u>	0.1121	0.0653	-0.0003	0.3283	0.2643	-0.7494	-0.9791	0.5288	0.0175
X7	-0.0423	0.527	-0.4334	0.0865	0.2944	-0.1677	<u>-0.1283</u>	-0.0808	0.0002	-0.3575	-0.3303	0.9605	1.0987	-0.7622	-0.0122
X8	-0.0338	0.5432	-0.4546	0.0888	0.281	-0.1536	-0.127	<u>-0.0816</u>	0.0004	-0.3559	-0.3333	0.9761	1.0887	-0.7892	-0.0108
X9	0.0195	-0.8347	0.6147	-0.1338	-0.2037	0.062	0.0384	0.0351	<u>-0.0008</u>	0.1777	0.3356	-0.9512	-0.7705	0.8658	0.0082
X10	-0.0443	0.5388	-0.4562	0.0917	0.2856	-0.1764	-0.1285	-0.0814	0.0004	<u>-0.3569</u>	-0.3261	0.9461	1.078	-0.7599	-0.0116
X11	-0.0422	0.6095	-0.5	0.1079	0.2723	-0.1486	-0.1242	-0.0797	0.0008	-0.3412	<u>-0.3411</u>	1.0024	1.0701	-0.8193	-0.0113
X12	-0.0377	0.6111	-0.4978	0.1065	0.2661	-0.1436	-0.1231	-0.0796	0.0008	-0.3373	-0.3415	<u>1.001</u>	1.0539	-0.8278	-0.0104
X13	-0.0441	0.5695	-0.4703	0.0939	0.2831	-0.1669	-0.1252	-0.0789	0.0006	-0.3419	-0.3243	0.9373	<u>1.1255</u>	-0.7441	-0.014
X14	-0.0277	0.594	-0.4863	0.1007	0.2503	-0.1218	-0.1174	-0.0773	0.0009	-0.3257	-0.3355	0.995	1.0057	<u>-0.8328</u>	-0.0083
X15	-0.0768	0.395	-0.329	0.0807	0.214	-0.1745	-0.0811	-0.046	0.0003	-0.2157	-0.201	0.5394	0.8205	-0.3575	<u>-0.0192</u>
X16	-0.0427	0.5413	-0.4471	0.0835	0.2694	-0.1782	-0.1212	-0.0779	0.0002	-0.3438	-0.3066	0.8777	1.1039	-0.6879	-0.0141
X17	0.0412	-0.5416	0.4438	-0.0975	-0.1844	0.1123	0.0844	0.0582	-0.001	0.2282	0.2648	-0.7575	-0.9128	0.5995	0.0135
X18	0.0401	-0.5733	0.4722	-0.0963	-0.2271	0.1295	0.1042	0.0674	-0.0008	0.2742	0.2959	-0.8494	-1.0442	0.6702	0.0148
X19	0.0401	-0.5876	0.4779	-0.1157	-0.2251	0.1097	0.1053	0.0695	-0.0008	0.2729	0.3092	-0.8969	-1.0083	0.7285	0.0125

X20	0.0571	-0.6228	0.5032	-0.1186	-0.2778	0.154	0.1214	0.0785	-0.0008	0.3441	0.3532	-1.0333	-1.0908	0.8282	0.0131
X22	0.0429	-0.605	0.4908	-0.1164	-0.245	0.1202	0.1124	0.0739	-0.0008	0.3009	0.3302	-0.9652	-1.0651	0.7802	0.0125
X23	-0.0504	0.6053	-0.5022	0.1017	0.2823	-0.1717	-0.1254	-0.0789	0.0007	-0.3408	-0.33	0.9558	1.0958	-0.7575	-0.0145
X24	0.0589	-0.527	0.4661	-0.1096	-0.2695	0.1409	0.123	0.0753	-0.001	0.3537	0.3401	-0.9995	-1.0244	0.8133	0.0098
X25	-0.0543	0.6088	-0.5092	0.1066	0.2838	-0.1703	-0.1293	-0.0784	0.0008	-0.3405	-0.3382	0.9815	1.0975	-0.7761	-0.0145
X26	-0.0396	0.4607	-0.4059	0.0591	0.2443	-0.1667	-0.1034	-0.0633	0.0005	-0.2746	-0.2498	0.7177	0.8823	-0.5379	-0.0146
X27	-0.0377	0.4831	-0.3934	0.0835	0.1704	-0.1266	-0.0793	-0.0505	0.0009	-0.187	-0.226	0.6412	0.765	-0.5073	-0.0121
X28	-0.0594	0.6445	-0.5347	0.1225	0.2974	-0.2063	-0.1334	-0.0828	0.0005	-0.3534	-0.3552	1.0106	1.1597	-0.8209	-0.0147
X29	-0.0284	0.4591	-0.3841	0.0699	0.316	-0.1474	-0.1268	-0.0784	0	-0.3548	-0.3184	0.9464	1.0445	-0.7568	-0.0093
X30	-0.0346	0.511	-0.411	0.0818	0.2804	-0.1626	-0.126	-0.0787	0.0004	-0.3404	-0.3139	0.9238	1.0271	-0.7497	-0.0099

*Significant at p=0.05 or at 5 %, Residual effect at Genotypic level 0.1

Characters					
X1	Plant height (cm)	X11	Days taken to first flower initiation	X21	Fruit yield per plant (g)
X2	Plant spread (cm) (E-W)	X12	Days taken to fruit set	X22	Estimated yield (q/ha)
X3	Plant spread (cm) (N-S)	X13	Fruit set (%)	X23	TSS (⁰ Brix)
X4	Total chlorophyll content of leaves (mg/g)	X14	Days taken to first harvest	X24	Titrateable acidity (%)
X5	No of nodes per plant	X15	Duration of harvesting	X25	TSS/Acid ratio
X6	No of branches per plant	X16	Number of pickings	X26	Total sugar (%)
X7	Leaf length (cm)	X17	Fruit diameter (mm) vertical	X27	Juice (%)
X8	Leaf breadth (cm)	X18	Fruit diameter (mm) horizontal	X28	Vitamin-C (mg/100g)
X9	Leaf perimeter (cm)	X19	Fruit weight (g)	X29	Sensory score
X10	Root: Shoot	X20	Number of fruit per plant	X30	Carotene (mg/100g)

Continued....

Table 4.6.2 Genotypic direct (diagonal) and indirect effects (non-diagonal) of different characters on fruit yield of capegooseberry

	X16	X17	X18	X19	X20	X22	X23	X24	X25	X26	X27	X28	X29	X30	Correlation with fruit yield
X1	0.0225	0.0638	-0.3758	-0.0015	0.1165	-0.4193	0.0474	-0.0196	-0.1371	0.0299	0.0171	-0.0481	0.035	-0.0945	-0.452
X2	-0.0446	-0.1307	0.8378	0.0034	-0.1982	0.9224	-0.089	0.0273	0.2395	-0.0543	-0.0342	0.0813	-0.0884	0.2177	0.9943
X3	-0.0442	-0.1286	0.8282	0.0033	-0.1922	0.8982	-0.088	0.029	0.2405	-0.0574	-0.0335	0.081	-0.0888	0.2102	0.9683
X4	-0.033	-0.113	0.676	0.0032	-0.1813	0.8529	-0.072	0.0273	0.2015	-0.0335	-0.0284	0.0743	-0.0647	0.1674	0.9195
X5	-0.0479	-0.096	0.7161	0.0028	-0.1906	0.806	-0.089	0.0301	0.241	-0.0621	-0.0261	0.081	-0.1313	0.2578	0.8688

X6	-0.0465	-0.086	0.6002	0.002	-0.1554	0.5811	-0.08	0.0231	0.2125	-0.0623	-0.0285	0.0826	-0.09	0.2196	0.6264
X7	0.0473	0.0966	-0.722	-0.0029	0.1832	-0.8132	0.0872	-0.0302	-0.2414	0.0578	0.0267	-0.0799	0.1158	-0.2545	-0.8766
X8	0.0478	0.1047	-0.7338	-0.003	0.1862	-0.8404	0.0863	-0.0291	-0.23	0.0556	0.0267	-0.0779	0.1126	-0.2498	-0.906
X9	-0.0133	-0.1822	0.8946	0.0033	-0.1804	0.8567	-0.078	0.0385	0.2468	-0.0395	-0.0454	0.0509	-0.0046	0.1134	0.9235
X10	0.0482	0.0939	-0.683	-0.0027	0.1867	-0.782	0.0852	-0.0312	-0.2284	0.0552	0.0226	-0.076	0.1165	-0.2471	-0.843
X11	0.045	0.114	-0.7712	-0.0032	0.2005	-0.898	0.0863	-0.0314	-0.2374	0.0525	0.0286	-0.08	0.1094	-0.2385	-0.9681
X12	0.0439	0.1111	-0.7543	-0.0031	0.1999	-0.8945	0.0851	-0.0314	-0.2347	0.0514	0.0276	-0.0775	0.1108	-0.2392	-0.9642
X13	0.0491	0.1191	-0.8248	-0.0031	0.1877	-0.8779	0.0868	-0.0287	-0.2334	0.0562	0.0293	-0.0791	0.1087	-0.2365	-0.9463
X14	0.0414	0.1057	-0.7154	-0.003	0.1926	-0.869	0.0811	-0.0307	-0.2231	0.0463	0.0263	-0.0757	0.1065	-0.2333	-0.9368
X15	0.0367	0.1036	-0.6824	-0.0023	0.1319	-0.6051	0.0671	-0.0161	-0.1806	0.0539	0.0272	-0.0586	0.0569	-0.1336	-0.6523
X16	0.0501	0.1079	-0.7698	-0.0029	0.1705	-0.7877	0.0858	-0.0276	-0.2242	0.0584	0.0217	-0.0692	0.0965	-0.2154	-0.8491
X17	-0.0368	-0.1468	0.834	0.0033	-0.1588	0.8634	-0.072	0.0167	0.1878	-0.0467	-0.0419	0.082	-0.0594	0.1547	0.9307
X18	-0.0434	-0.1378	0.889	0.0034	-0.1726	0.9077	-0.081	0.0217	0.2173	-0.0522	-0.0341	0.0747	-0.0825	0.1912	0.9785
X19	-0.0412	-0.1379	0.8718	0.0035	-0.1861	0.9444	-0.079	0.0259	0.2196	-0.046	-0.0327	0.0738	-0.0794	0.1908	1.0181
X20	-0.0441	-0.1204	0.7927	0.0033	-0.1936	0.889	-0.091	0.0313	0.2501	-0.0585	-0.0329	0.0887	-0.1036	0.2382	0.9584
X22	-0.0425	-0.1367	0.8699	0.0035	-0.1856	0.9277	-0.084	0.028	0.2332	-0.05	-0.034	0.0805	-0.0876	0.2115	1
X23	0.0482	0.1185	-0.81	-0.0031	0.1971	-0.8783	0.0892	-0.0271	-0.2399	0.0637	0.0308	-0.0789	0.1029	-0.2298	-0.9468
X24	-0.0439	-0.0779	0.612	0.0029	-0.1925	0.8241	-0.077	0.0315	0.2064	-0.0299	-0.0189	0.0758	-0.1192	0.2446	0.8883
X25	0.0469	0.1152	-0.8069	-0.0032	0.2023	-0.9037	0.0894	-0.0272	-0.2394	0.0621	0.0311	-0.0796	0.1105	-0.2397	-0.9742
X26	0.0408	0.0956	-0.6468	-0.0022	0.158	-0.6473	0.0793	-0.0131	-0.2072	0.0717	0.0305	-0.0618	0.0815	-0.1856	-0.6978
X27	0.0252	0.1427	-0.7025	-0.0026	0.1478	-0.7309	0.0637	-0.0138	-0.1728	0.0507	0.0431	-0.072	0.0671	-0.1576	-0.7879
X28	0.0452	0.1569	-0.8653	-0.0033	0.2235	-0.9725	0.0916	-0.0311	-0.2483	0.0577	0.0404	-0.0768	0.1203	-0.261	-1.0484
X29	0.0431	0.0744	-0.6259	-0.0024	0.1713	-0.6936	0.0783	-0.032	-0.2259	0.0499	0.0247	-0.0788	0.1172	-0.2773	-0.7476
X30	0.0416	0.0876	-0.6558	-0.0026	0.178	-0.757	0.0791	-0.0297	-0.2214	0.0514	0.0262	-0.0773	0.1254	-0.2592	-0.816

