

**Studies on Genetic Variability in Gaillardia
(*Gaillardia pulchella* Foug.)**

गैलार्डिया (गैलार्डिया पल्चेला फौग.) में आनुवांशिक विविधता पर अध्ययन

Rahul Kumar Byadwal

Thesis

**Master of Science in Horticulture
(Floriculture and Landscaping)**



2018

**Department of Floriculture and Landscaping,
College of Horticulture and Forestry, Jhalrapatan City,
Jhalawar - 326 023 (Rajasthan)
Agriculture University, Kota**

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Thesis

Submitted to the

Agriculture University, Kota

In Partial Fulfillment of the Requirements for

the Degree of

**Master of Science in Horticulture
(Floriculture and Landscaping)**



By

Rahul Kumar Byadwal

2018

**College of Horticulture and Forestry,
Jhalrapatan City, Jhalawar
Agriculture University, Kota**

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ACRONYMS

@	:	At the rate of
C.D	:	Critical difference
C.V	:	Coefficient of variation
cm	:	Centimeter
cv.	:	Cultivar
°C	:	Degree Celsius
d.f.	:	Degree of freedom
E-W	:	East-West
EC	:	Electrical conductivity
<i>et al.</i>	:	<i>et allia</i> (and others)
etc.	:	<i>et cetera</i> (and other things)
Fig.	:	Figure
g	:	Gram
GCV	:	Genotypic coefficient of variation
GA		Genetic advance
h ²	:	Heritability
ha	:	Hectare
hrs.	:	Hours
i.e.	:	(<i>id est</i>), that is
m	:	meter
Max.	:	Maximum
Min.	:	Minimum
mm	:	millimeter
MT	:	million tonnes
MS	:	Mean square
MSS	:	Mean sum of square
No.	:	Number
N-S	:	North-South
NS	:	Non significant
%	:	Per cent
/	:	Per
PCV	:	Phenotypic coefficient of variation
q	:	quintal
RH	:	Relative humidity
Temp.	:	Temperature
SEm ±	:	Standard error of mean
viz.	:	(<i>Videlicet</i>), namely
°, ', "	:	Degree, minute, second (in ref. to latitude and longitude)

Chapter-1

INTRODUCTION

Flowers are integral part of our society and play a crucial role in day to day life for religious, cultural and social rituals. India has a long history regarding the cultivation of flowers and uses. Though their cultivation has been done from many centuries, but recently the investments have been increased and made it a commercial activity.

Today, there is a huge demand for flowers in international and domestic market. Flowers symbolize purity, beauty, peace, love and passion. It is a popular saying that flowers are associated with human being from birth to death. Flowers are frequently used as cut flowers for bouquets, vases and flower arrangements for interior decorations and as loose flowers for floral rangoli, worshiping gods, flower showers in receptions, wedding and for making garlands, gajara, veni, etc.

The floriculture in India comprises the florist trade, production of nursery plants, potted plants, bulb and seed production, micro-propagation and extraction of essential oils from flowers. Cut flower stems like rose, chrysanthemum, carnation, anthurium, orchids, gerbera, gladiolus, liliun etc. are widely used in floristry for decorations and flower arrangements. Loose flowers like marigold, jasmines, gaillardia, crossandra, gomphrena, etc. are the traditional flowers grown in India. Indian floriculture is limited to small areas, requiring increased attention for research and development. It is necessary to develop adaptive technologies for flower crops for commercial cultivation with higher returns per unit area.

Government of India identified floriculture as a sunrise industry and accorded it 100 % export oriented status. There are more than 300 export-oriented units in India. Total exports of floriculture was Rs. 546.70 crores in 2016-17 (Anonymous, 2016). India is exporting flowers to USA, UK, Germany, Netherlands, United Arab Emirates and other countries. India has become importer of flowers from Germany, Netherland, USA, UK, France and other countries.

The area under flower cultivation in India during 2013-14 was 2.55 lakh hectares with production of 543 million cut flowers and 1754 MT of loose flowers. Area wise leading flower growing states in India are Tamil Nadu (55,000 ha) Andhra

Pradesh (35,000 ha), Karnataka (30,600 ha) and. Leading cut flower producing states are West Bengal (27%), Karnataka (13%), Orissa (11%), Uttar Pradesh (10%) and leading loose flower producing states are Tamil Nadu (19%), Karnataka (12%) and Madhya Pradesh (11%). Rajasthan contributes only 0.25 lakh hectare area under flower cultivation with production of 0.27 in lakh MT of loose flowers (Anonymous, 2013). The area under flower cultivation in India during 2017-18 was 3.06 lakh hectares with production of 2392 MT total flowers (Anonymous, 2017).

Gaillardia (*Gaillardia pulchella* Foug.) commonly known as “Blanket Flower”. Because of its wide array of colours and patterns including Mexican blankets, gold-tipped with russet-red centers but recent introductions have expanded the colour range further. *Gaillardia* is also known as “Fire Wheel or Indian Blanket or Brown-Eyed Susan” in European countries (Helen *et al.*, 2007). It belongs to the family Asteraceae and has basic chromosomes number of $x=18$ ($2n=36$) (Srivastava and Kandpal, 2006) and is native to Florida and western United States. The generic name of *gaillardia* was proposed in honour of Gaillard de Marentonneau in 18th century, a French supporter of botany (Bailey, 1929).

Gaillardia is an herbaceous annual or short-lived perennial growing up to a height of 30 to 150 cm. Out of twenty species available in the genus *Gaillardia*, only *Gaillardia pulchella* is annual and *Gaillardia aristata* is a perennial one in cultivation. The annual type grows to a height of 30 to 90 cm. The leaves that appear in initial stages are large, up to 10-20 cm length and more lobed than those that appear in the later stages. The characteristics such as leaf shape and size are highly variable in nature. Leaves may be basal and linear to lanceolate, grayish green and very hirsute (Helen *et al.*, 2007).

There are many varieties of *gaillardia* in the country of which two most common varieties are *Gaillardia pulchella* var. *Picta* and *Gaillardia pulchella* var. *Lorenziana*. The first group includes the single flowering types and later one is the semi double and double flowers with quilled petals and split tips. But the most important cultivated variety is *Lorenziana*, which belongs to annuals with double flowers of very attractive colours comprise of bright yellow, purple, cream yellow or orange, scarlet copper or bronze. Flowers are small and numerous, born in solitary, usually showy heads which is stated as capitulum with 4 to 6 cm in diameter.

Individual flowers in a capitulum are called florets which range from one to ten according to cultivars or genotypes. It has both ray and disc florets which are pistillate and hermaphrodite, respectively in nature. The ray-florets are yellow, red and mixed coloured with 3 to 5 toothed, while the disc-florets are yellow purple and fertile, bracts in 2 or 3 series and ligules 3 toothed, giving a fringed appearance to the flower. Flower has a long hairy stalk and single, semi- double and double types with single or multi-colored heads (Cox and Klett, 1984). The crop produces flowers in a wide range of colours such as yellow, orange, cream, scarlet, bronze, brick-red and red and can be grown all around the year (Shreedhar, 1993).

Now-a-days, gaillardia has gained importance for its profuse and long duration flowering habit. It is one of the hardiest annuals that can be grown in a variety of soils and under varied climatic conditions it tolerates temperature as low as -1°C . Gaillardia can withstand fairly high salinity and 50 per cent of yield could be obtained even at 8.7 ds/m^{-1} salinity level and this can be tried as a new flower crop for saline soils (Khimani, 1991).

Gaillardia becomes one the most popular flowers for commercial cultivation in India because of easy cultivation, wide adaptability to varying soils and climatic conditions, better resistance to insect pests and disease, hardy nature, long duration of flowering and attractive flower colours for floral display. Gaillardia is commercially grown for loose flowers in Gujarat, Madhya Pradesh, Maharashtra, Karnataka and Rajasthan. In Rajasthan, cultivation of this crop is grown in districts of Jaipur, Ajmer, Udaipur and Kota. The growing popularity of this crop has led to expanding its cultivation to other parts of the state. In Rajasthan, flowers are mostly used for making garlands. Due to its attractive spectacular forms, bright coloured flowers and hardiness it is grown in flower beds, for edging and mixed borders besides being grown for loose flowers. Gaillardia is also good for cut flowers, as the flowers last long in water for more than five days. Besides its utility in landscape, it is useful in reducing soil erosion in coastal dune areas. It can be used as a substitute for chrysanthemum and China aster for loose flower purpose as it is a photo insensitive and hardy crop. The plant has anti-tumor activity owing to the presence of methyl caffeate distributed throughout the plant (Srivastava and Kandpal, 2006). Some other traits like tolerance to drought, resistance to pest and diseases and easy perpetuation from seed make it more popular.

In view of the importance, popularity and potentiality of this crop, there is a lot of scope for identification of suitable varieties for local environment. In cross-pollinated crops, majority of seeds population are heterozygous in nature and growing of crop through seeds may result in large variability. Use of novel agro techniques and improved cultivars enhance the yield even though the selection of proper genotype among the various species with desirable traits will increase the production considerably.

Therefore, keeping the above points in view, the present investigation on **“Studies on Genetic Variability in Gaillardia (*Gaillardia pulchella* Foug.)”** under Humid South-Eastern Plains of Rajasthan was planned with the following objectives.

1. To study the performance of different gynotypes of gaillardia under Jhalawar conditions.
2. To study the genetic variability in gaillardia.
3. To study the correlation and path coefficient analysis in gaillardia.



Chapter-2

REVIEW OF LITERATURE

Gaillardia (*Gaillardia pulchella* Foug.) is commonly known as “Blanket Flower, Indian blanket or Sundance” and belong to Asteraceae family and it is an important hardy, summer and winter annual flower crop grown for both loose flower and landscape purpose. Genetic an improvement of any crop depends on the genetic variability present in the available genotypes. Selection of genotype is better and effective option rather than control of environmental factors. Huge number of gaillardia genotypes was spread over India and in different parts of the world. Those performance vary depend on climatic conditions under which they growing.

However, available genotypes for their performance in terms of vegetative growth, flowering yield and quality attributes. In this regard, there is a need for genetic variability of genotypes for the particular agro-climatic regions. For this reason, many workers have visibilities in different genotypes for studying their performance under different regions. Hence, literature pertaining to genetic parameters viz., variability, heritability, genetic advance and correlation and path coefficient analysis studies are enumerated here under suitable heads.

2.1 PERFORMANCE OF GENOTYPES:-

Pal and George (2002) studied genetic variation, heritability and correlation for vegetative and flowering characteristics in two indigenous and ten exotic chrysanthemum. Significant variation was observed for plant height, number of leaves, individual leaf area, length, width, days to flower bud emergence, stalk length and weight and shelf-life of flowers.

Baskaran *et al.* (2004) evaluated performance of chrysanthemum cultivars Ravikiran, Chandrika, Yellow Star, Red Gold, Nilima, Kasturi Shaventigae, Cassa, Arka Swarna, Arka Ravi and Button Type Local under open field conditions at Bangalore. The tallest plants (54.03 cm) were recorded in ‘Cassa’, while the dwarfest plants in ‘Button Type Local’. ‘Red Gold’ produced the maximum number of branches per plant (60.33) compared to the other cultivars. The duration of flowering was longest (51.66 days) in ‘Yellow Star’ and shortest (23.33 days) in ‘Chandrika’. High yield was recorded by ‘Red Gold’ (365.00 g), ‘Nilima’ (324.00 g) and ‘Yellow

Star' (287.00 g). The maximum flower diameter (8.14 cm) was recorded in 'Ravikiran', while 'Button Type Local' observed the highest number of flowers per plant (287.00).

Kulkarni *et al.* (2004) studied the performance of six China aster cultivars under North Karnataka conditions and reported that 'Phule Ganesh White' recorded the highest plant height (66.40 cm) and flower yield (236.33 g). While the plant spread was observed to be maximum in 'Phule Ganesh Purple' (27.49 cm) and 'Phule Ganesh Violet' produced the highest number of primary branches (23.60).

Kunigunda (2004) studied the performance of seven chrysanthemum varieties and reported that 'Lameet Bright' had a highest diameter of flowers (12.0 cm), stem diameter (0.86 cm), number of leaves per plant (27.0). While 'Yellow Crikette' recorded the highest breadth of petals (1.30 cm). 'La Cagouille' had highest plant height (117.7 cm) and length of leaves (17.3 cm) and 'White Crikette' had highest length of petals (4.2 cm).

Dilta *et al.* (2005) evaluated the fifty five genotypes of chrysanthemum and reported that the maximum plant height (78.83 cm) was recorded in 'Gulmohar' while minimum (40.33 cm) in 'Mini Queen'. Among all the genotypes, 'Surf' was the earliest one and took (89.67 days) for flowering, followed by 'Ellen Van Langen' (98.67 days) and 'Jaya' (99.67 days). The maximum number of days for flowering (131.67 days) was recorded in 'Gulmohar' and is considered to be late flowering type. 'Glance' produced the maximum number of flowers per plant (65.67), followed by 'Baggi' (50.33) and 'Mini Queen' (49.83).

Singh and Singh (2006) evaluated twenty nine genotypes of African marigold and statistically at par with 'TEG 16' and significantly different from other genotypes. The genotype 'TEG 21' was recorded with the maximum plant spread (79.10 cm), whereas 'TEG 8' was best with number of primary branches per plant (18.67), while the genotype 'TEG 26' exhibited the maximum stem diameter (1.77 cm) followed by 'TEG 14'.

Talukdar *et al.* (2006) evaluated eighteen standard chrysanthemum cultivars under polyhouse cum rain shelter and open conditions. However, 'Bolare Deo' bloomed earlier inside polyhouse (70.33 days) compared to open conditions (79.67 days) and it was also the earliest cultivar to bloom over the two conditions (75.00

days). The maximum flower size over the two conditions was recorded for 'Snow Ball' (19.81 cm) and 'Sonar Bangla' (18.08 cm), 'Snow Ball' bloomed for the maximum number of days (30.00 days) over two conditions and for additional five days inside polyhouse (33.33 days) compared to open conditions (27.67 days). 'Snow Ball' also exhibited the maximum vase life (18.25 days), with enhancement of its vase life by four day inside polyhouse (20.00 days) compared to open conditions (16.00 days). However, almost all the cultivars exhibited the maximum blooming period and vase life inside polyhouse as compared to open conditions.

Helen *et al.* (2007) evaluated twenty three blanket flower genotypes for landscape. Among these 'Torch Red Ember' rated highest for uniformity. 'Arizona Sun' and 'Lollipop Gold', the highest rating for flowering, and 'Torch Red Ember' and 'St. Lucie Co' genotypes received the highest rating for landscape impact.

Kumar *et al.* (2007) assessed twenty four spray type chrysanthemums for their performance and the maximum plant height (81.00 cm), plant spread (43.60 cm), stem thickness (4.32 cm), flower diameter (9.24 cm) and fresh weight of flower (2.44 g) were recorded in 'Purple Decorative', while the maximum leaves per plant (104.00) were noted in 'White Decorative'. The 'Yellow Button' produced the maximum number of primary branches (11.43) and flowers per plant (190.50). Earliest 50 per cent flowering (81.65 days) was observed in 'Prof. Harris', whereas 'Red Anemone' was late (116.35 days). The highest number of disc florets per flower (160.00) was recorded in 'Basanti'.

Swaroop *et al.* (2008) studied performance of twenty genotypes of chrysanthemum (*Dendranthema grandiflora* Tzvelev.) in New Delhi. The results revealed that all the genotypes differed significantly with respect to growth and flowering parameters. Cultivar 'Tata Centenary' recorded the maximum plant height (124.00 cm) and the maximum number of branches per plant (20.16). The maximum number of days taken for first flower bud appearance (83.50) and number of ray florets per flower (287.99) was recorded in 'Thai Chln Queen', while the maximum flower diameter (10.58 cm) was recorded in 'Snow Don'. The maximum number of flowers per plant (56.50) was obtained by 'PC-28'. The maximum duration of flowering on plant (56.83 days) was recorded in 'Flirt' and the maximum fresh weight of single flower (10.24 g) was recorded in 'Thai Chln Queen'.

Singh *et al.* (2008) conducted a varietal evaluation of gerbera as influenced by growing condition. The variety 'Essence' had the maximum stalk diameter (1.01 cm) followed by 'Dalma' (0.91 cm) which were superior over rest of the varieties under low cost polyhouse condition. In the net conditions, the maximum stalk diameter was observed in 'Essence' (0.94 cm) and the minimum stalk diameter was observed by 'Gold Spic' (0.52 cm).

Pal and Kumar (2010) studied on genetic variability on seventeen genotypes of African marigold. 'Pusa Basanti Gaiinda' exhibited the maximum mean performance for plant height (80.00 cm) at peak flowering period while the minimum was exhibited by 'Indame Orange' (30.90 cm).

Baskaran *et al.* (2010) evaluated the performance of ten chrysanthemum cultivars for better postharvest quality under open field condition. The results showed that the maximum stalk girth (0.32 cm) and the maximum flower weight (3.59 g) were recorded in 'Cassa'. The maximum flower diameter (8.14 cm) and the maximum length of ray florets (3.96 cm) were recorded in 'Ravikiran'. The maximum numbers of ray florets (253.2) were recorded by 'Nilima'. The maximum fresh weight (88.33 g), final weight (40.63 g), water loss (47.67g) and longer vase life of 16 days was recorded in 'Arka Swarna'. Based on the performance studies it was observed that 'Arka Swarna', 'Ravikiran', 'Red Gold', 'Nilima' and 'Arka Ravi' the performed better postharvest quality and may be selected for cut flower production.

Vasudevan and Rao (2010) conducted an evaluation of gerbera genotypes under mid hill condition of Garhwal Himalaya. Genotype 'Sunglow' produced longest flower stalk (70.04 cm). Largest flower size (11.45 cm) was produced by 'Sunglow' followed by 'Excellence' (11.35 cm) and 'Essence' (11.30 cm). The maximum vase life in water was recorded in 'Essence' (16.13 days).

Mahawer *et al.* (2011) evaluated seven genotypes of gaillardia and after screening of genotypes having the open-pollinated seedling of blanket flower maintained in the field repository, two lines viz., 'MPUAT GOPS-1' and 'MPUAT GOPS-3' were identified as most promising. 'MPUAT GOPS-1' had compact double flower with yellow ray florets and flower yield ranged from 154.00 to 351.00 g/plant (17.11 to 38.99 t/ha) was most preferred by the farmers. 'MPUAT GOPS-3' had dark red florets and yield of 174.6 to 328.0 g/plant (19.39 to 36.44 t/ha) and MPUAT GOPS -5 had flower diameter (5.6-06.0 cm).

Munikrishnappa *et al.* (2013) evaluated China aster varieties on growth and flower yield and reported 'Phule Ganesh Violet' recorded the highest plant height (74.56 cm), plant spread (44.33 cm) and number of primary branches (35.28) at different stages of plant growth. 'Phule Ganesh White' recorded the weight of 100 flowers was the maximum (975.37 g) and the maximum flower yield (37.91 t/ha) whereas, the minimum weight of 100 flowers (351.37 g) and flower yield (9.97 t/ha) was noticed in 'Mixed Variety Local'. The number of cut flower production was maximum (55.43) in 'Phule Ganesh Violet' and the lowest number of cut flowers per plant was produced in 'Shashank' (40.92).

Mahmood *et al.* (2013) evaluated the various cultivars of gerbera and reported that the longest stalk length (60.30 cm), the maximum number of flowers per plant (24.60), the maximum flower diameter (9.60 cm), vase life (6.60 days), number of leaves per plant (28.60) and plant spread (60.00) was exhibited by 'Alberino'.

Tamut and Kulkarni (2013) evaluated 19 genotypes of gaillardia (*Gaillardia pulchella* Foug.) and reported the maximum number of whorls (12.10), number of petals (154.63) and number of flower (97.33) per plant in the genotypes 'AGS-8', while the minimum number of whorls (1.00) and number of petals (18.69) in the genotypes 'AGS-19' (1.00).

Zosiamliana *et al.* (2013) evaluated seven cultivars of the China aster (*Callistephus chinensis* Ness.) for its growth, flowering and yield characters. 'Phule Ganesh Violet' produced the maximum plant height (66.50 cm), number of primary branches (21.40), secondary branches (32.80), plant spread (94.33 cm) and number of leaves (192.73) in all stage of plant growth. 'Phule Ganesh Pink' took the minimum number of days for first flower bud initiation (57.20 days), first flowering (66.73 days), 50% flowering (85.67), and flowering duration (60.96 days). 'Phule Ganesh White' showed the maximum flower diameter (7.37 cm), stalk length (34.78 cm), vase life (9.13 days) the maximum number of flower per plant (36.73) and yield per plant (208.81 g).

Bharathi *et al.* (2014) investigated twenty eight genotypes of African marigold (*Tegets erecta* L) and observed the earliest flower bud appearance in 'Bangalore Local Tall' (29.47 days) whereas earliest flower bud opening was observed in 'Double Orange' (46.00 days). The highest plant height (113.27 cm) was recorded in 'Dharmapuri Local'. While, the highest number of primary and secondary branches per plant was observed in 'Bidhan-1' (22.40 and 41.47 respectively). The highest

flower yield per plant was recorded in 'Coimabtaore Local Orange' (1.48 kg) followed by 'Coimbatore Local Yellow' (1.12 kg).

Choudhary *et al.* (2014) evaluated the performance of thirty genotypes of marigold under semi arid climatic conditions. The genotype 'Hisar Jaffri-2' recorded the maximum plant spread (77.72 cm), number of secondary branches per plant (150.97), number of buds per plant (217.10), duration of flowering (76.53 days) and flower yield per plot (20.99 kg). The genotypes 'MGH-148-3-3' recorded the maximum stem diameter (2.14 cm) and dry weight of plant (130.72 g), whereas it was minimum (0.61 cm and 9.91 g, respectively) in 'Hisar Beauty'. The maximum diameter of flower (8.21 cm) was recorded in 'MGH-09-276', while it was minimum (4.01 cm) in 'Hisar Jaffri-2'.

Kumar (2014) studied seven genotypes of the chrysanthemum for flower quality traits at IIHR Bengaluru. In 'Anmol' the maximum number of flowers per plant (81.51) and longest flowering duration (43.14 days) were recorded while the maximum plant height (47.25 cm) and flower diameters (5.03 cm) were recorded in 'Garden Beauty'. The minimum flower yield (42.3 g) was recorded in 'Yellow Delight' and the maximum average weight of flower (2.59 g) and flower yield per plant (131.43 g) were recorded in 'Autumn Joy'.

Ajeetkumar *et al.* (2015) studied the performance of nine dahlia hybrids and found that the highest plant height in 'Nandini' (59.27 cm). The maximum plant spread in 'Eternity Sports' (53.52 cm). The maximum number of branches (7.87) in 'S.P. Glory' per plant, while the minimum number of branches in 'Santasyma' (4.13). The minimum days taken for first flower bud appearance in 'Mangal Pandey' (38.00 days), 'S.P. Kamala' (48.60 days) while the maximum days taken for first bud appearance in 'Kenya Blue' (61.60 days). The maximum flower duration (14.06 days) found in hybrid 'Eternity Sports' and the minimum flowering duration (10.80 days) found in 'Nandini'. The maximum diameter of fully opened flower (24.5 cm) was found in hybrid 'Kenya Blue' while minimum diameter of fully opened flower (18.30 cm) was observed in 'Nandini'. The maximum individual flower weight was in variety 'Kenya White' (107.74 g) while the minimum weight of single flower (42.67 g) observed in 'Nandini'. The maximum number of flowers per plant (9.06) in hybrid 'S.P. Glory of India' and the minimum number of flowers per plant (5.46 days) was found in 'Santasyma'. The maximum flower yield per plant (881.42 g) was recorded in hybrid 'Kenya White' and followed by 'Kenya Blue' (720.37 g) and 'Eternity

Sport' (678.79 g), while minimum flower yield per plant (278.72 g) was recorded in 'S.P. Sriradha'.

Deka *et al.* (2015) studied the gerbera cultivars and reported that 'Pride of Sikkim' was the tallest (61.80 cm) and produced the longest stalk length (49.51 cm). 'Red Gem' produced the maximum number of leaves per plant (46.55), plant spread (54.10 cm). 'Pink Melody' took least number of days (63.78) and (76.00) for bud visibility and full bloom, respectively. With respect to flower characters 'Red Gem' recorded the maximum number of flowers per plant (53.17) and possessed longest shelf life (19.96 days) and vase life (19.81 days). Largest flower diameter (11.20 cm) observed in 'Orange Gleam' and duration of flowering (130.00days) was longest in 'Red Gem'.

Kumar *et al.* (2015) evaluated the fifteen genotypes of African marigold (*Tagetes erecta* L.) and reported that the genotype 'Nilakkotai Local Orange' recorded maximum plant height (104.20 cm), number of primary branches per plant (17.73), stem diameter (17.43 mm), number of flower per plant (59.4) and flower yield per plant (529.33 g). The genotype 'Pusa Narangi Gaiinda' recorded the minimum plant height (66.80 cm), number of leaves per plant (135.53), stem diameter (9.99 mm), whereas the minimum number of flower per plant (20.60) and flower yield per plant (120.93 g) was recorded in 'Dwarf Yellow'.

Srilatha *et al.* (2015) evaluated the nine varieties of chrysanthemum, cultivars Poornima, Indira, Ravikiran, Red Gold, Neelima, Yellow Gold, Pusa Kundan, White Anemone and Local Yellow and reported that 'Poornima' the maximum plant height (100.94 cm), more number of branches per plant (13.77) but maximum number of days for flowering (107.21 days) and 'Yellow Gold' less number of days (93.88 days) for first flowering.

Uddin *et al.* (2015) studied the growth and flowering performance of 32 chrysanthemum cultivars and reported that 'Yellow Bay' recorded the maximum number of flowers per plant (194.60) whereas the minimum was recorded from 'Samsan' (4.30). 'White Snowball' was early flower bud initiation (17.80 days) and late flower bud initiation 'Gold Apricot' (52.70 days). The maximum leaf area (52.90.cm²) was found in 'Crimson Tide' and the minimum (5.90.cm²) in 'Rayonnate spider', 'Crimson Tide' recorded the maximum flower diameter (17.60 cm) and flowers from 'First light' had largest shelf life (20.70 days).

Agale and Dawane (2016) evaluated 14 genotypes of gaillardia (*Gaillardia pulchella* Foug.) and reported that the genotype 'MG-9' had the maximum plant height (74.72), the maximum number of ray florets per flower (147.53), number of flowers per plant, number of flowers per hectare and the maximum weight of flowers per plant. The maximum shelf life was recorded in 'MG-3', 'MG-5' and 'MG-13' (4 days).

Bhaskarwar *et al.* (2016) studied the performance of seven genotypes of gaillardia (*Gaillardia pulchella* Foug.) and revealed that all the genotypes differed significantly with respect to growth, flowering and yield parameters. Genotype 'Local-5' obtained the maximum plant height (76.94 cm) while the maximum number of branches per plant (20.53) in 'Local-1' and plant spread (64.99 cm) in East-West direction and (66.51 cm) in North-South direction in 'Local-2'. The highest yield of flowers per hectare (65.80 q) and shelf life (3.63 days) were recorded in 'Local-2'. The maximum days to opening of flowers (8.93 days) and flowering span (52.26 days) were recorded in 'Local-4'.

Dewan *et al.* (2016) evaluated the fifteen varieties of chrysanthemum (*Chrysanthemum morifolium* Ramat). Significant responses in vegetative and flowering characters were observed in 'Calabria', 'Yellow Star', 'AAU Yellow', 'Gambit' and 'Solan Shringar'. The highest plant height in 'Yellow Star' (49.65 cm) followed by 'Gambit' (45.46 cm). 'Solan Shringar' showed the maximum number of branches (12.51) and the number of leaves per plant (125.11). Earliness in full bloom was associated with 'Shayama' (72.29 days) followed by 'Calabria' (82.44 days). The maximum vase life (9.44 days) under tap water was observed in 'Ramblored' followed by 'Gambit' (8.37 days) and also 'Gambit' showed the maximum flower diameter (8.46 cm), flower head height (3.14 cm), number of ray florets per head (186.30), flower fresh weight (1.36 g) and dry weight (0.43 g), while the maximum number of flowers per plant (42.34) was observed in 'Calabria'.

Girange *et al.* (2016) evaluated seven genotypes of gaillardia (*Gaillardia pulchella* Foug.) for growth, flowering and yield parameters. The genotype 'NG-05' recorded the maximum plant height (85.68), plant spread in East-West direction (68.38 cm), North-South direction (66.51 cm), plant fresh weight (1816.00 g) and plant dry weight (613.33 g). The genotype 'NG-4' recorded the minimum days to bud

initiation (55.49 days), days to opening of flower (7.13 days), days to 50 per cent flowering (65.19 days) and the maximum flowering span (55.24 days).

Reddy *et al.* (2016) evaluated the performance of 15 cultivar of chrysanthemum under coastal Andhra Pradesh condition and showed that 'Ratalam Selection' recorded the maximum stalk length (8.5 cm), while the flower diameter was recorded the maximum in 'Anjali' (5.9 cm), highest number of ray florets per head (315.33) and flower weight (4.24 g) and the maximum flower disc diameter (1.8 cm) was observed in 'Local Check'. The maximum number of flowers per plant (164.7) was recorded in 'Meera' and shelf life (5.0 days) in 'Jaya'.

Suvija *et al.* (2016) studied the fifty eight genotypes of chrysanthemum. 'Pusa Centenary' and 'Ravikiran' performed well as cut flower production such as flower diameter (11.2 and 11.4 cm) & individual flower weight (7.53 and 5.95 g). The maximum stem girth was found in 'Megami' and 'Sel-5' (2.00 cm). But the maximum shelf life (18.21 days) was observed in 'Pusa Centenary'.

Singh *et al.* (2017) studied the performance of eight varieties of gerbera (Ruby Red, Sangaria, Dalma, Dune, Essance, Kozak, Alsmeeera and Gold Spic) under low cost ployhouse condtions and reported that the 'Dune' recorded the maximum plant height (30.88 cm), flower stalk length (58.18 cm), flower diameter (9.44 cm) and number of flowers/plant/year (27.00) whereas, 'Essance' recorded the maximum flower stalk diameter (1.01 cm), duration of flowering (18.00 days) and vase life (10.00 days).

Singh *et al.* (2017) evaluated twelve genotypes of gladiolus African Star, Arti, Darshan, Friendship, Hunting Song, Legend, Pusa Srijana, Pusa Kiran, Snow Princess, Sunayana, Trader Horn and Urmi laid. The 'Trader Horn' showed the best performance for the maximum number of leaves per plant (9.75), plant height (137.09 cm), spike length (123.38 cm), floret diameter (10.93 cm), duration of flowering (16.17), number of florets per spike (20.08). The 'Legend' was noted for best yielding variety regarding, the maximum number of spikes per plot (37.00), sprouts per corm (2.67) and B:C ratio (2.18).

Singh *et al.* (2017) evaluated the different varieties of chrysanthemum and reported that the highest plant height (50.20 cm) and the maximum number of florets per flower were observed in 'Suneel' (339.67 cm). 'Dentiment' showed the maximum plant spread (34.74 cm), the maximum number of flowers per plant (103.60), the

maximum flower diameter (10.40 cm) and highest weight of ten flowers (63.00 g). While 'Jayanti' recorded maximum flower vase life (16.00 days).

2.2 GENETIC VARIABILITY:-

The improvement of the flower plants depends on the foundation of variability. There are two kinds of variabilities in crop plants, genetic and non genetic. It is the genetic variability, which is the pre-requisite for any breeding programmes. The non genetic variability is the result of genetic and environmental interactions. The non genetic or phenotypic component of variability is however, not of much use to breeders, since it cannot be perpetuated from generation to generation. The study of genetic variability was made for the first time by the great biologist (Fisher, 1918) and subsequently the estimates of genotypic and phenotypic variations were used to predict the expected genetic response.

The phenotypic and genotypic coefficients of variation were calculated according to the formula of given by (Burton 1952). Subsequently a number of other workers have also discovered several techniques for the estimation of components of variance (Lush, 1940) and (Robinson *et al.* 1966)

Verma *et al.* (2002) studied genotypic and phenotypic variation in 33 marigold germplasm and observed higher phenotypic coefficient of variation (PCV) than the genotypic coefficient of variation (GCV) in all the characters studied. The flower weight and plant canopy obtained high PCV (56.38 and 52.20) and GCV (53.84 and 51.42) and pedicel length obtained the lowest GCV (14.75).

