EVALUATION OF GENOTYPES OF FRENCH MARIGOLD (*Tagetes patula* L.) UNDER NAUNI, SOLAN CONDITIONS

Thesis

by

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CERTIFICATE - I

This is to certify that the thesis entitled**, "Evaluation of genotypes of French Marigold (*Tagetes patula* L.) under Nauni, Solan conditions",** submitted in partial fulfilment of the requirements for the award of degree of **MASTER OF SCIENCE FLORICULTURE AND LANDSCAPE ARCHITECTURE** to Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan (H P) is a record of bonafide research work carried out by **Ms. Preeti Sharma (H-2012-07-M)** under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of investigation have been fully acknowledged.

Place: **Nauni, Solan**
Dated: **2014**

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CERTIFICATE - II

This is to certify that the thesis entitled, **"Evaluation of genotypes of French Marigold (*Tagetes patula* L.) under Nauni, Solan conditions",** submitted by **Ms. Preeti Sharma (H-2012-07-M)** to Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan (H P), in partial fulfillment of the requirements for the award of degree of **MASTER OF SCIENCE HORTICULTURE (FLORICULTURE AND LANDSCAPE ARCHITECTURE)** has been approved by the Student's Advisory Committee after an oral examination of the same in collaboration with the external examiner.

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This is to certify that all the mistakes and errors pointed out by the external examiner/ internal examiner have been incorporated in the thesis entitled**, "Evaluation of genotypes of French Marigold (*Tagetes patula* L.) under Nauni, Solan conditions"** submitted to Dr.Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) **by Ms. Preeti Sharma (H-2012-07-M)** in partial fulfillment of the requirements for the award of degree of **MASTER OF SCIENCE FLORICULTURE AND LANDSCAPE ARCHITECTURE.**

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"The past is to prove that no one is perfect and the future is to prove that anyone can change."

Every result arrived at is a modest beginning of a higher goal. My work in the same spirit is just a step in the ladder. But before divulging anything out, let me first express my solemn reverence to the Supreme power of universe 'God' 'The Almighty' for bestowing me with mental strength and courage to accomplish this venture.

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Needless to say errors and omissions are mine.

Place: Nauni **(Preeti Sharma)**
Dated:-

CONTENTS

LIST OF TABLES

LIST OF PLATES

LIST OF ABBREVIATIONS

%	:	per cent
@	:	at the rate
°C	:	Degree centigrade
ANOVA	:	Analysis of variance
CD	:	Critical difference
Cm	:	centimeter
cv.	:	Cultivar
d.f.	:	Degree of freedom
et al.	:	etalia (Co - workers)
FYM	:	Farm Yard Manure
g	:	gram
H.P.	:	Himachal Pradesh
Ha	:	hectare
i.e.	:	id est (that is)
K	:	Potassium
Kg	:	kilogram
kg/m^2	:	kilogram per square meter
ml	:	milliliter
mm	:	millimeter
N	:	Nitrogen
NS	:	non-significant
P	:	Phosphorus
Q	:	quintal
RBD	:	Randomized Block Design
sq. m	:	square meter
t	:	tonnes
viz.,	:	videlicet (namely)

Chapter-1

INTRODUCTION

For many centuries flowers are known to play a significant role in human life. Flowers are wonderful creations of nature. They have the power to make man happy and cheerful. These are of utmost importance in every sphere of human life. India is bestowed with several agro-climatic zones conducive for production of sensitive and delicate floricultural products. During the decade after liberalization floriculture industry took giant steps in the export area. This era has seen a dynamic shift from sustenance production to commercial production. As per National Horticulture Board, (2012-13), the area under floriculture production in India is 232.74 thousand hectares with a production of 1.729 million tonnes of loose flowers and 76.73 million tonnes cut flowers. India's total export of floriculture is Rs. 455.90 crores in 2013-14.

Marigold is one of the most important flower crop grown commercially in different parts of India especially in the plains. The name *Tagetes* has been given after 'Tages' a demigod known for its beauty. It is a short duration, free blooming crop belonging to family Asteraceae. It has gained popularity because of adaptability to various soil and climatic conditions and longer blooming period. It is especially used for festive occasions, marriages, religious ceremonies, social functions. Flowers are sold in the market as loose flowers or after making into garlands. Marigold is also used for beautification and in landscape plans due to its variable height and colour of flowers. The flower is endowed with a wide spectrum of attractive colours, shape and size having good keeping quality. It is highly suitable as a bedding plant, in a herbaceous border, and is also ideal for newly planted shrubbery to provide colour and fill spaces. French marigold is ideal for rockeries, edging, hanging baskets and window boxes.

Besides this, both leaves and flowers are equally important from the medicinal point of view (Tripathy et. al. 1991). Leaf extract is a good remedy for

earache. Flower extract is a good blood purifier, a cure for blood piles, ulcers and eye diseases. The leaves of marigold plants are characterized by the presence of distinct odoriferous oil. Essential oil of marigold has a great use in perfumery industries. The oil has bronchodilatory, tranquilizing anti-inflammatory effect and juvenile hormone with insect repellent properties against flies, ants and mosquitoes. The world demand for its oil is about 10 tonnes annually (Naik et. al. 2003). Marigold plant has been found beneficial to control nematode population when planted as an intercrop and also effective as organic manure (Polthance and Yamazaki, 1996).

Marigold is not only being grown as an ornamental plant but also serve as a source of nutritional supplement for poultry feed due to presence of an antioxidant, carotenoid pigment known as lutein. Since yellow and orange colour in marigold is due to presence of this pigment hence lutien is added in the poultry diet to intensify the yellow colour of eggs yolk and broiler skin (Sreekala and Raghava, 2002). Carotenoids are having therapeutic values (Gau et. al. 1983). Dietary carotenoids can be used to treat cancer and photosensitive diseases. Marigold flower meal that remains after removal of lutein is chosen as a potential source of gum Arabic as it is believed to contain a polysaccharide component that has got the ability to protect the hydrophobic substances from oxidation. The essential oil present in different species of *Tagetes* are being used in perfume industry. All parts of *Tagetes patula* contain essential oil, which can readily be extracted by steam distillation (Dhingra and Dhingra, 1956). The oil has a pronounced odour and acts as a repellent to flies.

Marigold is a native of Mexico and South America from where it spread to different parts of the world during early part of the sixteenth century. *Tagetes patula* commonly known as French marigold is being grown commercially as loose flower in India and Central America. It has an added advantage that it is not season bound like other annual flower crops. Marigold plant needs a plenty of sunshine and is grown in open sunny situation. There are about 33 species of genus *Tagetes* and species namely *Tagetes erecta*, *Tagetes patula, Tagetes tenuifolia, Tagetes lucida, Tagetes lemmonii, Tagetes minuta, Tagetes pysilla* and *Tagetes corymbosa* are commercially important. French marigold (*Tagetes*

patula) are of great horticultural importance and are grown commercially for their exquisite blooms. Sowing of marigold in September-October resulted higher average flower size, number of flowers per plant, flowering period and flower yield than other months (Mishra, 1997).

French marigold has different strains varying in plant height, growth habit, flower size and shape. It has got yellow and orange colours in various shades like light yellow, canary yellow, golden yellow, bright yellow, cadmium yellow, deep orange, bright orange, white and bicoloured. Also, crimson and mahogany red colours are very attractive. Golden Boy, Gypsy Dancer, Rusty Red and Sussana are some of the important commercial cultivars of French Marigold.

Success in any crop breeding programme depends on the availability of genetic diversity. Generally, genotypes can be found in both domesticated and naturalized habitats in the form of local land races, modern cultivars and wild strains (Paisooksantivatna et. al. 2001). Genetic variability in marigold has been documented by earlier workers (Nand Kishore and Raghava, 2001).

On account of available congenial conditions at Nauni (Solan) in mid-hill zone (sub-temperate to sub-tropical with mild summer to cool winter) of Himachal Pradesh is suitable for successful cultivation of marigold in terms of yield and quality of flowers. Hence, the performance of cultivars should be studied along with the genetic diversity among themselves. The morphological screening helps in identifying a cultivar having specific traits suitable for a particular purpose (Kem et. al. 2003). Evaluation work on marigold has been carried out by Nair et. al. (1999) and Mohanty et. al. (2002) under Port Blair and Bhubaneshwar conditions, respectively for commercial exploitation.

So in order to boost up marigold cultivation in mid hills of Himachal Pradesh, some promising cultivars are required to be evaluated. The present investigation was therefore being taken up to evaluate various cultivars of French marigold with the following objective:

- Evaluation of genotypes of French marigold (*Tagetes patula* L.) under Nauni, Solan conditions.

Chapter-2

REVIEW OF LITERATURE

The relative performance of different cultivars of marigold in terms of vegetative and floral characters varies owing to genetic composition, soil and the prevailing environmental conditions. The review of relevant research work pertaining to growth and flowering attributes of French marigold has been presented in this chapter.