Significant at p=0.05 or at 5 %, Residual effect at Genotypic level 0.1

Characters					
X1	Plant height (cm)	X11	Days taken to first flower initiation	X21	Fruit yield per plant (g)
X2	Plant spread (cm) (E-W)	X12	Days taken to fruit set	X22	Estimated yield (q/ha)
X3	Plant spread (cm) (N-S)	X13	Fruit set (%)	X23	TSS (^o Brix)
X4	Total chlorophyll content of leaves (mg/g)	X14	Days taken to first harvest	X24	Titrateable acidity (%)
X5	No of nodes per plant	X15	Duration of harvesting	X25	TSS/Acid ratio

X6	No of branches per plant	X16	Number of pickings	X26	Total sugar (%)
X7	Leaf length (cm)	X17	Fruit diameter (mm) vertical	X27	Juice (%)
X8	Leaf breadth (cm)	X18	Fruit diameter (mm) horizontal	X28	Vitamin-C (mg/100g)
X9	Leaf perimeter (cm)	X19	Fruit weight (g)	X29	Sensory score
X10	Root: Shoot	X20	Number of fruit per plant	X30	Carotene (mg/100g)

Table 4.1.1: Performance of capegooseberry genotypes with respect to plant height, plant E-W, N-S spread and number of nodes per plant

Treatments	Plant height (cm)	Plant spread (cm)		No of nodes per plant
		E-W	N-S	
Amb. Sel.-1	101.72	66.72	76.61	186.00
Amb. Sel.-2	109.00	60.77	67.33	223.67
Amb. Sel.-3	92.78	63.00	70.22	173.67
Amb. Sel.-4	127.89	60.77	65.78	190.67
Amb. Sel.-5	118.55	63.11	67.33	200.67
Amb. Sel.-6	96.44	63.33	61.78	172.00
Amb. Sel.-7	118.77	63.44	72.55	193.33
Selection-7	64.80	118.67	117.67	318.33
Selection-9	68.15	146.67	147.00	313.33
Selection-21	71.52	111.33	116.33	403.67
Mean	96.96	81.78	86.26	237.53
CD at 5%	11.43	26.83	23.09	71.15
SEm±	3.85	9.03	7.77	23.94

Table 4.1.2: Performance of capegooseberry genotypes with respect to number of branches per plant, leaf length, leaf breadth and leaf perimeter

Treatments	No of branches per plant	Leaf length (cm)	Leaf breadth (cm)	Leaf perimeter (cm)
Amb. Sel.-1	47.00	13.42	10.75	38.70
Amb. Sel.-2	44.33	12.22	10.70	38.51
Amb. Sel.-3	33.33	13.51	11.45	39.47
Amb. Sel.-4	32.67	12.12	9.05	33.51
Amb. Sel.-5	32.67	12.06	10.21	38.54
Amb. Sel.-6	40.33	13.12	11.13	39.93
Amb. Sel.-7	33.67	12.10	9.48	35.51
Selection-7	50.67	8.33	4.90	22.13
Selection-9	50.33	9.16	5.98	24.50
Selection-21	55.00	7.05	4.37	15.11
Mean	42.0	11.31	8.80	32.59
CD at 5%	9.98	1.48	1.11	4.37
SEm±	3.36	0.50	0.37	1.47

Table 4.1.3: Performance of capegooseberry genotypes with respect to total chlorophyll content of leaves and root:shoot ratio

Treatments	Total chlorophyll content of leaves (mg/g)	Root:shoot
Amb. Sel.-1	2.34	0.18
Amb. Sel.-2	1.94	0.15
Amb. Sel.-3	2.86	0.18
Amb. Sel.-4	2.02	0.14
Amb. Sel.-5	2.18	0.17
Amb. Sel.-6	2.58	0.16
Amb. Sel.-7	2.18	0.14
Selection-7	3.36	0.19
Selection-9	3.11	0.23
Selection-21	2.97	0.20
Mean	2.55	0.17
CD at 5%	0.41	0.07
SEm±	0.14	0.02

Table 4.2.1: Performance of capegooseberry genotypes with respect to days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest and duration of harvesting

Treatments	Days taken to first flower initiation	Days taken to fruit set	Fruit set (%)	Days taken to first harvest	Duration of harvesting
Amb. Sel.-1	59.89	69.43	89.90	131.63	31.03
Amb. Sel.-2	60.55	70.59	85.10	134.29	28.37
Amb. Sel.-3	57.22	66.60	92.13	127.50	35.16
Amb. Sel.-4	55.11	62.49	88.05	119.49	40.14
Amb. Sel.-5	55.65	63.52	91.10	122.02	40.64
Amb. Sel.-6	58.39	67.27	93.10	128.97	33.69
Amb. Sel.-7	56.44	64.77	91.02	124.47	37.47
Selection-7	31.28	39.61	68.84	98.61	26.66
Selection-9	30.11	37.77	72.69	93.77	29.66
Selection-21	31.66	40.66	69.24	101.66	24.66
Mean	49.63	58.27	84.12	118.24	32.75
CD at 5%	2.53	2.00	1.78	1.99	1.53
SEm±	0.85	0.67	0.60	0.67	0.51

Table 4.2.2: Performance of capegooseberry genotypes with respect to number of picking, fruit diameter-vertical, fruit diameter-horizontal and fruit weight (g)

Treatments	Number of picking	Fruit diameter (mm)		Fruit weight(g)
		Vertical	Horizontal	
Amb. Sel.-1	6.22	21.39	19.96	6.93
Amb. Sel.-2	5.66	20.74	22.75	7.07
Amb. Sel.-3	6.55	18.96	15.41	7.40
Amb. Sel.-4	5.88	16.53	15.53	5.63
Amb. Sel.-5	7.45	20.01	14.78	6.07
Amb. Sel.-6	7.10	15.62	15.65	6.53
Amb. Sel.-7	5.85	17.40	15.67	6.50
Selection-7	3.67	34.30	36.81	21.75
Selection-9	4.33	30.78	33.12	17.35
Selection-21	3.33	23.74	26.04	11.88
Mean	5.61	21.95	21.57	9.71
CD at 5%	0.85	5.62	3.09	3
SEm±	0.29	1.89	1.04	1

Table 4.2.3: Performance of capegooseberry genotypes with respect to number of fruits per plant, fruit yield per plant (g) and estimated yield (q/ha)

Treatments	Number of fruits per plant	Fruit yield per plant (g)	Estimated yield (q/ha)
Amb. Sel.-1	55.33	382.14	19.10
Amb. Sel.-2	40.11	284.85	14.24
Amb. Sel.-3	54.67	408.03	20.40
Amb. Sel.-4	48.33	270.70	13.53
Amb. Sel.-5	53.33	323.60	16.18
Amb. Sel.-6	63.89	415.34	20.76
Amb. Sel.-7	52.45	341.13	17.06
Selection-7	110.00	2386.16	119.31
Selection-9	122.33	2074.32	103.71
Selection-21	116.67	1399.46	69.97
Mean	71.71	828.57	41.43
CD at 5%	29.37	492.37	24.62
SEm±	9.88	165.72	8.29

Table 4.3.1: Performance of capegooseberry genotypes with respect to total soluble solids (B^0), TSS/Acid ratio and total sugar (%)

Treatments	Total soluble solids (B^0)	TSS/Acid ratio	Total sugar (%)
Amb. Sel.-1	14.02	57.78	4.00
Amb. Sel.-2	13.83	53.92	3.90
Amb. Sel.-3	15.73	57.58	5.10
Amb. Sel.-4	15.60	50.58	4.80
Amb. Sel.-5	15.36	55.50	4.40
Amb. Sel.-6	14.92	57.86	4.20
Amb. Sel.-7	13.15	54.79	3.70
Selection-7	5.88	16.40	3.50
Selection-9	5.60	17.77	3.30
Selection-21	5.07	15.06	3.00
Mean	11.92	43.72	3.99
CD at 5%	1.74	12.03	0.43
SEm $\pm$	0.59	4.04	0.15

Table 4.3.2: Performance of capegooseberry genotypes with respect to juice (%), Vitamin-C (mg/100g) and sensory score

Treatments	Juice* (%)	Vitamin-C (mg/100g)	Sensory score
Amb. Sel.-1	54.68	31.12	8.00
Amb. Sel.-2	61.81	30.58	7.33
Amb. Sel.-3	66.66	32.24	8.25
Amb. Sel.-4	64.70	26.10	6.58
Amb. Sel.-5	56.86	28.66	6.58
Amb. Sel.-6	62.90	29.02	7.00
Amb. Sel.-7	63.64	29.78	7.75
Selection-7	51.25	23.16	5.83
Selection-9	54.46	25.53	5.83
Selection-21	57.36	22.69	4.75
Mean	59.43	27.89	6.79
CD at 5%	3.77	4.22	1.38
SEm $\pm$	1.27	1.42	0.46

* Variation being less, not subjected to angular transformation

Table 4.3.3: Performance of capegooseberry genotypes with respect to titratable acidity (%) and carotene (mg/100g)

Treatments	Titratable acidity* (%)	Carotene (mg/100g)
Amb. Sel.-1	0.25	1.71
Amb. Sel.-2	0.26	1.69
Amb. Sel.-3	0.27	1.73
Amb. Sel.-4	0.31	1.62
Amb. Sel.-5	0.28	1.60
Amb. Sel.-6	0.26	1.66
Amb. Sel.-7	0.24	1.67
Selection-7	0.36	1.49
Selection-9	0.32	1.52
Selection-21	0.34	1.43
Mean	0.29	1.61
CD at 5%	0.06	0.03
SEm±	0.02	0.01

* Variation being less, not subjected to angular transformation

Table 4.4.1: Range, Mean, Phenotypic coefficient of variation (PCV), Genotypic coefficient of variation (GCV), Heritability, Genetic advance and Genetic advance mean per cent for 30 characters in Capegooseberry