Hegde and Gopinath (2003) in gaillardia, phenotypic coefficient of variation was higher than the genotypic coefficient of variation for all characters studied. The high genotypic and phenotypic coefficients of variation were obtained for number of ray florets per flower and dry weight of flowers. The highest heritability was recorded by number of leaves per plant, leaf area per plant, plant height and dry weight of flowers. High genetic advance was recorded for number of leaves and number of ray florets per flower.

Kumar and Patil (2003) evaluated of eleven genotypes of China aster for 14 quantitative characters. The high genetic advance as per cent of mean observed for plant spread (75.19%), flower yield per plant (73.25%) and average weight of fresh flower (58.78%), indicating additive gene action. While, time taken for first flower

bud initiation showed high genetic advance (21.63%), indicating non additive gene action.

Mishra *et al.* (2006) studied the genetic parameters in twenty cultivars of spray type chrysanthemum and showed wide range of variability for flower yield and other eight related quantitative characters. The phenotypic coefficient of variation (PCV) was found to be higher than the genotypic coefficient of variation (GCV) for all the quantitative characters.

Madhumita and Pal (2008) studied the natural growth habit of eight cultivars of chrysanthemum and estimated the extent of genetic variation for different growth and flowering characters. The minimum differences observed between phenotypic and genotypic coefficients of variation among the characters suggested the least influence of the environment on the characters.

Namita *et al.* (2008) studied 11 genotypes of French marigold (*Tagetes patula*) and found that the PCV was higher than GCV, which indicated greater genotypic environment interaction (GxE). However, high genotypic (GCV= 40.23) and phenotypic (PCV= 42.70). Heritability estimated for all the characters were generally moderate to high. The coefficients of variation were found for number of flowers per plant followed by flower weight (GCV=37.85, PCV= 42.63) and flower yield (GCV=29.30, PCV= 32.46).

Singh and Mishra (2008) reported that mean squares of treatments were significant for most of the characters indicating varietal differences for all the characters in marigold. The estimates of phenotypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (GCV) for all the 31 characters under consideration. Highest range of variation was reported with numbers of leaves per plant.

Baskaran *et al.* (2009) reported high phenotypic and genotypic coefficients of variation in ten genotypes of chrysanthemum for traits like number of suckers per plant (GCV = 90.13, PCV = 95.67) and flower disc diameter (GCV =63.19, PCV = 66.76).

Kavitha and Anburani (2010) studied the genetic variability in African marigold and the values of phenotypic and genotypic coefficient of variation of the maximum number of flowers per plant (GCV= 40.57, PCV=41.72%) and plant height

(35.88) and number of lateral branches (43.12) and flower size parameters (53.17) and days to first flowering (27.22) and dry matter production (81.26).

Pal and Kumar (2010) studied genetic variability in seventeen genotypes of marigold and reported that coefficient of variation was the minimum for duration of flowering (GCV=13.27, PCV=13.33) and the maximum for seed yield per plant (GCV=53.57, PCV=53.61). The high heritability along with high genetic advance (268.83) was observed for fresh weight of flowers per plant, seed yield per plant (19.20), number of flowers per plant (33.43), days commencement to flowering (20.93) and plant spread (20.11) at peak flowering period. However, moderates to low genetic advance along with high heritability (3.50) were observed for flower stalk length and flower diameter (2.54).

Kumari *et al.* (2011) studied genetic variability in five genotypes of gerbera reported that phenotypic and genotypic coefficient of variation were highest for the number of flowers per plant (PCV = 41.78%, GCV = 40.96%) and leaf area index (PCV = 44.79%, GCV = 38.44%) and reported that highest heritability (98.90%) was found in number of flowers per plant followed by number of leaves per plant (88.00%), flower stalk diameter (84.80%), flower diameter (80.60%), flower stalk length (76.80%) and plant height (71.70%). The highest genetic advance was observed in number of leaves per plant (9.03) followed by plant height (8.42), flower stalk length (6.48), number of flowers per plant (5.71).

Vikash *et al.* (2011) reported that in fourteen characters in dahlia, the phenotypic coefficients of variation (PCV) were higher than genotypic coefficients of variation (GCV) in dahlia for all the characters studied. However, higher PCV and GCV estimates were found for stalk length of the flower, duration of flowering, number of ray florets/flower and individual flower weight. The high heritability with high genetic advance was observed for vase life, diameter of flower, stalk length of the flower and individual flower weight.

Sapna *et al.* (2013) assessed the twenty one genotypes of marigold (*Tagetes erecta* L.) for 16 quantitative traits. The results revealed that, flower yield per plant (genotypic) was found to be positively correlated with plant height, flowering duration, number of flowers per plant and flower diameter.

Senapathi *et al.* (2013) studied the twelve genotypes of gerbera to determine genetic variability and the genotypic and phenotypic coefficient of variation among flowering parameters are hollowness of the stalk (29.33% GCV and 29.52% PCV), number of flowers per plant (23.28% GCV and 23.46% PCV) and also reported that genetic advance and genetic advance as per cent of mean for various traits are number of flowers per plant (12.85%, 47.58%), flower diameter (1.38%, 14.00%), stalk diameter (1.38%, 42.72%) and stalk length (13.72%, 25.66%) and vegetative traits plant height (7.76%, 16.68%), leaf area (33.44%, 29.20%) respectively in gerbera.

Khangjarakpam *et al.* (2014) studied the genetic variability for quantitative traits in China aster and reported that phenotypic coefficient of variation higher than genotypic coefficient of variation for all the characters like plant height (PCV = 23.68%, GCV = 23.19%), plant spread (PCV = 27.71%, GCV = 27.37%), weight of flowers per plant (PCV = 45.97%, GCV = 45.55%) and highest genetic advance as per cent mean was observed in weight of flowers per plant (92.17%) followed by flower stalk length (88.23%) and lowest was recorded in flowering duration (3.35%).

Kumar *et al.* (2014) studied genetic variability in ten varieties of French marigold (*Tagetes patula* L.) and found phenotypic coefficients of variation (PCV) higher than their corresponding genotypic coefficients of variation (GCV). The yield of flowers per plant exhibited highly significant and positive correlation with number of primary branches (0.862), number of secondary branches (0.738), number of flowers per plant (0.862) and flower weight (0.732).

Singh *et al.* (2014) evaluated twenty one genotypes of African marigold were (*Tagetes erecta* L.) their genetic parameters higher genotypic and phenotypic coefficient of variation found for most of all for all traits. The high value (>90%) of heritability was observed for all traits except plant height, plant spread and stem girth. The high values of genetic advance as per cent of mean were recorded for number of flowers (59.79%).

Yuvraj and Dhatt (2014) reported that high variability in twenty three marigold genotypes was observed the highest value of phenotypic coefficients of variation (PCV) and genotypic coefficients of variation (GCV) for number of flowers per plant (117.95% and 116.50%, respectively). The estimates of genetic advance were comparatively the maximum for number of flowers per plant (237.02%), followed by flower yield per plant (105.37%).

Kumar (2015) studied genetic variability and character association among quantitative traits in gerbera and reported that highest phenotypic coefficients of variation (PCV) and genotypic coefficients of variation (GCV) recorded (17.55%, 16.82% respectively) in leaf breadth followed by disc diameter (16.25%, 16.16% respectively) and days to first flower opening (9.26%, 6.57%, respectively). The maximum genetic advance was recorded in plant spread (E-W) (8.28%) followed by leaf breadth (5.07%) and the minimum (4.84%) recorded in leaf length. The maximum genetic advance as per cent of mean (31.85%) was recorded in leaf breadth and the minimum was seen in plant spread (E-W) (12.77%) among the vegetative parameters.

Tamut *et al.* (2015) studied nineteen germplasms of gaillardia and observed significant variation among them. The phenotypic coefficients of variation (PCV) were higher than the genotypic coefficients of variation (GCV) for all the characters studied.

Vishnupriy *et al.* (2015) studied on genetic variability in African marigold (*Tagetes erecta* L.) and reported highest (33.40% PCV, 28.60% GCV) number of primary branches, single flower weight, flower compactness and total flower weight per plant 'Coimbatore Local Orange' × 'Siracole'. The highest heritability with high genetic advance as per cent mean was observed in the number of flowers per plant and single flower weight.

Rai *et al.* (2017) studied genetic variability in ten cultivars of China aster (*Callistephus chinensis* (L.) Nees) and reported that phenotypic and genotypic coefficient of variation were highest for plant height (PCV = 34.26%, GCV = 34.07%), plant spread (PCV = 31.66%, GCV = 30.71%) and reported that highest heritability (98.90%) was found in plant height and plant spread (94.04%). The highest genetic advance observed in weight of flowers per plant (57.15%) and followed by plant height (46.32%), plant spread (24.05%) and days to first flower opening (20.81%).

Singh *et al.* (2017) evaluated twelve genotypes of gladiolus to twenty seven contributing characters. The high value of PCV along with GCV indicated that there was more variability in the characters like, spikes diameter (PCV = 11.91%, GCV = 8.53%), duration of flowering (PCV = 21.13%, GCV = 14.81%), number of side spikes per plant (PCV = 236.29%, GCV = 233.76%), number of florets remaining

open (5.31 days) and number of florets remaining unopened (1.83). The high heritability with high values of genetic advance was observed for rachis length (46.32 cm), spike length (87.18 cm) and number of florets per spike (14.66).

2.3 CORRELATION AND PATH COEFFICIENT ANALYSIS:

A knowledge on correlation between different characters indicate the association between the character under study. The path analysis provides information and direct and indirect effect and provide a basis for planning more efficient breeding programmes.

The concept of path coefficient analysis was originally developed by (Wright, 1921) but the technique first used for plant selection by Dewey and Lu (1959). Path analysis is simply standardized by partial regression coefficient, which splits the correlation coefficients into the measures of direct and indirect effects of a set of independent variables on the dependent variable. Path analysis is carried out using the estimates of correlation coefficients.

Mathad *et al.* (2005) studied on correlation and path coefficient analysis in African marigold revealed that, flower yield per plant had significantly positive correlation with plant height, number of branches, plant spread, duration of flowering, number of flowers per plant, flower weight, flower diameter, number of seeds per flower head and seed yield per plant. The maximum positive direct effect on flower yield was shown by flower weight, seed yield per plant and plant height.

Mathew *et al.* (2005) studied on the correlation and path analysis in marigold and revealed that, number of flower buds and fresh weight of the flower showed highest positive direct effect while number of branches showed the lowest positive direct effect on flower yield. Similarly number of flowers per plant and flower yield showed the highest positive direct effect.

Poornima *et al.* (2006) reported that per plant in China aster significantly and positively associated with the plant spread, number of branch per plant and number of leaf per plant. A significant and positive correlation was observed between the flower diameter (11.77, 14.09) and weight of 25 flowers (33.49, 36.92) both at genotypic and phenotypic levels. The plant height and flower yield per plant had high total direct on the stalk length.

Karuppaiah and Kumar (2011) evaluated 34 genotypes of African marigold to assess association of yield components on flower yield, their relationship and the direct and indirect effect of yield components on flower yield. Number of branches per plant was highly significant to plant height (0.509) and stem girth (0.506) and flower yield was found to be significantly and positively correlated with number of branches per plant (0.298), flower head size (0.432), flower head weight (0.469) and number of flowers per plant (0.611).

Vikash *et al.* (2011) studied the association between fourteen vegetative and floral parameters along with their magnitude towards number of flowers per plant in twenty five accessions of dahlia by correlations and reported that, number of flowers per plant had positive and highly significant correlation with plant height, number of leaves, leaf area, stem girth, number of days for flower bud initiation, number of days for flowering, diameter of flower, number of ray florets per flower, individual flower weight, longevity of flower and vase life. Since these associations are in desirable direction and selection of these traits may ultimately improve the yield.

Anuja and Jahnvi (2012) studied the genotypic and phenotypic correlation and path coefficient analysis in fifteen genotypes of French marigold (*Tagetes patula* L.) for seven characters. The positive and significant correlation was recorded for flower yield per plant with stem girth, flower head diameter and number of flower per plant. The significant and positive direct effect path analysis recorded for flower yield per plant with flower head diameter, days to first flowering and number of flowers per plant.

Kumar *et al.* (2012) studied the correlation and path analysis in 24 genotypes of chrysanthemum for different yield attributing traits. The results indicated that the primary branches per plant (0.790), plant spread (0.516) and flowering duration (0.415) showed positive significant correlation with number of flowers per plant at both genotypic and phenotypic levels.

Misra *et al.* (2013) evaluated twenty five germplasm of spray chrysanthemum to determine correlation and path coefficient. Number of primary branches per plant was highest correlation (0.998) followed by number of secondary branches per plant (0.997) and number of leaves per plant (0.997). Path coefficient analysis revealed that number of primary branches per plant, the highest direct effect on flower yield

(0.6010) followed by number of secondary branches per plant (0.2452) and number of leaves per plant (0.1631).

Bharathi *et al.* (2014) studied 28 genotypes of African marigold to determine association between different quantitative traits of genotypes collected from various sources. The positive and significant correlation recorded for flower yield per plant with plant height (0.64), stem girth (0.60), number of flowers per plant (0.53), flower size (0.70), single flower weight (0.69) and number of petals per flower (0.52). Path analysis was funded the maximum direct effect in total duration (0.77), number of flowers per plant (0.56), flower size (0.51), single flower weight (0.38) and number of harvest per plant (0.21).

Kumar (2014) reported that genotypic and phenotypic level number of leaves per plant exhibited positive significant correlation with number of flowers per sq. m per year (0.504 and 0.451). Length of leaf was also highly significant and positive correlation with flower stalk length (0.582, 0.573), days to harvest stage after flower open (0.568, 0.554), and number of ray florets (0.544, 0.527) at both genotypic and phenotypic, respectively in gerbera.

Singh *et al.* (2014) studied the genetic correlation and path coefficient analysis in twenty one genotypes of African marigold (*Tagetes erecta* L.) were path coefficient analysis revealed that the number of primary branches per plant contributed highest and has significantly positive direct effect on fresh flower weight per plant.

Vetrivel *et al.* (2014) reported that the chrysanthemum (*Dendranthema grandiflora* Tzelev.) number of flower buds per plant shows highly positive significant correlation with number of leaves at harvest stage (0.726, 0.724), plant height at harvest stage showed positive correlation with flower bud diameter (0.774, 0.771) flower stalk length (0.616, 0.676), weight of cut stem (0.558, 0.612) and flower stalk girth (0.548, 0.595). Positive correlation were recorded between number of leaves at harvest stage with number of flower stalks per square meter (0.745, 0.724) and number of flower buds per plant (0.726, 0.724).

Tirakannanavar *et al.* (2015) studied on genotypic evaluation and correlation studies of ten China aster genotypes and reported that among the growth parameters, flower yield per plant is positively and significantly correlated with plant height (0.674, 0.670), plant spread (0.884, 0.880), number of primary branches (0.607,

0.603), days for commencement for flowering (0.852, 0.849), days for 50% flowering (0.552, 0.550), number of flowers per plant (0.844, 0.840) both phenotypic and genotypic correlation coefficient respective.

Arulmani *et al.* (2016) studied the correlation in gaillardia (*Gaillardia pulchella* Foug.). The leaf area highly significant and positively correlated with plant height (0.800), plant spread (E-W) (0.811), plant spread (N-S) (0.748,) and stem girth (0.666). Flower yield per plant was significantly and positively correlated with number of flower per plant (0.812, 0.842) and number of flowers per plot (0.725, 0.801) for both phenotypic and genotypic correlation coefficient respective.

Manjula and Nataraj (2016) studied the genetic correlation and path coefficient analysis of twenty five genotypes of dahlia (*Dahlia variabilis* L.) for different quantitative and qualitative characters. Flower yield per plant significantly and positively correlated and path analysis with plant height at 120 DAT (0.614, 0.962), number of branches per plant at 120 DAT (0.806,), duration of the crop (0.195), flower weight (0.206, 1.034), flower diameter (0.224), stalk length (0.549, 0.253), tuber weight (0.453, 0.194), number of tuber per plant (0.537, 0.353) and vase life (0.234, 0.285).

Suvija *et al.* (2016) studied the correlation and path analysis of 58 genotypes of chrysanthemum for different yield attributing traits. Flower yield per plant significantly and positively correlated with plant height, plant spread, stem girth, number of flowers per plant, flower diameter, number of ray florets, shelf life, individual flower weight and flower yield per plant respectively.

Singh *et al.* (2017) studied the correlation co-efficient in twelve genotypes of gladiolus (*Gladiolus hybridus* Hort.) for twenty seven characters. Spike length was highly positive association with rachis length (0.92, 0.88), floret diameter (0.94, 0.0.74), spike diameter (0.66, 0.50), duration of flowering (0.71, 0.42), number of florets per spike (0.89, 0.84), number of cormels per plant (0.69, 0.65), diameter of corm (0.48, 0.41), weight of corm (0.44, 0.40), weight of cormels per plant (0.20, 0.19), size index of corms (0.41, 0.38), florets remaining open at a time in vase (0.56, 0.33). At both genotypic and phenotypic levels, it was negative correlation with number of spikes per plot (-0.56, -0.48), number of corms per plant (-0.72, -0.50), number of corms per plot (-0.60, -0.54) and florets remaining unopened (-0.39, -0.37).

Chapter-3

MATERIALS AND METHODS

The present investigation entitled “**Studies on Genetic Variability in Gaillardia (*Gaillardia pulchella* Foug.)**” was carried out at the Instructional Farm, Department of Floriculture and Landscaping, College of Horticulture & Forestry, Jhalrapatan, Jhalawar, (Agriculture University, Kota) during the period from March, 2017 to September, 2017 to study the performance of twelve genotypes of gaillardia for growth, flowering, yield and quality parameters.

The details of the experiment, material used, methodology followed, statistical analysis and observations recorded during the course of investigation are described in this chapter under suitable heads.

3.1 GEOGRAPHICAL LOCATION OF THE EXPERIMENTAL SITE:

The experiment was laid out at the Instructional Farm of Department of Floriculture & Landscaping, College of Horticulture and Forestry, Jhalrapatan, Jhalawar at 316 m above mean sea level. Jhalawar falls in the South-Eastern Rajasthan and extends over 6.32 lakh hectares of land area between 23°4’ to 24°52’ North latitude and 75°29’ to 76°56’ East longitude. Agro-climatically the district falls in Zone-V known as Humid South- Eastern Plain of Rajasthan.

3.2 CLIMATE OF EXPERIMENTAL SITE:

The climate of the zone is typically sub-humid & sub-tropical characterized by extremes of temperature in both summer and winter season, with high rainfall and moderate relative humidity. The average annual rainfall in the region is about 954.7 mm mostly received from South-West monsoon during June to September and sometimes scanty showers during winter season.

Meteorological data (Table 3.1) show that during the growing period of the crop the mean maximum and minimum temperature ranged between 45.72 °C and 5.66 °C while, the mean maximum and minimum relative humidity ranged from 91.34 and 25.57 per cent. The total amount of rainfall recorded was 773.03 mm. The mean weekly meteorological observations recorded during the crop growth period by the metrological department of Jhalawar are presented in Table 3.1.

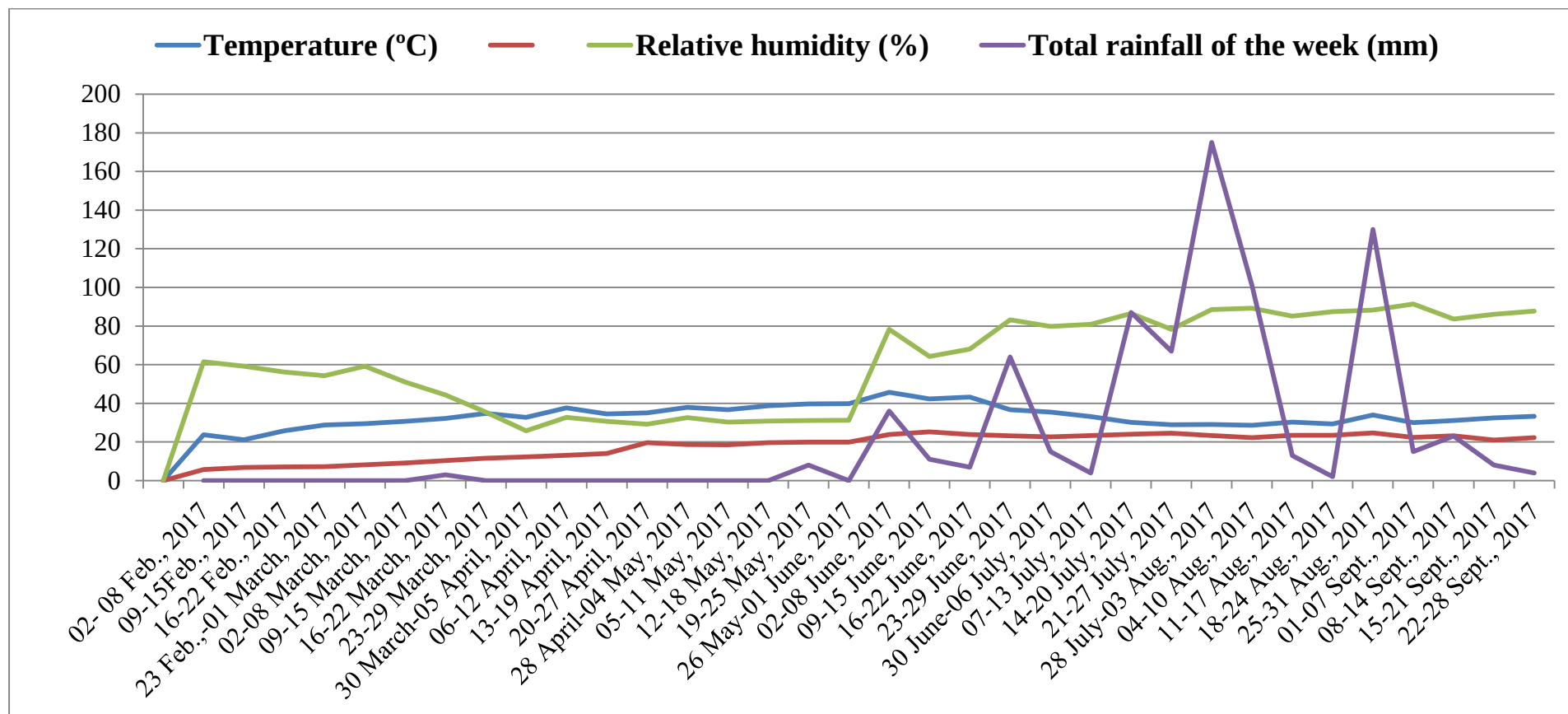
Table 3.1: Mean weekly weather data of crop growth period (February, 2017 to September, 2017)

Standard week number	Duration	Temperature (°C)		Relative humidity (%)	Total rainfall of the week (mm)
		Max.	Min.	Sum.	
6	02- 08 Feb., 2017	23.73	5.66	61.57	0.0
7	09-15Feb., 2017	21.17	6.82	59.17	0.0
8	16-22 Feb., 2017	25.79	7.05	56.14	0.0
9	23 Feb.,-01 March, 2017	28.77	7.24	54.28	0.03
10	02-08 March, 2017	29.42	8.15	59.14	0.0
11	09-15 March, 2017	30.76	9.16	51.00	0.0
12	16-22 March, 2017	32.14	10.32	44.37	3.0
13	23-29 March, 2017	34.80	11.61	35.48	0.0
14	30 March-05 April, 2017	32.69	12.24	25.75	0.0
15	06-12 April, 2017	37.66	13.14	32.79	0.0
16	13-19 April, 2017	34.52	14.02	30.65	0.0
17	20-27 April, 2017	35.02	19.67	29.23	0.0
18	28 April-04 May, 2017	37.98	18.69	32.64	0.0
19	05-11 May, 2017	36.67	18.54	30.35	0.0
20	12-18 May, 2017	38.69	19.65	30.89	0.0
21	19-25 May, 2017	39.75	19.92	31.06	8.0
22	26 May-01 June, 2017	39.86	19.96	31.23	0.0
23	02-08 June, 2017	45.72	23.90	78.28	36.0
24	09-15 June, 2017	42.25	25.20	64.19	11.0
25	16-22 June, 2017	43.28	23.86	68.13	7.0
26	23-29 June, 2017	36.72	23.15	83.25	64.0
27	30 June-06 July, 2017	35.52	22.60	79.85	15.0
28	07-13 July, 2017	33.20	23.35	80.95	4.0

29	14-20 July, 2017	30.15	24.03	86.46	87.0
30	21-27 July, 2017	28.95	24.60	78.26	67.0
31	28 July-03 Aug., 2017	29.07	23.36	88.54	175.0
32	04-10 Aug., 2017	28.58	22.30	89.22	101.0
33	11-17 Aug., 2017	30.35	23.43	85.19	13.0
34	18-24 Aug., 2017	29.29	23.46	87.39	2.0
35	25-31 Aug., 2017	33.97	24.71	88.27	130.0
36	01-07 Sept., 2017	30.03	22.34	91.34	15.0
37	08-14 Sept., 2017	31.08	23.23	83.67	23.0
38	15-21 Sept., 2017	32.46	21.04	86.13	8.0
39	22-28 Sept., 2017	33.26	22.27	87.75	4.0

Source: Meteorological Department, Jhalawar

Fig. 3.1 Mean weekly weather data of crop growth period (February, 2017 to September, 2017)



3.3 SOIL CHARACTERISTICS OF THE EXPERIMENTAL SITE:

The experimental site had black soil of the clay loam type with adequate drainage facility. In order to assess the physico-chemical properties of the experimental soil, the soil samples were drawn randomly from different spots in the experimental area at a depth of 10-15 cm before the commencement of the experiment. A representative sample was prepared and subjected to mechanical physical and chemical analyses. The results of analysis along with methods used for determination are presented in Table 3.2.

Table: 3.2 Physico-chemical properties of soil of the experimental field:

Properties		Value	Method employed
(A) Mechanical compositions			
1.	Sand (%)	23.67	Hydrometer method (Bouyoucos, 1927)
2.	Silt (%)	37.6	Hydrometer method (Bouyoucos, 1927)
3.	Clay (%)	39.8	Hydrometer method (Bouyoucos, 1927)
(B) Physical properties			
1.	Bulk density (Mg m^{-3})	1.40	Core sampler method (Piper, 1950)
2.	Particle density (Mg m^{-3})	2.65	Black (1965)
3.	Porosity (%)	43.2	Black (1965)
(C) Chemical properties			
1.	Organic carbon (%)	0.56	Walkley and Black (1934)
2.	Available Nitrogen (kg ha^{-1})	335.57	Alkali Permanganate method (Subbiah and Asija, 1956)
3.	Available phosphorus ($\text{P}_2\text{O}_5 \text{ kg ha}^{-1}$)	15.91	Olsen's method (Olsen <i>et al.</i> , 1954)
4.	Available Potassium ($\text{K}_2\text{O kg ha}^{-1}$)	216	Flame photometer method (Metson, 1956)
5.	EC (dSm^{-1} at 25°C)	0.98	Using solubridge (Jackson, 1973)

6.	pH (1 : 2, Soil : water suspension)	8.0	Potentiometric method using pH meter (Jackson, 1973)
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The soil of experimental site was clay loam in texture (black cotton), low in reaction and medium in respect to nitrogen, phosphorus and potassium content.

3.4 EXPERIMENTAL DETAILS:

3.4.1 Treatment details:

S.No.	Treatment	Treatment Combination	Source	Type
1.	T ₁	Genotype – 1	Indoor (M.P.)	Double
2.	T ₂	Genotype – 2	BUAT, Banda (U.P.)	Single
3.	T ₃	Genotype – 3	Chitradurga (Karnataka)	Semi Double
4.	T ₄	Genotype – 4	Amer (Jaipur, Raj.)	Double
5.	T ₅	Genotype – 5	Jamwaramgarh (Jaipur, Raj.)	Double
6.	T ₆	Genotype – 6	Pratapgarh (Alwar, Raj.)	Double
7.	T ₇	Genotype – 7	Jhalarapatan (Jhalawar, Raj.)	Double
8.	T ₈	Genotype – 8	Adar (M.P.)	Double
9.	T ₉	Genotype – 9	Ujjain-1 (M.P.)	Double
10.	T ₁₀	Genotype – 10	Rampura (Jaipur, Raj.)	Double
11.	T ₁₁	Genotype - 11	Ujjain-2 (M.P.)	Double
12.	T ₁₂	Genotype - 12	Jhunjhunu (Raj.)	Single

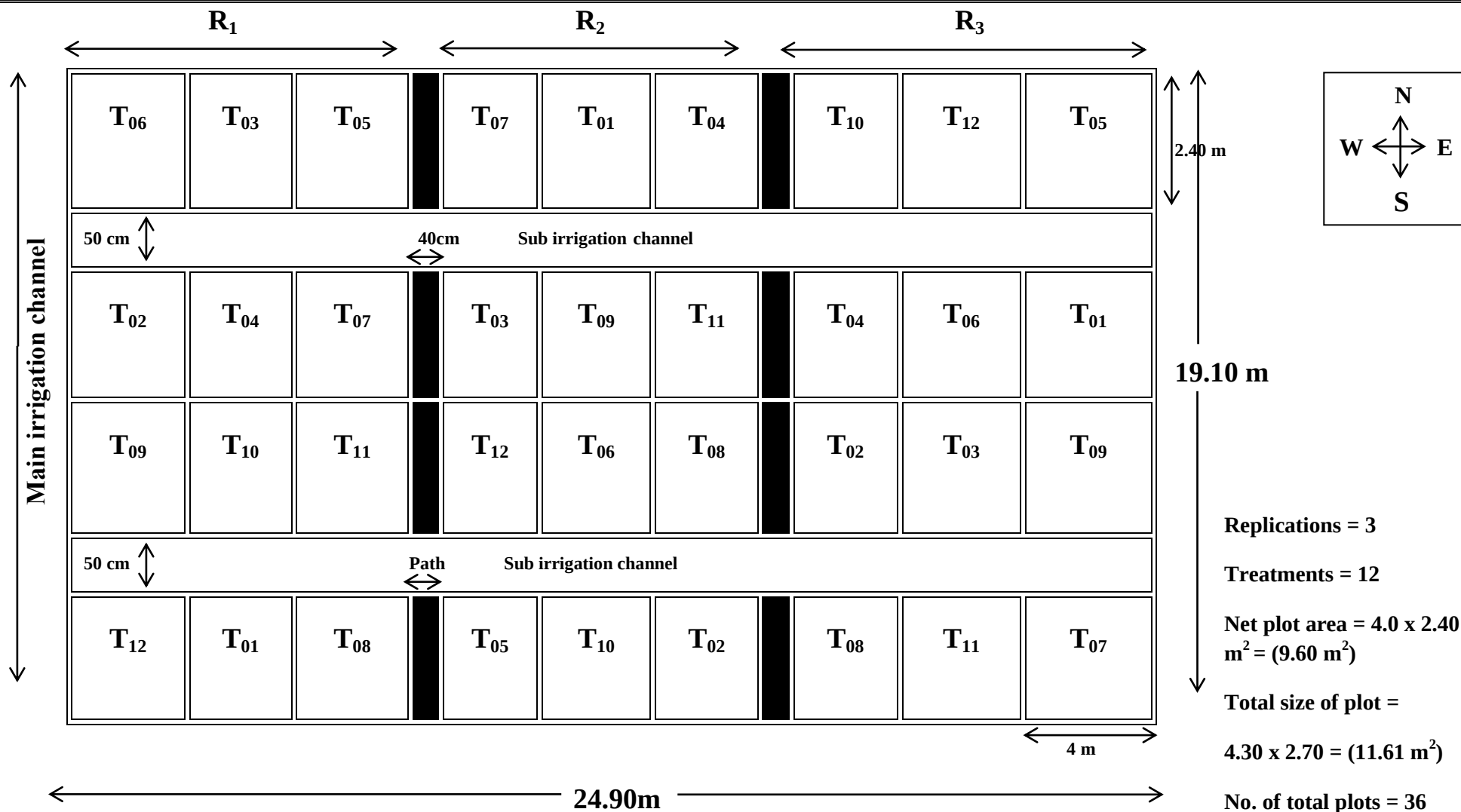


Fig. 3.1 The layout plan of the experiment

3.4.2 Design and layout:

Crop	Gaillardia (<i>Gaillardia pulchella</i> Foug.)
Genotypes	12 (Genotypes)
Spacing	40 cm x 30 cm (R× P)
Total number of treatments	12
Gross plot area	4.30 m × 2.70 m (11.61 m ²)
Net plot area	4.0 m × 2.40 m (9.60 m ²)
Total experimental field area	19.10 m × 24.90 m (458.16 m ²)
Replications	3
Total number of plots	36
Number of plants per plot	80
Total number of plants/m ² area	8
Experimental design	Randomization Block Design (RBD)
Date of seed sowing	2/02/2017
Date of transplanting	14/03/2017



Plate No. 1 (a) Seedling in polyhouse condition



Plate No. 1 (b) Seedling transplanting in main field

3.4.3 Planting materials:

Twelve genotypes of gaillardia used for the experiment. These genotypes were collected from various parts of Rajasthan, Madhya Pradesh, Uttar Pradesh and Karnataka state.