2.1 Plant growth and yield components

2.2 Variability and Heritability studies

2.3 Correlation studies

2.1 PLANT GROWTH AND YIELD COMPONENTS

Tsukamoto et. al. (1971) assessed the performance of different cultivars of French and African marigold. They reported that French marigold cv. 'Butter Ball' flowered best at 30^{o}C with 10 hours day length, whereas, African marigold, cv. 'Pot of Gold' did not respond either to day length or temperature. They also found that GA application @ 250ppm during cropping period slightly improved flowering in French marigold.

Various cultivars of both African and French marigold were evaluated by Sharga et. al. (1975). They found that only those cultivars which produced either 50 flowers or 800 g flowers by weight are to be used commercially. In French group, they recommended cvs namely 'Brownie Scout', 'Burpees', 'Nugget', 'Cupid Yellow', 'Petite Gold' and 'Yellow Pygmy' which either produced 100 flowers or 200 g flowers per plant. Meylan and Tripod (1979) also conducted an evaluation trial using 94 cultivars of marigold for various growth and flowering habits and recommended cvs Namely 'Orange Boy', 'Honey Comb' and 'Bolero' for commercial flower production.

Arora and Singh (1980) conducted an evaluation trial on marigold and concluded that African marigold cvs namely 'Giant Double African Orange', 'Climax' and 'Bangalore Selection' are suitable for commercial flower

cultivation. While cultivars 'Rusty Red', 'Butter Scotch', 'Red Brocade', 'Valencia' and 'Sussana' proved excellent for bedding purposes in French marigold. Nalawadi (1982) in his investigation on nutritional studies in some varieties of marigold found a wide variation in vegetative as well as floral characters of different genotypes. He reported that plant height varied significantly among the genotypes.

In another study Howe and Waters (1983) evaluated 24 cultivars of African marigold during early September and found that cultivars namely 'Torch', 'Yellow Jacket', 'Spin Wheel', 'Tiger Eyes', 'Gypsy Sunshine', 'Boy O' Boy', 'Harvest Moon Improved', 'Yellow Boy' and 'Janie Flame' are promising for bedding purpose. In an experiment Chezhiyan et. al. (1985) assessed the performance of various chrysanthemum cultivars for different characters for two years. They found that cv. 'Erior Tuck' gave the highest flower yield in both years, followed by cv. 'Freedom' in the first year and 'Hozur Yellow' in the second year.

In a study conducted by Bhati et. al. (1988) on various cultivars of *Tagetes* species for various growth and flowering attributes, they found that African marigold cvs 'African Giant Yellow', 'African Giant Orange' and French marigold cv. 'French Dwarf Red' produced 227.39, 216.09 and 139.05 q flowers/hac, respectively. Reddy et. al. (1988), while conducted an evaluation trial with various cultivars of *Tagetes erecta* found that cultivars 'Orange Boy', 'Giant Double African Orange', 'Coimbatore Local' and 'African Double Yellow' showed significant variations with respect to their flowering yields.

Singh and Dadlani (1989) conducted a field experiment to evaluate some of the chrysanthemum cultivars. They observed that cv. 'Suhag Singar' produced maximum flowers per plant followed by cv. 'Hemant Singar' while cvs namely 'Kundan' and 'Flirt' produced minimum number of flowers per plant, while Cultivar 'Sharad Mala' was found early in flowering. In another experiment, Zimmer (1989) studied the performance of different cultivars of French marigold under different durations of light and found that cvs 'Orange Winner' and 'Tanger' responded well to long duration of light in summers whereas cv. 'Tiger Eyes' grew well under long duration of light in winter.

In another study conducted by Howe and Waters (1990), different cultivars of *Tagetes erecta, T. patula* and their hybrids (*T. erecta* x *T. patula*) were assessed and found that different cultivars flower within 41-65 days after sowing in summer. They also observed that *Tagetes patula* and hybrid cultivars flowered within 45 days. *Tagetes erecta* cvs 'Inca Yellow' and 'Inca Gold' produce flowers of 4 inch diameter but *T. erecta* hybrids declined in quality soon as compared with *T. patula* cultivars.

Choi et. al. (1993), while evaluating 26 cultivars of chrysanthemum, reported that cvs. namely 'Kwibuim', 'Cheonsu', 'Bakkwang', Agendu' and 'Oweolocheong' were selected for commercial cultivation keeping in view the profitability in terms of flower yield. In another study Kanamadi and Patil (1993) evaluated eight chrysanthemum cultivars and found that cv. 'Megami' was early in flowering (46 days) whereas cv. 'Co-2' took maximum time to flower (132 days). They further reported that cv. 'Basanti' recorded maximum plant height (82.7 cm) while cv. 'Sharadmala' bears dwarf plants (26.5 cm). Cultivar 'Red Gold' produced maximum flowers (48.2) per plant followed by cv. 'Sharadmala' (41.3).

Shankar and Tewari (1993) evaluated 12 chrysanthemum cultivars and noticed that cv. 'Maghi' produced maximum number of primary and tertiary branches and cv. 'Flirt' produced maximum number of secondary branches per plant. Rice (1994) while working with various cultivars of *T. patula* x *T.erecta* hybrids in U.K. found cvs. 'Fantasia', 'Safari Mixture' and 'Sophia' to produced quality flowers.

Mehta et. al. (1995) conducted an evaluation trial on African marigold at Konkan region of Maharashtra with respect to various growth and flowering attributes. they reported that cv. 'Giant Double African Orange' produced the taller plants with more plant spread, number of branches per plant, leaf area and stem girth. Cultivar 'Honeycomb' had shown maximum duration of flowering whereas it was minimum in cv. 'Snow White'. Also, flower weight was recorded to be maximum in cv. 'Giant Double African Orange' followed by cvs 'Giant Double African Yellow' and MDU-1 respectively.

Singh et. al. (1997) tested the performance of African and French marigold and concluded that maximum yield of flowers per plant was in cv. 'Giant Double African Lemon'. Whereas, 'Giant Double African Orange' exhibited the most profused vegetative growth followed by cv. 'Giant Double African Lemon' with maximum number of petals (ray florets) and fresh flower weight. The average flower yield of African and French marigold was found to be 164.889 and 130.279 q/hac, respectively.

Gondhali et. al. (1998) conducted an experiment on evaluation of nine cultivars of chrysanthemum with respect to their growth and yield of spray flowers. They reported that cvs 'Shymal' and 'Indira' were tall, erect and profusely branched. On the other hand, cv. 'Nanako' had the maximum spreading habit. On the other hand, cvs 'Jaya' and 'Mountaineer' showed poor branching. Cultivars namely 'Indira' Shymal' and 'IIHR Self-5' resulted higher yields of spray flowers per plant.

An experiment was conducted on evaluation of chrysanthemum cultivars by Mishra, (1999). He found that cv. 'Suneel' had maximum flower number, yield per plant, maximum fresh weight and taller plants with larger spread. Cultivar 'Kundan' had long duration of flowering while cv. 'Jayanti' maintained freshness for longer period and cv. 'Syamal' has the biggest bloom. In another study Nair et. al. (1999) tested the performance of five cultivars of marigold. They reported that cvs namely 'Orange Boy' and 'Granada' were dwarf in stature with profuse branching and numerous flowers. These cultivars were recommended finally for bedding purposes.

Mahapatra et. al. (2000) evaluated 16 chrysanthemum cultivars namely 'Appa', 'Arun Singar', 'Baggi', 'Basanti', 'Bindiya', 'Birbal Sahni', 'Flirt', 'Hemant Singar', 'Pancho', 'Pol Geel', 'Pol Rose', 'Pol Wit', 'Punjab Gold', 'Ratlam Selection', 'Sharad Singar' and 'Suhag Singar' as pot plants. They reported significant differences among these cultivars with respect to various morphological and floral characters. Cultivars namely 'Pol Rose', 'Arun Singar', 'Sharad Singar', 'Suhag Singar' and 'Bindiya' were considered suitable for pot culture.

Gaikwad and Patil (2001) studied the performance of nine cultivars of chrysanthemum with respect to their growth, flowering and yield parameters under both open and polyhouse conditions. They observed that cv. 'Indira' had medium height and spread with more number of sprays per plant and per plot followed by cv. 'Mutant No.9' with larger size and good spray length. In another field experiment, Kelly and Harbaugh (2002) studied the performance of eighty four cultivars of African (*Tagetes erecta*) and French (*T.patula*) marigold. Cultivars were grouped into classes based on species, plant height, flower type and flower colour. In *Tagetes erecta* cvs 'Inca Gold', Royal Gold', 'Mesa Orange', 'Royal Orange', 'Inca Yellow' and 'Perfection Yellow' were suggested whereas cvs 'Yellow Boy', 'Harmony Boy', 'Hero Flame' 'Spray Boy' and 'Legend Gold' performed well in French marigold.