CHARACTERS	RANGE	MEAN	GCV	PCV	H (%)	GA	GAM (%)
Plant height (cm)	64.80-127.89	96.96	22.96	23.97	91.77	43.94	45.32
Plant spread E-W (cm)	60.77-146.67	81.78	36.90	41.57	78.80	55.20	67.49
Plant spread N-S (cm)	61.78-147	86.26	33.04	36.54	81.80	53.09	61.54
Total chlorophyll content of leaves (mg/g)	1.94-3.36	2.55	18.61	20.87	79.60	0.87	34.22
No of nodes per plant	172-403.67	237.53	31.83	36.31	76.90	136.55	57.49
No of branches per plant	32.67-55	42.00	18.85	23.39	64.94	13.14	31.29
Leaf length (cm)	7.05-13.51	11.31	19.82	20.85	90.40	4.39	38.82
Leaf breadth(cm)	4.37-11.45	8.80	30.28	31.16	94.40	5.34	60.61
Root and Shoot ratio	0.14-0.23	0.17	0	25.85	0	0	0
Leaf perimeter (cm)	15.11-39.93	32.59	26.76	27.59	94.09	17.43	53.47
Days taken to first flower initiation	30.11-60.55	49.63	26.06	26.23	98.72	26.47	53.34
Days taken to fruit set	37.77-70.59	58.27	22.80	22.89	99.24	27.27	46.80
Fruit set (per cent)	68.84-93.1	84.12	11.71	11.78	98.90	20.18	23.99
Days taken to first harvesting	93.77-134.29	118.24	12.44	12.48	99.38	30.21	25.55
Duration of harvesting	24.66-40.64	32.75	16.97	17.18	97.50	11.30	34.51
Number of pickings	3.33-7.45	5.61	24.411	25.977	88.30	2.649	47.26
Fruit diameter vertical (mm)	15.62-34.30	21.95	26.58	30.49	76.03	10.48	47.75
Fruit diameter horizontal (mm)	14.78-36.80	21.57	36.90	37.83	95.14	15.99	74.15
Fruit weight (g)	5.63-21.75	9.71	56.34	59.068	90.96	10.75	110.68
Number of fruits per plant	40.11-122.33	71.71	41.69	48.044	75.31	53.45	74.53
Fruit yield per plant (g)	270.70-2386.16	828.57	96.073	102.19	88.50	1542.63	186.18
Estimated yield (q/ha)	13.53-119.31	41.43	96.085	102.14	88.50	77.134	186.20
TSS (⁰ Brix)	5.06-15.73	11.92	37.40	38.36	95.06	8.95	75.11
Titrateable acidity (per cent)	0.24-0.36	0.29	10.94	18.95	33.33	0.038	13.15
TSS/acid ratio	15.06-57.86	43.72	42.40	45.40	87.18	35.65	81.55
Total sugar (per cent)	3-5.1	3.99	16.05	17.31	85.95	1.22	30.65
Juice (per cent)	51.25-66.66	59.43	8.43	9.21	83.88	9.46	15.91
Vitamin C (mg/100g)	22.69-32.24	27.89	10.83	13.97	60.10	4.82	17.30
Sensory score	4.75-8.25	6.79	14.72	18.90	60.62	1.60	23.60
Carotene (mg/100g)	1.43-1.73	1.61	6.20	6.20	100	0.21	12.78

Table 4.5.1 Genotypic and Phenotypic correlation coefficient between fruit yield and other characters in capegooseberry

S. No.	Characters	Genotypic correlation coefficient	Phenotypic correlation coefficient
1	Plant height (cm)	1	1
2	Plant spread E-W (cm)	-0.434	-0.347
3	Plant spread N-S (cm)	1.035	-0.324
4	Total chlorophyll content of leaves (mg/g)	0.812	-0.637*
5	No of nodes per plant	0.704	-0.392*
6	No of branches per plant	1.127	-0.571*
7	Leaf length (cm)	-0.874	0.312
8	Leaf breadth(cm)	0.990	0.302
9	Root and Shoot ratio	-0.430	-0.175
10	Leaf perimeter (cm)	-0.497	0.367
11	Days taken to first flower initiation	0.956	0.393
12	Days taken to fruit set	1.001	0.349
13	Fruit set (per cent)	0.936	0.401
14	Days taken to first harvesting	0.893	0.242
15	Duration of harvesting	0.429	0.747*
16	Number of pickings	0.731	0.393*
17	Fruit diameter vertical (mm)	-0.734	-0.230
18	Fruit diameter horizontal (mm)	0.938	-0.344
19	Fruit weight (g)	0.980	-0.354
20	Number of fruits per plant	0.961	-0.436*
22	Estimated yield (q/ha)	0.958	-0.364*
23	TSS (⁰ Brix)	-0.946	0.437*
24	Titrateable acidity (per cent)	-0.861	-0.333
25	TSS/acid ratio	-0.862	0.447*
26	Total sugar (per cent)	0.865	0.315
27	Juice (per cent)	0.706	0.290
28	Vitamin C (mg/100g)	0.937	0.453*
29	Sensory score	1.026	0.236
30	Carotene (mg/100g)	1.070	0.276

The experiment entitled **“Evaluation of Capegooseberry (*Physalis peruviana* L.) Under Humid Agro-climatic condition of Jhalawar”** was conducted during 2015-16 at the Protected Cultivation Unit, College of Horticulture and Forestry, Jhalawar.

As per objective of the experiment, attempt was made to evaluate Amb. Sel.-1, Amb. Sel.-2, Amb. Sel.-3, Amb. Sel.-4, Amb. Sel.-5, Amb. Sel.-6, Amb. Sel.-7, Selection-7, Selection-9, Selection-21 genotypes of capegooseberry. Growth, Production and Quality attributes of all genotypes were studied. Under these parameters, characters considered in the study were plant height (cm), plant spread (cm) (E-W and N-S), total chlorophyll content of leaves (mg/g), number of nodes per plant, number of branches per plant, leaf length (cm), leaf breadth (cm), root : shoot ratio (after final harvesting), leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set (per cent), days taken to first harvest, duration of harvesting, number of pickings, fruit diameter (mm), fruit weight (g), number of fruits per plant, fruit yield per plant, estimated yield (q/ha), TSS (°Brix), titratable acidity (per cent), TSS/acid ratio, total sugar (per cent), juice (per cent), Vitamin-C (mg/100g), carotene (mg/100g) and Sensory score. The variability were also studied. Based on all these studied characters, association analysis and path coefficient analysis was done. All these parameters are discussed here in various heads:

5.1 Growth attributes

5.2 Production attributes

5.3 Quality attributes

5.4 Variability attributes

5.5 Association analysis, and

5.6 Path coefficient analysis

5.1 Growth attributes

Data presented in Tables 4.1.1 to 4.1.2 and depicted in Figures 4.1.1 to 4.1.4 revealed that the plant growth attributes like plant height (cm), plant E-W spread and N-S spread (cm), total chlorophyll content of leaves (cm), number of nodes per plant, number of branches per plant, leaf length (cm), leaf breadth (cm), root : shoot ratio and leaf perimeter (cm) varied significantly, suggesting the presence of significant variation among the genotypes for these traits.

Maximum plant height (127.89cm) was found in Amb. Sel-4 followed by Amb. Sel-7 (118.77cm), Amb. Sel-5 (118.55cm), and Amb. Sel-2 (109.0cm). Maximum plant spread in

E-W (146.67cm) as well as N-S (147.0cm) was observed in Selection-9 followed by Selection-7. The maximum total chlorophyll content of leaves was recorded in genotype Selection-7 (3.36mg/g) followed by Selection-9 (3.11mg/g), Selection-21 (2.97mg/g) and Amb. Sel.-3 (2.86mg/g). The genotypes Selection-21 had the highest number of nodes per plant (403.67) followed by Selection-7 (318.33), Selection-9 (313.33) and Amb. Sel.-2 (223.67) (Table 4.1.1).

The highest number of branches per plant were recorded in genotypes Selection-21 (55.0) followed by Selection-7 (50.67), Selection-9 (50.33) and Amb. Sel.-1(47.0). Maximum leaf length (13.51cm) was recorded in the Amb. Sel.-3 followed by Amb. Sel.-1 (13.42cm), Amb. Sel.-6 (13.12cm) and Amb. Sel.-2 (12.22cm). The higher leaf breadth was noted in the Amb. Sel.-3 (11.45cm) followed by Amb. Sel.-6 (11.13cm), Amb. Sel.-1 (10.75cm) and Amb. Sel.-2 (10.70cm). The maximum root : shoot ratio were recorded in Selection-9 (0.23) followed by Selection-21 (0.20) and Selection-7 (0.19) and Amb. Sel.-6 (39.93cm) presented maximum leaf perimeter followed by Amb. Sel.-3 (39.47), Amb. Sel.-1 (38.70cm) and Amb. Sel.-5 (38.54) (Table 4.1.2).

The variation among genotypes with respect to the vegetative characters could be designated to the genetic attributes of respective genotypes. Such types of reason has also been assigned by Singh *et al.* (2011a) and Tulukcu, E. (2012) in capegooseberry, Mahour *et al.* (2012) in guava, Kumar *et al.* (2014) in aonla. Temperature has a significant influence on many aspect of growth attributes has been reported by Seyie *et al.* (2015) in tomato.

5.2 Production attributes

Table 4.2.1 to 4.2.3 and Figure 4.2.1 to 4.2.5 represent the days taken to first flower initiation, days taken to fruit set, fruit set (per cent), days taken to first harvest, duration of harvesting, number of pickings, fruit diameter (mm), fruit weight (g), number of fruits per plant, fruit yield per plant, estimated yield (q/ha), All these parameters were significantly different from each other.

The minimum number of days taken to first flower initiation (30.11 days) was taken by Selection-9 followed by Selection-7 (31.28 days), Selection-21 (31.66 days) and Amb. Sel.-4 (55.11 days). The minimum days taken to fruit set was noted in Selection-9 (37.77 days) followed by Selection-7 (39.61 days), Selection-21 (40.66 days) and Amb. Sel.-4 (62.49 days). The highest fruit set was recorded in Amb. Sel.-6 (93.10 per cent) followed by Amb. Sel.-3 (93.13 per cent), Amb. Sel.-5 (91.10 per cent) and Amb. Sel.-7 (91.02 per cent). The minimum days taken to first harvest was noticed in Selection-9 (93.77 days) followed by Selection-7 (98.61 days), Selection-21 (101.66 days) and Amb. Sel.-4 (119.49 days). The

minimum duration of harvesting was recorded in Selection-21 (24.66 days) followed by Selection-7 (26.66 days), Selection-9 (29.66 days) and Amb. Sel.-2 (28.37 days). The maximum number of pickings per plant were recorded in genotype Amb. Sel.-5 (7.45) followed by Amb. Sel.-6 (7.10), Amb. Sel.-3 (6.55) and Amb. Sel.-1 (6.22). The maximum vertical diameter of fruit was recorded in Selection-7 (34.30mm) followed by Selection-9 (30.78mm), Selection-21 (23.74mm) and Amb. Sel.-1 (21.39mm). The maximum horizontal diameter of fruit was recorded in Selection-7(36.81mm) followed by Selection-9 (33.12mm), Selection-21 (26.04mm) and Amb. Sel.-2 (22.75mm).