3.5 CULTURAL PRACTICES:

The details of various cultural operations carried out during the course of investigation are furnished below.

3.5.1 Raising seedling in nursery:

The seed was sown in well prepared raised nursery beds of convenient size 3m length, 1.5 m width, and 15 cm height from ground level under protected condition. Nursery beds are drenched with Bavistin (0.2 %). Seeds were sown on February 2, 2017 at depth of about 1.0 cm and then covered with thin layer of vermicompost and sand mixture. After seeds sowing, immediately watering with help of rose-cane for the first five days thereafter it was done at alternate days till the germination completed. The seed beds were kept free from weeds by regular weeding. Seedlings were maintained carefully up to 40 days till these seedlings were ready for transplanting.

3.5.2 Preparation of experimental field:

The experimental field was ploughed by MB plough to obtain fine tilth followed by two cross harrowing and was leveled by planking before making plots. All the stones and grass stubbles were collected manually and disposed out of the experimental area. The plots were prepared measuring 4.30 m in length and 2.70 m in width and 50 cm sub irrigation channel.

3.5.3 Transplanting:

Forty days old seedling uniform size of were transplanted before treat with Bavistin (0.2%) at a spacing of row to row 40 cm and plant to plant 30 cm (8 plants per sq meter). Light irrigation was given immediately after transplanting. The seedlings were irrigated regularly until establishment in the field. In each plot 80 plants were planted on March 14, 2017.

3.5.4 Manures and Fertilizers:

The well decomposed vermicompost at the rate of 5 kg per square meter was incorporated in the soil at the time of field preparation and addition to the recommended dose of fertilizer (RDF) 100 kg N, 80 kg P₂O₅ and 60 kg K₂O per hectare were applied in the form of urea, single super phosphate and muriate of potash, respectively. The balance amount of urea is applied in three split doses, the first dose consisted of one third nitrogen as basal application mixed in experimental plot soil at the time of transplanting along with full dose of P₂O₅ and K₂O were applied. The remaining two splits were applied as top dressing in the growing crop at 45 and 90 days after transplanting.

3.5.5 Gap filling:

Gap filling was done after one week of transplanting due to mortality of few seedlings. Seedlings for this purpose were taken from the reserve seedlings kept in the nursery beds.

3.5.6 Irrigation and weeding:

The crop was irrigated at an interval of 4-6 days throughout the period of experimentation, depending on the soil moisture status and prevailing climatic conditions. The experimental field was kept weed free by hand weeding at regular intervals of 25 to 30 days after transplanting.

3.5.7 Plant protection measures:

There no pests or diseases noticed in the experimental plot.

3.5.8 Harvesting of flowers:

The flowers were harvested from each treatment and replication when the ray and disc florets were fully opened and attained full size stage, were in early morning hours. Harvesting of flowers on the tagged plants in each treatment plot was done separately and carefully to note the required observations. After that, the harvested flowers were regularly marketed.

3.6 OBSERVATIONS RECORDED:

The following observations were recorded at different stages of plant growth from randomly selected five plants from each treatment and replications. The mean value of the data obtained from five tagged plants in each treatment was worked out to represent particular genotype with respect to a particular character.

3.6.1 VEGETATIVE PARAMETERS:

3.6.1.1 Plant height (cm):

The plant height was measured from the base of the plant to the tip of the plant at the final vegetative growth stage in each of five tagged plants in centimeters with the help of meter scale and average was worked out.

3.6.1.2 Number of branches per plant:

The number of primary branches arising from the main stem of each tagged plants at 90 days after transplanting (DAT) was counted and averages were calculated.

3.6.1.3 Plant spread (cm):

The plant spread was measured of the five tagged plants with help of meter scale and expressed in centimeters at the stage of final vegetative growth stage and average was calculated.

3.6.1.4 Plant fresh weight (g):

Fresh weight of five tagged plants was taken with the help of digital balance and average value recorded.

3.6.1.5 Plant dry weight (g):

Five tagged plants were selected for fresh weight put under sun for drying for five days and then temperature at 62 °C in oven till constant weight achieved. These dried plants were weighed in gram and average dry weight of plant was recorded.

3.6.1.6 Leaf length (cm):

The leaf length of third leaf of third primary branches at the stage of 90 days after transplanted was measured from five tagged plants with help of wooden scale and expressed in centimeters and average was calculated.

3.6.1.7 Leaf width (cm):

The leaf width of third leaf of third primary branches at the stage of 90 days after transplanted was measured from five tagged plants with help of wooden scale and expressed in centimeters and average was calculated.

3.6.2 FLOWERING PARAMETERS:

3.6.2.1 Days taken to first flower opening:

The days taken to first flower opening was counted from the date of transplanting to first flower opening on the each tagged plants and average days was calculated for each treatment.

3.6.2.2 Days taken to 50 per cent flowering:

The days taken to 50 per cent flowering of plants to produce flowers were recorded from each tagged plants by counted the days from the date of transplanting.

3.6.2.3 Flower diameter (cm):

The diameter of flower in five tagged plants of each treatment was measured by digital vernier calipers and average was calculated and expressed in centimeters.

3.6.2.4 Flower stalk length (cm):

The length of flower stalk was recorded by randomly selected flowers from the tagged plants and measured in centimeters with help of meter scale and then average value calculated.

3.6.2.5 Fresh flower weight (g):

The fresh weight of flower, produced by five tagged plant, 100 flower of each plot was weighed in kg of a digital weighing balance and then averaged mean was calculated.

3.6.2.6 Duration of flowering (days):

The duration of flowering was counted from the date of first flower opening to the date of final flower harvesting for each treatment plot and then the duration of flowering was counted in days.

3.6.2.7 Number of disc florets per flower:

The number of disc florets was counted from five randomly selected flowers from the each tagged plants then average was calculated.

3.6.2.8 Number of ray florets per flower:

The number of ray florets was counted from five randomly selected flowers from the each tagged plants then average was calculated.

3.6.2.9 Number of whorls of ray florets:

The number of whorls of ray florets was counted from five randomly selected flowers from the each tagged plants then average was calculated.

3.6.2.10 Length of ray floret (cm):

The length of ray floret was measured from five randomly selected flowers from the five tagged plants by measured with help of wooden scale in centimeters then average was calculated.

3.6.2.11 Width of ray floret (cm):

The width of ray floret was measured from five randomly selected flowers of the five tagged plants with help of wooden scale in centimeters and then average was calculated.

3.6.2.12 Colour of flower:

Flower colour was determined by using the Royal Horticulture Society (RHS) Colour chart.

3.6.2.13 Flower disc colour:

Disc colour was determined by using the Royal Horticulture Society (RHS) colour chart.

3.6.2.14 Type of ray floret:

The type of ray florets was determined in flower into two types flat and tubular.

3.6.2.15 Shelf life of flower (hours):

The shelf life of flowers was measured by counting the fully opened flowers after harvest keeping in plate under laboratory conditions at the average temperature 35.56 °C and relative humidity 49.22 per cent. Number of hours was counted until the flowers lost their marketable quality.

3.6.2.16 *In-situ* flower life (days):

The *in-situ* life of flowers was counted from the days taken from opening of flower bud to the beginning of withering of lower most florets in the field to represent longevity of flower *in-situ* for each tagged plants and the averages were calculated.

3.6.3 YIELD PARAMETERS:

3.6.3.1 Number of flowers per plant:

The number of flowers produced in each tagged plant was recorded and then average number of flowers produced per plant calculated for different genotypes.

3.6.3.2 Weight of flowers per plant (g):

The weight of flowers per plant was calculated the average weighted of fresh flower multiplied by number of total flowers per plant and this constituted the flower yield per plant and expressed in grams.

3.6.3.3 Weight of flowers per plot (kg):

The weight of flowers per plot was calculated the average weighted of flowers per plant to the multiplied by total number of plants per plot and this constituted the flower yield per plot and expressed in kilogram.

3.6.3.4 Number of flowers/pluckings:

The total number of flower plucked was counted from first flower harvesting to the final harvesting of flower by each tagged plants and then averages were calculated.

3.6.3.5 Estimated flower yield (q/ha):

The estimated yield per hectare of flowers was calculated in quintals on the basis of flower weight obtained from the each plots and computed for hectare area.

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

3.7 STATISTICAL ANALYSIS:

The statistical analysis of the data obtained during the course of investigation was done by following statistical models as under.

3.7.1 Analysis of variance:

The data obtained for each character were subjected to analysis of variance for randomized block design as per Panse and Sukhatme (1967).

The analysis was based on the following linear model.

$$Y_{ij} = \mu + G_i + R_j + E_{ij}$$

Where,

- Y_{ij} = Yield of i^{th} genotype in j^{th} replication.
- μ = General mean.
- G_i = Effect of i^{th} genotype.
- R_j = Effect of j^{th} replication.
- E_{ij} = Experimental error (uncontrolled variation) associated with i^{th} genotype in j^{th} replication.

Table 3.3: Analysis of variance for experimental design

Source	d.f	S.S	M.S	E.M.S	F ratio
Replication	(r-1)	S_r	M_r	$\sigma_e^2 + r\sigma_r^2$	M_r/M_e
Genotypes	(g-1)	S_g	M_g	$\sigma_e^2 + r\sigma_g^2$	M_g/M_e
Error	(r-1) (g-1)	S_e	M_e	σ_e^2	
Total	(rg-1)	S_t			

where,

d. f.	=	degrees of freedom
SS	=	sum of squares
MS	=	mean sum of squares
R	=	number of replications
G	=	number of genotypes
σ^2_e	=	error variance
σ^2_g	=	genotypic variance

3.7. 2 Estimation of variability parameters

3.7.2.1 Genetic variance

It is the variance contributed by genetic causes or the genetic occurrence of difference among the individuals due to their genetic makeup. It was calculated by using the formula.

$$V_g = \frac{MSV - V_E}{r}$$

Where,

V_g	=	Genotypic variance
MSV	=	Mean square for variation
V_E	=	Error mean square
r	=	Number of replications

3.7.2.2 Phenotypic variance:

It is the sum of variance contributed by genetic causes and environmental factors and was computed as:

$$V_p = V_g + V_e$$

Where,

V_p	=	Phenotypic Variance,
V_g	=	Genotypic Variance
V_e	=	Error Variance

3.7.2.3 Genotypic coefficient of variation (GCV)

The magnitude of genetic variation existing in a character was estimated by the formula given by Burton (1952).

$$GCV = \frac{\sqrt{V_g}}{\bar{X}} \times 100$$

Where,

V_g = Genotypic Variance and

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

3.7.2.4 Phenotypic coefficient of variation (PCV)

The magnitude of phenotypic variation existing in a character was estimated by using the following formula:

$$PCV = \frac{\sqrt{V_p}}{\bar{X}} \times 100$$

Where,

V_p = Phenotypic variance and

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

3.7.2.5 Heritability

Heritability in the broad sense was calculated by using the following formula as proposed by Burton and Devane (1953).

$$H = \frac{V_g}{V_p} \times 100$$

Where,

H = Heritability (Broad sense)

V_g = Genotypic variance and

V_p = Phenotypic variance

3.7.2.6 Expected genetic advance:

Expected genetic advance was measured by the formula as proposed by Lush (1949).

$$GA = \frac{V_g}{V_p} = \sqrt{V_p} \times K$$

$$= \frac{V_g}{\sqrt{V_p}} \times K$$

Where,

GA	=	Genetic advance
V_g	=	Genotypic variance
V_p	=	Phenotypic variance and
K	=	Selection differential (constant) i.e. 2.06 at 5% selection intensity (Allard, 1960).

3.7.2.7 Genetic advance

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

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

Where,

V_g = genotypic variance

V_p = 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.

$$GG = \frac{GA}{\bar{X}} \times 100$$

Where,

GA	=	Genetic advance
$\bar{X}$	=	General mean of the character under

3.7.3 Correlation studies:

Simple correlation between characters like plant height, number of primary branches, plant spread, plant fresh weight, plant dry weight, leaf length, leaf width, days to taken first flower opening, days taken to 50 per cent flowering, flower diameter, flower stalk length, fresh flower weight, duration of flowering, number of disc florets per flower, number of ray florets per flower, number of whorls per flower, length of ray floret, width of ray floret, shelf life of flower, *in-situ* flower life, number of flowers per plant, weight of flowers per plant, weight of flower per plot, number of flower plucking and estimated flower yield per hectare were worked out. Correlation co-efficients were tested by referring to correlation values (Fisher and Yates, 1963).

3.7.3.1 Phenotypic and genotypic correlation coefficient:

Simple correlation co-efficient pertaining to the phenotype and genotype for characters were computed as per method as suggested by Searle (1961).

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

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

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

3.7.4 Path coefficient analysis

The concept of path coefficient analysis developed by Wright (1921) and illustrated by Dewey and Lu (1959) was carried out separately to know the direct and indirect effects of the important components, which are the standardized partial regression. Coefficients were obtained by solving the following set of 'p' simultaneous equations through the use of 'Doo-little techniques' as given by Goulden (1959).

$$P_{01} + P_{02}r_{12} + \dots + P_{0p}r_{1p} = r_{01}$$

$$P_{01}r_{12} + P_{02} + \dots + P_{0p}r_{2p} = r_{02}$$

$$P_{01}r_{1p} + P_{02}r_{2p} + \dots + P_{0p} = r_{0p}$$

Where $P_{01}, P_{02}, \dots, P_{0p}$ are the direct path effects of 1, 2, $\dots, p$

Variables between dependent variable and independent variable and $r_{01}, r_{02}, \dots, r_{0p}$ are the correlation coefficients between dependent variable and independent variable. The indirect effect of ' i^{th} ' variable through ' j^{th} ' variable was worked out as $P_{0j} \times r_{ij}$.

The contribution of the remaining unknown factors is measured as the residual factor and calculated as

$$P_{0x}^2 = 1 (P_{01}^2 + 2P_{01}P_{02}r_{12} + 2P_{01}P_{03}r_{13} + \dots + P_{02}^2 + 2P_{02}P_{03}r_{23} + \dots + P_{0p}^2)$$

$$\text{Residual factor} = \sqrt{P_{0x}^2}$$

The direct and indirect effects were classified based on the scale given by Lenka and Misra (1973).

More than 1.0 - Very high

0.30 to 0.99 - High

0.20 to 0.29 - Moderate

0.10 to 0.19 - Low

0.000 to 0.009 – Negligible





Plate No. 2 Over all view of the experimental field

Chapter-4

EXPERIMENTAL RESULTS

The experimental results of present investigation entitled “**Studies on Genetic Variability in Gaillardia (*Gaillardia pulchella* Foug.)**” with respect to vegetative growth, flowering, yield, genetic variability, correlation studies and path coefficient analysis parameters are presented in this chapter. The data recorded for various characters under study were subjected to statistical analysis for comparison and interpretation of results. The analyzed results have been presented in tables and supporting graphical presentations of data have also been given for easy comparison. The analysis of variance Tables for different characters have been inducted as appendices (I to XXVI) at the end.

4.1 VEGETATIVE PARAMETERS

4.1.1 Plant height (cm)

The analyzed data of plant height of different genotypes have been presented in Table 4.1 and Fig. 4.1. The plant height ranged from 67.93 cm to 81.03 cm with a mean of 75.22 cm. The maximum plants height (81.03 cm) was recorded in the ‘Genotype-3’ which was followed by ‘Genotype-7’ (79.03 cm), while the minimum (67.93 cm) was recorded in ‘Genotype-12’. A close view of the data also exhibit that the maximum plant height recorded in ‘Genotype-3’ (81.03 cm) was at par to ‘Genotype-7’ (79.03 cm) whereas significantly taller as compared to rest of the genotypes. Similarly the minimum plant height recorded in ‘Genotype-12’ (67.93 cm) was at par to ‘Genotype-5’ (71.40 cm).

The genotypes ‘Genotype-1’ (78.40 cm), ‘Genotype-11’ (78.26 cm), ‘Genotype-2’ (75.86 cm), ‘Genotype-8’ (75.49 cm), ‘Genotype-6’ (74.86 cm) and ‘Genotype-10’ (73.60 cm) were observed to be of medium height group.

4.1.2 Number of primary branches

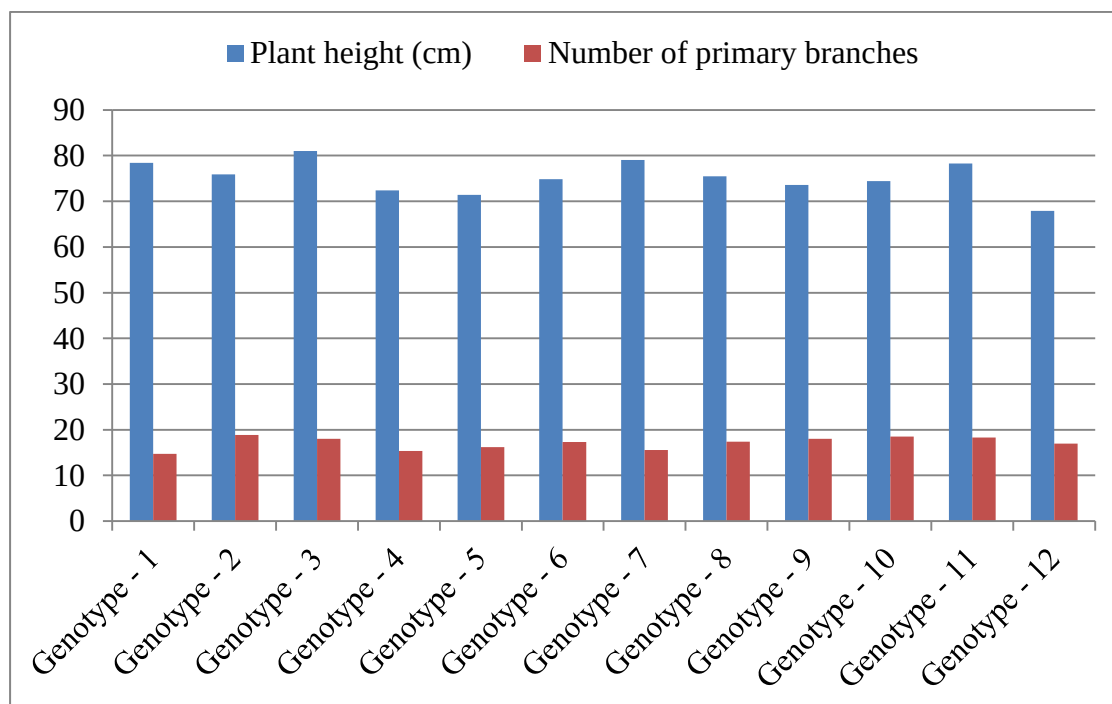
The data showed that highly significant differences among the genotypes for number of primary branches per plant (Table 4.1 and Fig 4.1). The number of primary branches per plant among the different genotypes ranged from 14.73 to 18.87 with a mean value of 17.10. The genotype ‘Genotype-2’ produced the maximum number of primary branches per plant (18.87) being at par with ‘Genotype-10’ (18.53) whereas ‘Genotype-1’ produced the minimum number of primary branches per plant (14.73).

The genotypes ‘Genotype-2’ (18.87), ‘Genotype-10’ (18.53), ‘Genotype-11’ (18.33), ‘Genotype-3’ (18.00), ‘Genotype-9’ (18.00) ‘Genotype-8’ (17.40) ‘Genotype-6’ (17.33) more number of primary branches per plant than the mean value (17.10), whereas ‘Genotype-12’ (16.93), ‘Genotype-5’ (16.20), ‘Genotype-7’ (15.53), ‘Genotype-4’ (15.33) and ‘Genotype-1’ (14.73) less number of primary branches per plant compared to mean value.

Table 4.1 Performance of gaillardia genotypes with respect to plant height (cm) and number of primary branches

S. No.	Name of genotypes	Plant height (cm)	Number of primary branches
1.	Genotype – 1	78.40	14.73
2.	Genotype – 2	75.86	18.87
3.	Genotype – 3	81.03	18.00
4.	Genotype – 4	72.39	15.33
5.	Genotype – 5	71.40	16.20
6.	Genotype – 6	74.86	17.33
7.	Genotype – 7	79.03	15.53
8.	Genotype – 8	75.49	17.40
9.	Genotype – 9	73.60	18.00
10	Genotype – 10	74.40	18.53
11.	Genotype – 11	78.26	18.33
12.	Genotype – 12	67.93	16.93
	Mean	75.22	17.10
	SEm±	0.70	0.31
	CD 5%	2.06	0.93

Fig.4.1 Performance of gaillardia genotypes with respect to plant height (cm) and number of primary branches



4.1.3 Plant spread (cm)

The analyzed data of plant spread of different genotypes of gaillardia have been presented in Table 4.2 and Fig. 4.2. The range was observed from 62.69 to 73.70 cm with an average value of 67.52 cm. The highest plant spread (73.70 cm) was recorded in the genotype ‘Genotype-6’ followed by genotype ‘Genotype-5’ (73.31 cm), while the lowest plant spread recorded in ‘Genotype-10’ (62.69 cm) was at par to ‘Genotype-7’ (63.40 cm) and ‘Genotype-11’ (63.75 cm). The genotypes ‘Genotype-2’ (69.95 cm), ‘Genotype-12’ (68.54 cm), ‘Genotype-4’ (68.47 cm), ‘Genotype-1’ (68.29 cm), ‘Genotype-3’ (66.54 cm), ‘Genotype-8’ (66.27 cm) and ‘Genotype-9’ (65.33 cm) observed to be of medium spread group.

4.1.4 Plant fresh weight (g)

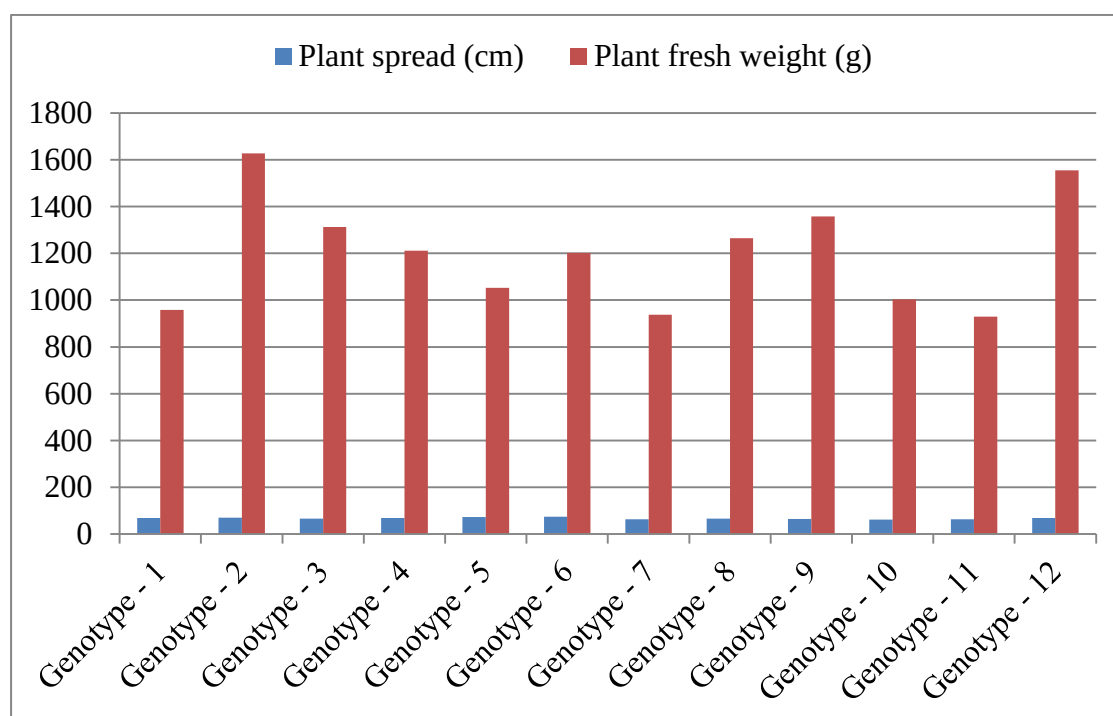
The data presented in Table 4.2 and Fig. 4.2 showed that fresh weight of plant had significant differences among the genotypes. The variations in fresh of weight plant in different genotypes ranged from 929.33 to 1626.93 g with a mean of 1200.79 g. The maximum fresh weight of plant was recorded in ‘Genotype-2’ (1626.93 g) followed by ‘Genotype-12’ (1554.00 g) and ‘Genotype-9’ (1357.33 g), while ‘Genotype-11’ recorded the minimum (929.33 g) fresh weight of plant. The genotypes ‘Genotype-2’, ‘Genotype-12’, ‘Genotype-9’, ‘Genotype-3’, ‘Genotype-8’, ‘Genotype-

4', 'Genotype-6' were maximum fresh weight of plant compared to mean value 1200.79 g, while other genotypes have minimum fresh weight of plant.

Table 4.2 Performance of gaillardia genotypes with respect to plant spread (cm) and plant fresh weight (g)

S. No.	Name of genotypes	Plant spread (cm)	Plant fresh weight (g)
1.	Genotype - 1	68.29	958.06
2.	Genotype - 2	69.95	1626.93
3.	Genotype - 3	66.54	1312.80
4.	Genotype - 4	68.47	1210.87
5.	Genotype - 5	73.31	1052.33
6.	Genotype - 6	73.70	1201.67
7.	Genotype - 7	63.40	938.13
8.	Genotype - 8	66.27	1264.33
9.	Genotype - 9	65.33	1357.33
10	Genotype - 10	62.69	1003.67
11.	Genotype - 11	63.75	929.33
12.	Genotype - 12	68.54	1554.00
	Mean	67.52	1200.79
	SEm±	0.62	29.30
	CD 5%	1.81	85.94

Fig. 4.2 Performance of gaillardia genotypes with respect to plant spread (cm) and plant fresh weight (g)



4.1.5 Plant dry weight (g)

The data presented in Table 4.3 and Fig. 4.3 showed that dry weight of plant have been significant differences among the genotypes. The variations in dry weight of plant in different genotypes were ranged from 164.50 to 321.46 g and a mean value of 229.46g. The maximum dry weight of plant (321.46 g) was recorded 'Genotype-2' followed by 'Genotype-12' (290.72 g) and 'Genotype-9' (270.40 g), while the minimum (164.50 g) was recorded by 'Genotype-11'. Whereas, the genotypes 'Genotype-2', 'Genotype-12', 'Genotype-9', were higher dry weight of plant compared to mean value among all the other genotypes.

4.1.6 Leaf length (cm)

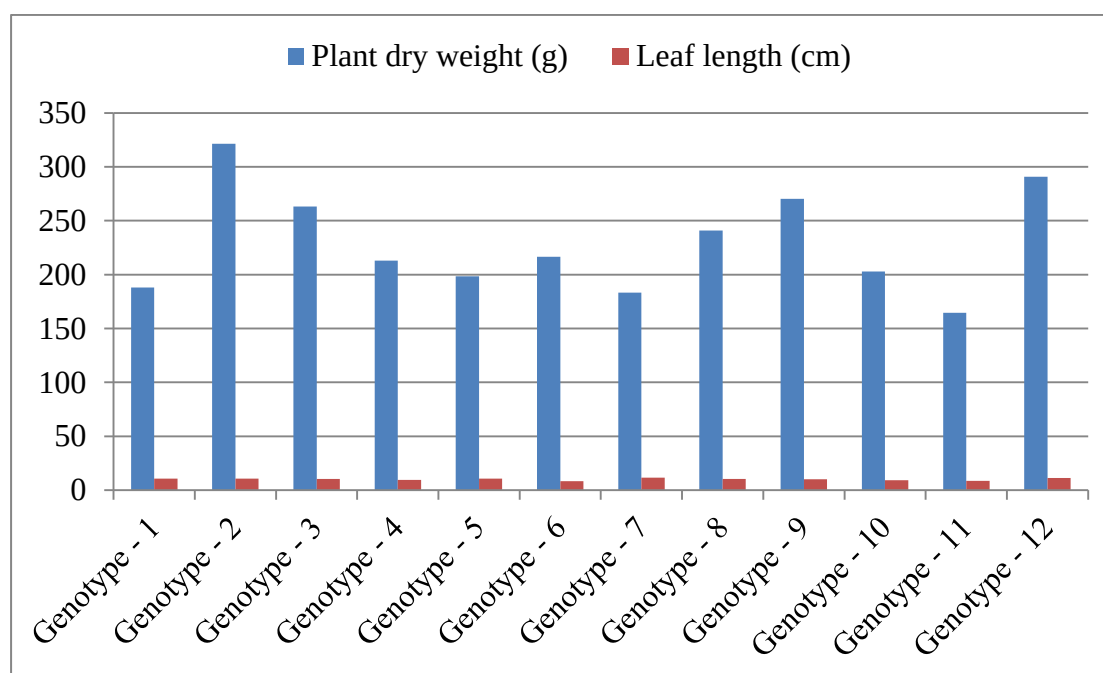
The data pertaining to leaf length have been presented in Table 4.3 and Fig.4.3. Highly significant differences were exhibited in the data for this character among the genotypes with a ranged from 8.46 to 11.67 cm with a mean of 10.11 cm. The maximum leaf length (11.67 cm) was recorded in 'Genotype-7' followed by 'Genotype-12' (11.27 cm), 'Genotype-1' (10.78 cm), 'Genotype-5' (10.78 cm) and 'Genotype-2' (10.64 cm), while the minimum leaf length was recorded in 'Genotype-6' (8.26 cm) being at par with 'Genotype-10' (9.10 cm) and 'Genotype-4' (9.33 cm).

Among different genotypes ‘Genotype-7’, ‘Genotype-12’, ‘Genotype-1’, ‘Genotype-5’, ‘Genotype-2’, ‘Genotype-3’, ‘Genotype-8’ and ‘Genotype-9’ were observed the maximum leaf length as compared to mean value (10.11 cm) but other genotypes were observed the minimum leaf length.

Table 4.3 Performance of gaillardia genotypes with respect to plant dry weight (g) and leaf length (cm)

S. No.	Name of genotypes	Plant dry weight (g)	Leaf length (cm)
1.	Genotype - 1	187.90	10.78
2.	Genotype - 2	321.46	10.64
3.	Genotype - 3	263.31	10.49
4.	Genotype - 4	212.84	9.33
5.	Genotype - 5	198.49	10.78
6.	Genotype - 6	216.53	8.26
7.	Genotype - 7	183.18	11.67
8.	Genotype - 8	240.88	10.27
9.	Genotype - 9	270.40	10.17
10.	Genotype - 10	202.88	9.10
11.	Genotype - 11	164.50	8.48
12.	Genotype - 12	290.72	11.27
	Mean	229.46	10.11
	SEm±	3.74	0.29
	CD 5%	10.98	0.86

Fig. 4.3 Performance of gaillardia genotypes with respect to plant dry weight (g) and leaf length (cm)



4.1.7 Leaf width (cm)

Leaf width showed highly significant differences among the genotypes of gaillardia are presented in Table 4.4 and Fig. 4.4. The leaf width range was recorded from 3.54 to 4.38 cm with the highest leaf width (4.38 cm) ‘Genotype-3’ which was at par to ‘Genotype-12’ (4.28 cm) and ‘Genotype-4’ (4.04 cm), while the lowest leaf width in ‘Genotype-9’ (3.54 cm) which was at par with ‘Genotype-10’ (3.58 cm), ‘Genotype-2’ (3.59 cm) and ‘Genotype-11’ (3.68 cm). The genotypes ‘Genotype-1’ (3.91 cm), ‘Genotype-5’ (3.82 cm), ‘Genotype-8’ (3.75 cm) and ‘Genotype-7’ (3.74 cm) produce leaf of medium width and around the mean value (3.87 cm).