Mohanty et. al. (2002) studied the floral biology of various cultivars of marigold and reported that 'Bhubneshwar Local Orange' and 'New Tech' were late flowering whereas, cv. 'Royal Bengal' was earliest to produce flower buds. Also, these cultivars took about 13 to 24 days for bud maturity after initiation, bud maturity to colour break as well as colour break to initiation of floret opening, whereas some other cultivars took 2 to 5 days and 6 to 7 days respectively. Complete opening of flowers was noticed after 10 to 17 days of initiation of opening of individual flower head.

Singh et. al. (2003) while conducting a field experiment on French marigold, reported that plant height, number of branches and plant spread were maximum in cv. 'French Spanish Brocade' followed by cvs 'Nuaghty Marienta' and 'Orange Gate'. The maximum number of branches after 60 days of transplanting was recorded in cv. 'Orange Gate' (12.31) followed by cv. 'French Spanish Brocade' (11.85) and the duration of flowering was maximum in cv. 'Orange Gate' (64.33 days) and minimum in cv. 'Mary Jane Yellow' (44.33 days) whereas the number of flowers per plant was maximum in cv. 'Orange Gate' (59.6) and minimum in cv. 'Yellow Gate'.

In a comparative study, Dhiman (2003) evaluated the performance of eleven cultivars of chrysanthemum and observed that cvs namely 'Ajay', 'Flirt' and 'Fiji' obtained higher yield in terms of number and weight basis with

medium sized flowers and were recommended for loose flower production. He also recommended large flowering type cvs viz. 'Pink Prince', 'Tata Century', 'Thaichung' and 'Snow Ball' for garden display or exhibition purposes.

Singh and Singh (2005), while assessing the performance of 13 germplasm of *Tagetes patula* (TPG-1 to TPG-13) and two of *Tagetes minuta* (TMG-1 TMG-2), reported that cvs namely TMG-1, TPG-3, TPG-7 and TPG-11 exhibited better performance in terms of plant growth and flower production as compare to other cultivars. They recommended these cvs to be used for breeding as well as cultivation programme under Tarai region of Uttranchal. In another investigation Rao et. al. (2005) studied the performance of different cultivars of African marigold under Andhra Pradesh condition. They reported that cv. 'Orange Double' was the best with respect to plant height, leaf area and flower yield as compared to cv. 'Pusa Naraangi Gainda'. On the other hand, maximum carotene content was extracted from the fresh petals of cv. 'Pusa Narangi Gainda'.

Dilta et. al. (2005) conducted an experiment to evaluate 55 genotypes of chrysanthemum for their suitability to grow for various purposes in sub-tropical regions of Himachal Pradesh. Studies revealed that plant height was found to be maximum in cv. 'Gulmohar' (78.83 cm) while minimum in 'Mini Queen' (40.33). Further it was observed that cv. 'Surf' was the earliest one and took 89.67 days for flowering, while cv. 'Gulmohar' is considered to be late flowering with 131.67 days. Maximum number of flowers per plant (65.67) was recorded in cv. 'Glance', while it was minimum in cv. 'Pink Cloud' (3.00).

Singh and Singh (2006) conducted a trial to study the performance of 29 genotypes of African marigold (*Tagetes erecta* Linn.). Studies revealed significant variation of germplasm in all the growth and flowering parameters. The germplasm TEG16 exhibited best performance on number of primary branches per plant and number of flowers per plant. However, maximum duration of flowering was recorded with TEG13. Germplasm TEG23 exerted poorest performance on various growth and flowering attributes.

Poornima et. al. (2006) while studying the performance of 5 genotypes of China aster found that cv. 'Poornima' recorded higher plant height. However, 'Local Types' recorded minimum plant height (11.37 cm). Maximum number of flowers and highest flower yield was obtained in cv. Shashank (50.22 and 9.51 tonnes/ hectare). However, Local recorded minimum number of flowers per plant and lowest flower yield (17.02 and 0.83 tonne/ ha).

Singh et. al. (2008) studied 29 lines of African marigold (*Tagetes erecta*) to assess the diversity present in the population for various growth and flowering attributes. They recorded maximum plant height and flower diameter for the germplasm TEG 26. Germplasm TEG 19 attained maximum flower yield per plant among all the twenty nine accessions.

Narsude et. al. (2010) while studying different African marigold (*Tagetes erecta*) genotypes under Marathwada conditions observed significant variations for different growth and yield attributes. Cultivar 'Pakharsangavi Local' showed maximum plant hieght (114.6cm) and stem girth (5.37 cm), whereas, maximum plant spread was observed in 'Tuljapur Local-2'. On the other hand, cv. 'Tuljapur Local-1' had the maximum number of flowers (71.00), yield per plant (630.48 g) and maximum yield (24.67 MT/hac). Longest duration of flowering was recorded in cv. 'Marigold Orange Bunch' (56.33 days) and was smallest in 'Mulegaon Local' (42 days).

Singh et. al. (2012) evaluated 40 hybrids of chrysanthemum for various morphological and floral characters for their suitability as garden decoration, loose and cut flower purpose. They reported that accessions A-22, A-24 and A-72 were tall with long sprays and uniform opening of flowers and found to be suitable as cut flowers. Accessions A-8, A-10, A-32, A-39, A-45, A-62, A-68, A-72 and A-108 were observed to be suitable for growing in a garden because of their large plant spread along with more number of flowers. Accessions A-4, A-8, A-20, A-22, A70, A-83, A-86, A87 and A-109, were found to be suitable for loose flower purpose.

In an experiment conducted to identify the suitable varieties of China aster under open-conditions, Zosiamliana et. al. (2013) found highly significant variation for various growth and flower yield parameters among seven varieties.

The maximum plant height, plant spread, number of primary and secondary branches was noted in ' Phule Ganesh Violet'. With regards to flower yield, 'Phule Ganesh White' recorded maximum value for both flower yield per plant (208.81 g) and flower yield per hectare (23.20 t/ha). Minimum values for all these characters were recorded in cv 'Local'.

Munikrishnappa et. al. (2013) evaluated the suitable varieties of China aster for growth and flower yield attributes under transitional tract of northern Karnataka. Among the varieties, 'Phule Ganesh Violet' recorded the highest plant height and plant spread while, the variety 'Violet Cushion' recorded the least plant height, plant spared. The maximum flower yield (37.91 t / ha) was recorded in 'Phule Ganesh White' and it was lowest in 'Mixed Variety Local' (9.97 ton). Number of cut flower production was maximum (55.43) in variety 'Phule Ganesh Violet' and the lowest number of cut flower per plant was produced in 'Shashank' (40.92). The maximum number of cut flowers (40.76 lakh / ha) was recorded in 'Phule Ganesh Violet' and minimum number of cut flower (31.64 lakh / ha) was recorded in variety 'Kamini'.

2.2 VARIABILITY AND HERITABILITY STUDIES

Singh and Sen (2000) while conducted an experiment on 12 cultivars of African marigold and French marigold recorded significant differences in all the characters studied. The coefficient of variation was found to be minimum for duration of flowering (P.C.V = 15.20, G.C.V = 14.89) and maximum for duration of flowering (PCV = 64.67, GCV = 63.84) in French marigold but in African marigold it was minimum for plant height at 60 days after transplanting (PCV = 8.14, GCV = 7.74). High heritability along with high genetic advance was observed for flower yield per hectare and number of flowers per plant in French marigold whereas in African marigold high values were observed for dry weight of flowers, flower yield per plot and flower yield per hectare.

Nand Kishore and Raghva (2001) conducted an experiment on 18 genotypes under Delhi conditions to observe the variability in sixteen different characters. Significant variations were observed in days to flowering varied from 102.6 to 130.7, diameter of flower (5.2 to 8.4 cm), plant height (53.87 to 84.83

cm), plant spread (45.85 to 74.53 cm), number of primary branches/ plant (7.17 to 12.37), number of secondary branches/ plant (44.69 to 64.83), flower stalk length (4.50 to 8.98 cm), shelf life (3.29 to 7.56 days), flower weight per plant (681.99 to 2414.40 g) and flower yield varied from 12.33 to 34.25 tons per hectare.

Mishra et. al. (2001) conducted a field experiment to estimate the magnitude of variation for various floral characteristics in 18 genotypes of dahlia. They concluded that cv. 'Monarch Sport' was the earliest in producing large sized flowers, had longest flowering duration and highest average number of flowers. On the contrast, cv. 'Gloriosa Samalatal' produced maximum number of flowers with smaller size. The coefficient of variation both at phenotypic and genotypic levels was found to be maximum for number of flowers with high heritability and genetic advance.

Patnaik and Mohanty (2002) determined the genetic variability, heritability and genetic advance in 13 cultivars of African marigold (*Tagetes erecta*). They observed that all the cultivars under study depicted significant difference for all the characters except number of branches. The genotypic and phenotypic variation and genetic advance were found to be highest for flower yield, whereas, heritability in broad sense along with genetic gain was highest for characters like plant height, weight of individual flower and yield of flower per plant, which may prove effective criteria for selection. Other characters with higher GCV and PCV were number of flowers per plant, weight of individual flowers and plant height.