The most important traits, fruit weight was high in Selection-7 (21.75g) followed by Selection-9 (17.35g), Selection-21 (11.88g) and Amb. Sel.-3 (7.40g). Number of fruits per plant was maximum in Selection-9 (122.33) followed by Selection-21 (116.67), Selection-7 (110) and Amb. Sel.-6 (63.89). The maximum fruit yield per plant was recorded in genotype Selection-7 (2386.16g) followed by Selection-9 (2074.32g), Selection-21 (1399.46g) and Amb. Sel.-6 (415.34g). The maximum estimated yield per plant was noticed in Selection-7 (119.31q/ha) followed by Selection-9 (103.71q/ha), Selection-21 (69.97q/ha) and Amb. Sel.-6 (20.76q/ha). Pal, B. (1991), Chandi, A. S. (2000) and Singh *et al.* (2011a) also confirmed variability of different genotypes of capegooseberry in terms of number of fruits per plant, fruit diameter and individual fruit weight and fruit yield per plant. Kumar *et al.* (2011a) reported little influence of environment traits was there on some of the traits like number of fruit set per shoot, number of fruit per tree, fruit weight, fruit diameter and yield per tree. The variation among the genotypes as regard to number of fruits per plant, fruit weight and yield per plant might be due to genetic variability, inherent character and climatic adaptability in a particular region, which might prove an important diagnostic character for selection of genotypes for local condition (Mahour *et al.* 2012), (Meena *et al.* 2012) and (Kumar *et al.* 2014).

5.3 Quality attributes

Data pertaining to various quality parameters viz. TSS (°Brix), titratable acidity (per cent), TSS/Acid ratio, total sugars (per cent), juice content (per cent), vitamin C (mg100g⁻¹), carotene content (mg100g⁻¹) and sensory score are presented in Tables 4.3.1 to 4.3.2 and depicted in the Figures 4.3.1 to 4.3.4.

The highest TSS was found in Amb. Sel.-3 (15.73 per cent) followed by Amb. Sel.-4 (15.60 per cent), Amb. Sel.-5 (15.36 per cent) and Amb. Sel.-1 (14.02 per cent). Amb. Sel.-7 had the lowest titratable acidity (0.24 per cent) followed by Amb. Sel.-1(0.25 per cent), Amb. Sel.-2 (0.26 per cent) and Amb. Sel.-6 (0.26 per cent). The maximum TSS: Acid ratio was

recorded in Amb. Sel.-6 (57.86) followed by Amb. Sel.-1 (57.78), Amb. Sel.-3 (57.58) and Amb. Sel.-5 (55.50).

The total sugar content was maximum (5.10 per cent) in Amb. Sel.-3 followed by Amb. Sel.-4 (4.80 per cent), Amb. Sel.-5 (4.40 per cent) and Amb. Sel.-6 (4.20 per cent). A higher sugar level of a fruit also serves as an index of maturity. The highest juice per cent was noticed in Amb. Sel.-3 (66.66 per cent) followed by Amb. Sel.-4 (64.70 per cent), Amb. Sel.-7 (63.64 per cent) and Amb. Sel.-6 (62.90 per cent). The genotype Amb. Sel.-3 (32.24mg/100g) showed the highest Vitamin-C followed by Amb. Sel.-1 (31.12mg/100g), Amb. Sel.-2 (30.58mg/100g) and Amb. Sel.-7 (29.78mg/100g). The genotype Amb. Sel.-3 (8.25) showed the highest Sensory score value followed by Amb. Sel.-1 (8.00), Amb. Sel.-7 (7.75) and Amb. Sel.-2 (7.33). Carotene was maximum in Amb. Sel.-3 (1.73mg/100g) followed by Amb. Sel.-1 (1.71mg/100g), Amb. Sel.-2 (1.69mg/100g) and Amb. Sel.-6 (1.66mg/100g).

Such variation may be due to environmental condition particularly during the peak growth and development of fruits or due to varietal differences as reported by Karer and Kahlon (2005), Gutierrez *et al.* (2007) and Singh *et al.*, (2011a).

According to Wolff (1991) such variation may be due to environment particularly during the peak growth and development of fruit or due to varietal differences in different genotypes of capegooseberry. This attributes has also been confirmed by Meena *et al.* (2012), Pandey *et al.* (2013) and Sahu, S (2013).

5.4 Variability attributes

The range in mean values, an indicator of variability revealed wider variation for plant height from 64.80cm (Selection-7) to 127.89cm (Amb. Sel.-4), plant spread E-W from 60.77cm (Amb. Sel.-4) to 146.67cm (Selection-9), plant spread N-S from 61.78cm (Amb. Sel.-6) to 147cm (Selection-9), number of nodes per plant from 172 (Amb. Sel.-6) to 403.67 (Selection-21), number of branches per plant from 32.67 (Amb. Sel.-4 and Amb. Sel.-5) to 55 (Selection-21), leaf perimeter 15.11cm (Selection-21) to 39.93cm (Amb. Sel.-6), days taken to first flower initiation from 30.11 (Selection-9) to 60.55 (Amb. Sel.-2), days taken to fruit set from 37.77 (Selection-9) to 70.59 (Amb. Sel.-2), fruit set from 68.84 per cent (Selection-7) to 93.10 per cent (Amb. Sel.-6), days taken to first harvesting from 93.77 days (Selection-9) to 134.29 days (Amb. Sel.-2), duration of harvesting from 24.66 (Selection-21) to 40.64 (Amb. Sel.-5), fruit diameter vertical from 15.62cm (Amb. Sel.-6) to 34.30cm (Selection-7), fruit diameter horizontal from 14.78cm (Amb. Sel.-5) to 36.80cm (Selection-7), number of fruits per plant from 40.11 (Amb. Sel.-2) to 122.33 (Selection-9), fruit yield per plant from 270.70g (Amb. Sel.-4) to 2386.16g (Selection-7), estimated yield from 13.53 q/ha. (Amb. Sel.-4) to 119.31 q/ha

(Selection-7), TSS/Acid ratio from 15.06 (Selection-21) to 57.86 (Amb. Sel.-6), whereas, it was quite low for other characters viz., total chlorophyll content of leaves from 1.94mg/g (Amb. Sel.-2) to 3.36mg/g (Selection-7), leaf length from 7.05cm (Selection-21) to 13.51cm (Amb. Sel.-3), leaf breadth from 4.37cm (Selection-21) to 11.45cm (Amb. Sel.-3), root : shoot ratio from 0.14 (Amb. Sel.-4) to 0.23 (Selection-9), number of pickings from 3.33 (Selection-21) to 7.45 (Amb. Sel.-5), fruit weight from 5.63g (Amb. Sel.-4) to 21.75g (Selection-7), TSS from 5.06 °Brix (Selection-21) to 15.73 °Brix (Amb. Sel.-3), titratable acidity from 0.24 per cent (Amb. Sel.-7) to 0.36 per cent (Selection-7), total sugars from 3 per cent (Selection-21) to 5.10 per cent (Amb. Sel.-3), juice from 51.25 per cent (Selection-7) to 66.66 per cent (Amb. Sel.-3), Vitamin-C from 22.69mg/100g (Selection-21) to 32.24mg/100g (Amb. Sel.-3), sensory score from 4.75 (Selection-21) to 8.25 (Amb. Sel.-3) and carotene from 1.43mg/100g (Selection-21) to 1.73mg/100g (Amb. Sel.-3) in (Table 4.4.1)

Comparison of coefficient of variations indicated that the phenotypic coefficient of variation was higher than the genotypic coefficient of variations for all the characters which indicated effect of environment on the character expression. Among all the characters high GCV and PCV were observed for plant spread E-W (36.90 and 41.57 per cent) followed by plant spread N-S (33.04 and 36.54 per cent), number of nodes per plant (31.83 and 36.31 per cent), leaf breadth (30.28 and 31.16 per cent), fruit diameter vertical (26.58 and 30.49 per cent), fruit diameter horizontal (36.90 and 37.83 per cent), fruit weight (56.34 and 59.07 per cent), number of fruits per plant (41.69 and 48.04 per cent), fruit yield per plant (96.07 and 102.19 per cent), estimated yield (96.08 and 102.14 per cent), TSS (37.40 and 38.36 per cent) and TSS/Acid ratio (42.40 and 45.40 per cent) as depicted in Table 4.4.1, in comparison to other characters, indicating the presence of high amount of genetic variability for these traits and selection for these characters would be effective because of the response to selection is directly proportional to the variability present in the experimental material. These results are in broad conformity to earlier researchers Jana *et al.* (2006) and Karunakaran *et al.* (2010) in papaya; Singh and Misra (2010) in bael; Singh *et al.* (2014) in Capegooseberry; Bhat and Dhillon (2015) in pear and Phom *et al.* (2015) observed high GCV and PCV values for most of the traits in tomato.

Moderate estimates of GCV and PCV were observed for leaf perimeter (26.76 and 27.59 per cent), days taken to first flower initiation (26.06 and 26.23 per cent) followed by number of picking (24.41 and 25.97 per cent), root : shoot ratio (0.0 and 25.85 per cent), plant height (22.96 and 23.97 per cent), number of branches per plant (18.85 and 23.39 per cent), days taken to fruit set (22.80 and 22.89 per cent), total chlorophyll content of leaves

(18.61 and 20.87 per cent), leaf length (19.82 and 20.85 per cent), titratable acidity (10.94 and 18.95 per cent), sensory score (14.72 and 18.90 per cent), total sugar (16.05 and 17.31 per cent) and duration of harvesting (16.97 and 17.18 per cent). However, the low estimates of GCV and PCV were observed for vitamin-C (10.83 and 13.97 per cent) followed by days taken to first harvesting (12.44 and 12.48 per cent), fruit set (11.71 and 11.78 per cent), juice (8.43 and 9.12 per cent) and carotene (6.20 and 6.20 per cent), indicated that the genotypes used had less genetic variability for these characters (Table 4.4.1). The heritability estimate of a quantitative character is very important as phenotypic expression of a genotype may be altered by environment at various stages of its development. Heritability indicates the effectiveness with which selection for genotypes can be done on the basis of its phenotypic variation. It expresses the extent to which individual phenotypes are determined by their genotypes. The heritability estimates serve as a useful guide to the breeder because selection would be fairly easy for the characters with high heritability. Thus, there would be a close correspondence between the genotypes and phenotypes which will be attributed to a relatively smaller contribution of the environment to the phenotype. But for a character with low heritability, selection may not be effective due to the masking effect of the environment on genotypic effect. The response to selection depends upon the relative magnitude of heritable variation present in relation to the phenotypic variation. Therefore, it is desirable to partition observed variability into its heritable and non heritable components. Burton (1952) suggested that genotypic coefficient of variation along with heritability would give a better idea about the efficiency of selection. Thus, a character with high genotypic coefficient of variation and high heritability will be more valuable in selection programme. In present investigation, high heritability was observed for carotene content in fruit (100 per cent) with high heritability of days taken to first harvesting (99.38 per cent), days taken to fruit set (99.24 per cent), fruit set (98.90 per cent), days taken to first flower initiation (98.72 per cent), duration of harvesting (97.50 per cent), fruit diameter horizontal (95.14 per cent), TSS (95.06 per cent), leaf breadth (94.40 per cent), leaf perimeter (94.09 per cent), plant height (91.77 per cent), fruit weight (90.96 per cent), leaf length (90.40 per cent), fruit yield per plant (88.50 per cent), estimated yield (88.50 per cent), number of picking (88.30 per cent), TSS/Acid ratio (87.18 per cent), total sugar (85.95 per cent), juice (83.88 per cent) and plant spread N-S (81.80 per cent). All the traits exhibited more than 80 per cent heritability (Table 4.4.1). The moderate heritability was noticed for total chlorophyll content of leaves (79.60 per cent), plant spread E-W (78.80 per cent), number of nodes per plant (76.90 per cent), fruit diameter vertical (76.03 per cent), number of fruits per plant (75.31 per cent), number of

branches per plant (64.94 per cent), sensory score (60.62 per cent) and vitamin-C (60.10 per cent). High heritability in broad sense indicated that large proportion of phenotypic variance was attributable to the genotypic variance and that differences among the genotypic were hereditary and showed that the above mentioned traits were less influenced by the environment.