4.2 FLOWERING PARAMETERS

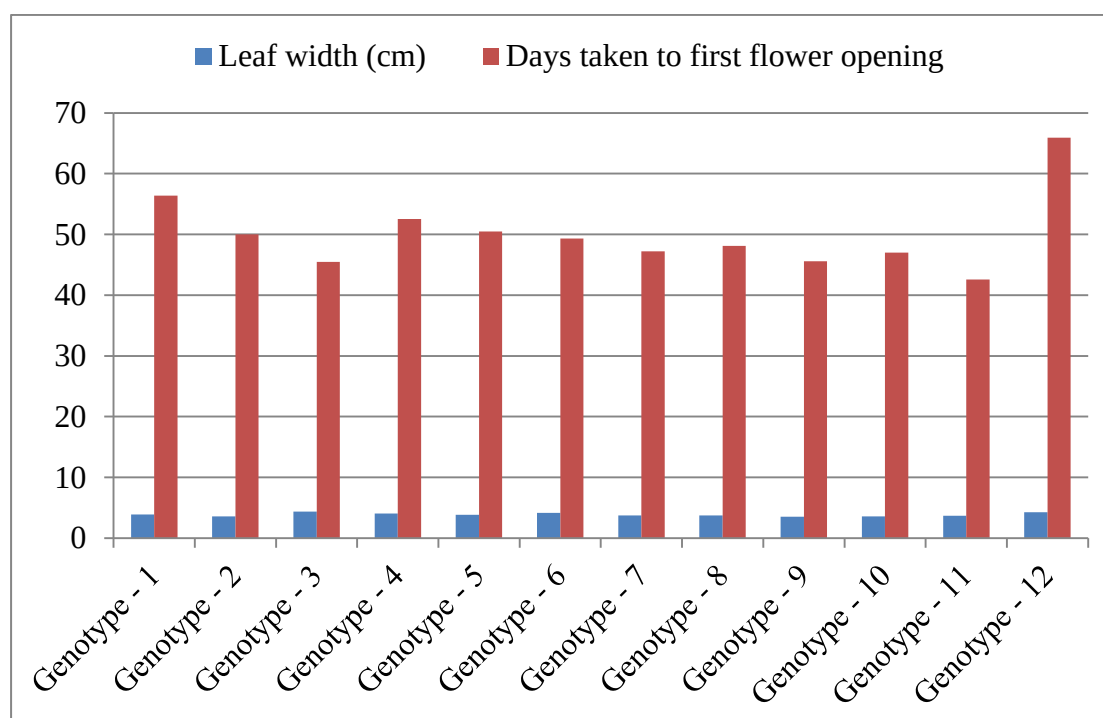
4.2.1 Days taken to first flower opening

The data pertaining to days taken to first flower opening have been presented (Table 4.4 and Fig. 4.4) in differences amongst genotypes with range from 42.60 to 65.93 days with an average value of 50.05 days. The minimum number of days taken to first flower opening (42.60 days) was genotype in ‘Genotype-11’ and it was at par with genotypes ‘Genotype-3’ (45.45 days) and ‘Genotype-9’ (45.60 days), while the maximum number of days taken to first flower opening in ‘Genotype-12’ (65.93 days) recorded amongst all the genotypes.

Table 4.4 Performance of gaillardia genotypes with respect to leaf width (cm) and days taken to first flower opening

S. No.	Name of genotypes	Leaf width (cm)	Days taken to first flower opening
1.	Genotype - 1	3.91	56.40
2.	Genotype - 2	3.59	50.00
3.	Genotype - 3	4.38	45.45
4.	Genotype - 4	4.04	52.53
5.	Genotype - 5	3.82	50.47
6.	Genotype - 6	4.15	49.33
7.	Genotype - 7	3.74	47.20
8.	Genotype - 8	3.75	48.13
9.	Genotype - 9	3.54	45.60
10	Genotype - 10	3.58	47.00
11.	Genotype - 11	3.68	42.60
12.	Genotype - 12	4.28	65.93
	Mean	3.87	50.05
	SEm±	0.11	0.55
	CD 5%	0.31	1.63

Fig. 4.4 Performance of gaillardia genotypes with respect to leaf width (cm) and days taken to first flower opening



4.2.2 Days taken to 50 per cent flowering

The data pertaining to days taken to 50 per cent flowering have been presented in Table 4.5 and Fig. 4.5. Days taken to 50 per cent flowering ranged from 64.93 to 84.33 days with an average value of 72.54 days. Significant differences were observed among different genotypes with respect to days taken to 50 per cent of flowering. The minimum days taken to 50 per cent of flowering in ‘Genotype-11’ (64.93 days) which was at par to ‘Genotype-7’ (67.53 days), ‘Genotype-3’ (67.93 days) and ‘Genotype-9’ (68.20 days), while the highest days taken to 50 per cent flowering in ‘Genotype-12’ (84.33 days). The genotypes ‘Genotype-8’ (70.87 days), ‘Genotype-6’ (72.47 days), ‘Genotype-10’ (72.47 days), ‘Genotype-4’ (74.03 days) and ‘Genotype-2’ (74.07 days) ‘Genotype-5’ (75.40 days) and ‘Genotype-1’ (77.78 days) were observed of medium group.

4.2.3 Flower diameter (cm)

The data pertaining to flower diameter have been shown in Table 4.5 and Fig. 4.5 and recorded at the time of peak flowering from full opened flowers and highly significant among the different genotypes. Flower diameter was ranged from 4.95 to 6.29 cm with a mean of 5.66 cm. The highest flower diameter (6.29 cm) was noted in the ‘Genotype-11’ which was statistically at par to the ‘Genotype-10’ (6.00 cm) and

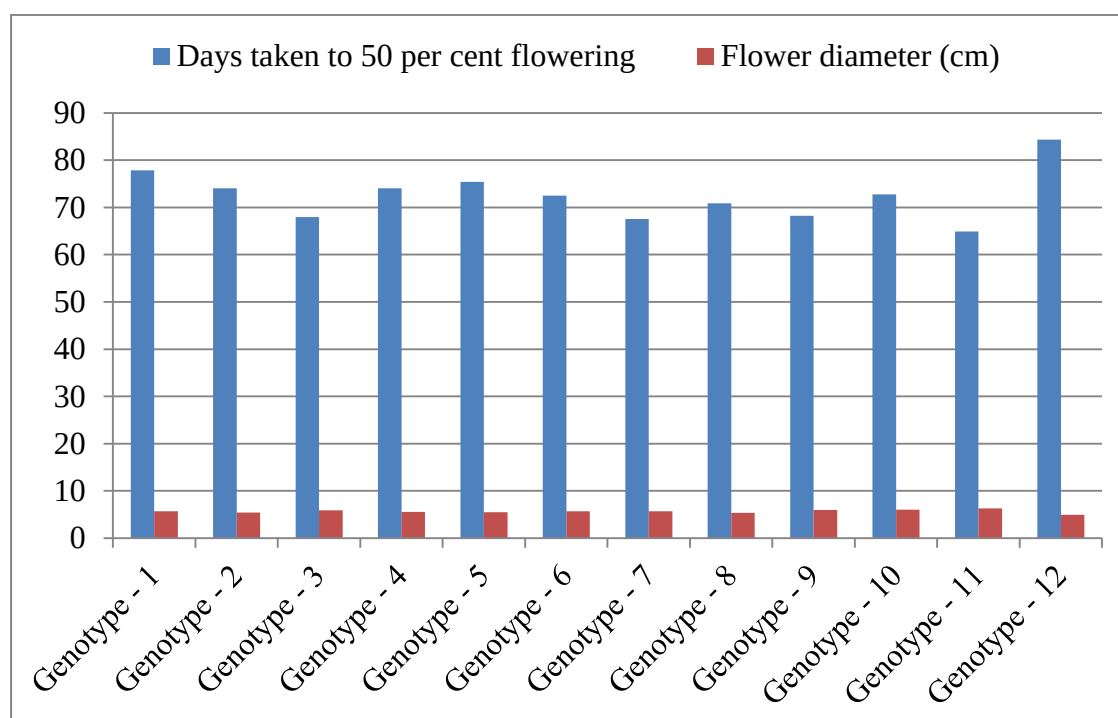
‘Genotype-9’ (5.94 cm), while the lowest flower diameter was recorded in ‘Genotype-12’ (4.95 cm).

Among the different the genotypes, ‘Genotype-11’ (6.29 cm), ‘Genotype-10’ (6.00 cm) ‘Genotype-9’ (5.94 cm), ‘Genotype-3’ (5.88 cm), ‘Genotype-1’ (5.67 cm) ‘Genotype-7’ (5.65 cm) and ‘Genotype-6’ (5.65 cm) recorded greater flower diameter as compared to mean value (5.65 cm) whereas, ‘Genotype-12’ (4.95 cm) ‘Genotype-8’ (5.35 cm) ‘Genotype-2’ (5.40 cm), ‘Genotype-5’ (5.50 cm) and ‘Genotype-4’ (5.58 cm) had the minimum flower diameter.

Table 4.5 Performance of gaillardia genotypes with respect to days taken to 50 per cent flowering and flower diameter (cm)

S. No.	Name of genotypes	Days taken to 50 per cent flowering	Flower diameter (cm)
1.	Genotype - 1	77.87	5.67
2.	Genotype - 2	74.07	5.40
3.	Genotype - 3	67.93	5.88
4.	Genotype - 4	74.03	5.58
5.	Genotype - 5	75.40	5.50
6.	Genotype - 6	72.47	5.65
7.	Genotype - 7	67.53	5.65
8.	Genotype - 8	70.87	5.35
9.	Genotype - 9	68.20	5.94
10	Genotype - 10	72.80	6.00
11.	Genotype - 11	64.93	6.29
12.	Genotype - 12	84.33	4.95
	Mean	72.54	5.66
	SEm±	0.69	0.11
	CD 5%	2.03	0.34

Fig. 4.5 Performance of gaillardia genotypes with respect to days taken to 50 per cent flowering and flower diameter (cm)



4.2.4 Flower stalk length (cm)

In the present studies, highly significant differences were observed among the genotypes for flower stalk length (Table 4.6 and Fig. 4.6) which was ranged from 17.42 to 32.64 cm with an average value of 29.05 cm. The maximum flower stalk length (32.64 cm) was reported in ‘Genotype-10’ followed by ‘Genotype-2’ (32.52 cm) and ‘Genotype-7’ (32.26 cm)’, while the minimum was (17.42 cm) noted in ‘Genotype-12’. The medium length of flower stalk was produced by ‘Genotype-9’ (31.54 cm), ‘Genotype-1’ (30.70 cm), ‘Genotype-11’ (30.11 cm), ‘Genotype-5’ (29.52 cm), ‘Genotype-8’ (28.27 cm), ‘Genotype-3’ (28.18 cm) and ‘Genotype-4’ (27.76 cm) were in the mid-group ranging around an average value (29.05 cm).

4.2.5 Fresh flower weight (g)

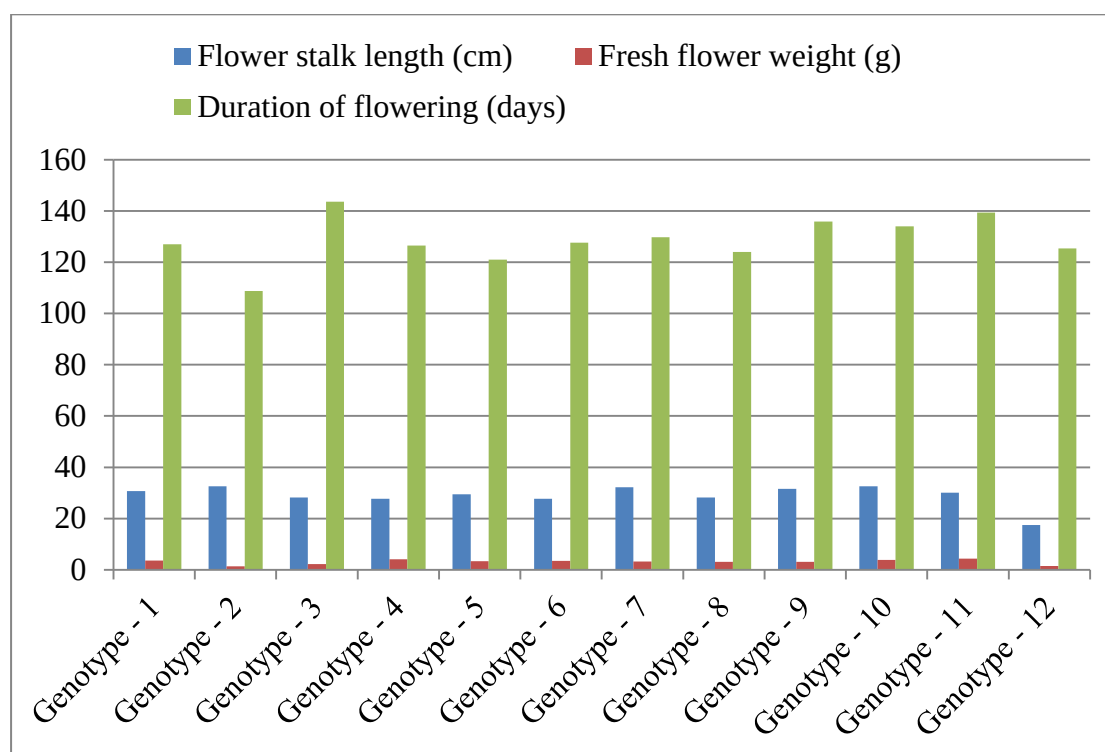
The data presented in Table 4.6 and Fig. 4.6 illustrated highly significant differences amongst the genotypes for average fresh weight of flower with range from 1.31 to 4.40 g and a mean value of 3.12 g. The highest fresh weight of flower (4.40 g) was recorded in the genotype ‘Genotype-11’ followed by ‘Genotype-4’ (4.16 g) and ‘Genotype-10’ (3.89 g), whereas the lowest weight (1.31 g) was recorded in ‘Genotype-2’ followed by ‘Genotype-12’ (1.49 g) all amongst genotypes. The genotypes ‘Genotype-11’, ‘Genotype-4’, ‘Genotype-10’, ‘Genotype-1’, ‘Genotype-6’,

‘Genotype-5’ ‘Genotype-7’ and ‘Genotype-8’ showed the maximum weight than mean value (3.12 g) while, ‘Genotype-12’, ‘Genotype-2’, ‘Genotype-3’ and ‘Genotype-9’ had the minimum weight of fresh flower.

Table 4.6 Performance of gaillardia genotypes with respect to flower stalk length (cm), fresh flower weight (g) and duration of flowering (days)

S. No.	Name of genotypes	Flower stalk length (cm)	Fresh flower weight (g)	Duration of flowering (days)
1.	Genotype – 1	30.70	3.60	127.06
2.	Genotype – 2	32.52	1.31	108.80
3.	Genotype – 3	28.18	2.24	143.66
4.	Genotype – 4	27.76	4.16	126.53
5.	Genotype – 5	29.52	3.36	121.06
6.	Genotype – 6	27.73	3.51	127.66
7.	Genotype – 7	32.26	3.27	129.80
8.	Genotype – 8	28.27	3.14	124.06
9.	Genotype – 9	31.54	3.05	135.86
10.	Genotype - 10	32.64	3.89	134.00
11.	Genotype - 11	30.11	4.40	139.40
12.	Genotype - 12	17.42	1.49	125.33
	Mean	29.05	3.12	126.94
	SEm±	0.44	0.03	2.76
	CD 5%	1.29	0.08	8.10

Fig. 4.6 Performance of gaillardia genotypes with respect to flower stalk length (cm), fresh flower weight (g) and duration of flowering (days)



4.2.6 Duration of flowering (days)

The data pertaining to duration of flowering have been presented in Table 4.6 and Fig. 4.6. The variation was observed in among the genotypes which highly significant with a ranged from between 108.80 to 143.66 days and an average value of 126.93 days. The maximum duration of flowering (143.66 days) was found in 'Genotype-3' which was at par to 'Genotype-11' (139.40 days), 'Genotype-9' (135.86 days) and 'Genotype-10' (134.00 days), while the minimum (108.80 days) was founded in 'Genotype-2'. The genotype 'Genotype-5' (121.06 days), 'Genotype-12' (125.33 days), 'Genotype-8' (124.06 days), 'Genotype-4' (126.53 days), 'Genotype-1' (127.06 days), 'Genotype-6' (127.66 days) and 'Genotype-7' (129.80 days) were belonged to medium group.

4.2.7 Number of disc florets per flower

Highly significant differences were found among the genotypes for this trait (Table 4.7 and Fig 4.7). The number of disc florets per flower with ranged from 117.26 to 242.30 with a mean value of 155.62. Further, the highest number of disc florets per flower was recorded in 'Genotype-1' (242.30). The genotypes 'Genotype-

7', (174.66), 'Genotype-4' (156.66), 'Genotype-11' (155.20), 'Genotype-5' (152.86), 'Genotype-9' (151.06) 'Genotype-6' (149.00), 'Genotype-10' (148.66) and 'Genotype-2' (147.86) were in medium range, whereas the lowest (117.26) was recorded in 'Genotype-12'.

4.2.8 Number of ray florets per flower

Highly significant differences were found among the genotypes for number of ray florets per flower (Table 4.7 and Fig 4.7) with a ranged from 16.53 to 214.26 with a mean of 141.90. The maximum number of ray florets per flower (214.26) was recorded in the genotype 'Genotype-11' which was at par to the 'Genotype-7' (208.80), 'Genotype-10' (194.53), 'Genotype-9' (192.60) and 'Genotype-8' (187.60), while the minimum was (16.53) noted in 'Genotype-12'. The data also revealed that 'Genotype-11', 'Genotype-7', 'Genotype-10', 'Genotype-9', 'Genotype-8', 'Genotype-1', 'Genotype-5' and 'Genotype-4' having the highest number of ray florets per flower compared to mean value, while, 'Genotype-12', 'Genotype-2', 'Genotype-3' and 'Genotype-6' having the lowest number of ray florets per flower compared to mean value.

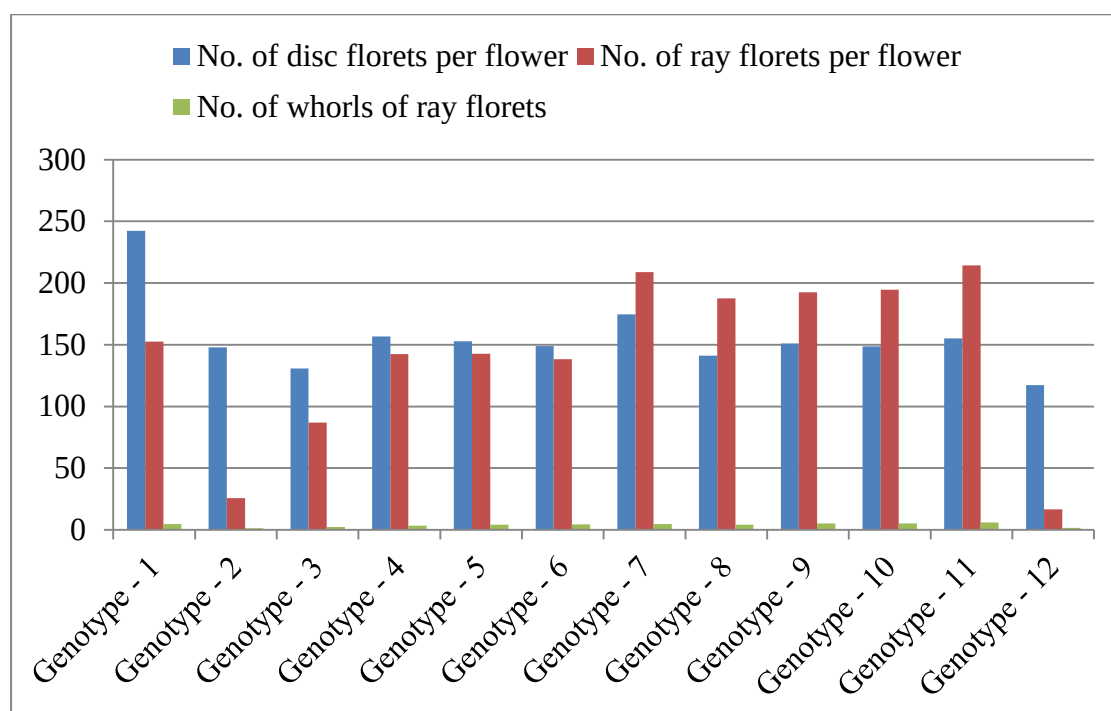
4.2.9 Number of whorls of ray florets:

The data pertaining to number of whorls of per flower have been presented in Table 4.7 and Fig 4.7. The number of whorls of per flower was ranged from 1.26 to 5.96 with an average value of 3.88. The highest number of whorls of ray florets per flower was recorded in 'Genotype-11' (5.96) followed by the 'Genotype-9' (5.26) and 'Genotype-10' (5.13), while the lowest was recorded in 'Genotype-12' (1.40) which was at par to 'Genotype-2' (1.26) and 'Genotype-3' (2.40). The genotypes 'Genotype-1', 'Genotype-7', 'Genotype-6', 'Genotype-5' and 'Genotype-4' were belonged to the medium group with average value (3.88 cm).

Table 4.7 Performance of gaillardia genotypes with respect to number of disc florets per flower, number of ray florets per flower and Number of whorls of ray florets

S. No.	Name of genotypes	No. of disc florets per flower	No. of ray florets per flower	No. of whorls of ray florets
1.	Genotype - 1	242.30	152.46	4.63
2.	Genotype - 2	147.86	25.53	1.26
3.	Genotype - 3	130.66	87.00	2.40
4.	Genotype - 4	156.66	142.46	3.46
5.	Genotype - 5	152.86	142.66	4.13
6.	Genotype - 6	149.00	138.33	4.33
7.	Genotype - 7	174.66	208.80	4.53
8.	Genotype - 8	141.26	187.60	4.06
9.	Genotype - 9	151.06	192.60	5.26
10.	Genotype - 10	148.66	194.53	5.13
11.	Genotype - 11	155.20	214.26	5.96
12.	Genotype - 12	117.26	16.53	1.40
	Mean	155.63	141.90	3.88
	SEm±	2.61	3.41	0.11
	CD 5%	7.65	10.00	0.33

Fig. 4.7 Performance of gaillardia genotypes with respect to number of disc florets per flower, number of ray florets per flower and number of whorls of ray florets



4.2.10 Length of ray floret (cm)

Length of ray floret among the different genotypes of gaillardia showed (Table 4.8 and Fig. 4.8) highly significant variations that ranged from 2.41 to 3.03 cm with a mean of 2.70 cm. The maximum length of ray floret was recorded in ‘Genotype-8’ (3.03 cm) which was at par to genotypes ‘Genotype-1’ (2.86 cm), ‘Genotype-11’ (2.83 cm), ‘Genotype-3’ (2.76 cm) and ‘Genotype-9’ (2.75 cm), while the minimum (2.41 cm) was recorded in ‘Genotype-6’ it was at par to ‘Genotype-5’ (2.50 cm). However, the genotypes ‘Genotype-12’ (2.71 cm), ‘Genotype-2’ (2.64 cm), ‘Genotype-7’ (2.61 cm) and ‘Genotype-4’ (2.54 cm) were produce in average ranged with the mean value (2.70 cm)

4.2.11 Width of ray floret (cm)

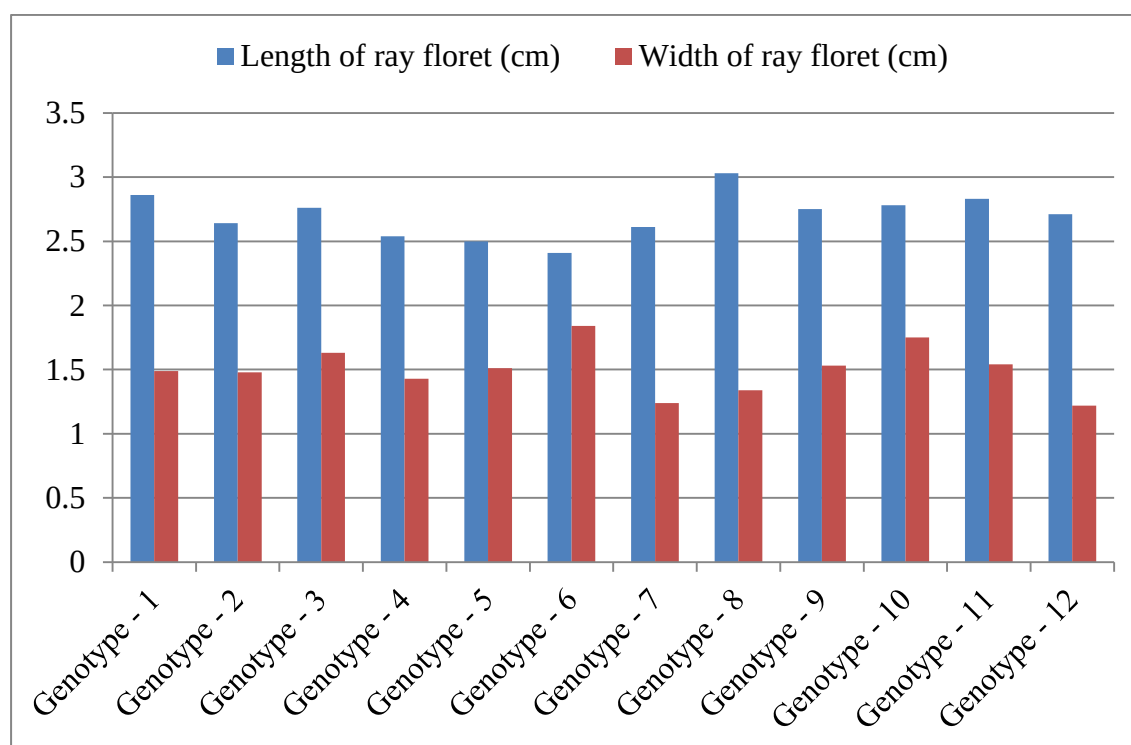
The data to width of ray floret have been presented in Table 4.8 and Fig. 4.8. The variations in width of ray floret in different genotypes were highly significant with a range from 1.22 to 1.84 cm and a mean value of 1.50 cm. The highest width of ray floret was recorded in ‘Genotype-6’ (1.84 cm) followed by ‘Genotype-10’ (1.75) and ‘Genotype-3’ (1.63), while the lowest (1.22) was recorded in ‘Genotype-12’ which was at par to ‘Genotype-7’ (1.24) and ‘Genotype-8’ (1.34). The genotypes

‘Genotype-4’, ‘Genotype-2’, ‘Genotype-1’, ‘Genotype-5’, ‘Genotype-9’ and ‘Genotype-11’ were belonged to mid group.

Table 4.8 Performance of gaillardia genotypes with respect to length of ray floret (cm) and width of ray floret (cm)

S. No.	Name of genotypes	Length of ray floret (cm)	Width of ray floret (cm)
1.	Genotype - 1	2.86	1.49
2.	Genotype - 2	2.64	1.48
3.	Genotype - 3	2.76	1.63
4.	Genotype - 4	2.54	1.43
5.	Genotype - 5	2.50	1.51
6.	Genotype - 6	2.41	1.84
7.	Genotype - 7	2.61	1.24
8.	Genotype - 8	3.03	1.34
9.	Genotype - 9	2.75	1.53
10	Genotype - 10	2.78	1.75
11.	Genotype - 11	2.83	1.54
12.	Genotype - 12	2.71	1.22
	Mean	2.70	1.50
	SEm±	0.06	0.05
	CD 5%	0.18	0.16

Fig. 4.8 Performance of gaillardia genotypes with respect to length of ray floret (cm) and width of ray floret (cm)



4.2.12 Colour of flower

The colour of flower is highly valuable feature that decides its market value with highly significant among the genotypes have been presented in Table 4.9. The highly market price of genotypes was earned to yellow colour of flower. The genotype ‘Genotype-11’, ‘Genotype-10’, ‘Genotype-9’, ‘Genotype-8’, ‘Genotype-7’, ‘Genotype-5’ and ‘Genotype-1’ (002B Yellow colour) respectively and ‘Genotype-2’ with respect to 008C (Light yellow colour). The ‘Genotype-12’ (N 025 D Reddish with yellow), ‘Genotype-6’ (040 B Red), ‘Genotype-3’ (030 B Orange red) and ‘Genotype-4’ (N030 A Dark red).

4.2.13 Colour of flower disc

The colour of disc flower have been presented (Table 4.9) highly valuable feature that decides its market value with highly significant amongst the genotypes. The flower of disc colour amongst genotypes were recorded greenish yellow colour in ‘Genotype-2’, ‘Genotype-8’, ‘Genotype-9’, ‘Genotype-10’, ‘Genotype-11’ and ‘Genotype-1’, ‘Genotype-7’, ‘Genotype-5’ (149A Yellowish green colour) and ‘Genotype-3’ (162C Reddish yellow) whereas, ‘Genotype-4’ and ‘Genotype-6’ (147C Reddish green) and ‘Genotype-12’ (188A Greenish gray).

4.2.14 Type of ray floret (flat/ tubular)

The type of ray floret of flower to demand higher in market of tubular type of ray florets of flower (Table 4.10) among genotypes ‘Genotype-2’ and ‘Genotype-12’ (both single type flower) were recorded flat type of ray floret and rest other genotypes noted tubular type of ray floret.

Table 4.9 Performance of gaillardia genotypes with respect to colour of flower and flower disc colour

S. No.	Name of genotypes	Colour of flower	Flower disc colour
1.	Genotype - 1	(002B - Yellow)	(002B - Yellow)
2.	Genotype - 2	(008C - Light yellow)	(149A - Yellowish green)
3.	Genotype - 3	(030B - Orange red)	(162C - Reddish yellow)
4.	Genotype - 4	(N030 A - Dark red)	(147C - Reddish green)
5.	Genotype - 5	(002B - Yellow)	(002B - Yellow)
6.	Genotype - 6	(040B - Red)	(147C - Reddish green)
7.	Genotype - 7	(002B - Yellow)	(002B - Yellow)
8.	Genotype - 8	(002B - Yellow)	(149A - Yellowish green)
9.	Genotype - 9	(002B - Yellow)	(149A - Yellowish green)
10.	Genotype - 10	(002B - Yellow)	(149A - Yellowish green)
11.	Genotype - 11	(002B - Yellow)	(149A - Yellowish green)
12.	Genotype - 12	(N 025D - Reddish with yellow)	(188A - Greenish gray)



Genotype-1



Genotype -2



Genotype-3



Genotype-4



Genotype-5



Genotype-6



Genotype-7



Genotype-8



Genotype-9



Genotype-10



Genotype-11



Genotype-12

Plate No. 3 Flowers of different genotypes of gaillardia

4.2.15 Shelf life of flower (hours)

The data pertaining to the shelf life of among genotypes (Table 4.10 and Fig. 4.10) were presented in highly significant among the genotypes, shelf life of flower with a ranged from 9.00 to 15.66 hours and a mean value of 12.71 hours. The maximum shelf life (15.66 hours) was recorded in ‘Genotype-10’ followed by ‘Genotype-9’ (15.60 hrs.) and ‘Genotype-11’ (14.66 hrs.) which was statistically at par with ‘Genotype-8’ (13.93 hrs.) and ‘Genotype-7’ (13.80 hrs.), while the minimum shelf life of flower was observed in ‘Genotype-2’ (9.00 hrs.). A close view of the data also exhibited that the minimum shelf life of flower recorded in ‘Genotype-4’ (9.93 hrs.) which was at par to ‘Genotype-12’ (10.60 hrs.). The genotype ‘Genotype-3’, (11.93 hrs.), ‘Genotype-6’ (11.93 hrs.), ‘Genotype-5’ (12.26 hrs.) and ‘Genotype-1’ (13.53 hrs.) observed to be of medium shelf life group.