Sreekala et. al. (2002) studied variability for yield components of African genotype and concluded that except flower diameter, all characters viz., plant height, plant spread, number of branches, days to flower, number of flowers per plant, flower weight, flower diameter, duration of flowering and flower yield showed higher phenotypic variance.

In an experiment Verma et. al. (2002) studied 33 genotypes of African marigold (*Tagetes erecta*) to see the genetic variability in them. They reported that PCV was higher than the GCV in all the characters studied. Flower weight

obtained high PCV (56.38 and 52.25%) along with high heritability (91.18%) and genetic advance (105.92%).

Pal and George (2002a) studied the genetic variation, heritability and correlation for vegetative and flowering attributes in 12 cvs of chrysanthemum out of which two are indigenous and ten exotic. The cultivars showed significant differences for all the characters. Significant variation was observed for plant height, days to bud formation and days to flowering. They observed the high heritability associated with high genetic advance as the percentage of mean for leaf area and flower weight, indicating the presence of additive gene action. Other traits exhibited high heritability associated with moderate and low genetic advance, indicating the presence of non-additive gene action.

Pal and George (2002b) studied the correlation for twelve cultivars of chrysanthemum and found that most of the correlations were positive. Flower diameter and weight were significantly correlated with plant height, spread and flower diameter.

In a field experiment Nair and Shiva (2003) studied genetic variability in 25 genotypes of gerbera for 11 characters. The widest range of variation was observed in cut flower yield/m^2. Heritability estimates genetic advance were found to be highest for cut flower yield/m^2 which indicate additive gene action. In another study high heritability along with high genetic advance in African marigold for characters such as number of buds per plant, number of flower per plant, flower yield and seed vigour, was observed by Mathew et. al. (2005a), which proved to be effective criteria for selection.

Mathew et. al. (2005b) in French marigold also obtained positive and significant correlation with flower yield by number of buds per plant, fresh weight of flower and dry weight of flowers.

Mathad et. al. (2005) analyzed the variance and found significant differences among treatments for all the characters. High phenotypic and genotypic coefficient of variation were recorded for flower yield per plot (PCV = 61.09, GCV = 60.54), flower yield per plant (PCV = 61.02, GCV = 60.47) and flower yield per hectare (PCV = 60.75, GCV = 60.22). High heritability coupled

with high genetic advance over percentage of mean was observed for days to first flower bud initiation (h^2 = 88.50, GAM = 66.54), flower weight (h^2 = 97.80, GAM = 103.51), flower yield per plant (h^2 = 98.20, GAM = 123.58) and flower yield per hectare (h^2 = 98.30, GAM = 123.0).

Pratap et. al. (2009) studied genetic variability, heritability and genetic advance for 10 genotypes of both French and African marigold. Phenotypic coefficients of variation (PCV) were higher than genotypic coefficient of variation (GCV) for all the characters studied. However, highest PCV and GCV estimates were found for area of leaf in both groups of marigold. High heritability with high genetic advance was observed for first picking of the flowers followed by last picking of the flowers in African marigold and in French marigold, high heritability with high genetic advance was observed for days to visibility of bud followed by first picking of the flowers.

In an investigation carried out by Namita et. al. (2009) for 11 selections of French marigold (*Tagetes patula*) showed significant differences in all the characters studied. The French Selection 1 (Fr. Sel.1) exhibited maximum mean performance for flower yield (370.33 g) while minimum was exhibited by Cherry Red (144.5 g). The coefficient of variation was minimum for number of seeds per head (GCV=12.15, PCV=13.66) and maximum for number of flowers per plant (GCV=40.23, PCV=42.70). High heritability was observed for days to flowering (94.89) whereas moderate heritability was observed for 1000 seed weight (53.84). High heritability along with high genetic advance was observed for flower yield (h^2=81.49, GA = 117.87) and number of flowers per plant (h^2 88.75, GA= 75.42). High genetic advance as per cent mean was observed for number of flowers per plant (78.08).

Anuja and Jahnavi (2012) studied genetic variability and heritability in 30 genotypes of French marigold (*Tagetes patula*) for flower yield and seven other characters. They compared the genotypic and phenotypic coefficient of variation for different traits and found that the values of PCV were higher as compared to GCV due to the influence of environment. High genotypic coefficient of variation was observed for flower yield per plant. Heritability estimates in general were high for most of the characters studied. High heritability coupled with high

genetic advance (as per cent of mean) was observed for number of flowers per plant, flower yield per plant and plant height.

Panwar et. al. (2013) evaluated Twenty-two genotypes of marigold (*Tagetes erecta* L.) for 16 growth and flowering related traits to study their genetic parameters such as variability, heritability, genetic (GCV) and phenotypic (PCV) coefficient of variation. The high genotypic and phenotypic coefficient of variation was observed for flower yield per plant and fresh weight per flower whereas, lowest value for both GCV and PCV were obtained for number days taken to flowering. High heritability (>70%) were recorded for flower diameter, fresh weight per flower and flower yield per plant. High genetic advance as per cent of mean was observed for flower yield per plant followed by fresh weight per flower and stalk length revealing the importance of additive gene effects for these characters

CORRELATION STUDIES

In an investigation carried out to analyse the correlation for 13 characters related to growth and flowering on diverse genotypes of African marigold (*Tagetes erecta*) and in 10 genotypes of French marigold (*Tagetes patula*). Bhanu Pratap et. al. (1999) Analysis of variance revealed that palnt height had a positive and significant relationship at genotypic and phenotypic levels with plant spread. Spread of plant was also positively and significantly correlated with size and yield of flowers per plant. In French marigold, plant height showed positive and significant correlations with days to bud formation and first and last picking of flowers.

Sreenivasulu et. al. (2007) conducted correlation studies for yield and yield contributing components in six genotypes of China aster. They reported that yield per hectare was positively and significantly associated with number of flowers per plant, plant height, duration of flowering, diameter of flower and fresh flower weight. Number of flower per plant was positively and significantly associated with plant height, diameter of flower and fresh weight of flowers.

Chapter-3

MATERIALS AND METHODS

The present investigations entitled, "**Evaluation of genotypes of French Marigold (*Tagetes patula* L.) under Nauni, Solan conditions**" were carried out at the experimental farm of the Department of Floriculture and Landscaping, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during March, 2013 to July 2013. The details of the materials used and techniques employed during the course of studies have been given below:

3.1 SITE/ LOCATION

The experimental site is located at a latitude of 30^{o} 52' 02" N and at a longitude of 77^{o} 11' 30" E with an elevation of 1276 m above mean sea level. The area falls under the mid-hill zone of Himachal Pradesh.

3.2 CLIMATE

The climate of this area, in general is sub-temperate and is characterized by mild summers and cool winters. May and June are the hottest months while January and February are the coolest ones. Maximum rainfall is received during July to September (monsoon season). The weather in general was favourable during the field experiment for the growth and flowering of marigold.

The mean meteorological data for the study period was embodied in Appendix I.

3.3 PLANTING MATERIAL:

The healthy, pure and disease free seeds of twenty five genotypes of French marigold were harvested from the farm from the experiment on production of F_1 hybrids in marigold during Dec 2012. It includes 10 inbred lines and 15 crosses. The inbred lines are being maintained under the project, whereas, the crosses were freshly attempted during Oct- Nov, using ms lines as female parents and inbred lines as tester parents.

List of genotypes

a) Inbred lines

1. Safari Queen
2. Spray Boy
3. Single Petal Red
4. Spray Max
5. Harmony Boy
6. Bonita Bolero
7. Sunkist
8. French Bonita
9. Double Dwarf Lemon
10. FM-786

b) Crosses / Newly developed F_1 hybrids

11. ms_4 x Harmony Boy
12. ms_4 x French Bonita
13. ms_4 x FM-786
14. ms_5 x FM-786
15. ms_6 x Sunkist
16. ms_6 x Spray Boy
17. ms_6 x FM-786
18. ms_6 x French Bonita
19. ms_7 x Sunkist
20. ms_7 x Bonita Bolero
21. ms_7 x Spray Max
22. ms_7 x Safari Queen
23. Ms_{10} x Spray Boy
24. ms_{10} x French Bonita
25. ms_{10} x Bonita Bolero

3.4 NURSERY RISING

The nursery beds of size 1m x 1m (raised 15 cm above ground level) were prepared. The soil was well pulverized after incorporating well rotten farm yard manure (FYM) @ 5 kg/sq. m area. Nursery soil was then drenched with carbendazim (0.1%) before seed sowing. The seeds of different genotypes were sown 1-2 cm deep in lines/furrows on March 23rd 2013 and covered with sieved well rotten FYM. After seed sowing the beds were covered with hessian cloth/ gunny bags and irrigated lightly with watering can. Seed germination started after 5-6 days of sowing and at this stage, covering material was removed. The seedlings developed 3-4 leaves and become ready for transplanting by April 24th, 2013.