Similarly, heritability for different traits has also been reported. High heritability has been reported by Dash *et al.* (1998) in papaya, Verma *et al.* (2002) in strawberry, Raghava and Tiwari (2008) in guava, Rajan *et al.* (2009) in mango, Singh and Misra (2010) in bael, Kumar *et al.* (2012) in snapdragon, Singh *et al.* (2014) in Capegooseberry and Bhat and Dhillon (2015) in pear have also been reported in literature.

Heritability estimate alone do not provide reliable information about the gene action governing the expression of a particular character and also this does not provide the information of the amount of genetic progress that would result from the selection of best individuals. Johnson *et al.* (1955) had pointed out that the heritability estimates along with genetic advance were more useful than heritability estimates alone in predicting the response to selection. High genetic advance was observed for fruit yield per plant (1542.63) followed by number of nodes per plant (136.55), estimated yield (77.18), plant spread E-W (55.20), number of fruits per plant (53.65) and plant spread N-S (53.09). Moderate genetic advance was observed for plant height (43.94), TSS/Acid ratio (35.65), days taken to harvesting (30.21), days taken to fruit set (27.27), days taken to first flower initiation (26.47), whereas, it was low for fruit set (20.18), leaf perimeter (17.43), fruit diameter horizontal (15.99), number of branches per plant (13.14), duration of harvesting (11.30), fruit weight (10.75), fruit diameter vertical (10.48), juice (9.46), TSS (8.95), leaf breadth (5.34), vitamin-C (4.82), leaf length (4.39), number of pickings (2.64), sensory score (1.60), total sugar (1.22), total chlorophyll content in leaves (0.87), carotene (0.21), titratable acidity (0.038) and root : shoot ratio (0.00) in (Table 4.4.1). High genetic advance have been reported by earlier researchers Ara *et al.* (2009) in strawberry, Nwosu *et al.* (2014) and Saleem *et al.* (2013) in tomato, Kuamr *et al.* (2015) in papaya and Mishra *et al.* (2015) in strawberry. Low genetic advance have also been reported by Basavaraj *et al.* (2015) and Kathayat *et al.* (2015) in tomato.

In the present investigation, genetic advance as per cent of mean was also estimated in order to determine the relative merits of different characters that can be further utilized in the selection programme. Relative comparison of heritability along with genetic advance as per cent of mean over the characters indicated that characters *viz.*, plant spread (N-S), leaf breadth, leaf perimeter, days taken to first flower initiation, fruit diameter horizontal (cm),

fruit weight, fruit yield per plant, estimated yield, total soluble solids, TSS/acid ratio, had high heritability estimates along with high genetic advance as per cent of mean. Almost similar findings were reported earlier by Raghava and Tiwari (2008) in guava, Ara *et al.* (2009) in strawberry, Singh and Misra (2010) in bael, Bihari and Suryanarayan *et al.* (2011) in guava, Nwosu *et al.* (2014) in tomato etc. High heritability coupled with high genetic advance recorded for various traits in the present study indicates the presence of additive gene action and these traits are likely to respond better to selection. Panse and Sukhatme (1967) suggested that the genotypic variations for such characters is probably due to high additive gene effects and are least influenced by the environment. The phenotypic selection based on such a character is likely to be more effective for improvement and hence, these characters provide good opportunity for further breeding programme using simple breeding methods.

Traits such as plant height, days taken to first flower initiation, days taken to fruit set, days taken to first harvesting and TSS/Acid ratio had high heritability and associated with moderate genetic advance (Table 4.4.1). Kumar *et al.* (2002) in grape, Rajan *et al.* (2005) in guava, Doss *et al.* (2006) in mulberry, reported high heritability along with moderate genetic advance, which is in an agreement with present findings.

High heritability along with lower genetic advance for the traits like leaf length, leaf breadth, leaf perimeter, fruit set, duration of harvesting, number of pickings, fruit diameter (horizontal), fruit weight, TSS, total sugar, juice and carotene may be attributed to the non-additive gene effects and this may be improved through hybridization. Moderate heritability in combination with high genetic advance was observed for plant spread (E-W), number of nodes per plant and number of fruits per plant (Table-4.4.1).

Thus, high heritability along with high genetic advance as per cent of mean was observed for plant spread (N-S), leaf breadth, leaf perimeter, days taken to first flower initiation, fruit diameter horizontal (cm), fruit weight, fruit yield per plant, estimated yield, total soluble solids, TSS/acid ratio (Table 4.4.1). In this condition selection will be more effective for these characters. However, low heritability and low genetic gain was reported for root : shoot ratio and titratable acidity therefore, selection in this character would not be much effective.

5.5 Association analysis

The potential productivity of any crop is basically valued in terms of fruit yield per plant. Its improvement by direct selection is generally difficult because yield is a complex polygenic character largely influenced by its various component characters as well as by the

environment. Hence, it becomes essential to estimate association of yield with component characters and among themselves. The efficiency of selection thus, can be increased if it is simultaneously practiced for characters which are correlated with yield. In the quantitative traits the genotype is influenced by the environment thereby, affecting the phenotypic expression as well as association and consequently direction of association between the characters.

The knowledge of magnitude and direction of correlation is used for judging how improvement in one character will cause simultaneous change in the other characters. High magnitude of positive correlation coefficient at genotypic level between component characters and yield is important for indirect selection. Since, suitable test for significance of genotypic correlation is not available therefore, major emphasis has been put on phenotypic correlation coefficients, which are tested by 't-test'.

In general, the genotypic correlation coefficients were higher than the respective phenotypic correlations which might be from modifying effect of environment on the association of characters at genotypic level. Selection of yield as such may not be effective since there may be number of genes for fruit yield per plant and fruit yield per plant may be resultant of interaction among its various components. Therefore, for a rational approach to improve fruit yield per plant, it may be useful to collect information on character association.

All possible phenotypic and genotypic correlation coefficients between fruit yield/plant and its components during 2015-16 are given in (Table 4.5.1 and 4.5.2) are discussed as under:

The correlation of fruit yield per plant was positive and significant at phenotypic level with plant spread E-W (0.838), plant spread N-S (0.822), total chlorophyll content of leaves (0.773), number of nodes per plant (0.666), number of branches per plant (0.4 62), fruit diameter vertical (0.749), fruit diameter horizontal (0.885), fruit weight (0.945), number of fruits per plant (0.904), estimated yield (1.0) and titratable acidity (0.491). Although it showed negative and significant correlation at phenotypic level with leaf length (-0.764), leaf breadth (-0.814), leaf perimeter (-0.768), days taken to first flower initiation (-0.886), days taken to fruit set (-0.878), fruit set (-0.833), days taken to first harvest (-0.866), duration of harvesting (-0.594), number of pickings (-0.769), TSS (-0.857), TSS/Acid ratio (-0.803), total sugar (-0.598), juice (-0.645), vitamin-C (-0.635), sensory score (-0.603) and carotene (-0.741). Similarly, positive association of fruit yield has been earlier reported with fruit weight, fruit diameter vertical as well as horizontal. Significant positive association of fruit length, fruit girth and fruit weight of litchi (Rai *et al.*, 2001); plant spread, fruit weight and

number of fruits per plant in pomegranate (Mir *et al.*, 2009); fruit weight and fruit diameter vertical as well as horizontal in bael (Singh and Misra, 2010); fruit width, fruit weight and fruit volume in ber (Shukla *et al.* 2012); nut weight, kernel weight, nut length and kernel length in pecan (Kumar *et al.*, 2013); plant height, number of fruits per plant and fruit weight in tomato (Saleem *et al.* 2013); fruit weight, fruit length and fruit diameter in capegooseberry (Singh *et al.*, 2014); berry size and berry weight in Strawberry (Ghoochani *et al.* 2015); fruit weight, fruit diameter and fruit volume in strawberry (Mishra *et al.*, 2015) with fruit yield has also been reported by earlier researchers and these results are in close conformity with the present study.

Among other attributes, the plant height showed positive and significant correlation at phenotypic level with duration of harvesting, number of pickings, TSS, TSS/Acid ratio and vitamin-C; plant spread (E-W) with plant spread (N-S), total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, root : shoot ratio, fruit diameter-vertical as well as horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity; plant spread (N-S) with total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, leaf length, leaf breadth, root : shoot ratio, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, number of pickings, fruit diameter vertical, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield, TSS, titratable acidity, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene; total chlorophyll content of leaves with plant spread (E-W), plant spread (N-S), number of nodes per plant, number of branches per plant, leaf perimeter, fruit diameter vertical, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity; number of nodes per plant with plant spread (E-W), plant spread (N-S), total chlorophyll content of leaves, number of branches per plant, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity; number of branches per plant with plant spread (E-W), plant spread (N-S), total chlorophyll content of leaves, number of nodes per plant, fruit diameter vertical, fruit diameter horizontal, number of fruits per plant, estimated yield and titratable acidity; leaf length with plant spread (N-S), leaf breadth, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, number of pickings, fruit weight, number of fruits per plant, TSS, titratable acidity, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene; leaf breadth with plant spread (N-S), leaf length, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, number of

pickings, fruit diameter horizontal, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene; leaf perimeter with plant spread (N-S), total chlorophyll content of leaves, leaf length, leaf breadth, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, total sugar, juice, vitamin-C, sensory score and carotene.

Days taken to first flower initiation showed positive correlation with plant spread (N-S), leaf length, leaf breadth, leaf perimeter, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, number of pickings, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene; days taken to fruit set with plant spread (N-S), leaf length, leaf breadth, leaf perimeter, days taken to first flower initiation, fruit set, days taken to first harvest, duration of harvesting, number of pickings, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene; fruit set with plant spread (N-S), leaf length, leaf breadth, leaf perimeter, days taken to first flower initiation, days taken to fruit set, days taken to first harvest, duration of harvesting, number of pickings, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene; days taken to first harvest with plant spread (N-S), leaf length, leaf breadth, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, duration of harvesting, number of pickings, fruit weight, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene; duration of harvesting with plant spread (N-S), leaf length, leaf breadth, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, number of pickings, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C and carotene; number of pickings with plant spread (N-S), leaf length, leaf breadth, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene; fruit diameter vertical with plant spread (E-W), plant spread (N-S), total chlorophyll content of leaves, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield; fruit diameter horizontal with plant spread (E-W), plant spread (N-S), total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, leaf breadth, fruit diameter vertical, fruit weight, number of fruits per plant, estimated yield; fruit weight with plant spread (E-W), plant spread (N-S), total chlorophyll content of leaves, number of nodes per plant, leaf length, days taken to first harvest, fruit diameter vertical, fruit diameter horizontal, number of fruits per plant, estimated yield and titratable acidity; number of fruits per plant with plant spread (E-W), plant spread (N-S), total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, leaf length, fruit diameter vertical, fruit diameter horizontal,

fruit weight, estimated yield and titratable acidity; estimated yield with plant spread (E-W), plant spread (N-S), total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter vertical, fruit diameter horizontal, fruit weight, number of fruits per plant and titratable acidity.