4.2.16 *In-situ* flower life (days)

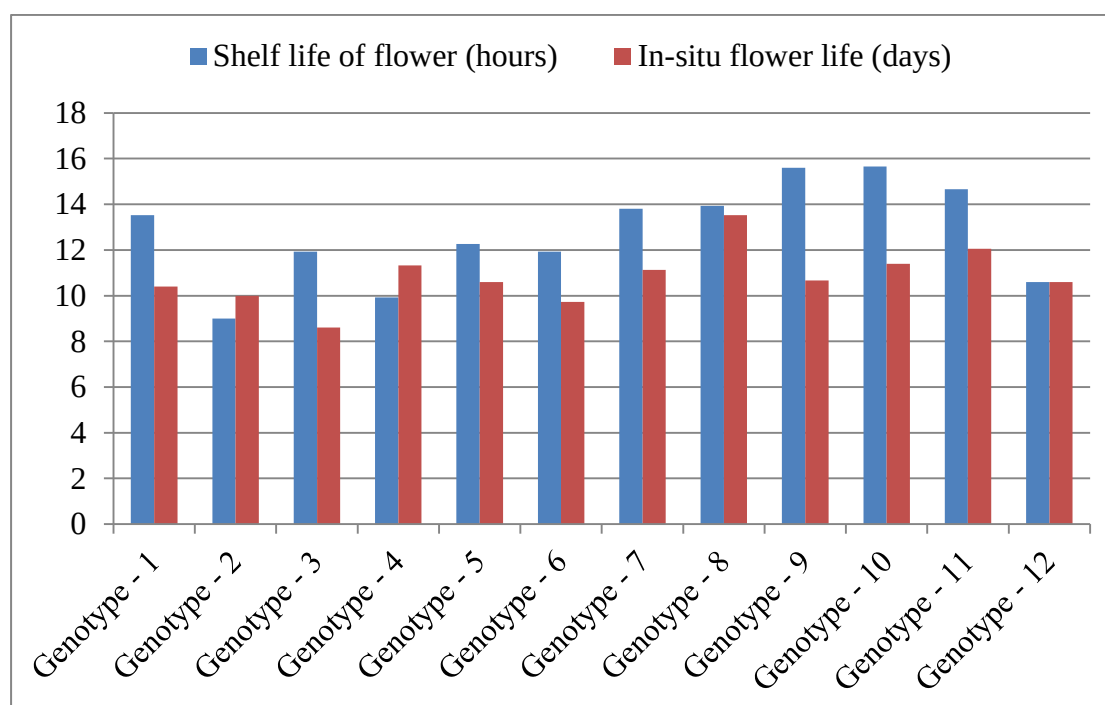
The data pertaining to the *in-situ* flower life of different genotypes were presented in Table 4.10 and Fig. 4.10. The *in-situ* life of flower varied significantly among the genotypes with a ranged between 8.60 to 13.53 days and mean value of 10.75 days. The highest *in-situ* life of flower (13.53 days) was found in ‘Genotype-8’ followed by ‘Genotype-11’ (12.06 days), ‘Genotype-10’ (11.40 days) and ‘Genotype-4’ (11.33 days), while the lowest was founded in ‘Genotype-3’ (8.60 days).

The genotypes ‘Genotype-7’ (11.13 days), ‘Genotype-9’ (10.66 days), ‘Genotype-5’ (10.60 days), ‘Genotype-1’ (10.40 days) and ‘Genotype-2’ (10.00 days) were closed to medium range whereas, the lowest was recorded in ‘Genotype-3’ (8.60 days) with at par to ‘Genotype-12’ (9.60 days).

Table 4.10 Performance of gaillardia genotypes with respect to shelf life of flower (hours), *In-situ* flower life (days) and type of ray floret (flat/tubular)

S. No.	Name of genotypes	Shelf life of flowers (hours)	<i>In-situ</i> flower life (days)	Type of ray floret (flat/tubular)
1.	Genotype - 1	13.53	10.40	Tubular
2.	Genotype - 2	9.00	10.00	Flat
3.	Genotype - 3	11.93	8.60	Tubular
4.	Genotype - 4	9.93	11.33	Tubular
5.	Genotype - 5	12.26	10.60	Tubular
6.	Genotype - 6	11.93	9.73	Tubular
7.	Genotype - 7	13.80	11.13	Tubular
8.	Genotype - 8	13.93	13.53	Tubular
9.	Genotype - 9	15.60	10.66	Tubular
10.	Genotype - 10	15.66	11.40	Tubular
11.	Genotype - 11	14.66	12.06	Tubular
12.	Genotype - 12	10.60	10.60	Flat
	Mean	12.74	10.84	
	SEm±	0.25	0.23	
	CD 5%	0.76	0.69	

Fig. 4.10 Performance of gaillardia genotypes with respect to shelf life of flower (hours) and *In-situ* flower life (days)



4.3 YIELD PARAMETERS

4.3.1 Number of flowers per plant

Highly significant differences were found among the genotypes for this character (Table 4.11 and Fig. 4.11). The number of flowers per plant was ranged from 75.60 to 131.53 with a mean value of 96.47. The maximum number of flowers per plant was noted in 'Genotype-11' (131.35) followed by 'Genotype-7', 'Genotype-10' and 'Genotype-3' (117.93, 106.40 and 104.20, respectively), while the minimum was recorded in 'Genotype-8' (75.60) which was at par to 'Genotype-2' (78.40). The genotype 'Genotype-1' (96.40), 'Genotype-6' (94.46), 'Genotype-9' (92.46), 'Genotype-5' (90.40) were observed with average mid value (96.47).

4.3.2 Weight of flowers per plant (g)

The data (Table 4.11 and depicted in Fig 4.11) pertaining to weight of flowers per plant ranged from 102.67 to 578.72 g with a mean value of 307.29 g. The maximum weight of flowers per plant (578.72 g) was noted in 'Genotype-11' which was at par with genotypes 'Genotype-10' (413.54 g) and 'Genotype-7' (385.65 g), while the minimum was recorded in 'Genotype-2' (102.67 g) with it was at par to 'Genotype-12' (129.66 g) and 'Genotype-3' (233.07 g).

The genotypes 'Genotype-11', 'Genotype-10', 'Genotype-7', 'Genotype-1', 'Genotype-4' 'Genotype-6' reported more weight of flowers per plant as compared to an average value (307.29 g) whereas, 'Genotype-2', 'Genotype-12', 'Genotype-3', 'Genotype-8', 'Genotype-9' and 'Genotype-5' had lesser weight of flowers per plant.

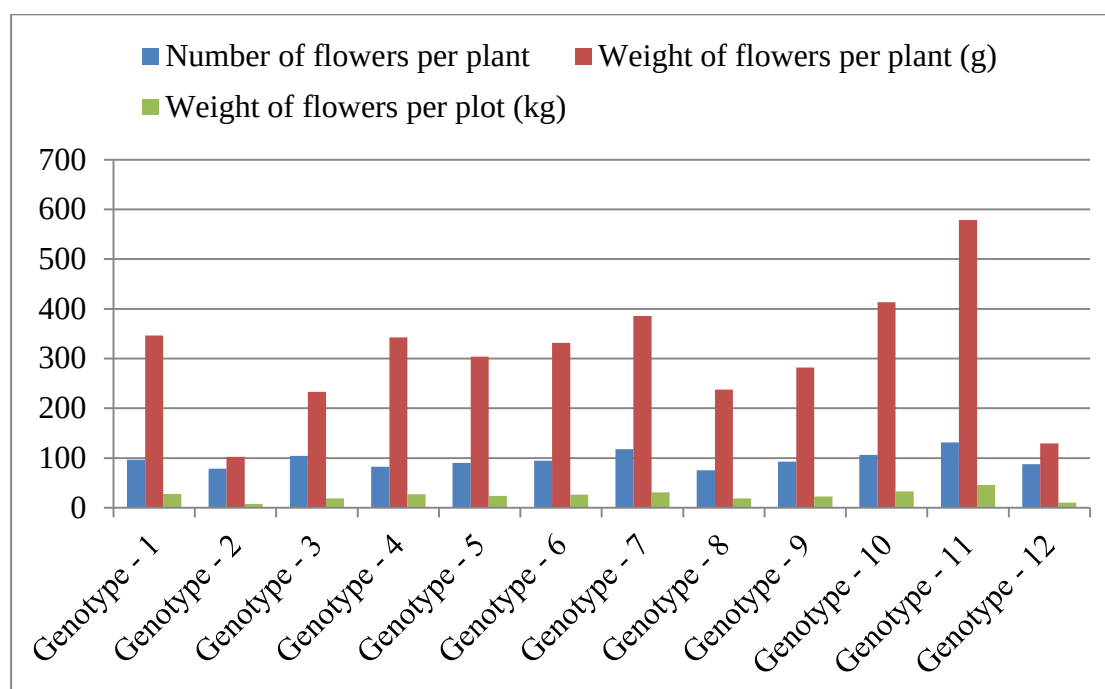
4.3.3 Weight of flowers per plot (kg)

The data related to weight of flower per plot have been presented in Table 4.11 and depicted in Fig 4.11. The data depicted highly significant differences were among the genotypes with the respect to this trait. The weight of flower per plot ranged from 8.07 kg to 45.89 kg with an average value of 24.45 kg. The maximum weight of flower per plot (45.08 kg) was recorded in genotype 'Genotype-11' which was statistically superior to all genotypes and followed in descending order of weight in 'Genotype-10' (32.99 kg), 'Genotype-7' (30.79 kg), 'Genotype-1' (27.57 kg), 'Genotype-4' (27.26 kg), 'Genotype-6' (26.42 kg), 'Genotype-5' (24.21 kg), 'Genotype-9' (22.44 kg), 'Genotype-8' (18.91 kg), 'Genotype-3' (18.51 kg) and 'Genotype-12' (10.32 kg) while, the minimum weight (80.71 kg) was noted in 'Genotype-2'.

Table 4.11 Performance of gaillardia genotypes with respect to number of flowers per plant, weight of flowers per plant (g) and weight of flower per plot (kg)

S. No.	Name of genotypes	Number of flowers per plant	Weight of flowers per plant (g)	Weight of flowers per plot (kg)
1.	Genotype – 1	96.40	346.70	27.57
2.	Genotype – 2	78.40	102.67	8.07
3.	Genotype – 3	104.20	233.07	18.51
4.	Genotype – 4	82.46	342.77	27.26
5.	Genotype – 5	90.40	304.03	24.21
6.	Genotype – 6	94.46	331.59	26.42
7.	Genotype – 7	117.93	385.65	30.79
8.	Genotype – 8	75.60	237.35	18.91
9.	Genotype – 9	92.46	281.75	22.44
10	Genotype – 10	106.40	413.54	32.99
11.	Genotype – 11	131.53	578.72	45.89
12.	Genotype – 12	87.46	129.66	10.32
	Mean	96.48	307.29	24.45
	SEm $\pm$	0.60	3.46	30.60
	CD 5%	1.78	10.15	89.76

Fig. 4.11 Performance of gaillardia genotypes with respect to number of flowers per plant, weight of flowers per plant (g) and weight of flowers per plot (kg)



4.3.4 Number of flower pluckings

The data pertaining to number of flower pluckings have been presented in the Table 4.12 and Fig 4.12. The genotypes were varied significantly with a range from 14.53 to 21.33 with a mean value of 18.21. The highest number of flower pluckings was recorded in ‘Genotype-11’ (21.33) followed by ‘Genotype-9’ (20.26), ‘Genotype-7’ (19.46) and ‘Genotype-1’ (19.10), while the minimum (14.53) was recorded in ‘Genotype-2’.

The genotypes ‘Genotype-11’, ‘Genotype-9’, ‘Genotype-7’, ‘Genotype-1’, ‘Genotype-10’, ‘Genotype-4’, ‘Genotype-6’, ‘Genotype-8’ showed the maximum number of flower pluckings when compared to the mean value whereas, other genotypes showed the minimum number of flower pluckings.

4.3.5 Estimated flower yield per hectare (q)

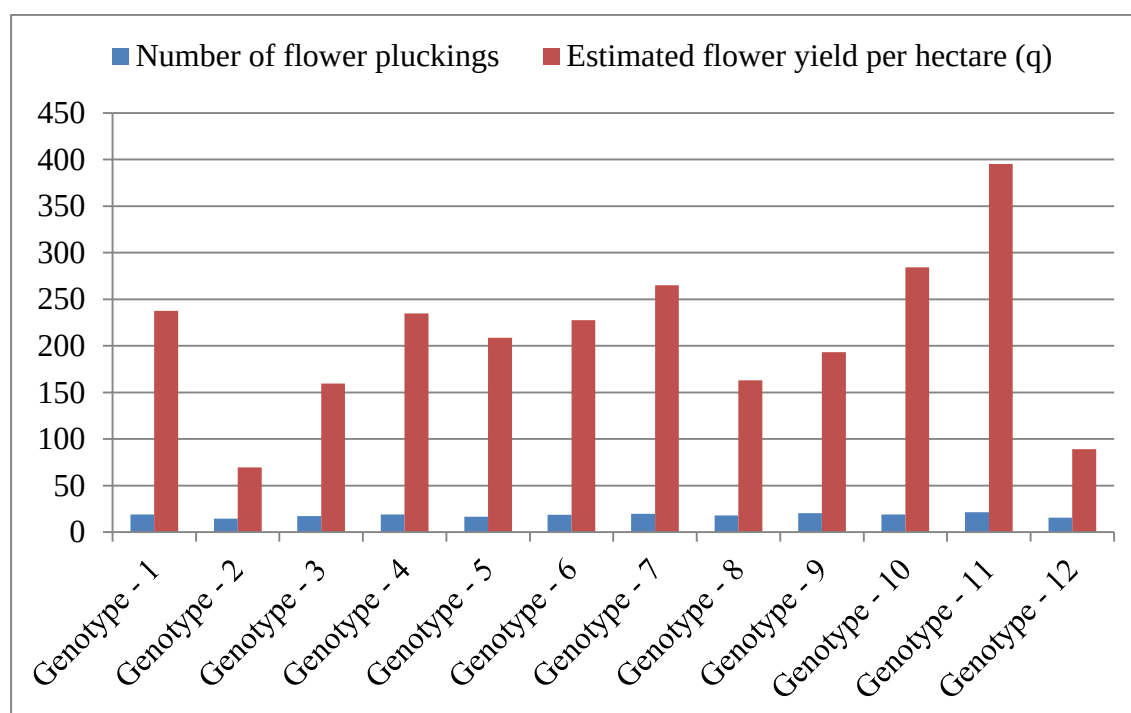
Highly significant variations were shown by the genotypes for estimated flower yield per hectare (Table 4.12 and Fig 4.12). It was ranged from 69.51 to 395.26 q and a mean of 210.58 quintal per hectare. The highest flower yield per hectare (395.26 q/ha) was recorded in ‘Genotype-11’ followed by the genotype ‘Genotype-10’ (284.18 q/ha) and ‘Genotype-7’ (265.17 q/ha) which was at par with ‘Genotype-1’

(237.44 q/ha), ‘Genotype-4’ (234.79 q/ha) and ‘Genotype-6’ (227.59 q/ha), while the lowest flower yield (69.51 q/ha) was recorded in ‘Genotype-2’ followed by ‘Genotype-12’ (88.89 q/ha), ‘Genotype-3’ (159.46 q/ha) and ‘Genotype-8’ (162.90 q/ha) which was at par to the genotype ‘Genotype-9’ (193.25 q/ha) and ‘Genotype-5’ (208.58 q/ha).

Table 4.12 Performance of gaillardia genotypes with respect to number of flower pluckings and estimated flower yield per hectare (q)

S. No.	Name of genotypes	Number of flower pluckings	Estimated flower yield per hectare (q)
1.	Genotype - 1	19.10	237.44
2.	Genotype - 2	14.53	69.51
3.	Genotype - 3	17.28	159.46
4.	Genotype - 4	18.86	234.79
5.	Genotype - 5	16.66	208.58
6.	Genotype - 6	18.66	227.59
7.	Genotype - 7	19.46	265.17
8.	Genotype - 8	17.86	162.90
9.	Genotype - 9	20.26	193.25
10.	Genotype - 10	18.93	284.18
11.	Genotype - 11	21.33	395.26
12.	Genotype - 12	15.60	88.89
	Mean	18.21	210.58
	SEm±	0.24	2.63
	CD 5%	0.69	7.71

Fig. 4.12 Performance of gaillardia genotypes with respect to number of flower pluckings and estimated flower yield per hectare (q)



4.4 GENETIC VARIABILITY:

The calculated values of phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), environmental coefficient of variation (ECV), heritability, genetic advance (GA) and genetic advance per cent as mean (GAM) were presented in the Table 4.13 and graphically presented in Fig 4.13.

The genotypes exhibited the significant variation among all the different characters studied. The phenotypic coefficient variation (PCV) values of different parameters were higher than the genotypic coefficient of variation (GCV) of different parameters studied in the present field experiment.

4.4.1 VEGETATIVE PARAMETERS

4.4.1.1 Plant height (cm)

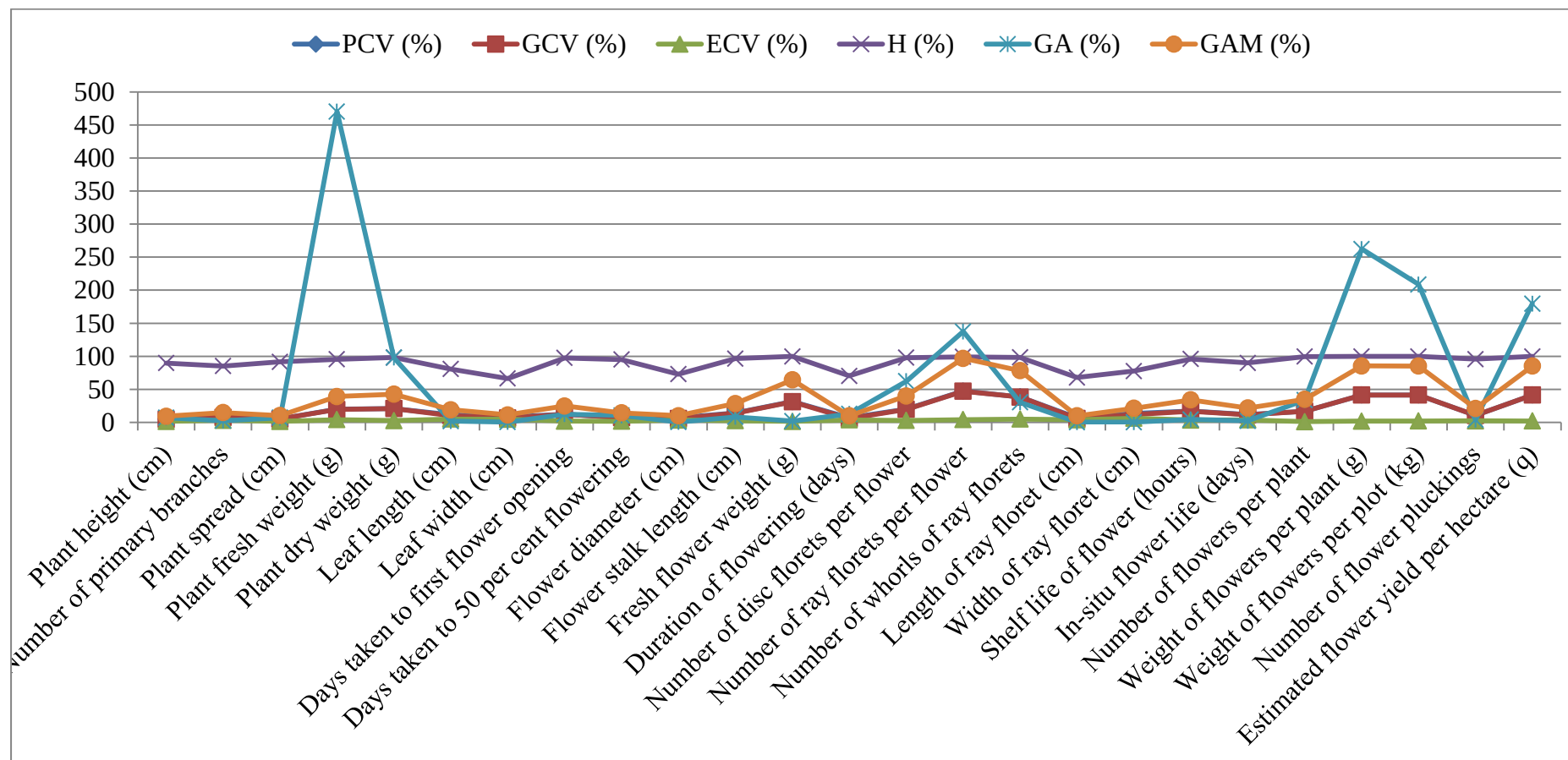
The plant height ranged from 67.93 cm to 81.03 cm (Table 4.13 and Fig. 4.13) with an average value of 75.22 cm. The estimated of phenotypic, genotypic and environmental coefficient of variations (5.04%, 4.77% and 1.62%, respectively) in

were recorded. The recorded heritability, genetic advance and genetic advance as per cent mean were 89.68%, 7.00% and 9.31%, respectively.

Table 4.13: Range, Mean, Phenotypic coefficient of variation (PCV), Genotypic coefficient of variation (GCV), Environment coefficient of variation (ECV), Heritability, Genetic advance and Genetic advance mean of per cent for 25 characters in gaillardia.

CHARACTERS	RANGE	MEAN	PCV (%)	GCV (%)	ECV (%)	H (%)	GA (%)	GAM (%)
Plant height (cm)	67.93-81.03	75.22	5.04	4.77	1.62	89.68	7.00	9.31
Number of primary branches	14.73-18.87	17.10	8.40	7.76	3.22	85.26	2.52	14.76
Plant spread (cm)	62.69-73.70	67.52	5.47	5.24	1.58	91.62	6.98	10.33
Plant fresh weight (g)	929.33-1626.93	1200.79	19.91	19.46	4.23	95.49	470.38	39.17
Plant dry weight (g)	164.50-321.46	229.46	21.08	20.89	2.85	98.20	97.85	42.65
Leaf length (cm)	8.26-11.67	10.11	11.46	10.30	5.03	80.73	1.93	19.06
Leaf width (cm)	3.54-4.38	3.87	8.28	6.74	4.80	66.35	0.43	11.32
Days taken to first flower opening	42.60-65.93	50.05	12.40	12.25	1.92	97.59	12.48	24.92
Days taken to 50 per cent flowering	64.93-84.33	72.54	7.39	7.20	1.65	95.02	10.50	14.47
Flower diameter (cm)	4.95-6.29	5.66	6.79	5.80	3.53	72.91	0.58	10.20
Flower stalk length (cm)	17.42-32.64	29.05	14.29	14.04	2.63	96.60	8.26	28.45
Fresh flower weight (g)	1.31-4.40	3.12	31.34	31.30	1.52	99.76	2.00	64.41
Duration of flowering (days)	108.80-143.66	126.94	6.91	5.79	3.78	70.22	12.69	10.00
Number of disc florets per flower	117.26-242.30	155.63	19.86	19.65	2.90	97.86	62.32	40.05
Number of ray florets per flower	16.53-214.26	141.90	47.41	47.23	4.16	99.23	137.53	96.92
Number of whorls of ray florets	1.26-5.96	3.88	38.64	38.31	5.05	98.29	30.30	78.24
Length of ray floret (cm)	2.41-3.03	2.70	7.15	5.90	4.05	67.93	0.27	10.01
Width of ray floret (cm)	1.22-1.84	1.50	13.36	11.78	6.30	77.73	0.32	21.39
Shelf life of flower (hours)	9.00-15.66	12.74	17.24	16.88	3.52	95.82	4.34	34.04
<i>In-situ</i> flower life (days)	8.60-13.53	10.84	11.77	11.46	3.74	89.89	2.36	21.79
Number of flowers per plant	75.60-131.53	96.48	16.98	16.95	1.09	99.59	33.61	34.84
Weight of flowers per plant (g)	102.67-578.72	307.29	41.54	41.40	1.95	99.78	262.39	85.39
Weight of flowers per plot (kg)	8.07-45.89	24.45	41.53	41.47	2.17	99.73	208.62	85.32
Number of flower pluckings	14.53-21.33	18.21	10.78	10.54	2.25	95.65	3.87	21.24
Estimated flower yield per hectare (q)	69.51-395.26	210.58	41.53	41.47	2.16	99.73	179.69	85.33

Fig. 4.13 Range, Mean, Phenotypic coefficient of variation (PCV), Genotypic coefficient of variation (GCV), Environment coefficient of variation (ECV), Heritability, Genetic advance and Genetic advance mean of per cent for 25 characters in gaillardia



4.4.1.2 Number of primary branches

The number of primary branches (Table 4.13 and Fig. 4.13) varied from 14.73 to 18.87 with a mean value of 17.10. The estimated phenotypic, genotypic and environmental coefficients of variation 8.40%, 7.76% and 3.22%, respectively whereas the heritability (85.26 %), genetic advance (2.52%) and genetic advance as per cent mean (14.76%) were recorded

4.4.1.3 Plant spread (cm)

The plant spread ranged between 62.69 cm to 73.70 cm (Table 4.13 and Fig. 4.13) with an average value of 67.52 cm. The phenotypic, genotypic and environmental coefficients of variation (5.47%, 5.24% and 1.58%), respectively were found. The heritability (91.62%), genetic advance (6.98%) and genetic advance as per cent mean was observed (10.33%).

4.4.1.4 Plant fresh weight

The character plant fresh weight was ranged from 929.33 g to 1626.93 g with an average mean of 1200.78 g. The estimated of PCV (19.91%), GCV (19.46%) and ECV (4.23%) were observed with heritability (95.49%), highest genetic advance (470.38%) and genetic advance as per cent mean (39.17%).

4.4.1.5 Plant dry weight

The dry weight of plant was ranged from 164.50 g to 321.46 g with a mean value of 229.46 g. The calculated of PCV (21.08%), GCV (20.89%) and ECV (2.85%) were observed with heritability (98.20%), genetic advance (97.85%) and genetic advance as per cent mean were noted (42.65%).

4.4.1.6 Leaf length

The leaf length was ranged from 8.26 cm to 11.67 cm with an average value of 10.11 cm. The phenotypic, genotypic and environmental coefficients of variations were (11.46%, 10.30% and 5.03%) respectively. The heritability (80.73%) was recorded coupled with genetic advance and high genetic advance mean as per cent of mean (1.93% and 19.06%) respectively.

4.4.1.7 Leaf width

The character of leaf width ranged from 3.54 cm to 4.38 cm with grand mean of 3.87 cm. The estimated PCV (8.28%), GCV (6.47%) and ECV (4.80%) were recorded. The heritability (66.35%) was recorded with genetic advance and high genetic advance as per cent mean (0.43% and 11.32%) were, respectively also recorded.

4.4.2 FLOWERING PARAMETERS

4.4.2.1 Days taken to first flower opening

Among the genotypes studied days of first flower opening presents (Table 4.13 and Fig 4.13) that higher phenotypic coefficient of variation (12.40%) than the genotypic coefficient of variation (12.25%) and environmental coefficient variation (1.92%). The heritability (97.59%), genetic advance (12.48%) and genetic advance as per cent mean (24.92%) was observed.

4.4.2.2 Days taken to 50 per cent flowering

The days taken to 50 per cent flowering ranged from 64.93 to 84.33 days with an average mid value of 72.54 days for this character. The phenotypic, genotypic and environmental coefficients of variation were with (7.39%, 7.20% and 1.65 %) respectively. The heritability, genetic advance and genetic advance as per cent mean were (95.02%, 10.50%, 14.47%) respectively.

4.4.2.3 Flower diameter

The flower diameter ranged from 4.95 to 6.29 cm with an average value of 5.66 cm. The estimated value of PCV, GCV and ECV (6.79%, 5.80% and 3.53%, respectively) in found. The heritability, genetic advance and genetic advance as per cent mean were (72.91%, 0.58% and 10.20%) respectively.

4.4.2.4 Flower stalk length

The among genotypes were significantly differed with respect to average length of flower stalk with ranged from 17.42 to 32.64 cm with a mean value of 29.05 cm. The stalk length exhibited that (28.45%) of genetic advance as per cent mean with heritability (96.60%), phenotypic coefficient of variation (14.29%), genotypic coefficient of variation (14.04%), environmental coefficient of variation (2.63%) and genetic advance (8.26%).

4.4.2.5 Fresh flower weight

Average individual flower weight was ranged from 1.31 g to 4.40 g with an average value of 3.12 g. The estimated value of PCV (31.34%), GCV (31.30%) and ECV (1.52%) were low coupled with heritability (99.76%) whereas, fresh flower weight recorded highest genetic advance as per cent mean was (64.41%) compared to other characters.

4.4.2.6 Duration of flowering (days)

Duration of flowering in different genotypes of gaillardia ranged from 108.80 days to 143.66 days with grand mean of 126.94 days. The estimated of PCV, GCV and ECV (6.91%, 5.79%,

3.78%, respectively) were recorded, whereas high genetic advance, heritability and genetic advance as per cent mean were 12.69%, 70.22% and 10.00%, respectively.

4.4.2.7 Number of disc florets per flower

The numbers of disc florets per flower had a highest genetic advance (62.32%) among all the traits of about. The other values like phenotypic, genotypic, environmental coefficient of variation, heritability and genetic advance as per cent mean were 19.86%, 19.65%, 2.90%, 96.60% and 40.05%, respectively.

4.4.2.8 Number of ray florets per flower

The number of ray florets per flower was ranged from 16.53 cm to 214.26 cm with a mean of 141.90 cm. The phenotypic (47.41%), genotypic (47.23%) and environmental (4.16%) coefficients of variations were low to moderate. High genetic advance (137.53%), heritability (99.23%) with genetic advance as per cent of mean (96.92%) was observed.

4.4.2.9 Number of whorls of ray florets

Number of whorls of ray florets was ranged from 1.26 to 5.96 with an average value of 3.88 whorls of ray florets per flower. The estimated of PCV, GCV and ECV were 38.64%, 38.31% and 5.05%, respectively. The heritability, genetic advance and genetic advance as per cent of mean 98.29 %, 30.30% and 78.24%, respectively. were observed

4.4.2.10 Length of ray floret (cm)

The phenotypic coefficient of variation, genotypic coefficient of variation, environmental coefficient variation, heritability, genetic advance and genetic advance as per cent mean for length of ray floret (7.15%, 5.90%, 4.05%, 67.93%, 0.27% and 10.01%, respectively) for had significantly differences among the genotypes.

4.4.2.11 Width of ray floret (cm)

The width of ray floret showed significant variation among the different genotypes of gaillardia. The width of ray floret was recorded (13.36% PCV, 11.78% GCV, 6.30% ECV) and width of ray floret was recorded low heritability (77.73%) as well as low genetic advance (0.32%) and high genetic advance as per cent mean (21.39%).

4.4.2.12 Shelf life of flower (hours)

The shelf life of flower was ranged from 9.00 hours to 15.66 hours with a mean value of 12.74 hours. The estimated value of phenotypic (17.24%), genotypic (16.88%) and environmental (3.52 %) coefficients of variations were moderate. whereas shelf life of flower exhibits the heritability (95.82%), genetic advance (4.34%) and highest genetic advance per cent mean (34.04%) compared to other traits

4.4.2.13 *In-situ* flower life (days)

The *in-situ* life was ranged from 8.60 days to 13.53 days with an average value of 10.84 days. The *in-situ* life was recorded the heritability (89.89%), phenotypic (11.77%) genotypic coefficient of variation (11.46%), environmental coefficient of variation (3.74%), genetic advance (2.36%) and highest genetic advance as per cent mean (21.79%) and the *in-situ* life of flowers were significantly varied among the different genotypes.

4.4.3 YIELD PARAMETERS

4.4.3.1 Number of flowers per plant

The data of number of flowers per plant exhibited highest genetic advance as per cent of mean of (34.84) heritability (99.59%) and genetic advance was (33.61%). In this character the genotypes were significantly varied whereas it exhibited the (16.98%, 16.95% and 1.09%, respectively) phenotypic, genotypic and environmental coefficient of variation. The number of flowers per plant was ranged from 75.60 to 131.53 with an average value of 96.48 flowers per plant.

4.4.3.2 Weight of flowers per plant (g)

The weight of flowers per plant was recorded phenotypic, genotypic and environmental coefficient of variation, heritability, genetic advance and genetic advance as per cent mean (41.54%, 41.40%, 1.95%, 99.78%, 262.39% and 85.39%, respectively). The weight of flowers per plant was ranged from 102.67 g to 578.72 g with a mean value of 307.29 g flowers per plant.

4.4.3.3 Weight of flowers per plot (kg)

The weight of flowers per plot was ranged from 8.07 kg to 45.89 kg with an average value of 24.45 kg. The weight of flowers per plot presented the significant variation among the genotypes and which was recorded of PCV (41.53%), GCV (41.47%) and ECV (2.17%) whereas the highest genetic advance, heritability and moderate genetic advance as per cent mean were 208.62%, 99.73% and 85.32%, respectively.