3.5 CULTIVATION PRACTICES

3.5.1 Field preparation

The field selected for experiment was ploughed with tractor about two weeks before transplanting. Well rotten farm yard manure (FYM) @ 5 kg per square meter was mixed thoroughly in the soil. The stubbles of previous crop, weeds and grasses were removed and then field was leveled. The raised beds (about 15 cm above ground level) of size (1.0 x 1.0 m) were made.

3.5.2 Fertilizer application:

Full dose of phosphorus (20g/m^2) and potassium (20g/m^2) and half dose of nitrogen (7.5 g/m^2) were incorporated as basal dose. The remaining half dose of nitrogen (7.5 g/m^2) was applied after 30 days of transplanting. Nitrogen, phosphorus and potassium were applied through urea, single super phosphate and muriate of potash respectively.

3.5.3 Transplanting

Plants were transplanted in prepared field according to the layout given below (3.6) during evening hours on April 24th, 2013. Irrigation was applied immediately after transplanting. Plants were irrigated daily for one week after transplanting until the plants established themselves.

3.6 EXPERIMENTAL DETAILS

The details of layout are given below:

1.	Species	**:**	French Marigold (*Tagetes patula)*
2.	Number of genotypes	**:**	25 (including one check)
3.	Number of replications	**:**	3
4.	Plot size	**:**	1m x1 m
5.	Spacing	**:**	25cm x 25cm
6.	Number of plants/ plot	**:**	16
7.	Design	**:**	Randomized Block Design

3.7 Inter cultural operations followed

3.7.1 Irrigation

Irrigation was done according to the requirement of the crop. During April-May, crop was irrigated daily but June onward, irrigation frequency was reduced due to onset of rainy season.

3.7.2 Weeding and hoeing

Weeding and hoeing were performed as and when required. During cultivation *Cyperus rotundus* was found as major weed and controlled manually using hand hoes. This practice not only helped in control of weed population but improved aeration as well.

3.7.3 Pinching

This operation was done in French marigold in order to produce multistemmed plants and to encourage vegetative growth. This was done by removing 2-3 cm apical growing portion of plant after 25-30 days of transplanting.

3.7.4 Disbudding

It was performed on the French marigold by removing the growing buds to promote vegetative growth as well as to get more number of flowers.

3.8 DISEASES AND PESTS

No serious insect pests and diseases were observed during the cropping season, but a schedule spray of Diathane M-45(0.2%) and Bavistin (0.1%) was done at fortnightly interval as precautionary measure.

3.9 OBSERVATIONS RECORDED

3.9.1 Plant Height (cm)

Final height was recorded at the time of peak flowering from ground level to the apex of plant using meter scale/rod.

3.9.2 Plant Spread (cm)

It was measured as average of the distance between outermost side shoots in East to West direction and distance between outermost side shoots in North to South direction.

3.9.3 Days taken to flower bud formation

Numbers of days taken from transplanting till the appearance of first flower bud were counted.

3.9.4 Days taken to flowering

Number of days taken from transplanting to the time when first bloom appeared on the plant was counted.

3.9.5 Duration of flowering (days)

Days were counted from the date of first bloom appearance to the stage when 50% flowers begin to form seeds.

3.9.6 Number of flowers per plant

It is the sum total of all the flowers harvested from a plant.

3.9.7 Flower size (cm)

Size of flowers was recorded at the time of peak flowering as the average of distances between apices of petals in East to West and North to South directions.

3.9.8 Total number of flowers per picking

It was measured as total number of flowers harvested in one picking.

3.9.9 Weight of flowers per picking (g)

It was recorded as total fresh weight of the flowers in each picking.

3.9.10 Total number of pickings

Number of times flowers were harvested from a plant.

3.9.11 Flower weight (g)

Weight of one random flower from each plant was determined in grams (g) to get the weight of one flower.

3.9.12 Flower yield per square meter (g)

It was worked out by multiplying the average flower yield per plant with total number of plants per square meter.

3.9.13 Parameters of variability

Parameters of variability were calculated as per formula given by Burton and De Vane (1953).

a) Phenotypic coefficient of variation (P.C.V)

$$P.C.V = \frac{\sqrt{\text{Phenotypic variance (Vp)}}}{\bar{X}} \quad X\ 100$$

b) Genotypic coefficient of variation (G.C.V)

$$G.C.V = \frac{\sqrt{\text{Genotypic variance (Gp)}}}{\bar{X}} \quad X\ 100$$

Where $\bar{X}$ = General population mean.

Heritability

Heritability in broad sense was calculated as per the formula given by Allard (1960).

$$\text{Heritability } (h^2\ \%) = \frac{\text{Genotypic variance}}{\text{Phenotypic variance}} \times 100$$

Genetic advance

As per Allard (1960) the expected advance resulting from selection of 5 percent superior individuals was calculated by

GA = h x p x k

Where

h	=	Heritability in broad sense
p	=	Phenotypic standard variation
k	=	selection differential at 5 percent selection intensity (The value of k = 2.06)

Genetic gain

Genetic advance expressed as per cent of population. Johnson et. al. (1955) suggested the formula to calculate the genetic gain.

$$\text{Genetic gain } (\%) = \frac{\text{Genetic advance}}{\text{Genetic mean of population } (\bar{x})} \times 100$$

For categorizing the magnitude of different parameters the limit used by Sharma (1960) were followed.

P.C.V and G.C.V	>30%	-	High
	15-30%	-	Moderate
	<15%	-	Low
Heritability (h^2)	>80%	-	High
	50-80%	-	Moderate
	<50%	-	Low
Genetic gain	>50%	-	High
	25-50%	-	Moderate
	<25%	-	Low

3.8 STASTICAL ANALYSIS

Data pertaining to present investigation were statistically analyzed using standard procedure of factorial randomized block design described by Gomez and Gomez (1984). Treatment effects were tested at 5% levels of significance. Standard error of difference between treatment mean and critical difference were worked out.

Chapter-4

EXPERIMENTAL RESULTS

The study entitled "**Evaluation of genotypes of French Marigold (*Tagetes patula* L.) under Nauni, Solan conditions**" was carried out at the experimental farm of Department of Floriculture and Landscaping, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan during the year 2013. The salient research findings have been presented in this chapter. The observations recorded on various growth and flowering parameters exhibited significant variation among different genotypes which is as follows:

4.1 PLANT HEIGHT (cm)

Data presented in Table 1 reveal the performance of different marigold genotypes for plant height. There were 25 genotypes which consisted of 10 inbred lines and 15 hybrids (Plate 1). It is evident from the data that maximum plant height (68.80 cm) was observed in French marigold genotype 'ms_7 x Bonita Bolero' which was found to be statistically at par with genotype 'ms_{10} x Bonita Bolero' (67.66 cm). On the contrast, minimum plant height was recorded in genotype 'French Bonita' (32.95 cm). It was, however, found to be statistically at par with plant height observed in genotypes 'Single Petal Red' (33.38 cm), 'Spray Boy' (35.58 cm), 'Double Dwarf Lemon' (35.87 cm), 'Sunkist' (36.09 cm) and 'Bonita Bolero' (39.16 cm).

A comparison of plant height among inbred lines of marigold shows that maximum plant height was found in 'Spray Max' (41.28 cm), while minimum value for plant height was observed in genotype 'French Bonita' (32.95 cm). As regards the variation in plant height among hybrids, maximum plant height was recorded in 'ms_7 x Bonita Bolero' (68.80 cm) and minimum value for plant height was observed in 'ms_6 x Sunkist' (40.30 cm). In general among all the genotypes under study more plant height was found in hybrids as compared to inbred lines.

(a) French marigold genotypes at different stages of growth

(b) French marigold genotypes at flowering stage

Plate 1 Field view of the experiment

Table 1. Performance data of different French marigold genotypes (plant height cm)

Genotypes	Plant height (cm)
Safari Queen	40.30
Spray Boy	35.58
Single Petal Red	33.38
Spray max	41.28
Harmony Boy	50.76
Bonita Bolero	39.16
Sunkist	36.09
French Bonita	32.95
Double Dwarf Lemon	35.87
FM-786	41.15
ms_4 x Harmony Boy	52.70
ms_4 x French Bonita	46.27
ms_4 x FM- 786	42.03
ms_5 x FM- 786	43.43
ms_6 x Sunkist	40.30
ms_6 x Spray Boy	47.86
ms_6 x FM-786	51.03
ms_6 x French Bonita	52.09
ms_7 x Sunkist	50.97
ms_7 x Bonita Bolero	68.80
ms_7 x Spray Max	59.78
ms_7 x Safari Queen	51.94
ms_{10} x Spray Boy	62.63
ms_{10} x French Bonita	44.53
ms_{10} x Bonita Bolero	67.66
mean	48.00
C.D $_{0.05}$	5.50

4.2 PLANT SPREAD (cm)

Data pertaining to the performance of different marigold genotypes for plant spread has been presented in Table 2. It is evident from the data that maximum plant spread (52.34 cm) recorded in genotype 'ms_{10} x Spray Boy' was found to be at par with plant spread recorded in 'ms_{10} x Bonita Bolero' (47.88 cm). On the other hand, minimum plant spread (27.82 cm) was observed in genotype 'Bonita Bolero' and it was found to be at par with genotypes 'Spray Boy' (28.90 cm), 'Sunkist' (30.21 cm), 'French Bonita' (30.30 cm), 'Safari Queen' (30.50 cm) and 'Spray Max' (32.07 cm).