TSS showed significantly positive correlation with plant height, plant spread (N-S), leaf length, leaf breadth, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, no of picking, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene; titratable acidity with plant spread (E-W), plant spread (N-S), total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, leaf length, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield; TSS/Acid ratio with plant height, plant spread (N-S), leaf length, leaf breadth, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, no of picking, TSS, total sugar, juice, vitamin-C, sensory score and carotene; total sugar with plant spread (N-S), leaf length, leaf breadth, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, no of picking, TSS, TSS/Acid ratio, juice, vitamin-C, sensory score and carotene; juice with plant spread (N-S), leaf length, leaf breadth, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, no of picking, TSS, total sugar, vitamin-C and carotene; vitamin-C with plant height, plant spread (N-S), leaf length, leaf breadth, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, no of picking, TSS, TSS/Acid ratio, total sugar, juice per cent, sensory score and carotene; sensory score with plant spread (N-S), leaf length, leaf breadth, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, no of picking, TSS, TSS/Acid ratio, total sugar and vitamin-C, carotene and carotene had significant and positive correlation with plant spread (N-S), leaf length, leaf breadth, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, no of picking, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score. It confirms the findings of Biswas *et al.* (2007) in strawberry; Rathor *et al.* (2009) in mango; Karunakaran *et al.* (2010) in papaya; Khandavi *et al.* (2012) in Kagzi lime; Singh *et al.* (2014) in capegooseberry; Srivastava *et al.* (2014) in sweet cherry; Nwosu *et al.* (2014) and Phom *et al.* (2015) in tomato.

Plant height exhibited significant negative correlation at phenotypic level with total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, number of fruits per plant and estimated yield; plant spread (E-W) with leaf length, leaf breadth, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, number of pickings, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene; total chlorophyll content of leaves with plant height, leaf length, leaf breadth, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, number of pickings, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene; number of nodes per plant with plant height, leaf length, leaf breadth, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, number of pickings, fruit diameter vertical, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene; number of branches per plant with plant height, leaf length, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, number of pickings, TSS, TSS/Acid ratio, total sugar, sensory score and carotene; leaf length with plant spread (E-W), total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter vertical, fruit diameter horizontal and estimated yield; leaf breadth with plant spread (E-W), total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter vertical, fruit weight, estimated yield and titratable acidity; leaf perimeter with plant spread (E-W), number of nodes per plant, number of branches per plant, fruit diameter vertical, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield, titratable acidity; days taken to first flower initiation with plant spread (E-W), total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter vertical, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity; days taken to fruit set with plant spread (E-W), total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter vertical, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity; fruit set with plant spread (E-W), total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter vertical, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity; days taken to first harvest with plant spread (E-W), total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter vertical, fruit diameter horizontal, number of fruits per plant, estimated yield and titratable acidity; duration

of harvesting with plant spread (E-W), total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter vertical, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity; number of pickings with plant spread (E-W), total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter vertical, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity; fruit diameter vertical with number of nodes per plant, leaf length, leaf breadth, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, no of picking, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C and carotene; fruit diameter horizontal with leaf length, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, no of picking, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene; fruit weight with leaf breadth, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, duration of harvesting, no of picking, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene; number of fruits per plant with plant height, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, no of picking, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene; estimated yield with plant height, leaf length, leaf breadth, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, duration of harvesting, no of picking, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene.

TSS had significantly negative correlation with plant spread (E-W), total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter vertical, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield, titratable acidity; titratable acidity with leaf breadth, leaf perimeter, days taken to first flower initiation, days taken to fruit set, fruit set, days taken to first harvest, number of pickings, TSS, TSS/Acid ratio, total sugar, juice, vitamin-C, sensory score and carotene; TSS/Acid ratio with plant spread (N-S) total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter vertical, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity; total sugar with plant spread (N-S) total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter vertical, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity; juice with plant spread (N-S) total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter

vertical, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity; vitamin-C with plant spread (N-S) total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter vertical, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity; sensory score with plant spread (N-S), total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter vertical, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity and carotene had significant and negative correlation with plant spread (N-S), total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter vertical, fruit diameter horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity. These findings are in agreement with the findings of Cynthia *et al.* (2000) in papaya; Shukla *et al.* (2012) in ber and Saleem *et al.* (2013) in tomato.

5.6 Path coefficient analysis

The correlation analysis provide an information which is incomplete in the sense that it does not throw light on the underlying causes that are operative for the various interrelationship. The expression of a complex character such as fruit yield/plant depends upon the interplay of a number of component attributes. A better picture of the contribution of each component building up the total genetic architecture of a complex character may be obtained through the analysis of causal schemes. Hence, in such a situation Wright (1921) had been useful in partitioning direct and indirect causes of association which allow a detailed examination of specific forces acting to produce a given correlation and measures the relative importance of each causal character. Such a study provides a realistic basis for allocation of weightage to each attribute in deciding suitable criteria for genetic improvement. The aim of this analysis in the present investigation was to compare the results obtained from simple correlation analysis and to demonstrate the significance of path coefficient analysis in determining the true nature of character association.

In the present study path coefficient analysis was computed both at genotypic and phenotypic levels for all characters. Path coefficient analysis was carried out by taking fruit yield/plant as dependent variable to partition the correlation coefficients into direct and indirect effects in order to determine the contribution of different characters towards the fruit yield/plant. Direct and indirect effects of various characters on fruit yield/plant indicated that there is agreement between direction and magnitude of direct effect of various characters and correlation with fruit yield/plant. Thus, a significant improvement in fruit yield per plant can

be expected through selection in the component traits with high positive direct effects (Table 4.6.1- 4.6.2).

It is revealed from the table that high order positive direct effect at phenotypic level towards fruit yield/plant was exerted by days taken to first flower initiation (1.9139), plant spread E-W (1.1799), leaf perimeter (1.55), estimated yield (1.1388), number of nodes per plant (0.6251), leaf breadth (0.6001), number of fruits per plant (0.5839), fruit diameter vertical (0.5325), plant height (0.3473), TSS/Acid ratio (0.3439), carotene (0.3312), total chlorophyll content of leaves (0.2522), sensory score (0.2199), juice (0.2017), root : shoot ratio (0.1352), fruit weight (0.1443), vitamin-C (0.0257), whereas, the negative direct effect at phenotypic level towards fruit yield/plant was exerted by fruit set (-2.6775), fruit diameter horizontal (-2.3901), plant spread N-S (-1.8923), days taken to first harvest (-1.6555), days taken to fruit set (-0.9964), duration of harvesting (-0.5583), titratable acidity (-0.3636) number of pickings (-0.3043), total sugar (-0.1816), leaf length (-0.1149), TSS (-0.017) and number of branches per plant (-0.0014). These findings are in agreement with the findings as reported by Saleem *et al.* (2013) and Phom *et al.* (2015) in tomato and Ghoochani *et al.* (2015) in Strawberry.

The magnitude of residual effect (effect of the factor other than studied) was moderate which indicates that major portion of contribution towards fruit yield.

Thus, on the basis of present study it may be concluded that the characters like days taken to first flower initiation, plant spread E-W, leaf perimeter, estimated yield, number of nodes per plant, leaf breadth, number of fruits per plant, fruit diameter vertical, plant height, TSS/Acid ratio, carotene, total chlorophyll content of leaves, sensory score, juice, root : shoot ratio, fruit weight, vitamin-C, may be of merit value when making selection for desirable genotypes.

The experiment entitled “**Evaluation of Capegooseberry (*Physalis peruviana* L.) Under Humid Agro-climatic condition of Jhalawar**” was carried out to study the performance, variability, correlation coefficient and path coefficient analysis for fruit yield and their component traits. The experiment material comprised of ten genotypes of capegooseberry which were grown during 2015-16 at the Protected Cultivation Unit, College of Horticulture and Forestry, Jhalawar following RBD. The observations were recorded on growth, production, quality and genetic variability parameters. The experimental results presented and discussed in the previous chapters are summarized here under suitable heads:

6.1 Growth attributes

- The genotype ‘Amb. Sel.-4’ showed maximum plant height (127.89cm) in ‘Selection-7’ the least (64.80cm).
- The maximum plant spread E-W (146.67cm) as well as N-S (147.0) was recorded in the ‘Selection-9’ and minimum plant spread E-W in ‘Amb. Sel.-2’ (60.77cm) and ‘Amb. Sel.-4’ (60.77cm). Minimum plant spread in N-S direction was there in ‘Amb. Sel.-6’ (61.78cm).
- The genotype ‘Selection-7’ (3.36mg/g) presented maximum total chlorophyll content of leaves and ‘Amb. Sel.-2’ (1.94mg/g) minimum.
- The higher number of nodes per plant was recorded in ‘Selection-21’ (403.67) and lower in ‘Amb. Sel.-6’ (172.0).
- The maximum number of branches per plant was found in ‘Selection-21’ (55.0) and minimum in ‘Amb. Sel.-4’ (32.67) and ‘Amb. Sel.-5’ (32.67).
- The leaf length was maximum in ‘Amb. Sel.-3’ (13.51cm) and minimum in ‘Selection-21’ (7.05cm).
- The maximum leaf breadth was noted in the ‘Amb. Sel.-3’ (11.45cm) and minimum in ‘Selection-21’ (4.37cm).
- The genotype having maximum root : shoot ratio was ‘Selection-9’ (0.23) and it was found minimum in ‘Amb. Sel.-4 and Amb. Sel.-7’ (0.14).
- The genotype ‘Amb. Sel.-6’ (39.93cm) was having maximum perimeter of leaves and in genotype ‘Selection-21’ (15.11cm) it was minimum amongst all genotypes.

6.2 Production attributes

- The genotype which there minimum number of days taken to first flower initiation (30.11 days) was ‘Selection-9’ and that which there maximum number of days was ‘Amb. Sel.-2’ (60.55 days).
- The minimum days taken to fruit set was observed in ‘Selection-9’ (37.77 days) and it was very much late in ‘Amb. Sel.-2’ (70.59 days).
- The maximum fruit set was recorded in ‘Amb. Sel.-6’ (93.10 per cent), while the minimum in Selection-7 (68.84 per cent).
- The least days taken to first harvest was recorded in genotype ‘Selection-9’ (93.77 days) and the maximum in ‘Amb. Sel.-2’ (134.29 days).
- The minimum duration of harvesting (24.66 days) was recorded in the ‘Selection-21’ and maximum in ‘Amb. Sel.-5’ (40.64 days).
- The genotype ‘Amb. Sel.-5’ (7.45) had highest number of pickings and ‘Selection-21’ (3.33) the lowest amongst all genotypes.
- The maximum fruit diameter (vertical- 34.30mm, horizontal- 36.81mm) was recorded in the ‘Selection-7’ and minimum in ‘Amb. Sel.-6’.
- The genotype ‘Selection-7’ showed maximum fruit weight (21.75g) and the least fruit weight was there in ‘Amb. Sel.-4’ (5.63g).
- The higher number of fruit per plant was recorded in ‘Selection-9’ (122.33) and the lower in ‘Amb. Sel.-2’ (40.11).
- The genotype ‘Selection-7’ (2386.16g) presented maximum fruit yield per plant and ‘Amb. Sel.-4’ (270.70g) the minimum.
- The maximum estimated yield was found in ‘Selection-7’ (119.31q/ha) and minimum in ‘Amb. Sel.-4’ (13.53q/ha).