4.4.3.4 Number of flower pluckings

The number of flower pluckings was ranged from 14.53 to 21.33 with grand mean of 18.21 per hectare. The estimated value of PCV (10.78%), GCV (10.54%) and ECV (2.25%) whereas, the heritability (95.65 %) genetic advance (3.87%) and genetic advance as per cent of mean (21.24%).

4.4.3.5 Estimated flower yield per hectare (q)

The estimated flower yield per hectare ranged from 69.51 q to 395.26 q with a mean of 210.58 quintal per hectare. The estimated value of PCV (41.53%), GCV (41.47%) and ECv (2.16%) were recorded with high genetic advance, heritability and genetic advance as per cent of mean (179.69%, 99.73% and 85.33%, respectively).

4.5. CORRELATION STUDIES

The correlation coefficients among the different characters were worked out at phenotypic and genotypic levels (Table 4.14). In general, the genotypic correlation coefficients were higher in magnitude than phenotypic correlation coefficients.

4.5.1 Plant height (cm)

The plant height showed significant of positive correlation at both genotypic and phenotypic correlation level with flower diameter (0.65, 0.47), flower stalk length (0.60, 0.57), duration of flowering (0.11, 0.09), number of disc florets per flower (0.41, 0.38), number of ray florets per flower (0.35, 0.32), number of whorls of ray florets (0.27, 0.25), length of ray floret (0.33, 0.24), width of ray floret (0.23, 0.20), shelf life flower (0.29, 0.26), number of flowers per plant (0.53, 0.50), weight of flowers per plant (0.36, 0.34), weight of flowers plot (0.48, 0.44), number of flower pluckings (0.37, 0.35) and estimated flower yield per hectare (0.36, 0.34), while non significant positive correlation with number of primary branches (0.06 and 0.07) and single fresh flower weight (0.18, 0.17).

Negative correlation with plant spread (-0.40, -0.37), plant fresh weight (-0.40, -0.38), plant dry weight (-0.30, -0.29), leaf length (-0.03, -0.05), days taken to first flower opening (-0.64, -0.60), days taken to 50 per cent flowering (-0.71, -0.65) and non significant negative correlation with leaf width (-0.07, -0.07), *in-situ* life of flower (-0.16, -0.15) at both genotypic and phenotypic level.

4.5.2 Number of primary branches

The number of primary branches exhibited significant positive correlation with plant fresh weight (0.43, 0.37), plant dry weight (0.47, 0.43), flower diameter (0.36, 0.21), flower stalk length (0.14, 0.13), duration of flowering (0.01, -0.02), length of ray floret (0.22, 0.16), width of ray floret (0.43, 0.39), shelf life of flower (0.13, 0.12) and number of flower per plant (0.08, 0.08) both at genotypic and phenotypic level.

The negative correlation at genotypic and phenotypic level for plant spread (-0.21, -0.22), leaf length (-0.37, -0.36), leaf width (-0.28, -0.25), days taken to first flower opening (-0.45, -0.42), days taken to 50 per cent flowering (-0.34, -0.33), single fresh flower weight (-0.31, -

0.28), number of disc florets per flower (-0.63, -0.60), number of ray floret per flower (-0.14, -0.13), number of whorls of ray florets (-0.09, -0.09), *in-situ* life of flower (-0.05, -0.03), weight of flowers per plant (-0.12, -0.11), weight of flowers per plot (-0.08, -0.07), number of flower pluckings (-0.14, -0.13) and estimated yield per hectare (-0.12, -0.11).

4.5.3 Plant spread (cm)

This trait showed significant positive correlation at genotypic and phenotypic level with plant fresh weight (0.31, 0.31), plant dry weight (0.22, 0.20), leaf width (0.42, 0.35), days taken to first flower opening (0.38, 0.37), days taken to 50 per cent flowering (0.49, 0.48) and width of ray floret (0.21, 0.19).

Significant negative association with leaf length (-0.04, -0.02), flower diameter (-0.55, -0.39), flower stalk length (-0.30, -0.28), single fresh flower weight (-0.24, -0.23), duration of flowering (-0.65, -0.48), number of disc floret per flower (-0.03, -0.03), number of ray florets per flower (-0.51, -0.49), number of whorls of ray florets (-0.40, -0.37), length of ray floret (-0.64, -0.56), shelf life of flower (-0.64, -0.60), *in-situ* life of flower (-0.41, -0.40), number of flowers per plant (-0.56, -0.53), weight of flowers per plant (-0.43, -0.41), weight of flowers per plot (-0.39, -0.37), number of flower pluckings (-0.53, -0.50) and estimated flower yield (-0.43, -0.41).

4.5.4 Plant fresh weight (g)

Plant fresh weight showed significant positive correlation at genotypic and phenotypic level with plant dry weight (0.99, 0.95), leaf length (0.26, 0.19), leaf width (0.24, 0.22), days taken to first flowering opening (0.38, 0.37), days taken to 50 per cent flowering (0.38, 0.37).

Flower diameter (-0.63, -0.50), flower stalk length (-0.45, -0.43), single fresh flower weight (-0.85, -0.83), duration of flowering (-0.65, -0.50), number of disc florets per flower (-0.58, -0.56), number of ray florets per flower (-0.81, -0.79), number of whorls of ray florets (-0.82, -0.79), length of ray floret (-0.06, -0.04), width of ray floret (-0.20, -0.16), shelf life of flower (-0.62, -0.60), *in-situ* life of flower (-0.31, -0.26), number of flowers per plant (-0.67, -0.66), weight of flowers per plant (-0.89, -0.86), weight of flowers per plot (-0.87, -0.86) and number of flower pluckings (-0.73, -0.69) and positive association with flower yield per hectare at genotypic and phenotypic level.

Table 4.14: Phenotypic (above diagonal) and Genotypic (below diagonal) coefficient correlation among 25 characters in gaillardia

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00	0.07	-0.37*	-0.38*	-0.29	-0.05	-0.07	-0.60	-0.65	0.47**	0.57	0.17
2	0.06	1.00	-0.22	0.37*	0.43**	-0.36*	-0.25	-0.42*	-0.33	0.21	0.13	-0.28
3	-0.40*	-0.21	1.00	0.31	0.20	-0.02	0.35*	0.37*	0.48**	-0.39*	-0.28	-0.23
4	-0.41*	0.43*	0.31	1.00	0.95**	0.19	0.22	0.37*	0.37*	-0.50**	-0.43*	-0.83
5	-0.30	0.47**	0.22	0.99**	1.00	0.30	0.14	0.30	0.32	-0.47**	-0.31	-0.88
6	-0.03	-0.37*	-0.04	0.26	0.33	1.00	0.05	0.40*	0.29	-0.47**	-0.16	-0.56
7	-0.07	-0.28	0.42*	0.24	0.15	0.07	1.00	0.38*	0.33*	-0.27	-0.60	-0.23
8	-0.64	-0.45*	0.38*	0.38*	0.31	0.43*	0.52*	1.00	0.93	-0.70	-0.75	-0.42**
9	-0.71	-0.34	0.49**	0.38*	0.32	0.36	0.38*	0.96	1.00	-0.65	-0.62	-0.40*
10	0.65**	0.36	-0.55*	-0.63**	-0.54**	-0.62**	-0.40	-0.86	-0.85	1.00	0.57	0.57
11	0.60	0.14	-0.30	-0.45*	-0.32	-0.15	-0.79	-0.76	-0.65	0.67	1.00	0.38
12	0.18	-0.31	-0.24	-0.85	-0.89	-0.61	-0.28	-0.43**	-0.41*	0.66	0.38	1.00
13	0.11	0.01	-0.65**	-0.65**	-0.64	-0.49*	-0.24	-0.35	-0.45*	0.75**	0.09	0.73
14	0.41*	-0.63	-0.03	-0.58	-0.52**	0.13	-0.25	0.04	0.03	0.22	0.45**	0.41*
15	0.35	-0.14	-0.51**	-0.81	-0.77	-0.36	-0.56**	-0.63	-0.65	0.69	0.56	0.84
16	0.27	-0.09	-0.40*	-0.82	-0.79	-0.49*	-0.54*	-0.57	-0.56	0.77	0.52**	0.87
17	0.33	0.22	-0.64	-0.06*	0.02	0.10	-0.31	-0.11	-0.15	0.19	0.07	-0.00
18	0.23	0.43*	0.21	-0.20	-0.16	-0.76	0.01	-0.47**	-0.29	0.66**	0.37*	0.33
19	0.29	0.13	-0.64	-0.62	-0.52	-0.22	-0.54	-0.50	-0.50**	0.68	0.42*	0.55
20	-0.16	-0.05	-0.41*	-0.31	-0.34*	-0.13	-0.57**	-0.12	-0.15	-0.01	0.06	0.45**
21	0.53**	0.08	-0.56	-0.67	-0.63	-0.23	-0.12	-0.46**	-0.56	0.77	0.27	0.45**
22	0.36	-0.12	-0.43	-0.89	-0.90	-0.57	-0.31	-0.52	-0.55	0.83	0.40	0.89
23	0.48*	-0.08	-0.39	-0.87	-0.73	-0.49	-0.43	-0.58	-0.59	0.89	0.50	0.89
24	0.37*	-0.14	-0.53**	-0.73	-0.72	-0.49**	-0.31	-0.53**	-0.62	0.82	0.39*	0.83
25	0.36*	-0.12	-0.43*	-0.89	-0.90	-0.56**	-0.31	-0.52**	-0.54	0.83	0.40*	0.90

1. Plant height (cm)

6. Leaf length (cm)

11. Flower stalk length (cm)

16. No. of whorls of ray florets

21. No. of flowers / plant

***Singnificant at p=0.05 leval**

2. Number of primary branches

7. Leaf width (cm)

12. Single fresh flower weight (g)

17. Length of ray floret (cm)

22. Weight of flowers / plant (g)

****Singnificant at p=0.01 leval**

3. Plant spread (cm)

8. Days taken for first flower opening

13. Duration of flowering (days)

18. Width of ray floret (cm)

23. Weight of flowers/ plot (kg)

4. Plant fresh weight (g)

9..Days taken for 50 per cent flowering

14. No. of disc florets / flower

19. Shelf life of flower (hrs.)

24. No. of flower plucking

5. Plant dry weight (g)

10. Flower diameter (cm)

15. .No. of ray florets / flower

20. *In-situ* life of flower (days)

25. Estimated flower yield / ha(q)

Table 14.14 : Phenotypic (above diagonal) and Genotypic (Below diagonal) coefficient correlation among 25 characters in gaillardia

	13	14	15	16	17	18	19	20	21	22	23	24	25
1	0.09	0.38*	0.32	0.25	0.24	0.20	0.26	-0.15	0.50**	0.34	0.44*	0.35*	0.34*
2	-0.02	-0.60	-0.13	-0.09	0.16	0.39*	0.12	-0.03	0.08	-0.11	-0.07	-0.13	-0.11
3	-0.48**	-0.03	-0.49**	-0.37*	-0.56	0.19	-0.60	-0.40*	-0.53	-0.41	-0.37	-0.50**	-0.41*
4	-0.50**	-0.56	-0.79	-0.79	-0.04*	-0.16	-0.60	-0.26	-0.66	-0.86	-0.86	-0.69	-0.86
5	-0.54	-0.51**	-0.76	-0.78	0.04	-0.15	-0.50	-0.33*	-0.62	-0.90	-0.70	-0.71	-0.89
6	-0.34*	0.12	-0.30	-0.41*	0.16	-0.68	-0.15	-0.15	-0.21	-0.51	-0.43	-0.44**	-0.51**
7	-0.07	-0.20	-0.45**	-0.42*	-0.16	0.02	-0.42	-0.43**	-0.10	-0.25	-0.35	-0.27	-0.25
8	-0.27	0.04	-0.62	-0.55	-0.08	-0.43**	-0.48	-0.13	-0.45**	-0.51	-0.58	-0.50**	-0.51**
9	-0.36*	0.03	-0.63	-0.53	-0.14	-0.24	-0.49**	-0.14	-0.55	-0.53	-0.59	-0.60	-0.53
10	0.52**	0.19	0.60	0.66	0.06	0.44**	0.56	-0.00	0.65	0.70	0.76	0.68	0.70
11	0.06	0.45**	0.55	0.49**	0.02	0.33*	0.40*	0.06	0.26	0.40	0.49	0.36*	0.40*
12	0.61	0.40*	0.84	0.86	0.00	0.29	0.54	0.43**	0.45**	0.90	0.90	0.81	0.90
13	1.00	0.10	0.66	0.74	0.20	0.15	0.68**	0.25	0.60	0.70	0.74	0.79	0.70
14	0.13	1.00	0.35*	0.40*	0.12	-0.01	0.24	0.01	0.17	0.35	0.41	0.37*	0.35*
15	0.78	0.35*	1.00	0.94	0.22	0.14	0.82	0.53	0.51**	0.81	0.88	0.86	0.81
16	0.85	0.42*	0.95	1.00	0.16	0.29	0.83	0.41*	0.56	0.86	0.70	0.89	0.86
17	0.23	0.14	0.24	0.17	1.00	-0.26	0.42*	0.44**	0.05	0.04	0.12	0.17	0.04
18	0.20	-0.00	0.17	0.34	-0.24	1.00	0.17	-0.32	0.15	0.27	0.31	0.21	0.27
19	0.85**	0.23	0.83	0.86	0.51*	0.23	1.00	0.37	0.52**	0.61	0.77	0.72	0.61
20	0.36	0.01	0.56	0.44*	0.55**	-0.40	0.41	1.00	-0.01	0.38	0.29	0.33*	0.33*
21	0.72	0.17	0.51**	0.57	0.05	0.18	0.54**	-0.02	1.00	0.78	0.75	0.64	0.78
22	0.83	0.36	0.81	0.87	0.05	0.31	0.62	0.34	0.78	1.00	0.99	0.89	0.85
23	0.88	0.42	0.87	0.75	0.14	0.35	0.78	0.30	0.76	0.96	1.00	0.87	0.88
24	0.96	0.38*	0.88	0.91	0.19	0.23	0.76	0.34*	0.65	0.89	0.91	1.00	0.90
25	0.83	0.36*	0.81	0.87	0.05	0.31	0.62	0.34*	0.78	0.87	0.95	0.92	1.00

1. Plant height (cm)

6. Leaf length (cm)

11. Flower stalk length (cm)

16. No. of whorls of ray florets

21. No. of flowers / plant

***Singnificant at p=0.05 leval**

2. Number of primary branches

7. Leaf width (cm)

12. Single fresh flower weight (g)

17. Length of ray floret (cm)

22. Weight of flowers / plant (g)

****Singnificant at p=0.01 leval**

3. Plant spread (cm)

8. Days taken for first flower opening

13. Duration of flowering (days)

18. Width of ray floret (cm)

23. Weight of flowers/ plot (kg)

4. Plant fresh weight (g)

9..Days taken for 50 per cent flowering

14. No. of disc florets / flower

19. Shelf life of flower (hrs.)

24. No. of flower plucking

5. Plant dry weight (g)

10. Flower diameter (cm)

15. .No. of ray florets / flower

20. *In-situ* life of flower (days)

25. Estimated flower yield / ha(q)

4.5.5 Plant dry weight (g)

It showed significant positive correlation at genotypic and phenotypic level with leaf length (0.33, 0.30), leaf width (0.15, 0.14), days taken to first flower opening (0.31, 0.30), days taken to 50 per cent flowering (0.32, 0.32), length of ray floret (0.02, 0.04).

It had significant and negative association flower diameter (-0.54, -0.47), flower stalk length (-0.32, -0.31), single fresh flower weight (-0.89, -0.88), duration of flowering (-0.64, -0.54), number of disc florets per flower (-0.52, -0.51), number of ray florets per flower (-0.77, -0.76), number of whorls of ray florets (-0.79, -0.78), width of ray floret (-0.16, -0.15), shelf life of flower (-0.52, -0.50), *in-situ* life of flower (-0.34, -0.33), number of flowers per plant (-0.63, -0.62), weight of flowers per plant (-0.90, -0.90), weight of flowers per plot (-0.73, -0.70), number of flower pluckings (0.72, -0.71) and estimated flower yield per hectare (-0.90, -0.89) with at both genotypic and phenotypic level.

4.5.6 Leaf length (cm)

Leaf length exhibited significantly positive association with at both genotypic and phenotypic level for leaf width (0.07, 0.05), days taken to first flower opening (0.43, 0.40), days taken to 50 per cent flowering (0.36, 0.29), number of disc florets per flower (0.13, 0.12), length of ray floret (0.10, 0.16).

Flower diameter (-0.62, -0.47), flower stalk length (-0.15, -0.16), single fresh flower weight (-0.61, -0.56), duration of flowering (-0.49, -0.34), number of ray florets per flower (-0.36, -0.30), number of whorls of ray florets (-0.49, -0.41), width of ray floret -0.76, -0.68), shelf life of flower (-0.22, -0.15), *in-situ* life of flower (-0.13, -0.15), number of flower per plant (-0.23, -0.21), weight of flowers per plant (-0.57, -0.51), weight of flowers per plot (-0.49, -0.43), number of flower pluckings (-0.49, -0.44) and estimated flowers yield per hectare (-0.56, -0.51) with at both genotypic and phenotypic level, respectively.

4.5.7 Leaf width (cm)

Leaf width manifested significant positive correlation at genotypic and phenotypic level with days taken to first flower opening (0.52, 0.38), days taken to 50 per cent flowering (0.38, 0.33), width of ray floret (0.01, 0.02) and showed significant negative association with flower diameter (-0.40, -0.27), flower stalk length (-0.79, -0.60), single fresh flower weight (-0.28, -0.23), duration of flowering (-0.24, -0.07), number of disc florets per flower (-0.25, -0.20), number of ray florets per flower (-0.56, -0.45), number of whorls of ray florets (-0.54, -0.42), length of ray floret (-0.31, -0.16), shelf life of flower (-0.54, -0.42), *in-situ* life of flower (-0.57, -0.43), number of flowers per plant (-0.12, -0.10), weight of flowers per plant (-0.31, -

0.25), weight of flowers per plot (-0.43, -0.35), number of flower pluckings (-0.31, -0.27), estimated flowers yield per hectare (-0.31, -0.25).

4.5.8 Days taken to first flower opening

This trait showed significantly positive correlation at genotypic and phenotypic level with days taken to 50 per cent flowering (0.96, 0.93), number of disc florets per flower (0.04, 0.04) and expressed significant negative correlation association with flower diameter (-0.86, -0.70), flower stalk length (-0.76, -0.75), single fresh flower weight (-0.43, -0.42), duration of flowering (-0.35, -0.27), number of ray florets per flower (-0.63, -0.62), number of whorls of ray florets (-0.57, -0.55), length of ray floret (-0.11, -0.08), width of ray floret (-0.47, -0.43), shelf life of flower (-0.50, -0.48), *in-situ* life of flower (-0.12, -0.13), number of flower per plant (-0.46, -0.45), weight of flowers per plant (-0.52, -0.51), weight of flowers per plot (-0.58, -0.58), number of flower pluckings (0.53, -0.50) and estimated flowers yield per hectare (-0.52, -0.51).

4.5.9 Days taken to 50 per cent flowering

The trait was found having significantly negative correlation at genotypic and phenotypic level with flower diameter (-0.85, -0.65), flower stalk length (-0.65, -0.62), single fresh flower weight (-0.41, -0.40), duration of flowering (-0.45, -0.36), number of ray florets per flower (-0.65, -0.63), number of whorls of ray florets (-0.56, -0.53), length of ray floret (-0.15, -0.14), width of ray floret (-0.29, -0.24), shelf life of flower (-0.50, -0.49), *in-situ* life of flower (-0.15, -0.14), number of flower per plant (-0.56, -0.55), weight of flowers per plant (-0.55, -0.53), weight of flowers per plot (-0.59, -0.59), number of flower pluckings (-0.62, -0.60), estimated flowers yield per hectare (-0.54, -0.53) and had with positive association with number of disc florets per flower (0.03, 0.03).

4.5.10 Flower diameter (cm)

There was significantly positive correlation with respect to flower diameter at both genotypic and phenotypic level with flower stalk length (0.67, 0.57), single fresh flower weight (0.66, 0.57), duration of flowering (0.75, 0.52), number of disc florets per flower (0.22, 0.19), number of ray florets per flower (0.69, 0.60), number of whorls of ray florets (0.77, 0.66), length of ray floret (0.19, 0.06), width of ray floret (0.66, 0.44), shelf life of flower (0.68, 0.56), number of flower per plant (0.77, 0.65), weight of flowers per plant (0.83, 0.70), weight of flowers per plot (0.89, 0.76), number of flower pluckings (0.82, 0.68), estimated flowers yield per hectare (0.83, 0.70) and had significant negative association with *in-situ* life of flower (-0.01, -0.00).

4.5.11 Flower stalk length (cm)

Flower stalk length showed significant positive correlation at genotypic and phenotypic level with single fresh flower weight (0.38, 0.38), duration of flowering (0.09, 0.06), number of disc florets per flower (0.45, 0.45), number of ray florets per flower (0.56, 0.55), number of whorls of ray florets (0.52, 0.49), length of ray floret (0.07, 0.02), width of ray floret (0.37, 0.33), shelf life of flower (0.42, 0.40), *in-situ* life of flower (0.06, 0.06), number of flower per plant (0.27, 0.26), weight of flowers per plant (0.40, 0.40), weight of flowers per plot (0.50, 0.49), number of flower pluckings (0.39, 0.36) and estimated flowers yield per hectare (0.40, 0.40).

4.5.12 Single fresh flower weight (g)

There was significant positive correlation with respect to single fresh flower weight at genotypic and phenotypic level with duration of flowering (0.73, 0.61), number of disc florets per flower (0.41, 0.40), number of ray florets per flower (0.84, 0.84), number of whorls of ray florets (0.87, 0.86), width of ray floret (0.33, 0.29), shelf life of flower (0.55, 0.54), *in-situ* life of flower (0.45, 0.43), number of flower per plant (0.45, 0.45), weight of flowers per plant (0.89, 0.90), weight of flowers per plot (0.89, 0.90), number of flower pluckings (0.83, 0.81) and estimated flowers yield per hectare (0.90, 0.90). Length of ray floret (-0.00, 0.00) non significant positive correlation with single fresh flower weight.

4.5.13 Duration of flowering (days):

It trait was significant correlation to positive direction with number of disc florets per flower (0.13, 0.10), number of ray florets per flower (0.78, 0.66), number of whorls of ray florets (0.85, 0.74), length of ray floret (0.23, 0.20), width of ray floret (0.20, 0.15), shelf life of flower (0.85, 0.68), *in-situ* life of flower (0.36, 0.25), number of flower per plant (0.72, 0.60), weight of flowers per plant (0.83, 0.70), weight of flowers per plot (0.88, 0.74), number of flower pluckings (0.96, 0.79) and estimated flowers yield per hectare (0.83, 0.70) at genotypic and phenotypic level.

4.5.14 Number of disc florets per flower

Duration of flowering had significant and positive correlation with number of ray florets per flower (0.35, 0.35), number of whorls of ray florets (0.42, 0.40), length of ray floret (0.14, 0.12), shelf life of flower (0.23, 0.24), *in-situ* life of flower (0.01, 0.01), number of flower per plant (0.17, 0.17), weight of flowers per plant (0.36, 0.35), weight of flowers per plot (0.42, 0.41), number of flower pluckings (0.38, 0.37), estimated flowers yield per hectare (0.36, 0.35) and had significant negative association with width of ray floret (-0.00, -0.01) at genotypic and phenotypic level.

4.5.15 Number of ray florets per flower

Significant positive correlation at genotypic and phenotypic level with number of whorls of ray florets (0.95, 0.94), length of ray floret (0.24, 0.22), width of ray floret (0.17, 0.14), shelf life of flower (0.83, 0.82), *in-situ* life of flower (0.56, 0.53), number of flower per plant (0.51, 0.51), weight of flowers per plant (0.81, 0.81), weight of flowers per plot (0.87, 0.88), number of flower pluckings (0.88, 0.86) and estimated flowers yield per hectare (0.81, 0.81).

4.5.16 Number of whorls of ray florets

Number of whorls of ray florets exhibited significant and positive correlation at both genotypic and phenotypic levels with length of ray floret (0.17, 0.16), width of ray floret (0.34, 0.29), shelf life of flower (0.86, 0.83), *in-situ* life of flower (0.44, 0.41), number of flower per plant (0.57, 0.56), weight of flowers per plant (0.87, 0.86), weight of flowers per plot (0.75, 0.70), number of flower pluckings (0.91, 0.89) and estimated flowers yield per hectare (0.87, 0.86).

4.5.17 Length of ray floret (cm)

Length of ray floret had significant correlation at both genotypic and phenotypic level with shelf life of flower (0.51, 0.42), *in-situ* life of flower (0.55, 0.44), number of flower per plant (0.05, 0.05), weight of flowers per plant (0.05, 0.04), weight of flowers per plot (0.14, 0.12), number of flower pluckings (0.19, 0.17) and estimated flowers yield per hectare (0.05, 0.04) and had significant negative association with width of ray floret (-0.24, -0.26).

4.5.18 Width of ray floret (cm):

This trait showed significant positive correlation with shelf life of flower (0.23, 0.17), number of flower per plant (0.18, 0.15), weight of flowers per plant (0.31, 0.27), weight of flowers per plot (0.35, 0.31), number of flower pluckings (0.23, 0.21), estimated flowers yield per hectare (0.31, 0.27) and had significant negative association with *in-situ* life of flower (-0.40, -0.32).

4.5.19 Shelf life of flower (hours)

Shelf life of flower showed significantly positive correlation at genotypic and phenotypic level with *in-situ* life of flower (0.41, 0.37), number of flower per plant (0.54, 0.52), weight of flowers per plant (0.62, 0.61), weight of flowers per plot (0.78, 0.77), number of flower pluckings (0.76, 0.72) and estimated flowers yield per hectare (0.62, 0.61).

4.5.20 *In-situ* life of flower (days)

It was significant and positive correlation at both genotypic and phenotypic levels with weight of flowers per plant (0.34, 0.38), weight of flowers per plot (0.30, 0.29), number of

flower pluckings (0.34, 0.33), estimated flowers yield per hectare (0.34, 0.33) and had significantly negative association with number of flower per plant (-0.02, -0.01).

4.5.21 Number of flower per plant

Number of flower per plant showed significant positive correlation with weight of flowers per plant (0.78, 0.78), weight of flowers per plot (0.76, 0.75), number of flower per pluckings (0.65, 0.64), estimated flowers yield per hectare (0.78, 0.78) at both genotypic and phenotypic level respectively.

4.5.22 Weight of flowers per plant (g)

This trait was showed significant positive at both genotypic and phenotypic level with weight of flowers per plot (0.96, 0.99), number of flower pluckings (0.89, 0.89) and estimated flowers yield per hectare (0.87, 0.85) respectively.

4.5.23 Weight of flowers per plot (kg)

Weight of flower per plot had significantly positive correlation at genotypic and phenotypic level with number of flower pluckings (0.91, 0.89) and estimated flowers yield per hectare (0.95, 0.88).

4.5.24 Number of flower pluckings

There was significant positive association of number of flower pluckings at genotypic and phenotypic level with estimated flower yield per hectare (0.92, 0.90) respectively.

4.6 PATH COEFFICIENT ANALYSIS:

Path coefficient analysis was worked out using only genotypic level for all 25 characters and presented in Table 4.15. The path coefficient of the characters exhibiting the direct and indirect effects of significant characters over weight of flowers per plant are described here as under.

The path correlation coefficients among different characters showed that weight of flowers per plant had maximum positive direct effect with estimated flower yield per hectare (0.809), single fresh flower weight (0.136), number of flowers per plant (0.109), weight of flowers per plot (0.080), plant dry weight (0.077), days taken to first flower opening (0.056), *in-situ* life of flower (0.044), flower stalk length (0.042), plant spread (0.036), number of whorls of ray florets (0.027), number of flower pluckings (0.015), flower diameter (0.011), duration of flowering (0.010), length of ray floret (0.009), plant height (0.003) and leaf width (0.000), while negative direct effect with number of ray florets per flower (-0.075), plant fresh weight (-0.069), days taken to 50 per cent flowering (-0.034), number of disc florets per

flower (-0.020), shelf life of flower (-0.010), width of ray floret (-0.007), leaf length (-0.006) and had non significant negative direct effect of number of primary branches (-0.000).

4.6.1 Plant height (cm)

There was significant and positive correlation between plant height and weight of flower per plant. It was mainly due to indirect effect of weight of flowers per plot (0.025). However, the value of direct effect was comparatively low (0.003).

4.6.2 Number of primary branches

The significant positive association between them was mainly due to the indirect effect of weight of flower per plot (0.001) and the value of direct effect was comparatively lower and in negative direction (-0.000).

4.6.3 Plant spread (cm)

Plant spread had positive correlation direct effect (0.036) of days taken to 50 per cent flowering and the value of indirect effect was comparatively high (0.017).

4.6.4 Plant fresh weight (g)

The significant positive correlation between plant fresh weight and weight of flower per plant. It was mainly due to indirect effect of weight of flowers per plot (0.076). The value of direct effect was (-0.069) comparatively low and in negative direction.

4.6.5 Plant dry weight (g)

Dry weight of plant had positive association between them was mainly due to the indirect effect (0.026) and however, the value of direct effect was comparatively higher (0.077) than direct effect.

4.6.6 Leaf length (cm)

The significant positive association between leaf length and weight of flower per plant was mainly due to the indirect effect of width of ray floret (0.005). The value of direct effect was comparatively low and in negative direction (-0.006).

4.6.7 Leaf width (cm)

Significant positive correlation between them was mainly due to the direct effect (0.000). The value of indirect effect due to weight of flower per plot (0.001) was comparatively higher than other indirect effect.

4.6.8 Days taken to first flower opening

The significant positive correlation between them was mainly due to the indirect effect of days taken to 50 per cent flowering (0.054). However, the value of direct effect was comparatively high (0.056).