Table 2. Performance data of different French marigold genotypes (plant spread cm)

Genotypes	Plant spread (cm)
Safari Queen	30.50
Spray Boy	28.90
Single Petal Red	33.52
Spray max	32.07
Harmony Boy	38.67
Bonita Bolero	27.82
Sunkist	30.20
French Bonita	30.30
Double Dwarf Lemon	34.49
FM-786	35.85
ms_4 x Harmony Boy	43.51
ms_4 x French Bonita	38.49
ms_4 x FM- 786	40.92
ms_5 x FM- 786	38.20
ms_6 x Sunkist	42.45
ms_6 x Spray Boy	44.32
ms_6 x FM-786	45.45
ms_6 x French Bonita	46.11
ms_7 x Sunkist	46.87
ms_7 x Bonita Bolero	51.04
ms_7 x Spray Max	45.37
ms_7 x Safari Queen	43.32
ms_{10} x Spray Boy	52.34
ms_{10} x French Bonita	44.22
ms_{10} x Bonita Bolero	47.88
mean	40.20
C.D $_{0.05}$	4.89

Among inbred lines, 'FM-786' has recorded maximum plant spread (35.85 cm) while minimum value was recorded in 'Bonita Bolero' (27.82 cm). Similarly, among hybrids, genotype 'ms_{10} x Spray Boy' showed maximum plant spread (52.34 cm), while minimum plant spread was recorded in genotype 'ms_5 x FM-786' (38.20 cm). In general the hybrids showed more plant spread as compared to inbred lines.

4.3 DAYS TAKEN TO BUD FORMATION

As regards number of days taken to bud formation, it differed significantly among various genotypes. The perusal of data in Table 3 revealed that genotype 'ms_6 x Spray Boy' was the earliest and took 28.91 days to bud formation.

Table 3. Performance data of different French marigold genotypes (days taken to bud formation)

Genotypes	Number of days taken to bud formation
Safari Queen	33.14
Spray Boy	36.01
Single Petal Red	35.04
Spray max	40.94
Harmony Boy	44.76
Bonita Bolero	42.02
Sunkist	41.92
French Bonita	39.23
Double Dwarf Lemon	46.30
FM-786	36.15
ms_4 x Harmony Boy	30.04
ms_4 x French Bonita	30.79
ms_4 x FM- 786	36.24
ms_5 x FM- 786	41.53
ms_6 x Sunkist	34.56
ms_6 x Spray Boy	28.91
ms_6 x FM-786	33.84
ms_6 x French Bonita	35.99
ms_7 x Sunkist	38.78
ms_7 x Bonita Bolero	42.40
ms_7 x Spray Max	43.12
ms_7 x Safari Queen	37.98
ms_{10} x Spray Boy	46.89
ms_{10} x French Bonita	38.17
ms_{10} x Bonita Bolero	38.69
mean	38.47
C.D $_{0.05}$	2.01

It was statistically at par with days taken to bud formation recorded in genotypes 'ms_4 x Harmony Boy' (30.04 days) and 'ms_4 x French Bonita' (30.79 days). On the contrast, maximum number of days taken to bud formation (46.89) were observed in 'ms_{10} x Spray Boy' and it was found to be at par with 'Double Dwarf Lemon' (46.30) and 'Harmony Boy' (44.76 days).

A comparison of data among inbred lines shows that genotype 'Safari Queen' (33.14 days) was the earliest to show bud formation while 'Double Dwarf Lemon' took maximum days to bud formation (46.30 days). On the other hand, among hybrids minimum days to bud formation was recorded in 'ms_6 x Spray Boy' (28.91 days). Maximum days for bud formation were observed in 'ms_{10} x Spray Boy' (46.89 days).

4.4 DAYS TAKEN TO FLOWERING

Data on number of days taken to flowering is presented in Table 4 and showed significant differences among various genotypes.

It is evident from the data in Table 4 that genotype 'ms_6 x Spray Boy' took minimum number of days for flowering (36.94 days). It was, however, found to be statistically at par with number of days taken to flowering in 'ms_4 x Harmony Boy' (37.47 days). On the other hand, genotype 'Double Dwarf Lemon' took maximum days to flowering (56.76). It was found to be statistically at par with number of days taken to flowering in genotype 'Harmony Boy' (52.30 days).

A comparison among inbred lines shows that there is not much difference for number of days taken to flowering, whereas hybrids show a significant difference for this character (Plate 2). Among inbred lines maximum days taken to flower formation were recorded in 'Double Dwarf Lemon' (56.76 days) and minimum days were observed in genotype 'Single Petal Red' (41.83 days) Among hybrids, 'ms_6 x Spray boy' took minimum days (36.94) for flowering, whereas maximum days were recorded in 'ms_7 x Spray Max' (51.45 days) (Plate 3)

Sunkist

French Bonita

Bonita Bolero

Single Petal Red

Harmony Boy

Safari Queen

Plate 2: Some inbred lines of French marigold under evaluation

Ms_{10} x Spray Boy

ms_6 x Spray Boy

ms_7 x Sunkist

ms_6 x Sunkist

ms_4 x FM-786

ms_4 x French Bonita

Plate 3: Some of the F1 hybrids under evaluation

Table 4. Performance data of different French marigold genotypes (days taken to flowering)

Genotypes	Days taken to flowering
Safari Queen	46.01
Spray Boy	50.21
Single Petal Red	41.83
Spray max	49.37
Harmony Boy	52.30
Bonita Bolero	49.49
Sunkist	48.78
French Bonita	47.37
Double Dwarf Lemon	56.76
FM-786	45.50
ms_4 x Harmony Boy	37.47
ms_4 x French Bonita	39.84
ms_4 x FM- 786	44.02
ms_5 x FM- 786	48.67
ms_6 x Sunkist	43.67
ms_6 x Spray Boy	36.94
ms_6 x FM-786	41.28
ms_6 x French Bonita	44.25
ms_7 x Sunkist	46.81
ms_7 x Bonita Bolero	50.23
ms_7 x Spray Max	51.45
ms_7 x Safari Queen	47.13
ms_{10} x Spray Boy	50.67
ms_{10} x French Bonita	47.67
ms_{10} x Bonita Bolero	47.60
mean	47.00
C.D $_{0.05}$	2.45

4.5 DURATION OF FLOWERING (days)

A perusal of data embodied in Table 5 revealed that genotypes differ significantly with respect to duration of flowering.

It is evident from the data in Table 5 that maximum duration of flowering (62.00 days) was recorded in genotype 'ms_6 x FM-786' which was statistically at

par with 'ms_6 x French Bonita' (60.39 days), 'ms_7 x Bonita Bolero' (59.68 days), 'ms_4 x French Bonita' (59.03 days), 'ms_{10} x Bonita Bolero' (58.98 days), 'ms_7 x Spray Max' (58.42 days). On the contrast, minimum duration of flowering was recorded for the genotype 'Harmony Boy' (40.96 days) which was found to be at par with genotype 'Bonita Bolero' (41.61 days) 'Spray Max' (42.66 days), 'Double Dwarf Lemon' (43.53 days) and 'FM-786' (43.63 days).

Table 5. Performance data of different French marigold genotypes (duration of flowering)

Genotypes	Duration of flowering
Safari Queen	50.28
Spray Boy	47.99
Single Petal Red	49.67
Spray max	42.66
Harmony Boy	40.96
Bonita Bolero	41.61
Sunkist	45.17
French Bonita	46.76
Double Dwarf Lemon	43.53
FM-786	43.63
ms_4 x Harmony Boy	53.88
ms_4 x French Bonita	59.03
ms_4 x FM- 786	55.19
ms_5 x FM- 786	53.73
ms_6 x Sunkist	53.93
ms_6 x Spray Boy	55.78
ms_6 x FM-786	62.00
ms_6 x French Bonita	60.39
ms_7 x Sunkist	58.00
ms_7 x Bonita Bolero	59.68
ms_7 x Spray Max	58.42
ms_7 x Safari Queen	51.89
ms_{10} x Spray Boy	52.72
ms_{10} x French Bonita	58.09
ms_{10} x Bonita Bolero	58.98
mean	52.25
C.D $_{0.05}$	3.76

Out of the 10 inbred lines 'Safari Queen' has longer flowering duration (50.28 days), whereas minimum duration of flowering was recorded in 'Harmony Boy' (40.96 days). In a comparison among hybrids, 'ms_6 x FM-786' showed maximum duration of flowering (62.00 days) and genotype 'ms_7 x Safari Queen' on the contrast has minimum duration of flowering (51.89 days). In general, duration of flowering was recorded more in hybrids as compared to inbred lines.