6.3 Quality attributes

- The highest TSS was observed in ‘Amb. Sel.-3’ (15.73 °Brix) and lowest in ‘Selection-21’ (5.07 °Brix).
- The genotype having maximum titratable acidity was ‘Selection-7’ (0.36 per cent) and the lower acidity was there in ‘Amb. Sel.-7’ (0.24 per cent).
- The genotype ‘Amb. Sel.-6’ showed maximum TSS/Acid ratio (57.86) and ‘Selection-21’ showed the least (15.06).
- The maximum total sugar (5.10 per cent) was recorded in the ‘Amb. Sel.-3’ and minimum in ‘Selection-21’ (3.0 per cent).

- The genotype 'Amb. Sel.-3' (66.66 per cent) presented maximum juice and 'Selection-7' the minimum (51.25 per cent).
- The higher vitamin-C was recorded in 'Amb. Sel.-3' (32.24mg/100g) and lower in 'Selection-21' (22.69mg/100g).
- The maximum sensory score was found in 'Amb. Sel.-3' (8.25) and minimum in 'Selection-21' (4.25).
- The genotype 'Amb. Sel.-3' (1.73mg/100g) had maximum carotene content and 'Selection-21' the lowest (1.43mg/100g).

6.4 Variability, Correlation and Path coefficient analysis

- Most of the characters under study exhibited high estimates of heritability viz. carotene content in fruit, days taken to first harvesting, days taken to fruit set, fruit set, days taken to first flower initiation, duration of harvesting, fruit diameter-horizontal, TSS, leaf breadth, leaf perimeter, plant height, fruit weight, leaf length, fruit yield per plant, estimated yield, number of picking, TSS/Acid ratio, total sugar, juice and plant spread N-S. These characters would be effective in selection for capegooseberry improvement.
- A wide range of expected genetic advance as per cent of mean was observed for different characters. High estimates of genetic advance as per cent of mean was reported for the characters viz. estimated yield, fruit yield per plant, fruit weight, TSS/Acid ratio, TSS, number of fruits per plant, fruit diameter-horizontal, plant spread E-W, plant spread N-S, leaf breadth, number of nodes per plant, leaf perimeter and days taken to first flower initiation. High heritability along with high genetic advance as per cent of mean was observed for plant spread (N-S), leaf breadth, leaf perimeter, days taken to first flower initiation, fruit diameter-horizontal (mm), fruit weight, fruit yield per plant, estimated yield, total soluble solids and TSS/acid ratio. In this condition more effective selection might be under the control of additive gene effects. On the other hand low heritability with low genetic advance as per cent of mean was observed for root : shoot ratio and titratable acidity.
- The magnitude of the phenotypic coefficient of variation was higher than the corresponding genotypic coefficient of variation for all the characters which indicated effect of environment on the character expression. The GCV and PCV were higher for plant spread E-W followed by plant spread N-S, number of nodes per plant, leaf breadth, fruit diameter-vertical, fruit diameter-horizontal, fruit weight, number of fruit per plant, fruit yield per plant, estimated yield, TSS and TSS/Acid ratio.

- In general, the estimates of genotypic correlation were higher than the corresponding phenotypic correlation coefficient. It may result from the modifying effect of environment on the association of characters at genotypic level. The fruit yield per plant had highly significant positive correlation with characters like plant spread E-W, plant spread N-S, total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter-vertical, fruit diameter-horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity. From these associations, it appears that higher fruit yield can be obtained by increasing these characters.
- Path coefficient analysis revealed that the characters like days taken to first flower initiation, plant spread E-W, leaf perimeter, estimated yield, number of nodes per plant, leaf breadth, number of fruits per plant, fruit diameter-vertical, plant height, TSS/Acid ratio, carotene, total chlorophyll content of leaves, sensory score, juice, root : shoot ratio, fruit weight, vitamin-C had high positive direct effect on fruit yield.
- The magnitude of residual effect was moderate which indicated that major portion of contribution towards fruit yield may be explained on the basis of characters included in the study.

Chapter -7

CONCLUSION

On the basis of results obtained from the field experiment entitled “**Evaluation of Capegooseberry (*Physalis peruviana* L.) Under Humid Agro-climatic condition of Jhalawar**” following conclusions can be drawn:

It may be concluded that there is highly significant differences among the genotypes for all the characters. Among the all genotypes of capegooseberry ‘Selection-7’ was found maximum yielding one followed by ‘Selection-9’ and ‘Selection-21’ in respect to, maximum fruit diameter-vertical as well as horizontal, fruit weight, number of fruits per plant and fruit set per cent. The ‘Amb. Sel.-3’ was found superior in respect to, TSS, total sugar, juice per cent, vitamin-C, sensory score and carotene.

High heritability with high values of genetic advance was observed for plant spread (N-S), leaf breadth, leaf perimeter, days taken to first flower initiation, fruit diameter-horizontal (mm), fruit weight, fruit yield per plant, estimated yield, total soluble solids and TSS/acid ratio.

The correlation of fruit yield was positive and significant at phenotypic level with plant spread E-W, plant spread N-S, total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter-vertical, fruit diameter-horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity. It is revealed from the result that high order positive direct effect towards fruit yield was exerted by days taken to first flower initiation, plant spread E-W, leaf perimeter, estimated yield, number of nodes per plant, leaf breadth, number of fruits per plant, fruit diameter-vertical, plant height, TSS/Acid ratio, carotene, total chlorophyll content of leaves, sensory score, juice, root : shoot ratio, fruit weight and vitamin-C. These observations may be of merit value when making selection for desirable genotypes.

Evaluation of Capegooseberry (*Physalis peruviana* L.) Under Humid Agro-climatic condition of Jhalawar

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ABSTRACT

A field experiment entitled “Evaluation of Capegooseberry (*Physalis peruviana* L.) Under Humid Agro-climatic condition of Jhalawar” was conducted at the Protected Cultivation Unit, College of Horticulture and Forestry, Jhalawar during 2015-2016. The experiment consisted of 10 genotypes viz., Amb. Sel.-1, Amb. Sel.-2, Amb. Sel.-3, Amb. Sel.-4, Amb. Sel.-5, Amb. Sel.-6, Amb. Sel.-7, Selection-7, Selection-9 and Selection-21 and was laid out in randomized block design with three replications.

Among all genotypes of capegooseberry ‘Selection-7’ was found maximum yielder followed by Selection-9 and Selection-21. Further these three genotypes were found having maximum fruit diameter-vertical as well as horizontal, fruit weight, number of fruits per plant and fruit set per cent. The ‘Amb. Sel.-3’ was found superior in respect to TSS, total sugar, juice per cent, vitamin-C, sensory score and carotene.

Analysis of variance indicated presence of considerable variability for all characters. High GCV and PCV were observed for plant spread E-W followed by plant spread N-S, number of nodes per plant, leaf breadth, fruit diameter-vertical, horizontal, fruit weight, number of fruits per plant, fruit yield per plant, estimated yield, TSS and TSS/Acid ratio. Therefore, these characters can aid in selection programme.

These characters may be considered by breeder for breeding programme. High heritability with high values of genetic advance was observed for plant spread (N-S), leaf breadth, leaf perimeter, days taken to first flower initiation, fruit diameter horizontal (mm), fruit weight, fruit yield per plant, estimated yield, total soluble solids and TSS/acid ratio.

The result from character association indicated that fruit yield had highly significant positive correlation with plant spread E-W, plant spread N-S, total chlorophyll content of leaves, number of nodes per plant, number of branches per plant, fruit diameter-vertical, horizontal, fruit weight, number of fruits per plant, estimated yield and titratable acidity.

Path coefficient analysis revealed that characters viz., days taken to first flower initiation, plant spread E-W, leaf perimeter, estimated yield, no of nodes per plant, leaf breadth, number of fruit per plant, fruit diameter-vertical, plant height, TSS/Acid ratio, carotene, total chlorophyll content of leaves, sensory score, juice, root : shoot ratio, fruit weight, vitamin-C had high positive direct effect on fruit yield.

Result obtained from the present study based on variability parameters, correlation and path analysis revealed that selection programme based on plant spread E-W, spread N-S, total chlorophyll content of leaves, no of nodes per plant, no of branches per plant, days taken to

first flower initiation, fruit diameter-vertical, horizontal, fruit weight, number of fruits per plant, total soluble solids, TSS/acid ratio, carotene, sensory score, juice content and vitamin-C proved positive effect on yield in Capegooseberry.

Based on overall study of various parameters of all 10 genotypes, it appeared that genotype Selection-7 was found maximum yielder (2.386 kg/plant) but organoleptic score wise rated lesser (5.83). However, Amb. Sel.-3 had less yield (408.03g/plant) but quality wise (Organoleptic score 8.25) it has superior. Hence, it can be considered for cultivation.

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रसभरी (फाइसेलिस पेरुवियाना एल.) का झालावाड़ की आर्द्र कृषि जलवायुवीय दशा में मूल्यांकन

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सारांश I

उद्यानिकी एवं वानिकी महाविद्यालय झालरापाटन झालावाड़ की संरक्षित खेती इकाई अन्तर्गत रसभरी (फाइसेलिस पेरुवियाना एल.) का झालावाड़ की आर्द्र कृषि जलवायुवीय दशा में मूल्यांकन हेतु वर्ष 2015-16 की रबी ऋतु में 10 प्रारूपोंय अम्बेडकर सेलेक्शन-1, अम्बेडकर सेलेक्शन-2, अम्बेडकर सेलेक्शन-3, अम्बेडकर सेलेक्शन-4, अम्बेडकर सेलेक्शन-5, अम्बेडकर सेलेक्शन-6, अम्बेडकर सेलेक्शन-7, सेलेक्शन-7, सेलेक्शन-9 एवं सेलेक्शन-21 को शामिल करते हुए यादृच्छिक खण्ड अभिकल्पना में तीन पुनरावृत्तियों के साथ अनुसंधान किया गया।

सेलेक्शन-7 प्रारूप में अधिकतम फल उत्पादन पाई गई। इसके बाद सेलेक्शन-9 व सेलेक्शन-21 में सर्वाधिक फल उत्पादन हुआ। इन तीनों प्रारूपों में फल की अधिकतम लम्बाई व चौड़ाई, फल वजन प्रति पौधा, फलों की संख्या के साथ-साथ अधिक फल टिकाव पाया गया। अम्बेडकर सेलेक्शन-3 में सर्वाधिक कुल घुलन गील ठोस, कुल भारकरी, रस की मात्रा, विटामीन-सी, इन्द्रियजनित अंक तथा कैरोटीन दर्ज किया गया।

विविधता वि. लेशन से सभी लक्षणों में पर्याप्त विभिन्नता देखी गई। पौधे का पूर्व-परिचम तथा उत्तर-दक्षिण फैलाव, गाँठ की संख्या प्रति पौधा, पत्ती की चौड़ाई, फल की लम्बाई एवं चौड़ाई, फल वजन, फल संख्या प्रति पौधा, फल उपज प्रति पौधा, कुल घुलन गील ठोस तथा कुल घुलन गील ठोस/अम्ल अनुपात में उच्च जीन प्रारूप गुणांक भिन्नता व लक्षण प्रारूप भिन्नता देखा गया। अतः इनसे सुधार हेतु चयन प्रवृत्ति का प्रयोग किया जा सकता है।