Table 4.15: Studies in path analysis at genotypic level of among 25 characters in gaillardia

	1	2	3	4	5	6	7	8	9	10	11	12
1	<u>0.003</u>	0.000	-0.001	-0.001	-0.001	-0.000	-0.000	-0.002	-0.002	0.002	0.002	0.001
2	0.000	<u>-0.000</u>	0.000	-0.000	-0.000	0.000	0.000	0.000	0.000	-0.000	0.000	0.000
3	-0.014	-0.007	<u>0.036</u>	0.011	0.008	-0.001	0.015	0.014	0.017	-0.019	-0.011	-0.008
4	0.028	-0.029	-0.021	<u>-0.069</u>	-0.068	-0.018	-0.017	-0.027	-0.026	0.044	0.031	0.059
5	-0.023	0.037	0.017	0.076	<u>0.077</u>	0.026	0.011	0.024	0.025	-0.042	-0.025	-0.069
6	0.000	0.002	0.000	-0.002	-0.002	<u>-0.006</u>	-0.000	-0.003	-0.002	0.004	0.001	0.004
7	0.000	-0.000	0.000	0.000	0.000	0.000	<u>0.000</u>	0.000	0.000	-0.000	-0.000	-0.000
8	-0.036	-0.025	0.021	0.021	0.017	0.024	0.029	<u>0.056</u>	0.054	-0.048	-0.042	-0.024
9	0.024	0.012	-0.017	-0.013	-0.011	-0.012	-0.013	-0.033	<u>-0.034</u>	0.029	0.022	0.014
10	0.008	0.004	-0.006	-0.007	-0.006	-0.007	-0.005	-0.010	-0.010	<u>0.012</u>	0.008	0.008
11	0.025	0.006	-0.012	-0.019	-0.013	-0.006	-0.033	-0.032	-0.027	0.028	<u>0.042</u>	0.016
12	0.025	-0.042	-0.032	-0.116	-0.121	-0.083	-0.038	-0.058	-0.056	0.090	0.052	<u>0.136</u>
13	0.001	0.000	-0.007	-0.007	-0.007	-0.005	-0.002	-0.004	-0.005	0.008	0.001	0.007
14	-0.008	0.013	0.001	0.012	0.010	-0.002	0.005	-0.001	-0.001	-0.004	-0.009	-0.008
15	-0.026	0.011	0.038	0.060	0.058	0.027	0.042	0.047	0.049	-0.052	-0.042	-0.063
16	0.007	-0.002	-0.011	-0.022	-0.021	-0.013	-0.015	-0.015	-0.015	0.021	0.014	0.023
17	0.003	0.002	-0.006	-0.000	0.000	0.001	-0.003	-0.001	-0.001	0.002	0.001	0.000
18	-0.002	-0.003	-0.001	0.001	0.001	0.005	-0.000	0.003	0.002	-0.005	-0.003	-0.002
19	-0.003	-0.001	0.007	0.006	0.005	0.002	0.006	0.005	0.005	-0.007	-0.004	-0.006
20	-0.007	-0.002	-0.018	-0.013	-0.015	-0.006	-0.025	-0.005	-0.007	-0.000	0.003	0.020
21	0.058	0.009	-0.061	-0.073	-0.069	-0.025	-0.013	-0.050	-0.061	0.084	0.030	0.049
22	0.004	-0.001	-0.003	-0.007	-0.005	-0.004	-0.003	-0.004	-0.005	0.007	0.004	0.007
23	0.005	-0.002	-0.008	-0.011	-0.011	-0.007	-0.005	-0.008	-0.009	0.012	0.006	0.012
24	0.292	-0.101	-0.347	-0.721	-0.733	-0.458	-0.255	-0.421	-0.443	0.670	0.329	0.730

Residual effect = 0.0078

5. Plant dry weight (g)

10. Flower diameter (cm)

15. No. of ray florets / flower

20. *In-situ* life of flower (days)

1. Plant height (cm)

6. Leaf length (cm)

11. Flower stalk length (cm)

16. No. of whorls of ray florets

21. No. of flowers / plant

2. Number of primary branches

7. Leaf width (cm)

12. Single fresh flower weight (g)

17. Length of ray floret (cm)

22. Weight of flower s/ plot (kg)

3. Plant spread (cm)

8. Days taken for first flower opening

13. Duration of flowering (days)

18. Width of ray floret (cm)

23. No. of flower plucking

4. Plant fresh weight (g)

9. Days taken for 50 per cent flowering

14. No. of disc florets / flower

19. Shelf life of flower (hrs.)

24. Estimated flower yield / ha(q)

Table 4.15: Studies in path analysis at genotypic level of among 25 characters in gaillardia

13	14	15	16	17	18	19	20	21	22	23	24	R
0.000	0.001	0.001	0.001	0.001	0.001	0.001	-0.001	0.002	0.025	0.001	0.001	0.001
0.000	0.000	0.000	0.000	-0.000	-0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
-0.023	-0.001	-0.018	-0.014	-0.023	0.007	-0.023	-0.014	-0.020	-0.015	-0.019	-0.015	-0.015
0.045	0.040	0.056	0.057	0.004	0.014	0.043	0.021	0.047	0.076	0.051	0.062	0.062
-0.049	-0.040	-0.060	-0.061	0.002	-0.012	-0.040	-0.026	-0.049	-0.011	-0.056	-0.070	-0.069
0.003	-0.001	0.002	0.003	-0.001	0.005	0.001	0.001	0.001	0.003	0.003	0.004	0.004
-0.000	-0.000	-0.000	-0.000	-0.000	0.000	-0.000	-0.000	0.000	0.001	-0.000	-0.000	-0.000
-0.020	0.002	-0.035	-0.031	-0.006	-0.026	-0.028	-0.007	-0.026	0.021	-0.029	-0.029	-0.029
0.015	-0.001	0.022	0.019	0.005	0.099	0.017	0.005	0.019	-0.034	0.021	0.019	0.019
0.009	0.003	0.008	0.009	0.002	0.008	0.008	-0.000	0.009	-0.020	0.009	0.020	0.009
0.004	0.019	0.023	0.022	0.003	0.016	0.017	0.003	0.011	0.024	0.016	0.017	0.017
0.100	0.056	0.115	0.118	-0.000	0.045	0.075	0.061	0.061	-0.008	0.113	0.122	0.122
<u>0.010</u>	0.001	0.008	0.009	0.002	0.002	0.009	0.004	0.007	0.141	0.020	0.009	0.009
-0.003	<u>-0.020</u>	-0.007	-0.008	-0.003	0.000	-0.005	-0.000	-0.003	-0.022	-0.008	-0.007	-0.007
-0.059	-0.026	<u>-0.075</u>	-0.071	-0.018	-0.013	-0.062	-0.042	-0.038	-0.070	-0.066	-0.061	-0.061
0.023	0.011	0.025	<u>0.027</u>	0.005	0.009	0.023	0.012	0.015	-0.008	0.024	0.023	0.023
0.002	0.001	0.002	0.001	<u>0.009</u>	-0.002	0.004	0.005	0.000	-0.001	0.002	0.000	0.000
-0.001	0.000	-0.001	-0.002	0.002	<u>-0.007</u>	-0.002	0.003	-0.001	-0.016	-0.002	-0.002	-0.002
-0.009	-0.002	-0.009	-0.009	-0.005	-0.002	<u>-0.010</u>	-0.004	-0.006	-0.003	-0.008	-0.006	-0.007
0.016	0.001	0.025	0.019	0.024	-0.018	0.018	<u>0.044</u>	-0.001	-0.003	0.015	0.015	0.015
0.079	0.019	0.055	0.062	0.006	0.019	0.058	-0.002	<u>0.109</u>	-0.016	0.071	0.085	0.086
0.007	0.003	0.007	0.006	0.001	0.003	0.006	0.002	0.006	<u>0.080</u>	0.007	0.008	0.951
0.014	0.006	0.013	0.014	0.003	0.003	0.011	0.005	0.010	-0.025	<u>0.015</u>	0.013	0.013
0.678	0.290	0.662	0.706	0.039	0.251	0.507	0.280	0.636	1.000	0.709	<u>0.809</u>	0.811

Residual effect = 0.0078

5. Plant dry weight (g)	10. Flower diameter (cm)	15. No. of ray florets / flower	20. <i>In-situ</i> life of flower (days)
1. Plant height (cm)	11. Flower stalk length (cm)	16. No. of whorls of ray florets	21. No. of flowers / plant
2. Number of primary branches	12. Single fresh flower weight (g)	17. Length of ray floret (cm)	22. Weight of flower s/ plot (kg)
3. Plant spread (cm)	13. Duration of flowering (days)	18. Width of ray floret (cm)	23. No. of flower plucking
4. Plant fresh weight (g)	14. No. of disc florets / flower	19. Shelf life of flower (hrs.)	24. Estimated flower yield / ha(q)

4.6.9 Day taken to 50 per cent flowering

This trait was significant positive association with weight of flower per plant. It was mainly due to the indirect effect of width of ray floret (0.099) and the value of direct effect was comparatively low and in negative direction (-0.034).

4.6.10 Flower diameter (cm)

The significant positive correlation between them was mainly due to the indirect effect of estimated flower yield (0.020). However, the value of direct effect was comparatively high (0.012).

4.6.11 Flower stalk length (cm)

Significant positive correlation between flower stalk length and weight of flowers per plant was mainly due to the direct effect of (0.042). The value of indirect effect of weight of flower per plot (0.024) was comparatively high than indirect effect.

4.6.12 Single fresh flower weight (g)

The significant positive correlation between them was mainly due to the indirect effect of estimated flower yield per hectare (0.122). The value of direct effect was comparatively high (0.136).

4.6.13 Duration of flowering (days)

The significant positive association between duration of flowering and weight of flowers per plant was mainly due to the indirect effect (0.141) and the value of direct effect was comparatively low (0.010).

4.6.14 Number of disc florets per flower

Significant positive correlation between them was mainly due to the indirect effect of (0.000) width of ray floret and the value of direct effect was comparatively low and negative direction (-0.020).

4.6.15 Number of ray florets per flower

The number of ray florets per flower was non significant positive correlation with weight of flowers per plant mainly due to the indirect effect of width of ray floret (-0.071) and the value of direct effect was comparatively higher and negative direction (-0.075).

4.6.16 Number of whorls of ray florets

The significant positive association between them was mainly due to direct effect (0.027) and the value of indirect effect of number of flower pluckings (0.024) was comparatively high.

4.6.17 Length of ray florets (cm)

Length of ray floret had positive correlation with weight of flower per plant mainly due to direct effect (0.009). However, the value of indirect effect of shelf life of flower was comparatively low (0.005) than direct effect.

4.6.18 Width of ray floret (cm)

Significant positive association between them was mainly due to indirect effect of *in-situ* life of flower (0.003) and the value of direct effect was comparatively low and in negative direction (-0.007).

4.6.19 Shelf life of flower (hours)

The shelf life of flowers was non significant positive correlation with weight of flower per plant while, indirect effect of number of flower pluckings (-0.008) and the value of direct effect was comparatively low and in negative direction (-0.010).

4.6.20 *In-situ* life of flower (days)

The significant correlation between *in-situ* life of flower and weight of flower per plant was mainly due to indirect effect of number of flower pluckings (0.015) and the value of direct effect was comparatively high (0.044).

4.6.21 Number of flowers per plant

It had significantly positive correlation mainly due to the indirect effect of estimated flower yield per hectare (0.085). However, the value of the direct effect was comparatively high (0.109).

4.6.22 Weight of flowers per plot (kg)

The significant positive association between weight of flowers per plot and weight of flowers per plant was mainly due to the direct effect (0.080) and the value of the indirect effect of estimated flower yield per hectare was comparatively higher (0.008) than other indirect effect.

4.6.23 Number of flower pluckings

Significant positive correlation between them was mainly due to the indirect effect of estimated flower yield per hectare (0.013) and the value of direct effect was comparatively high (0.015).

4.6.24 Estimated flower yield per hectare (q)

The positive correlation association between estimated flower yield per hectare and weight of flowers per plant was mainly due to the direct effect (0.809).



Chapter-5

DISCUSSION

The result of the experiment entitled “**Studies on Genetic Variability in Gaillardia (*Gaillardia pulchella* Foug.)**” presented in the previous chapter revealed significant variations among the genotypes for various vegetative, flowering, yield and genetic variability characters. The observed results have been discussed in this chapter in light of findings of earlier research works.

5.1 VEGETATIVE PARAMETERS

5.1.1 Plant height (cm)

The results revealed highly significant differences in plant height among the genotypes with the maximum plant height (81.03 cm) in ‘Genotype-3’ followed by ‘Genotype-7’ (79.03 cm), while the minimum (67.93 cm) was recorded in ‘Genotype-12’. Plant height is attributed to be an important genotypic character that depends upon the genetic constitution. The variation in plant height among the various genotypes might be due to genotypic differences in phenotypic expression of plant height and variations in different genotype-environmental interaction also affect plant height. It could have also been influenced due to development of better root system and luxuriant growth which resulted in large quantity of photosynthetic under favorable conditions. The results find support from reports of Agale and Dawane (2016), Bhaskarwar *et al.* (2016), Girange *et al.* (2016) and Mahawer *et al.* (2011) in gaillardia. Swaroop *et al.* (2008), Kumar *et al.* (2007), Dilta *et al.* (2005), Baskaran *et al.* (2004), and Kulkarni *et al.* (2004) in chrysanthemum.

The variations in plant height could be primarily due to genetical characters of gaillardia genotypes, which might have been further influenced by the environmental conditions in gaillardia. Similar findings were also reported by Bhaskarwar *et al.* (2016) in chrysanthemum.

4.1.2 Number of primary branches

The number of primary branches had significant variation among the different genotypes of gaillardia. The genotype ‘Genotype-2’ produced the maximum number of primary branches per plant (18.87) being at par with ‘Genotype-10’ (18.53) whereas ‘Genotype-1’ produced the minimum number of primary branches (14.73). Variation for this character may be due to genetic behavior of the genotype. The results also find support from

findings of Agale and Dawane (2016), Bhaskarwar *et al.* (2016), Girange *et al.* (2016) and Tamut and Kulkarni (2013) in gaillardia.

5.1.3 Plant spread (cm)

The genotypes studied under this experiment were having highly significant differences for plant spread. The genotype 'Genotype-6' recorded the maximum (73.70 cm) plant spread, whereas the minimum (62.69 cm) was recorded by 'Genotype-10'. The variation in plant spread among the various genotypes might be due to genotypic differences in phenotypic expression of plant spread and variations in different genotype-environmental interaction effects on plant spread in gaillardia. Similar findings have been reported by Singh *et al.* (2017) in chrysanthemum'. Agale and Dawane (2016), Bhaskarwar *et al.* (2016) and Girange *et al.* (2016) in gaillardia. Ajeetkumar *et al.* (2015) in dahlia. Mahmood *et al.* (2013) in gerbera and Zosiamliana *et al.* (2013) in China aster.

5.1.4 Plant fresh weight (g)

The results revealed that there were highly significant differences among the genotypes with respect to plant fresh weight. 'Genotype-2' produced the maximum weight (1626.93 g), while the minimum (929.33 g) in 'Genotype-11'. This was mainly attributed by increased growth characters such as plant height, plant spread and production of higher number of branches and leaves. Similar variation has been reported by Girange *et al.* (2016) in gaillardia and Choudhary *et al.* (2014) in marigold.

5.1.5 Plant dry weight (g)

The results indicated that there were highly significant differences in plant dry weight among the genotypes. The maximum (321.46 g) plant dry weight was recorded in 'Genotype-2', while the minimum dry weight (164.50 g) was observed in 'Genotype-11'. This was mainly attributed by increased growth characters such as plant height, plant spread and production of higher number of branches and leaves in dry matter contents. Similar results were reported by Girange *et al.* (2016) in gaillardia and Choudhary *et al.* (2014) in marigold.

4.1.6 Leaf length (cm)

Highly significant differences were showed by the genotypes for leaf length with the maximum leaf length (11.67 cm) in 'Genotype-7' and the minimum (8.26 cm) in 'Genotype-6'. The variation in leaf length among the genotypes might be due to their genetic makeup regulating leaf growth in longitudinal direction and growth rate of plants especially in early stage that might have been further persuaded by the environment conditions occurred during the vegetative growth period. The findings are in line with

those of Vasudevan and Rao (2010) in gerbera. Kunigunda (2004) and Pal and George (2002) in chrysanthemum.

5.1.7 Leaf width (cm)

The results presented in previous chapter elucidated that there were highly significant differences among the genotypes of leaf width. The maximum leaf width (4.38 cm) was recorded in 'Genotype-3' that was significantly higher over all the genotypes, whereas the minimum leaf width (3.54 cm) was noted in 'Genotype-9' which was at par with 'Genotype-10' (3.58 cm) and 'Genotype-2' (3.59 cm). The variation in leaf length among the genotypes might be due to variation in their genetic constitution that could have leading to differential rates of photosynthesis and ultimately variation in vegetative and reproductive growth of the plants. This might have also been influenced by the environmental effect on expression of genes. Variation in leaf width amongst gaillardia genotypes has also been reported by Vasudevan and Rao (2010) in gerbera. Pal and George (2002) and Kunigunda (2004) in chrysanthemum.

5.2 FLOWERING PARAMETERS

5.2.1 Days taken to first flower opening

The evaluated data was significantly differed for the days taken to first flower opening, whereas 'Genotype-11' was identified as the lowest days taken to first flower opening (42.60 days) followed by 'Genotype-3' (45.45 days), while the 'Genotype-12' identified as highest days taken to first flower opening (65.93 days).

The lowest days taken to first flower opening had been primarily dependent upon the food reserve in the plant that could be related to growth rate of plant regulating accumulation of carbohydrates. Difference in number of days taken to first flower opening for among different genotypes might be due to presence of sufficient genetic traits in the different genotypes in gaillardia. Such variation in days taken to first flower opening were also reported by Talukdar *et al.* (2006), Dilta *et al.* (2005) and Swaroop *et al.* (2008) in chrysanthemum. Ajeetkumar *et al.* (2015) in dahlia. Girange *et al.* (2016) and Tamut and Kulkarni (2013) in gaillardia.

5.2.2 Days taken to 50 per cent flowering

The studied genotypes showed significant differences and reported that the minimum days taken to 50 per cent flowering was recorded in 'Genotype-11' (64.93 days) and the

maximum days taken to 50 per cent flowering (84.33 days) was recorded in ‘Genotype-12’.

The variation in days taken to 50 per cent flowering among the genotypes could be due to their genetic makeup and genotype environment interactions leading to varied rates. These results are in conformity with the reports of Bhaskarwar *et al.* (2016) and Girange *et al.* (2016) in gaillardia and Zosiamlia *et al.* (2013) in China aster.

5.2.3 Flower diameter (cm)

The flower diameter was significantly differed among the different genotypes. The maximum flower diameter was (6.29 cm) reported in ‘Genotype-11’ which was at par to ‘Genotype-10’ (6.00 cm), whereas the minimum was reported in ‘Genotype-12’ (4.95 cm) being at par to ‘Genotype-8’ (5.35 cm).

This variation may be due to differences in the genetic makeup of genotypes and due to the genotypic differences in phenotypic expression of flower diameter. The flower diameter might be due to inherent character of individual genotype. Similar variations have been reported previously by Reddy *et al.* (2016), Suvija *et al.* (2016), Talukdar *et al.* (2006) in chrysanthemum. Tamut and Kulkarni (2013) and Mahawer *et al.* (2011) in gaillardia.

5.2.4 Flower stalk length (cm)

Among the genotypes, flower stalk length was recorded different. The maximum flower stalk length (32.64 cm) was recorded in ‘Genotype-10’, whereas the minimum (17.42 cm) was recorded in ‘Genotype-12’. Flower stalk length might be associated with plant height. The variation in stalk length among the various genotypes might be due to genotypic differences in phenotypic expression of stalk length. Another probable reason for the stalk length among the varieties might be due to environmental conditions prevailed during growth stage of stalk (Baskaran *et al.*, 2010). It was also reported that the cultivars with higher plant height produced the longer flower stalk as compared to cultivars with smaller plant height (Uddin *et al.*, 2015) in chrysanthemum. The results are in line with those of Tamut and Kulkarni (2013) in gaillardia. Zosiamlia *et al.* (2013) in China aster and Singh *et al.* (2017) in gerbera.

5.2.5 Fresh flower weight (g)

The maximum fresh weight of flower was recorded in ‘Genotype-11’ (4.40 g), while the minimum was recorded in ‘Genotype-2’ (1.31 g). The variation in flower weight is mainly dependent upon the flower diameter and type of flower like single, semi-double, double type of genotype and it may be attributed to the inherent characters of the individual

genotype and environmental factors. The variation in fresh flower weight was also reported by Swaroop *et al.* (2008) and Kumar *et al.* (2007) in chrysanthemum. Dewan *et al.* (2016), Reddy *et al.* (2016) and Suvija *et al.* (2016) in chrysanthemum. Ajeetkumar *et al.* (2015) in dahlia.

5.2.6 Duration of flowering (days)

The maximum duration of flowering (143.66 days) was found in 'Genotype-3' which was at par to the 'Genotype-11' (139.40 days), whereas the minimum duration of flowering (108.80 days) was found in 'Genotype-2'. The duration of flowering period could be dependent upon the carbohydrate reserve of the plants as blooming is an energy requiring process.

The variation in duration of flowering among the genotypes was attributed to genotype of the plant, environmental influence and other management factors. Similar results for variation in duration of flowering among the genotypes have also been reported earlier by Singh *et al.* (2017) and Deka *et al.* (2015) in gerbera. Ajeetkumar *et al.* (2015) in dahlia, Choudhary *et al.* (2014) in marigold and Zosiamlina *et al.* (2013) in China aster.

5.2.7 Number of disc florets per flower

The results showed that there were highly significant differences in number of disc florets among the genotypes. The maximum number of disc florets (242.30) per flower was recorded in 'Genotype-1' while the minimum number of disc florets per flower (117.26) was in 'Genotype-12'.

The variation in number of disc florets per flower might be primarily due to their genetic makeup that could have also been influenced by the environmental condition prevailed during trial period. The number of disc florets per flower might have been positive correlated with number of whorls of ray florets and number of ray florets. Similar results on disc florets number have been reported by Reddy *et al.* (2016), Swaroop *et al.* (2008) and Kumar *et al.* (2007) in chrysanthemum

5.2.8 Number of ray florets per flower

The close view of the data depicted that the number of ray florets per flower varied significantly among the genotypes. The maximum numbers of ray florets per flower (214.26) was recorded in 'Genotype-11' which was at par to 'Genotype-7' (208.80), while the minimum (16.53) was recorded in 'Genotype-12'.

The variation in number of ray florets per flower might be due to their genetic makeup and also the genotypes grown in the trial were different in the type of flower and florets arrangement. Similar results were also found by Dewan *et al.* (2016) in chrysanthemum. Agale and Dawane (2016), Tamut and Kulkarni (2013) in gaillardia.

5.2.9 Number of whorls of ray florets

The results presented in previous chapter showed that the number of whorls of ray florets varied significantly among the genotypes. The maximum number of whorls of ray florets (5.96) was recorded in ‘Genotype-11’, whereas the minimum (1.26) in ‘Genotype-2’.

The variation in number of whorls of ray florets might be due to their genetic makeup and also the genotypes grown in the trial were different in the type of flower and florets arrangement. Variation in number of whorls of ray florets might also be due to different in their morphological variations among the floral characters. The similar results were also found by Tamut and Kulkarni (2013) in gaillardia. Baskaran *et al.* (2004) in chrysanthemum and Vikash *et al.* (2011) in dahlia.

5.2.10 Length of ray floret (cm)

The results indicated that highly significant variation in length of ray floret was recorded among the genotypes. The maximum length of ray florets was recorded in ‘Genotype-8’ (3.03 cm), while the minimum was recorded in ‘Genotype-6’ (2.41 cm).

The variation in length of ray floret might be due to hereditary traits of different genotypes. The results indicated that length of ray floret was closely associated with other flower characters like flower diameter, number of ray florets per flower, width of ray floret and type of flower in the genotypes. Similar results have been reported by Baskaran *et al.* (2010) and Kunigunda (2004) in chrysanthemum

5.2.11 Width of ray floret (cm)

The results showed highly significant differences in width of ray floret among the genotypes with the maximum width of ray floret (1.84 cm) in ‘Genotype-6’ and the minimum in ‘Genotype-12’ (1.22 cm). The width of ray floret closely associated with other flower characters like flower diameter, number of whorls of ray florets, number of ray florets per flower, length of ray floret and type of flower in the genotypes.

Hence, it could be stated that variation in length of ray floret in the genotypes might be due to their genetic constitution because of parentages and variation in phenotypic expression of floret length due to sum and product of genotypic and environment conditions. Similar results on width of ray floret have been reported by Singh *et al.* (2017) in gladiolus and Baskaran *et al.* (2010) in chrysanthemum.

5.2.12 Shelf life of flower (hours)

The maximum shelf life of flowers (15.66 hours) was recorded in ‘Genotype-10’ which was at par to ‘Genotype-9’ (15.60 hours), while minimum number of hours of shelf life (9.00 hours) was recorded in ‘Genotype-2’. This might be due genotypic differences among the genotypes and may be an inherent trait. The variation is might be due to the inherited trait of better storage of photosynthetic. Generally, being an ethylene non sensitive flower the difference in days taken to flower senescence may be due to the genotypes characters.

Thus it’s concluded that variation in shelf life of flower of different genotypes may be due to leading differential accumulation of carbohydrates due to varied leaf production and disparity in sensitivity to ethylene. The longest shelf life was mainly due to reduced rate of evaporation and transpiration and prevailing low temperature in chrysanthemum (Suvija *et al.*, 2016). Similar results also were found by Agale and Dawane (2016), Bhaskarwar *et al.* (2016) in gaillardia.

5.2.13 In-situ life of flower

The performances of the *in-situ* life of flower that highly significant differences among the genotypes. The maximum *in-situ* life of flower was recorded in ‘Genotype-8’ (13.53 days), while the minimum was recorded in ‘Genotype-3’ (8.60 days).

The genotypes had a variation in the *in-situ* life due to the inherited trait of better storage of photosynthetic which depends upon the presence of the number of leaves in its growth period (Dewan *et al.*, 2016). Differential sensitivity of the varieties to ethylene could also be a probable reason of variation in vase life in chrysanthemum (Baskaran *et al.*, 2010). It also depends upon the storage food material present in the plant and due to reduced rate of evaporation, transpiration and prevailing to low temperature in chrysanthemum (Suvija *et al.*, 2016). Similar variations are also reported by Uddin *et al.* (2015) in chrysanthemum.

5.3 YIELD PARAMETERS

5.3.1 Number of flowers per plant

The results showed that there were significant differences in number of flowers per plant among the genotypes and highest number of flowers per plant was recorded in ‘Genotype-11’ (131.53) followed by ‘Genotype-7’ (117.93), while the minimum number of flowers per plant (75.60) was recorded in ‘Genotype-8’. The variation in number of flowers per plant might be due to the genetic constitutions of genotypes. However, it may be directly

related to the number of branches per plant and recurrent blooming habit due to their genetic makeup.

The numbers of flowers per plant among different the genotypes might be due to their genetic makeup that could have also been influenced by the environmental conditions (especially temperature and photoperiod) prevailed during the experimental period. Variation in the number of flowers due to germplasm was also reported by Suvija *et al.* (2016), Uddin *et al.* (2015), Dilta *et al.* (2005), Kumar *et al.* (2007) and Baskaran *et al.* (2004) in chrysanthemum. Ajeetkumar *et al.* (2015) in dahlia.

5.3.2 Weight of flowers per plant (g)

The results indicated highly significant differences among the genotypes. The weight flowers per plant were in a range of ‘Genotype-2’ (102.67 g) to ‘Genotype-11’ (578.72 g). Higher weight of flowers was due to the heavier flowers, vigorous of plant height and flower diameter. Several studies reported genotype differences grown in similar environments in number of flowers, flower weight and yield is genetically determined. The variation in flower weight is due to increased flower size and presence of fairly more number of ray florets and thickness of ray florets (Swaroop *et al.*, 2008) in chrysanthemum.

The variation in weight of flowers per plant among the genotypes might be due to the higher rate of water absorption than the transpiration rate (Baskaran *et al.*, 2010). Higher weight of flowers per plant might be due to increase in morphological parameters like plant height, number of leaves and leaf area which might have contributed in production of more photosynthates resulting in greater accumulation of dry matter. Similar results were reported by Suvija *et al.* (2016), Talukdar *et al.* (2003) in chrysanthemum. Ajeetkumar *et al.* (2015) in dahlia, Tamut and Kulkarni (2013), Mahawer *et al.* (2011) in gaillardia and Zosiamliana *et al.* (2013) in China aster.

5.3.3 Weight of flowers per plot (kg)

The results showed highly significant differences among the genotypes and the highest weight of flower per plot was reported in ‘Genotype-11’ (45.89 kg) followed by ‘Genotype-10’ (32.99 kg), while the lowest weight of flower per plot was reported in ‘Genotype-2’ (8.07 kg). Weight of flowers per plant was associated with other parameters like flower morphological characters, weight of single flower, weight of flowers per plant, plant height, number of leaves and leaf area which might have contributed in production of more photosynthates resulting in greater accumulation of dry matter.

The variation in weight of flowers per plot among the genotypes might due to the higher rate of water absorption than the transpiration rate in the flower (Baskaran *et al.*, 2010) in chrysanthemum. Several findings also reported in the Suvija *et al.* (2016), Talukdar *et al.* (2003) in chrysanthemum. Tamut and Kulkarni (2013), Mahawer *et al.* (2011) in gaillardia and Zosiamliana *et al.* (2013) in China aster.

5.3.4 Number of flower pluckings

The results revealed that there were highly significant differences in number of flower plucked in different genotypes. The maximum number of flower pluckings (21.33) was noted in 'Genotype-11', while the minimum (14.53) was recorded in 'Genotype-2' and the number of flower pluckings were closely associated with duration of flowering and flower bud opening time.

The variation in number of flower pluckings of different genotypes might be due to hereditary traits of the genotypes, environmental influence and other management factors. Similar results were also recorded by Girange *et al.* (2016) in gaillardia.

5.3.5 Estimated flower yield per hectare (q)

The genotypes were significant differ and the highest flower yield per hectare (395.26 q) was recorded in the genotype 'Genotype-11' followed by 'Genotype-10' (284.18 q), while the lowest yield of flower per hectare was (69.51 q) observed in 'Genotype-2'. The estimated flower yield per hectare in various genotypes was closely associated with fresh flower weight, number of flower per plant and number of branches per plant increased the flower yield per hectare. Several findings also reported in the Suvija *et al.* (2016) in chrysanthemum. Ajeetkumar *et al.* (2015) in dahlia, Tamut and Kulkarni (2013), Mahawer *et al.* (2011) in gaillardia and Zosiamliana *et al.* (2013) in China aster.

5.4 GENETIC VARIABILITY

The results indicated (Table 4.13) that significant differences among the genotypes for 25 characters studied in the experiment. Extent of variability was measured in terms of variance, genotypic co-efficient of variation (GCV), phenotypic co-efficient of variation (PCV), environmental co-efficient variation (ECV) along with per cent heritability (h^2), advance mean and genetic advance per cent of mean.

In general, phenotypic co-efficient of variation was greater than the corresponding genotypic co-efficient of variation for all the characters. The findings were on the line of Namita *et al.* (2008) and Verma *et al.* (2002). It was indicating the importance and influence of interaction of environment expression of the characters. The differences

between the PCV and GCV were relatively very small which that large amount of variability was contributed by genetic component and less by environmental influence.

The PCV and GCV values were higher for number of ray florets per flower followed by weight of flowers per plant, weight of flowers per plot, estimated flower yield per hectare, number of whorls of ray floret and fresh flower weight, which indicates that greater amount of variability among the different genotypes thus useful for making selections particularly based on that characters.

The highest PCV and GCV were reported for number of ray florets per flower also found the highest variability for the weight of flowers per plant (Khangjarakpam *et al.*, 2014) in China aster suggesting selection of genotypes based on this trait will be effective for further improvement through breeding programmes. Similar findings were also reported by Arulmani *et al.* (2016) and Tamut *et al.* (2015) in gaillardia. Khangjarakpam *et al.* (2014) in China aster. Vikash *et al.* (2011) in dahlia. Baskaran *et al.* (2009) in chrysanthemum.

The estimates of heritability (broad sense) ranged from 66.35-99.78 % for different characters under study. The highest heritability associated with the weight of flowers per plant, fresh flower weight, weight of flowers per plot, estimated flower yield per hectare, number of flowers per plant and number of ray florets per flower, number of whorls of ray floret, plant dry weight, number of disc florets per flower and the lowest heritability found in leaf width, length of ray floret, duration of flowering, flower diameter and width of ray floret was also reported by Vishnupriy *et al.* (2015) in marigold. Similar findings were recorded by Singh *et al.* (2014) in marigold and Vikash *et al.* (2011) in dahlia.

The results indicated that differences in genetic advance among the all characters the highest genetic advance with weight of flowers per plot and followed by the plant fresh weight, weight of flowers per plant, estimated flower yield per hectare and number of ray florets per flower, while the lowest genetic advance associated with length of ray floret, width of ray floret, leaf width, flower diameter and other traits belong to medium group. Similar results were also reported by Rai *et al.* (2017) in China aster, Yuvraj and Dhatt, (2014) in marigold, Khangjarakpam *et al.* (2014) in China aster and Senapathi *et al.* (2013) in gerbera,

In present study, estimated high heritability with high genetic advance mean of per cent (GAM) for vegetative growth characters were observed for plant height, number of primary branches, plant spread, plant fresh weight, plant dry weight, leaf length and leaf width. Flowering traits were recorded in duration of flowering, days taken first flower

opening, indicating the possible role of additive gene action. Similarly, for yield and quality parameters high genetic advance over per cent mean (GAM) was observed for number of ray florets per flower, number of flowers per plant and plot, flower yield both per plant and hectare, stalk length, shelf life of flower and *in-situ* flower life. The results are in conformity to those observed for number of ray florets per flower by Hegde and Gopinath (2003) in *gaillardia*. Similar findings were recorded by Vishnupriy *et al.* (2015) in marigold, Kumar (2015) in gerbera, Singh *et al.* (2014) in marigold, Khangjarakpam *et al.* (2014) in China aster and Senapathi *et al.* (2013) in gerbera.

5.5 CORREALATION STUDIES

The potential productivity of any crop is basically valued in terms of weight of flowers per plant. It is an 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. Further each character is likely to be modified by action of genes present in the genotypes of plant and also by the environment and it becomes difficult to evaluate this complex character directly. Therefore, correlation study of yield with its component traits has been executed to find out the yield contributing traits.

In general, the genotypic correlation coefficients were the respective higher than phenotypic correlation coefficients which might be from modifying effect of environment on the association of characters at genotypic level. Similar results were reported by Gourishankarayya *et al.* (2005) and Singh and Kumar (2008) in marigold. These findings therefore indicate that there is strong inherent association between various characters and the phenotypic expression for different characters under study was lessened by the influence of the environment.