4.6 FLOWER SIZE (cm)

The results pertaining to flower size are presented in Table 6. It is evident from the data that flower size varied significantly among various genotypes. An inquisition of data (Table 6) shows that out of 25 genotypes 'ms_6 x Spray Boy' has recorded the largest sized flowers (6.37 cm). It was found to be statistically at par with flower size recorded in 'ms_{10} x Bonita Bolero' (6.26 cm), 'ms_4 x French Bonita' (6.17 cm), 'ms_{10} x French Bonita' (6.12 cm), 'ms_4 x FM-786' (6.04 cm) and 'ms_7 x Spray Max' (6.03 cm). On the contrast, minimum value for flower size was recorded in genotype 'Double Dwarf Lemon' (3.09 cm), it was significantly at par with genotype 'FM-786' (3.80 cm).

Among inbred lines 'Single Petal Red' has maximum flower size (5.12 cm), whereas minimum flower size was recorded in 'Double Dwarf Lemon' (3.09 cm). For hybrids maximum flower size was recorded in 'ms_6 x Spray Boy' (6.37 cm) and for this the minimum value among hybrids was observed for the genotype 'ms_7 x Sunkist' (5.02 cm).

4.7 FLOWER WEIGHT (g)

An inquisition of data presented in Table 7 shows that genotypes differ significantly among themselves with respect to weight of single flower.

It is evident from the data that the maximum single flower weight (3.89 g) was recorded in genotype 'ms_7 x Bonita Bolero' was found to be at par with genotypes 'ms_5 x FM-786' (3.85 g) 'ms_{10} x Spray Boy' (3.79 g), 'ms_7 x Spray Max' (3.77 g), 'ms_6 x Sunkist' (3.77 g), 'ms_4 x Harmony Boy' (3.76 g), 'ms_4 x FM-786', (3.73 g) and 'ms_4 x French Bonita' (3.60 g). On the other hand, genotype 'Single Petal Red' has recorded the minimum weight of a flower (1.20 g), which was statistically at par with genotype 'Harmony Boy' (1.28 g) and 'French Bonita' (1.33 g).

A comparison among inbred lines shows that 'Spray Boy' has maximum weight for a single flower (2.02 g) and genotype 'Single Petal Red' has recorded minimum single flower weight (1.20 g). Among hybrids, maximum single flower weight was observed in 'ms_7 x Bonita Bolero' (3.89 g), while minimum single flower weight was recorded in 'ms_6 x French Bonita' (2.98 g).

Table 6. Performance data of different French marigold genotypes (flower size cm)

Genotypes	Flower size (cm)
Safari Queen	5.03
Spray Boy	4.80
Single Petal Red	5.12
Spray max	5.01
Harmony Boy	4.63
Bonita Bolero	4.07
Sunkist	4.39
French Bonita	4.43
Double Dwarf Lemon	3.09
FM-786	3.80
ms_4 x Harmony Boy	5.38
ms_4 x French Bonita	6.17
ms_4 x FM- 786	6.04
ms_5 x FM- 786	6.13
ms_6 x Sunkist	5.24
ms_6 x Spray Boy	6.37
ms_6 x FM-786	4.89
ms_6 x French Bonita	5.34
ms_7 x Sunkist	5.02
ms_7 x Bonita Bolero	5.25
ms_7 x Spray Max	6.03
ms_7 x Safari Queen	4.60
ms_{10} x Spray Boy	5.44
ms_{10} x French Bonita	6.12
ms_{10} x Bonita Bolero	6.26
mean	5.15
C.D $_{0.05}$	0.47

Table 7. Performance data of different French marigold genotypes (single flower weight)

Genotypes	Flower weight (g)
Safari Queen	1.57
Spray Boy	2.02
Single Petal Red	1.20
Spray max	1.54
Harmony Boy	1.28
Bonita Bolero	1.49
Sunkist	1.85
French Bonita	1.33
Double Dwarf Lemon	1.72
FM-786	2.01
ms_4 x Harmony Boy	3.76
ms_4 x French Bonita	3.60
ms_4 x FM- 786	3.73
ms_5 x FM- 786	3.85
ms_6 x Sunkist	3.77
ms_6 x Spray Boy	3.49
ms_6 x FM-786	3.38
ms_6 x French Bonita	2.98
ms_7 x Sunkist	3.18
ms_7 x Bonita Bolero	3.89
ms_7 x Spray Max	3.77
ms_7 x Safari Queen	3.59
ms_{10} x Spray Boy	3.79
ms_{10} x French Bonita	3.57
ms_{10} x Bonita Bolero	3.45
mean	2.56
C.D $_{0.05}$	0.31

4.8 NUMBER OF FLOWERS PER PLANT

Data related to number of flowers per plant in Table 8 showed significant differences among various genotypes.

The perusal of data reveals that genotype 'ms_{10} x Spray Boy' has recorded maximum yield of flowers in terms of number of flowers per plant (100.23). It was proved statistically at par with genotypes 'ms_{10} x Bonita Bolero' (95.17) and 'ms_4 x FM-786' (95.10). On the other hand, minimum number of flowers per plant was observed in 'Spray Boy' (51.03).

Among inbred lines, 'Spray Max' has obtained maximum number of flowers per plant (78.30), while minimum flowers were recorded in 'Spray Boy' (51.03). For hybrids, 'ms_{10} x Spray Boy' produced maximum flowers (100.23) whereas 'ms_7 x Sunkist' produce minimum number of flowers (87.07) per plant.

Out of the four pickings, 2nd picking was the best as it registered maximum number of flowers for all the genotypes (32.94). The data does not show much variation in1st and 3rd picking for number of flowers per plant. The number of flowers per plant in the third picking was found as 19.83, whereas in the first picking 19.78 flowers per plant were recorded. Number of flowers per plant in fourth picking were reduced greatly and found minimum among all the pickings (8.48).

The interaction between genotypes and pickings shows that maximum number of flowers per picking were found in 'ms_{10} x French Bonita' (40.40) in second picking which was found to be at par with 'ms_{10} x Bonita Bolero' (38.47), 'ms_4 x FM-786' (38.43), 'ms_6 x Sunkist' (38.27) and 'ms_{10} x French Bonita' (37.87) in second picking. On the other hand, minimum number of flowers was recorded in genotype 'Spray Boy' (6.00) in fourth picking which was however, found to be at par with genotypes 'Double Dwarf Lemon' (6.11), 'Harmony Boy' (7.32), 'FM-786' (7.33), 'ms_6 x Spray Boy'(7.36), 'ms_6 x FM-786' (7.43), ' 'Sunkist' (7.63), 'French Bonita' (7.66), 'ms_6 x French Bonita' (7.83) and 'Bonita Bolero' (8.07) in fourth picking.

In 1st picking, 'ms_{10} x Bonita Bolero' produced highest number of flowers (24.47). It was found to be at par with number of flowers in genotypes 'ms_{10} x Spray Boy' (23.24), 'ms_7 x Safari Queen' (23.23), 'ms_7 x Bonita Bolero' (23.15), 'ms_7 x Spray Max' (22.63), 'ms_6 x French Bonita' and 'ms_7 x Sunkist' (22.47) .

On the contrast, minimum number of flowers in first picking was obtained in genotype 'French Bonita' (12.67). It was found to be statistically at par with genotype 'Spray Boy' (12.97) and 'Double Dwarf Lemon' (15.11).

Genotype 'ms_{10} x Spray Boy' has recorded maximum number of flowers (40.40) in 2nd picking. It was found to be at par with 'ms_{10} x Bonita Bolero' (38.47), 'ms_4 x FM-786' (38.43) and 'ms_6 x Sunkist' (38.27). On the other hand, genotype 'Spray Boy' produced minimum number of flowers in 2nd picking (22.07).

In 3rd picking maximum flowers were recorded in genotype 'ms_{10} x Spray Boy' (25.63). It was found to be at par with genotype 'ms_4 x Harmony Boy' (25.10), 'ms_5 x FM-786' (24.63), 'ms_4 x FM-786' (23.90), 'ms_{10} x French Bonita' (23.40), 'ms_{10} x Bonita Bolero' (23.27), 'ms_6 x FM-786' (23.20), 'Spray Boy' produced minimum number of flowers (10.00) in 3rd picking.

Very few flowers were obtained in the 4th picking. In 4th picking again genotype 'ms_{10} x Spray Boy' produced maximum number of flowers (10.95) and minimum number of flowers was recorded in genotype 'Spray Boy' (6.00).