पौधे का उत्तर-दक्षिण फैलाव, पत्ती की चौड़ाई, पत्ती की परिधि, प्रथम पुष्पण में सबसे कम दिन, फल उपज प्रति पौधा, कुल घुलन गील ठोस तथा कुल घुलन गील ठोस/अम्लता अनुपात उच्च व आनुगति के साथ मात्रा माध्य प्रति पौधा के रूप में उच्च आनुवांशिक प्रगति का दर्शाते हैं। अतः इनमें सुधार हेतु चयन प्रवृत्ति का प्रयोग किया जा सकता है।

साहचर्य अध्ययन के परिणाम से ज्ञात हुआ कि फल उपज का पौधे का पूर्व-परिचम व उत्तर-दक्षिण फैलाव, कुल हरित लवक की मात्रा, गाँठ की संख्या प्रति पौधा, भाखाओं की संख्या प्रति पौधा, फल की लम्बाई एवं चौड़ाई, फल वजन, फल की संख्या प्रति पौधा तथा कुल अम्लता साथ दोनों स्तरों पर प्रबल धनात्मक साहचर्य देखा गया।

पथ गुणांक वि. लेशन से ज्ञात हुआ कि फल उपज पर प्रथम पुष्पण में कम दिन, पौधे का पूर्व-परिचम व उत्तर-दक्षिण फैलाव, पत्ती की परिधि, गाँठ की संख्या प्रति पौधा, पत्ती की चौड़ाई, फल की संख्या प्रति पौधा, फल की लम्बाई, पौधे की उचाई, कुल घुलन गील ठोस/अम्लता अनुपात, कैरोटीन, कुल हरित लवक की मात्रा, इन्द्रियजनित अंक, रस की मात्रा, जड़: तना अनुपात, फल वजन तथा विटामीन-सी का प्रभाव अधिक प्रत्यक्ष एवं धनात्मक था।

वर्तमान अध्ययन जो कि विविधता प्राचलन, सह-सम्बन्ध एवं पथ वि. लेशन पर आधारित है, के परिणामों से यह निष्कर्ष निकलता है कि पौधे का फैलाव व पूर्व-परिचम व उत्तर-दक्षिण, कुल हरित लवक की मात्रा, गाँठ की संख्या प्रति पौधा, प्रथम पुष्पण में कम दिन, फल की लम्बाई एवं चौड़ाई, फल वजन, फल संख्या प्रति पौधा, कुल घुलन गील ठोस, कुल घुलन गील ठोस/अम्लता अनुपात, कैरोटीन, रस की मात्रा एवं विटामीन-सी के चुनाव से रसभरी के उत्पादन स्तर की वृद्धि में मदद मिलेगी।

सभी 10 प्रारूपों के अध्ययन के आधार पर सेलेक्शन-7 सर्वाधिक उत्पादक (2७386 किग्रा प्रति पौधा), परन्तु इन्द्रियजनित मूल्यांकन (5७83) कमतर पाया गया। यद्यपि अम्बेडकर सेलेक्शन-3 में प्रति पौधा उपज (408७03 ग्राम प्रति पौधा) कम पाया गया किन्तु गुणवत्ता मूल्यांकन (इन्द्रियजनित अंक 8.25) की दृष्टि से यह बेहतर पायी गयी। अतः इसे खेती अन्तर्गत लाया जा सकता है।

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Appendix – I

Analysis of variance for Plant height (cm) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	23.7803	11.8901	0.267
Treatments	9	13785.36	1531.71	34.45
Error	18	800.21	44.456	
Total	29	14609.35		

*Significant at 5% level of significance

Appendix – II

Analysis of variance for Plant spread E-W (cm) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	798.3838	399.1919	1.631
Treatments	9	26795.06	2977.23	12.17
Error	18	4404.96	244.720	
Total	29	31998.40		

*Significant at 5% level of significance

Appendix –III

Analysis of variance for Plant spread N-S (cm) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	197.1634	98.5817	0.544
Treatments	9	23562.95	2618.11	14.44
Error	18	3262.48	181.249	
Total	29	27022.59		

*Significant at 5% level of significance

Appendix – IV

Analysis of variance for Total chlorophyll content of leaves (mg/g) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	0.2382	0.1191	2.050
Treatments	9	6.64	0.74	12.69
Error	18	1.05	0.058	
Total	29	7.92		

*Significant at 5% level of significance

Appendix – V

Analysis of variance for No of nodes per plant of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	10581.6667	5290.8333	3.075
Treatments	9	169816.13	18868.46	10.97
Error	18	30969.67	1720.537	
Total	29	211367.47		

*Significant at 5% level of significance

Appendix – VI

Analysis of variance for No of branches per plant of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	34.4000	17.2000	0.508
Treatments	9	1996.67	221.85	6.56
Error	18	608.93	33.830	
Total	29	2640.00		

*Significant at 5% level of significance

Appendix-VII

Analysis of variance for Leaf length (cm) of capegooseberry

Source of variance	D. F.	S.S.	M.S.	F. Cal
Replication	2	1.3631	0.6816	0.916
Treatments	9	140.43	15.60	20.97
Error	18	13.40	0.744	
Total	29	155.19		

*Significant at 5% level of significance

Appendix – VIII

Analysis of variance for Leaf breadth (cm) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	2.2511	1.1256	2.690
Treatments	9	195.54	21.73	51.93
Error	18	7.53	0.418	
Total	29	205.32		

*Significant at 5% level of significance

Appendix – IX

Analysis of variance for Root and Shoot ratio of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	0.0014	0.0007	0.455
Treatments	9	0.02	0.00	1.52
Error	18	0.03	0.002	
Total	29	0.05		

*Significant at 5% level of significance

Appendix –X

Analysis of variance for Leaf perimeter (cm) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	23.8685	11.9343	1.842
Treatments	9	2096.37	232.93	35.95
Error	18	116.64	6.480	
Total	29	2236.88		

*Significant at 5% level of significance

Appendix –XI

Analysis of variance for Days taken to first flower initiation of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	1.4804	0.7402	0.341
Treatments	9	4536.30	504.03	232.39
Error	18	39.04	2.169	
Total	29	4576.82		

*Significant at 5% level of significance

Appendix –XII

Analysis of variance for Days taken to fruit set of capegooseberry

Source	D.F.	S.S.	M.S.	F-Cal
Replications	2	4.8309	2.4155	1.783
Treatment	9	4778.93	530.99	391.89
Error	18	24.39	1.355	
Total	29	4808.15		

*Significant at 5% level of significance

Appendix –XIII

Analysis of variance for Fruit set (per cent) of capegooseberry

Source	D.F.	S.S.	M.S.	F-Cal
Replications	2	3.5285	1.7642	1.635
Treatment	9	2629.36	292.15	270.74
Error	18	19.42	1.079	
Total	29	2652.31		

*Significant at 5% level of significance

Appendix – XIV

Analysis of variance for Days taken to first harvesting of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	4.8309	2.4155	1.783
Treatments	9	5854.68	650.52	480.11
Error	18	24.39	1.355	
Total	29	5883.90		

*Significant at 5% level of significance

Appendix – XV

Analysis of variance for Duration of harvesting of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	2.7993	1.3996	1.769
Treatments	9	840.51	93.39	118.03
Error	18	14.24	0.791	
Total	29	857.56		

*Significant at 5% level of significance

Appendix – XVI

Analysis of variance for Number of pickings of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	1.0041	0.5020	2.024
Treatments	9	52.77	5.86	23.64
Error	18	4.46	0.248	
Total	29	58.24		

*Significant at 5% level of significance

Appendix – XVII

Analysis of variance for Fruit diameter vertical (mm) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	3.1553	1.5777	0.147
Treatments	9	1015.34	112.82	10.52
Error	18	193.07	10.726	
Total	29	1211.56		

*Significant at 5% level of significance

Appendix -XVIII

Analysis of variance for Fruit diameter horizontal (mm) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	4.5917	2.2958	0.709
Treatments	9	1739.85	193.32	59.70
Error	18	58.29	3.238	
Total	29	1802.73		

*Significant at 5% level of significance

Appendix -XIX

Analysis of variance for Fruit weight (g) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	0.6485	0.3243	0.109
Treatments	9	834.84	92.76	31.19
Error	18	53.53	2.974	
Total	29	889.02		

*Significant at 5% level of significance

Appendix – XX

Analysis of variance for Number of fruits per plant of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	1098.1517	549.0759	1.874
Treatments	9	26772.24	2974.69	10.15
Error	18	5275.24	293.069	
Total	29	33145.63		

*Significant at 5% level of significance

Appendix – XXI

Analysis of variance for Fruit yield per plant (g) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	390376.5520	195188.2760	2.369
Treatments	9	17850695.52	1983410.61	24.07
Error	18	1482950.45	82386.136	
Total	29	19724022.53		

*Significant at 5% level of significance

Appendix – XXII

Analysis of variance for Estimated yield (q/ha) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	976.0438	488.0219	2.369
Treatments	9	44629.57	4958.84	24.08
Error	18	3707.34	205.964	
Total	29	49312.96		

*Significant at 5% level of significance

Appendix – XXIII

Analysis of variance for TSS (⁰Brix) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	0.1743	0.0871	0.084
Treatments	9	545.40	60.60	58.74
Error	18	18.57	1.032	
Total	29	564.14		

*Significant at 5% level of significance

Appendix – XXIV

Analysis of variance for Titratable acidity (per cent) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	0.0024	0.0012	1.073
Treatments	9	0.04	0.00	4.44
Error	18	0.02	0.001	
Total	29	0.07		

*Significant at 5% level of significance

Appendix – XXV

Analysis of variance for TSS/acid ratio of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	58.1898	29.0949	0.592
Treatments	9	9789.24	1087.69	22.12
Error	18	885.28	49.182	
Total	29	10732.71		

*Significant at 5% level of significance

Appendix – XXVI

Analysis of variance for Total sugar (per cent) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	0.0740	0.0370	0.581
Treatments	9	11.67	1.30	20.36
Error	18	1.15	0.064	
Total	29	12.89		

*Significant at 5% level of significance

Appendix – XXVII

Analysis of variance for Juice (per cent) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	15.4405	7.7202	1.600
Treatments	9	721.57	80.17	16.61
Error	18	86.87	4.826	
Total	29	823.88		

*Significant at 5% level of significance

Appendix – XXVIII

Analysis of variance for Vitamin C (mg/100g) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	9.8501	4.9250	0.813
Treatments	9	300.79	33.42	5.52
Error	18	109.00	6.055	
Total	29	419.64		

*Significant at 5% level of significance

Appendix – XXIX

Analysis of variance for Sensory score of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	1.0292	0.5146	0.793
Treatments	9	32.80	3.64	5.62
Error	18	11.68	0.649	
Total	29	45.51		

*Significant at 5% level of significance

Appendix – XXX

Analysis of variance for Carotene (mg/100g) of capegooseberry

Source of variance	D. F.	S. S.	M.S.	F. Cal
Replication	2	0.0023	0.0012	2.853
Treatments	9	0.27	0.03	74.75
Error	18	0.01	0.000	
Total	29	0.28		

*Significant at 5% level of significance



**Plate 1: Seedlings of different genotypes of
Capegooseberry**





Plate 3: Fruits of different genotypes of Capegooseberry



(a)



(b)

**Plate 2: Capegooseberry fruits after harvest (a-Fruits without husk,
(b- Fruits with husk)**



Plate 4: Sensory evaluation of Capegooseberry fruits