The phenotypic and genotypic correlation coefficients among different characters showed that weight of flowers per plant had positive significant association with single fresh flower weight (0.90, 0.90), estimated flower yield per hectare (0.90, 0.92), number of flower pluckings (0.88, 0.95), number of whorls of ray floret (0.86, 0.87), weight of flowers per plot (0.85, 0.87), number of ray florets per flower (0.81, 0.81), number of flowers per plant (0.78, 0.78), flower diameter (0.70, 0.83), duration of flowering (0.70, 0.83), shelf life of flower (0.61, 0.62), flower stalk length (0.40, 0.40), number of disc florets per flower (0.35, 0.36), plant height (0.07, 0.06), *in-situ* life of flower (0.33, 0.34), width of ray floret (0.27, 0.31), length of ray floret (0.04, 0.05), while significantly negative correlations were observed with plant dry weight (-0.89, -0.90), plant fresh

weight (-0.86, -0.89), days taken to 50 per cent flowering (-0.53, -0.54), days taken to first flower opening (-0.51, -0.52), leaf length (-0.51, -0.56), plant spread (-0.41, -0.43), leaf width (-0.25, -0.31) and number of primary branches (-0.11, -0.12) both at phenotypic and genotypic coefficients correlation, respectively.

Beside this, plant height resulted in the maximum significantly positive association with flower stalk length and number of flowers per plant and it revealed significantly highest negative correlation with days taken to 50 per cent flowering, days taken to first flower opening and plant fresh weight respectively. Similar results were observed by Arulmani *et al.* (2016) in gaillardia and Suvija *et al.* (2016) and Vetrivel *et al.* (2014) in chrysanthemum. Significantly positive correlation of number of primary branches was found with plant dry weight and width of ray floret, while significant negative association of this trait was found with number of disc floret per flower, respectively. Similar findings were also reported by Arulmani *et al.* (2016) in gaillardia and Suvija *et al.* (2016) in chrysanthemum, Kumar (2014) in gerbera and Misra *et al.* (2013) in chrysanthemum. Arulmani *et al.* (2016) reported the plant spread had the maximum positive correlation with days taken to 50 per cent flowering, days taken to first flower opening, while the negative correlation with shelf life of flower, length of ray florets per flower and *in-situ* life of flower respectively. Plant fresh weight associated with the maximum positive with plant dry weight, leaf length and negative associated of weight of flower per plot, number of flower pluckings respectively. Plant dry weight the highest positive correlation with days taken to 50 per cent flowering, leaf length, days taken to first flower opening and negative of weight of flower per plot and single fresh flower weight respectively. Similar findings were reported by Arulmani *et al.* (2016) in gaillardia. Leaf length positive associated with days taken to first flower opening, days taken to 50 per cent flowering, length of ray floret and negative correlation of width of ray floret, single fresh flower weight, respectively. Leaf width was the maximum positive correlation with days taken to first flower opening, days taken to 50 per cent flowering and negative association of flower stalk length and number of ray florets. Similar observations have been reported by Kumar (2014) in gerbera

Days taken to first flower opening with positive correlation of days taken to 50 per cent flowering and negative with flower stalk length, flower diameter and number of ray florets per flower. The similar correlation findings have been reported by Arulmani *et al.* (2016) in gaillardia, Karuppaiah and Kumar (2011) in African marigold. Tirakannanavar *et al.* (2015) reported the days taken to 50 per cent flowering highest significant positive

correlation with number of disc florets per flower and negative correlation of flower diameter, flower stalk length and estimated flower yield per hectare. Arulmani *et al.* (2016) reported the flower diameter correlation with significant positive of weight of flowers per plot, number of flower pluckings and negative with shelf life of flower. Flowers stalk length with positive correlation of number of ray florets per flower, number of flower pluckings, number of whorls of ray floret and weight of flowers per plot. The similar correlation findings have been reported by Vetrivel *et al.* (2014) in chrysanthemum. Single fresh flower weight positively correlated with weight of flowers per plot, number of flower pluckings, number of whorls of ray floret, number of ray florets per flower and negative with length of ray floret. Similar findings were also reported by Arulmani *et al.* (2016) in gaillardia, Karuppaiah and Kumar (2011) in African marigold. Vikash *et al.* (2011) reported positively correlated with duration of flowering and flower diameter in dahlia. Duration of flowering positively associated with maximum of number of flower pluckings, estimated flower yield per hectare, number of whorls of ray floret and weight of flowers per plot. Similar results were also reported by Arulmani *et al.* (2016) in gaillardia and Suvija *et al.* (2016) in chrysanthemum. Number of disc florets per flower was positively correlated with number of flower pluckings, weight of flower per plot, number of whorls of ray floret, number of ray florets per flower, while the negative correlation with width of ray floret. Similar results were reported by Bharathi *et al.* (2014) in African marigold. Suvija *et al.* (2016) reported the number of ray florets per flower had significant positive correlation with number of whorls of ray floret, number of flower pluckings, shelf life of flower and weight of flower per plot. Number of whorls of ray floret was highly positive correlation with estimated flower yield per hectare, weight of flower per plot, shelf life of flower, number of flower pluckings and number of flowers per plant. Length of ray floret was highest positive correlation with *in-situ* life of flower, shelf life of flower, while the negative correlation of width of ray floret. Width of ray floret positive correlation with number of flower pluckings, weight of flower per plot and shelf life of flower, while the negative correlation with number of flowers per plant. Similar correlations were recorded by Singh *et al.* (2017) in gladiolus, Arulmani *et al.* (2016) in gaillardia. Shelf life of flower highly positive associated with number of flower pluckings, weight of flower per plot, number of flowers per plant and *in-situ* life of flower. Similar findings were recorded by Arulmani *et al.* (2016) in gaillardia. (Misra *et al.*, 2013) reported the *in-situ* life of flower was highest positive correlation with weight of flower

per plot, estimates flower yield per hectare, number of flower pluckings, while negative correlation with number of flowers per plant.

The number of flowers per plant was positively correlated with weight of flower per plot, number of flower pluckings and estimates flower yield per hectare. Weight of flowers per plot was positive correlation with number of flower pluckings, weight of flower per plant and estimates flower yield per hectare. Number of flower pluckings highly significant positive correlation with estimated flower yield per hectare. Estimated flower yield per hectare was highly significant positive correlation with weight of flowers per plant at phenotypic and genotypic correlation co-efficient level respectively. Similar correlation of yield were also reported earlier by several workers viz., Arulmani *et al.* (2016) in gaillardia, Suvija *et al.* (2016) in chrysanthemum, Tirakannanavar *et al.* (2015) in China aster, Vetrivel *et al.* (2014) in chrysanthemum, Kumar (2014) in gerbera, Bharathi *et al.* (2014) in marigold, Karuppaiah and Kumar (2011) in African marigold, Poornima *et al.* (2006) in China aster, Mathad *et al.* (2005) and Mathew *et al.* (2005) in marigold.

5.6 PATH ANALYSIS

In the present study, path coefficient analysis was computed at genotypic level for all the characters. It analysis was carried out by weight of flowers per plant as depended variable to partition the co-efficients correlation into direct and indirect effects in order to determine the contribution of different characters towards the weight of flowers per plant. The direct and indirect effects of various characters on weight of flowers per plant showed that there is agreement between direction and magnitude of direct effect of various characters and correlation with weight of flowers per plant. Thus, a significant improvement in weight of flowers per plant can be expected through selection in the component traits with higher order positive direct effects (Table 4.15). Path coefficient analysis was devised by Dewey and Lu (1959), however, provides a realistic basis for allocation of appropriate weight age to various attributes, while the designing a pragmatic programme for an improvement of yield.

The path coefficient analysis at genotypic level revealed that weight of flowers per plant had the maximum positive direct effect on estimated flower yield, single fresh flower weight, number of flowers per plant, weight of flowers per plot, plant dry weight, *in-situ* flower life, days taken to first flower opening, flower stalk length, plant spread, number of whorls of ray floret, number of flower pluckings, flower diameter, duration of flowering, length of ray florets per flower and plant height, whereas, the negative direct effect at

genotypic level towards weight of flowers per plant was exerted by number of ray florets per flower, plant fresh weight, days taken to 50 per cent flowering, number of disc florets per flower, shelf life of flower, width of ray floret, leaf length and number of primary branches. At genotypic level residual effect was found to be 0.0078. Similar results was also reported by Bharathi *et al.* (2014) in marigold, Misra *et al.* (2013) in chrysanthemum, Anuja and Jahnavi (2012) in marigold, Vikash *et al.* (2011) in dahlia, Mathad *et al.* (2005) and Mathew *et al.* (2005) in marigold.



Chapter-6

SUMMARY AND CONCLUSION

A field experiment entitled “**Studies on Genetic Variability in Gaillardia (Gaillardia pulchella Foug.)**” was carried out during 2017-18 at the Instructional Farm, Department of Floriculture & Landscaping, College of Horticulture & Forestry, Jhalrapatan, Jhalawar. The experimental results presented and discussed in the previous chapters are summarized here.

1. The maximum plant height (81.03 cm) was recorded in ‘Genotype-3’, while the minimum (67.93 cm) was recorded in ‘Genotype-12’.
2. The maximum number of primary branches (18.87) was recorded in ‘Genotype-2’, while the minimum (14.73) was recorded in ‘Genotype-1’.
3. The maximum plant spread (73.70 cm) was recorded in ‘Genotype-6’, whereas minimum (62.69 cm) was recorded in ‘Genotype-10’.
4. The highest plant fresh weight was observed in ‘Genotype-2’ (1626.93 g), while the lowest in ‘Genotype-11’ (929.33 g).
5. The maximum plant dry weight (321.46 g) was recorded in ‘Genotype-2’, while the minimum (164.50 g) was recorded in ‘Genotype-11’.
6. The maximum leaf length (11.67 cm) was illustrated in ‘Genotype-7’, while the minimum leaf length (8.06 cm) was observed in ‘Genotype-6’.
7. The maximum leaf width (4.38 cm) was recorded in ‘Genotype-3’, while the minimum leaf width (3.54 cm) was recorded in ‘Genotype-9’.
8. The maximum days taken to first flower opening (65.93) was recorded in ‘Genotype-12’ which was at par to (56.40 days) ‘Genotype-1’, while minimum days taken to first flower opening (42.60 days) was recorded in ‘Genotype-11’.
9. The highest days taken to 50 per cent flowering (84.33 days) were illustrated in ‘Genotype-12’, while the minimum days taken to 50 per cent flowering (64.93 days) were recorded in ‘Genotype-11’.
10. The largest flower diameter (6.29 cm) was recorded in ‘Genotype-11’, while the smaller (4.95 cm) was recorded in ‘Genotype-12’.
11. The highest flower stalk length (32.64 cm) was recorded in ‘Genotype-10’ followed by (32.52 cm) ‘Genotype-2’, whereas lowest flower stalk length (17.42 cm) was recorded in ‘Genotype-12’.

12. The highest fresh flower weight (4.40 g) was recorded in 'Genotype-11', while the lowest fresh flower weight (1.31 g) was recorded in 'Genotype-2'.
13. The maximum duration of flowering (143.66 days) was recorded in 'Genotype-3', which is at par in 'Genotype-11' (139.40 days), while the minimum (108.80 days) was reported in 'Genotype-2'.
14. The maximum number of disc florets per flower (242.30) was recorded in 'Genotype-1', while minimum number of disc florets per flower (117.26) was recorded in 'Genotype-12'.
15. The maximum number of ray florets per flower (214.26) was recorded in 'Genotype-11', whereas the minimum number of ray florets per flower (16.25) was recorded in 'Genotype-12'.
16. The maximum number of whorls of ray florets (5.96) was recorded in 'Genotype-11' and the minimum number of whorls of ray florets (1.40) was recorded in 'Genotype-12'.
17. The highest length of ray floret (3.03 cm) was recorded in 'Genotype-8' which it's at par (2.86 cm) in 'Genotype-1', while the minimum (2.41 cm) was observed in 'Genotype-6'.
18. The maximum width of ray floret (1.75 cm) was recorded in 'Genotype-10', while the minimum width of ray floret (1.22 cm) was founded in 'Genotype-12'.
19. The maximum shelf life of flower was recorded in 'Genotype-10' (15.66 hours) which was at par to 'Genotype-9' (15.60 hours), while the minimum shelf life of flower was recorded in 'Genotype-2' (9.00 hours).
20. The maximum *in-situ* flower life was recorded in 'Genotype-8' (13.53 days) which was at par to 'Genotype-9' (12.06 days), while the minimum *in-situ* flower life was recorded in 'Genotype-6' (9.73 days).
21. The maximum number of flowers per plant was recorded in 'Genotype-11' (131.53) which at par to 'Genotype-7' (117.93), while the minimum number of flowers per plant was recorded in 'Genotype-8' (75.60).
22. The maximum weight of flowers per plant (578.2 g) was recorded in 'Genotype-11', while the minimum weight of flowers per plant (102.67 g) in 'Genotype-2'.
23. The highest weight of flowers per plot was recorded in 'Genotype-11' (45.89 kg) which was at par to 'Genotype-10' (32.99 kg), while the lowest weight of flowers per plot was recorded in 'Genotype-2' (8.07 kg).

24. The maximum number of flower pluckings (21.33) was recorded in 'Genotype-11', while the minimum number of flower pluckings (14.53) was recorded in 'Genotype-2'.
25. The maximum estimated flower yield per hectare was recorded in 'Genotype-11' (395.26 q), while the minimum estimated flower yield per hectare (69.51 q) was recorded in 'Genotype-2'.
26. The highest genotypic coefficient of variation (GCV) was observed for number of ray florets per flower (47.23%) followed by weight of flowers per plot (41.47%).
27. The highest heritability was recorded for weight of flowers per plant (99.78%). Heritability estimates of higher order were showed for fresh flower weight (99.76%), weight of flowers per plot (99.73%), number of flowers per plant (99.59%), number of whorls of ray floret (98.29%), plant dry weight (98.20%).
28. Expected genetic gain was highest for plant fresh weight (470.38%). High value of expected genetic gain was also recorded for weight of flowers per plant (262.39%) weight of flowers per plant (208.62%) and number of ray floret per flower (137.53%).
29. Genetic advance per cent of mean was the maximum for number of ray florets per flower (96.92%). High value of genetic advance per cent of mean was also recorded for weight of flowers per plant (85.39%), weight of flowers per plot (85.32%), estimated flower yield per hectare (85.33%) and number of ray florets per flower (78.24%).
30. Correlation studies revealed that highly significant and positive association of weight of flowers per plant with single fresh flower weight, estimated flower yield per hectare, number of flower pluckings, number of whorls of ray florets, weight of flowers per plot, number of ray florets per flower, number of flowers per plant, flower diameter, duration of flowering and shelf life of flower also showed significant and positive correlation with weight of flowers per plant, indicating the possibility of simultaneous selection for these traits to improve the yield.
31. Path analysis for flower yield per plant revealed that single fresh flower weight, number of flowers per plant, weight of flowers per plot, plant dry weight, days taken to first flower opening, flower diameter and number of whorls of ray floret had positive direct effect on flower yield which indicated the possibility of increasing flower yield by selecting the genotypes for these characters directly.

CONCLUSION

On the basis of results of the present experiment the following conclusion may be drawn. Under the agro-climatic conditions of sub-humid region of Rajasthan, out of 12 genotypes tested, the 'Genotype-11' was found superior for 12 characters out of 25 characters such as days taken to first flower opening (42.60 days), days taken to 50 per cent flowering (64.93 days), flower diameter (6.29 cm), fresh flower weight (4.40 g), duration of flowering (139.40 days), number of ray florets per flower (214.26), number of whorls of ray floret (5.96), number of flowers per plant (131.53), weight of flowers per plant (578.72 g), weight of flowers per plot (45892.30 g), number of flower pluckings (21.33) and estimated flower yield per hectare (395.26 q). The 'Genotype-10' was recorded best for the higher number of primary branches (18.53), flower diameter (6.00 cm), flower stalk length (32.26 cm), the maximum shelf life of flower (15.66 hrs.). The 'Genotype-1' observed (242.30) maximum number of disc florets per flower and duration of flowerings in 'Genotype-3' (143.66 days).

'Genotype-11' and 'Genotype-10' recorded maximum fresh flower weight, weight of flowers per plant, weight of flowers per plot, flower diameter, days taken to first flower opening and duration of flowering, shelf life of flower, number of flowers per plant and these genotypes were found to be superior with respect to all other genotypes of gaillardia.

High PCV and GCV was recorded in number of ray floret per flower, weight of flowers per plant, weight of flowers per plot, number of whorls of ray floret, fresh flower weight, plant dry weight, number of disc florets per flower, plant fresh weight, number of flowers per plant, indicate the existence of wide range of genetic variability and hence there is a good scope for an improvement of these characters through selection and responsiveness of these traits to appropriate selection for evolution of an improved genotypes of gaillardia due to low influence of environment whereas these traits had a more an importance for selection in breeding programmes.

The correlation of weight of flower per plant was positive and significant at phenotypic level single fresh flower weight, estimated flower yield per hectare, number of flower pluckings, weight of flowers per plant, number of whorls of ray floret, number of ray florets per flower, number of flowers per plant, duration of flowering, flower diameter and flower stalk length. It is revealed from the results that high order positive direct effect

and significant at genotypic level with flower yield was exerted by estimated flower yield per hectare, single fresh flower weight, number of flowers per plant, weight of flowers per plot, plant dry weight, days taken to first flower opening, *in-situ* life of flower and flower stalk length, plant spread and number of whorls of florets per flower.

Path analysis revealed that estimated flower yield followed by single fresh flower weight, number of flowers per plant, weight of flowers per plot, plant dry weight, *in-situ* flower life, days taken to first flower opening, flower stalk length, plant spread, number of whorls of ray floret, number of flower pluckings, flower diameter, duration of flowering, length of ray florets per flower and plant height had positive and direct effects towards weight of flower per plant.



Chapter-7

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Studies on Genetic Variability in Gaillardia (*Gaillardia pulchella* Foug.)

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ABSTRACT

A field experiment was conducted during summer season of 2017-18 to study the “**Studies on Genetic Variability in Gaillardia (*Gaillardia pulchella* Foug.)**” at the Instructional Farm, Department of Floriculture & Landscaping, College of Horticulture & Forestry, Jhalrapatan, Jhalawar. The experiment consisted of 12 genotypes such as ‘Genotype-1’, ‘Genotype-2’, ‘Genotype-3’, ‘Genotype-4’, ‘Genotype-5’, ‘Genotype-6’, ‘Genotype-7’, ‘Genotype-8’, ‘Genotype-9’, ‘Genotype-10’, ‘Genotype-11’ and ‘Genotype-12’ laid out in randomized block design with three replications.

The genotype ‘Genotype-11’ was found superior for 12 characters out of 25 characters such as for days taken to first flower opening (42.60 days), days taken to 50 per cent flowering (64.93 days), flower diameter (6.29 cm), fresh flower weight (4.40 g), duration of flowering (139.40 days), number of ray florets per flower (214.26), number of whorls of ray floret (5.96), number of flowers per plant (131.53), weight of flowers per plant (578.72 g), weight of flowers per plot (45.89 kg), number of flower pluckings (21.33) and estimated flower yield per hectare (395.26 q). The ‘Genotype-10’ was noted best the number of primary branches (18.53), flower diameter (6.00 cm), flower stalk length (32.26 cm), maximum shelf life of flower (15.66 hrs.). The ‘Genotype-1’ was observed in number of disc florets per flower (242.30) and the maximum duration of flowering was observed in ‘Genotype-3’ (143.66 days).

The estimates on phenotypic co-efficient of variation (PCV) were more than genotypic co-efficient of variation (GCV) for all character. High heritability with high values of genetic advance was observed for weight of flowers per plot, plant fresh weight, weight of flowers per plant, estimated flower yield per hectare and number of ray florets per flower.

Weight of flowers per plant had high positive association with single fresh flower weight, number of flower pluckings, weight of flowers per plant, number of whorls of ray floret, weight of flowers per plot, number of ray florets per flower, flower diameter, duration of flowering and shelf life of flower.

Path co-efficient analysis revealed at genotypic level with that characters on positive direct effect viz., estimated flower yield per hectare, number of flowers per plant, single fresh flower weight, weight of flower per plot, plant dry weight, days taken to first flower opening, *in-situ* life of flower, flower stalk length, plant spread, number of whorls of ray floret and flower diameter.

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गैलार्डिया (गैलार्डिया पल्चेला फौग.) में अनुवांशिक विविधता पर अध्ययन

राहुल कुमार ब्याडवाल *

शोधकर्ता

डॉ. ए. मिश्रा **

मुख्य सलाहकार

सारांश

उधानिकी एवं वानिकी महाविद्यालय झालरापाटन, झालावाड़ के पुष्प एवं भूदृश्य विज्ञान विभागान्तर्गत निर्देशन प्रक्षेत्र पर गैलार्डिया (गैलार्डिया पल्चेला फौग.) में अनुवांशिक विविधता पर अध्ययन हेतु वर्ष 2017-18 ग्रीष्मकालीन में गैलार्डिया की 12 जीनप्रारूप जैसे की 'जीनप्रारूप-1', 'जीनप्रारूप-2', 'जीनप्रारूप-3', 'जीनप्रारूप-4', 'जीनप्रारूप-5', 'जीनप्रारूप-6', 'जीनप्रारूप-7', 'जीनप्रारूप-8', 'जीनप्रारूप-9', 'जीनप्रारूप-10', 'जीनप्रारूप-11' और 'जीनप्रारूप-12' शामिल करते हुए यादृच्छिक खण्ड अभिकल्पना में तीन पुनरावर्तियों के साथ एक अनुसंधान किया गया।

जीनप्रारूप 'जीनप्रारूप-11' में प्रथम फूल खुलने के लिए लगा समय (42.60 दिनों), 50 प्रतिशत फूल आने में लगा (64.93 दिनों), फूल का व्यास (6.29 सेमी), एकल ताजा फूल का वजन (4.40 ग्राम), फूल आने की अवधि (139.40 दिनों), प्रति फूल कणिकाओं की बारंबारता (214.26), कणिकाओं के घेरो की फूल में बारंबारता (5.96), प्रति पौधे फूलों की बारंबारता (131.53), प्रति पौधे फूलों का वजन (578.72 ग्राम), प्रति भूखंड फूलों का वजन (45.89 किलोग्राम), फूलों को तोड़ने की बारंबारता (21.33) और अनुमानित प्रति हेक्टेयर फूल उपज (395.26 कुंटल) में कुल 25 लक्षणों में से 12 श्रेष्ठ पाये गये। 'जीनप्रारूप-10' में प्राथमिक शाखाओं की संख्या (18.53), फूल का व्यास (6.00 सेमी), फूल डंठल की लम्बाई (32.26 सेमी), फूल की अधिकतम ताजा बने रहने की अवधि (15.66 घंटे), में सबसे अच्छे पाया गया। 'जीनप्रारूप-1' में प्रति फूल डिस्क फ्लोरेट्स (242.30) की बारंबारता सबसे अधिक पायी गई और 'जीनप्रारूप-3' (143.66 दिनों) में फूलों के आने की अधिकतम अवधि पायी गई।

लक्षणप्रारूप सह-कुशलता (पीसीवी) के अनुसार सभी लक्षणों के लिए जीनप्रारूप सह-कुशलता (जीसीवी) से अधिक पायी गई। सर्वाधिक गम्यता के साथ सर्वाधिक मात्रा में जननिक लाभ प्रति भूखंड फूलों का वजन, एकल ताजा पौधे का वजन, प्रति पौधा फूलों का वजन, अनुमानित फूल उपज प्रति हेक्टेयर और प्रति फूल कणिकाओं की बारंबारता पायी गई।

प्रति पौधा फूलों का वजन, एकल ताजा फूल का वजन के साथ उच्च सकारात्मक संघ देखा गया, फूलों को तोड़ने की संख्या, प्रति पौधा फूल का वजन, प्रति फूल कणिकाओं के घेरो की बारंबारता, प्रति भूखंड फूलों का वजन, प्रति फूल कणिकाओं की बारंबारता, फूल का व्यास, फूल आने की अवधि और फूल की अधिकतम ताजा बने रहने की अवधि पायी गई।

पथ सह-कुशल विश्लेषण सकारात्मक प्रत्यक्ष प्रभाव पर हैं, कि लक्षणों के साथ जीनप्रारूप स्तर पर पता चला अर्थात, अनुमानित फूल उपज प्रति हेक्टेयर, प्रति पौधा फूलों की बारंबारता, एकल ताजा फूल का वजन, प्रति भूखंड फूल का वजन, पौधे का सूखा वजन, प्रथम फूल आने में लगे दिन, मूल स्थान पर ताजा बने रहने की अवधि, फूल के डंठल की लम्बाई, पौधे का प्रसार, प्रति फूल कणिकाओं के घेरो की बारंबारता और फूल का व्यास पायी गई |

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**प्राध्यापक एवं विभागाध्यक्ष पुष्प एवं भूदृश्य विज्ञान विभाग, उधानिकी एवं वानिक महाविद्यालय, झालरापाटन, झालावाड़ (राज.)

APPENDIX-I

Analysis of variance for plant height

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	441.92	40.17	27.06*	2.25
Replication	2	5.26	2.63		
Error	22	32.66	1.48		
Total	35	479.84			

*Significant at 5% level of significance

APPENDIX-II

Analysis of variance for number of primary branches

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	61.42	5.58	18.35*	2.25
Replication	2	0.56	0.28		
Error	22	6.69	0.30		
Total	35	68.68			

*Significant at 5% level of significance

APPENDIX-III

Analysis of variance for plant spread (cm)

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	425.83	38.71	33.81*	2.25
Replication	2	4.33	2.17		
Error	22	25.19	1.14		
Total	35	455.35			

*Significant at 5% level of significance

APPENDIX-IV

Analysis of variance for plant fresh weight

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	1830109.19	166374.56	64.59*	2.25
Replication	2	5409.80	2704.90		
Error	22	56671.12	2575.96		
Total	35	1892190.11			

*Significant at 5% level of significance

APPENDIX-V

Analysis of variance for plant dry weight

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	76288.74	6935.34	165.04*	2.25
Replication	2	70.14	35.07		
Error	22	924.47	42.02		
Total	35	77283.35			

*Significant at 5% level of significance

APPENDIX-VI

Analysis of variance for leaf length

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	38.57	3.51	13.57*	2.25
Replication	2	0.33	0.16		
Error	22	5.68	0.25		
Total	35	44.58			

*Significant at 5% level of significance

APPENDIX-VII

Analysis of variance for leaf width

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	2.63	0.24	6.91*	2.25
Replication	2	0.11	0.05		
Error	22	0.76	0.03		
Total	35	3.50			

*Significant at 5% level of significance

APPENDIX-VIII

Analysis of variance for days taken to first flower opening

Source of Variation	D.F	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	1250.61	113.69	122.62*	2.25
Replication	2	2.16	1.08		
Error	22	20.40	0.93		
Total	35	1273.17			

*Significant at 5% level of significance

APPENDIX-IX

Analysis of variance for days taken to 50 per cent flowering

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	918.16	83.46	58.19*	2.25
Replication	2	2.90	1.45		
Error	22	31.55	1.43		
Total	35	952.61			

*Significant at 5% level of significance

APPENDIX-X

Analysis of variance for flower diameter

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	3.99	0.36	9.07*	2.25
Replication	2	0.06	0.03		
Error	22	0.88	0.04		
Total	35	4.93			

*Significant at 5% level of significance

APPENDIX-XI

Analysis of variance for flower stalk length

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	556.33	50.57	86.35*	2.25
Replication	2	1.00	0.50		
Error	22	12.88	0.58		
Total	35	570.21			

*Significant at 5% level of significance

APPENDIX-XII

Analysis of variance for single fresh flower weight

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	31.46	2.86	1273.17*	2.25
Replication	2	0.006	0.003		
Error	22	0.05	0.001		
Total	35	31.52			

*Significant at 5% level of significance

APPENDIX-XIII

Analysis of variance for duration of flowering

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	2036.33	185.12	8.07*	2.25
Replication	2	79.16	39.58		
Error	22	504.33	22.92		
Total	35	2619.82			

*Significant at 5% level of significance

APPENDIX-XIV

Analysis of variance for number of disc florets per flower

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	31090.54	2826.41	138.43*	2.25
Replication	2	93.47	46.73		
Error	22	449.20	20.42		
Total	35	31633.21			

*Significant at 5% level of significance

APPENDIX-XV

Analysis of variance for number of ray florets per flower

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	148617.26	13510.66	387.18*	2.25
Replication	2	13.00	6.50		
Error	22	767.69	34.89		
Total	35	149397.95			

*significant at 5% level of significance

APPENDIX-XVI

Analysis of variance for number of whorls of ray florets

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	73.46	6.67	173.87*	2.25
Replication	2	0.10	0.05		
Error	22	0.84	0.03		
Total	35	74.41			

*Significant at 5% level of significance

APPENDIX-XVII

Analysis of variance for length of ray floret

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	0.97	0.088	7.35*	2.25
Replication	2	0.01	0.006		
Error	22	0.26	0.012		
Total	35	1.24			

*Significant at 5% level of significance

APPENDIX-XVIII

Analysis of variance for width of ray floret

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	1.14	0.103	11.47*	2.25
Replication	2	0.01	0.007		
Error	22	0.20	0.009		
Total	35	1.35			

*Significant at 5% level of significance

APPENDIX-XIX

Analysis of variance for shelf life of flower

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	154.81	14.07	69.77*	2.25
Replication	2	1.21	0.61		
Error	22	4.44	0.20		
Total	35	160.46			

*Significant at 5% level of significance

APPENDIX-XX

Analysis of variance for *in-situ* life of flower

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	50.06	4.55	27.67*	2.25
Replication	2	0.06	0.03		
Error	22	3.62	0.16		
Total	35	53.74			

*Significant at 5% level of significance

APPENDIX-XXI

Analysis of variance for number of flower per plant

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	8833.78	803.07	727.72*	2.25
Replication	2	0.76	0.38		
Error	22	24.28	1.10		
Total	35	8858.82			

*Significant at 5% level of significance

APPENDIX-XXII

Analysis of variance for weight of flowers per plant

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	536975.63	48815.97	1358.90*	2.25
Replication	2	56.46	28.23		
Error	22	790.31	35.92		
Total	35	537822.40			

*Significant at 5% level of significance

APPENDIX-XXIII

Analysis of variance for weight of flowers per plot

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	3266.33	296.939	499.24*	2.25
Replication	2	3.11433	1.55716		
Error	22	13.085	0.59477		
Total	35	3282.53			

*Significant at 5% level of significance

APPENDIX-XXIV

Analysis of variance for number of flower pluckings

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	123.64	11.24	66.95*	2.25
Replication	2	0.13	0.06		
Error	22	3.69	0.16		
Total	35	127.46			

*Significant at 5% level of significance

APPENDIX-XXV

Analysis of variance for estimated flower yield per hectare

Source of Variation	D.F.	S.S	M.S.	F. Cal.	F-Tab.
Treatment	11	251999.13	22909.01	1104.68*	2.25
Replication	2	32.32	16.16		
Error	22	456.24	20.74		
Total	35	252487.69			

*Significant at 5% level of significance

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CURRICULUM VITAE



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Tehsil- Jamwa Ramgarh, Distt- Jaipur (Raj.) Pin Code - 303109**

Objective

Seeking a position to utilize my skills and abilities in the education field that offers professional growths while being resourceful innovative and flexible.

Educational Qualifications

QUALIFICATION	UNIVERSITY/BOARD	YEAR	Percentage
NET	Agricultural Scientists Recruitment Board	2018	57.78
M. Sc. (Horti.) Floriculture & Landscaping	College of Horticulture & Forestry Jhalawar (Rajasthan)	2018	78.90
B. Sc. (Hons) Horticulture	Banda University of Agriculture & Technology, Banda (U.P.)	2016	77.29
12 th	RBSE, Ajmer	2011	75.08
10 th	RBSE, Ajmer	2009	57.17

Personal Details

Father's Name : Ramesh Chandra Meena
Mother's Name : Dafa Devi Meena
Date of Birth : 15 April, 1992
Nationality : Indian
Languages known : Hindi and English
Sex : Male
Marital Status : Unmarried

Extra curriculum:

1. Diploma in Computer Course:- RS-CIT (80 %)

Declaration

I here by declare that the above written particulars are true to the best of my knowledge and belief.

Date: - 14 August, 2018

Place: - Jaipur

(Rahul Kumar Byadwal)