. In general, among all the genotypes under study maximum yield of flowers in terms of number of flowers per plant was found in hybrids as compared to inbred lines.

Table 8. Performance data of different French marigold genotypes (Number of flowers per plant and total number of flowers per picking)

Genotypes	Number of flowers- 1st picking	Number of flowers 2nd picking	Number of flowers 3rd picking	Number of flowers 4th picking	Total number of flowers
Safari Queen	17.51	27.49	18.45	9.60	73.05
Spray Boy	12.97	22.07	10.00	6.00	51.03
Single Petal Red	16.81	29.07	19.00	8.66	73.54
Spray max	17.23	29.30	22.47	9.29	78.30
Harmony Boy	13.97	24.54	17.97	7.32	63.79
Bonita Bolero	17.33	26.50	17.23	8.07	69.14
Sunkist	18.20	26.02	18.13	7.63	69.98
French Bonita	12.67	27.40	18.72	7.66	66.45
Double Dwarf Lemon	15.11	25.13	19.38	6.11	65.73
FM-786	18.40	29.77	16.47	7.33	71.97
ms_4 x Harmony Boy	21.33	34.67	26.10	8.10	90.20
ms_4 x French Bonita	18.54	37.66	23.17	8.66	88.03
ms_4 x FM- 786	22.77	38.43	23.91	9.98	95.10
ms_5 x FM- 786	18.72	37.05	24.63	10.06	90.47
ms_6 x Sunkist	22.97	38.27	22.64	8.94	92.82
ms_6 x Spray Boy	20.70	36.37	20.37	7.36	84.80
ms_6 x FM-786	21.63	36.63	23.20	7.43	88.90
ms_6 x French Bonita	22.50	35.73	20.70	7.83	86.77
ms_7 x Sunkist	22.47	36.10	20.87	7.63	87.07
ms_7 x Bonita Bolero	23.15	34.90	22.23	9.86	90.15
ms_7 x Spray Max	22.63	36.30	19.69	8.96	87.59
ms_7 x Safari Queen	23.23	37.40	22.15	9.81	92.60
ms_{10} x Spray Boy	23.24	40.40	25.63	10.95	100.23
ms_{10} x French Bonita	20.93	37.87	23.40	9.34	91.54
ms_{10} x Bonita Bolero	24.47	38.47	23.27	8.96	95.17
Mean	19.78	32.94	20.79	8.48	81.98
C.D $_{0.05}$	2.82	2.57	2.78	2.39	5.39

$CD_{0.05}$ for:

Genotypes = 1.312

Pickings = 0.53

Genotypes x Pickings = 2.62

4.9 WEIGHT OF FLOWERS PER PICKING

An acquisition of data presented in Table 9 shows that genotypes differ significantly among themselves with respect to weight of flowers per picking.

It is evident from the data that genotype 'ms_{10} x Spray Boy' recorded maximum yield with respect to total weight (380.37 g) of flowers per plant. It was found to be statistically at par with flower weight recorded in genotypes 'ms_4 x FM-786' (354.80 g), 'ms_7 x Bonita Bolero' (350.35 g) and 'ms_6 x Sunkist' (350.03 g). On the contrast, minimum total weight of flowers was observed in genotype 'Harmony Boy' (88.08 g) and it was found to be at par with 'Single Petal Red' (88.26 g), 'French Bonita' (88.54 g), 'Bonita Bolero' (103.25 g)' 'Spray Boy'(103.43 g), 'Double Dwarf Lemon' (112.97 g) and 'Safari Queen' (114.51 g).

Among inbred lines, maximum weight was recorded in 'FM-786' (144.29 g), whereas minimum weight was registered in 'Harmony Boy' (88.08 g). Among hybrids, maximum weight of flowers was recorded in 'ms_{10} x Spray Boy' (380.87 g), while minimum value for this was recorded in genotype 'ms_6 x French Bonita' (273.01 g).

For all the genotypes, amongst 4 pickings, maximum weight of flowers was recorded in 2nd picking (96.96). The weight of flowers per picking in the third picking was found as 60.30, whereas, the weight of flowers per picking for first picking was recorded as 57.78 g. Weight of flowers per picking was greatly reduced in fourth picking and recorded as 24.27 g.

The interaction between genotypes and pickings shows that maximum weight of flowers per picking was found in 'ms_{10} x Spray Boy' (153.22 g) in second picking. It was found to be at par with genotypes 'ms_6 x Sunkist' (144.23 g), 'ms_4 x FM-786' (143.83 g) and 'ms_5 x FM-786' (143.00 g). In contrast, minimum weight of flowers per picking was recorded in second picking in genotype 'Harmony Boy' (9.40 g) which was found to be at par with all the 10 inbred lines in fourth picking and also with genotype 'French Bonita' (16.88 g) in first picking.

For 1st picking, genotype 'ms_7 x Bonita Bolero' registered maximum weight of flowers per picking (89.94 g). It was found to be at par with genotype 'ms_{10} x Spray Boy' (87.92), 'ms_6 x Sunkist' (86.73), whereas minimum value was recorded for weight of flowers per picking in genotype 'French Bonita' (16.88 g).

In 2nd picking maximum flower weight was registered in genotype 'ms_{10} x Spray Boy' (153.22 g). It was found to be at par with genotypes 'ms_{10} x Spray Boy' (87.92), 'ms_6 x Sunkist' (144.23), 'ms_4 x FM-786' (143.83), ms_5 x FM-786' (143.00). On the other hand, genotype 'Harmony Boy' has recorded minimum flower weight (31.40 g), which was found to be statistically at par with genotypes 'Single Petal Red' (34.88), 'French Bonita' (36.52), 'Bonita Bolero' (39.59), 'Safari Queen' (43.12) and 'Double Dwarf Lemon' (43.39).

In 3rd picking maximum weight of flowers was again recorded in genotype 'ms_{10} x Spray Boy' (97.59 g) and it was found to be at par with genotypes 'ms_5 x FM-786' (95.08 g), 'ms_4 x Harmony Boy' (94.88 g), ms_4 x FM-786' (88.71 g) and 'ms_7 x Bonita Bolero'. In contrast, flower weight per picking was found to be minimum in genotype 'Harmony Boy' (20.20 g). it was found to be at par with genotypes 'Single Petal Red' (22.80 g), 'Spray Boy' (22.96 g), 'French Bonita' (24.93 g), 'Bonita Bolero' (25.70 g) and 'Safari Queen' (28.94 g).

For 4th picking same results were obtained with a maximum value of 41.64 g in 'ms_{10} x Spray Boy'. It was found to be at par with genotypes 'ms_5 x FM-786' (38.86), 'ms_7 x Bonita Bolero' (38.08), 'ms_4 x FM-786' (37.27), 'ms_7 x Safari Queen' (35.78) and 'ms_6 x Sunkist' (33.78). In contrast minimum value was reported in 'Harmony Boy' (9.40 g). All inbred lines were found to be at par with genotype 'Harmony Boy'.

In general, among all the genotypes under study maximum yield with respect to flower weight per plant was found in hybrids as compared to inbred lines.

Table 9. Performance data of different Marigold genotypes (weight of flowers per picking and total weight)

Genotypes	Weight of flowers- 1st picking (g)	Weight of flowers 2nd picking (g)	Weight of flowers 3rd picking (g)	Weight of flower 4th picking	Total weight (g)
Safari Queen	27.35	43.12	28.95	15.09	114.51
Spray Boy	26.32	44.74	20.20	12.16	103.43
Single Petal Red	20.17	34.88	22.81	10.41	88.26
Spray max	26.48	45.17	34.79	14.39	120.82
Harmony Boy	17.92	31.40	22.96	9.40	81.68
Bonita Bolero	25.88	39.59	25.71	12.07	103.25
Sunkist	33.59	48.30	33.61	14.23	129.73
French Bonita	16.88	36.52	24.94	10.20	88.54
Double Dwarf Lemon	25.93	43.39	33.25	10.40	112.97
FM-786	36.90	59.70	33.00	14.69	144.29
ms4 x Harmony Boy	80.16	130.29	94.89	30.50	335.84
ms4 x French Bonita	66.88	135.80	83.50	31.13	317.30
ms4 x FM- 786	84.99	143.83	88.71	37.27	354.80
ms5 x FM- 786	71.93	143.00	95.08	38.87	348.88
ms6 x Sunkist	86.73	144.23	85.29	33.78	350.03
ms6 x Spray Boy	72.28	126.75	70.99	25.71	295.73
ms6 x FM-786	73.17	123.78	78.46	25.10	300.51
ms6 x French Bonita	67.16	106.53	61.77	23.51	258.97
ms7 x Sunkist	71.59	114.88	66.34	24.59	277.41
ms7 x Bonita Bolero	89.94	135.71	86.62	38.08	350.35
ms7 x Spray Max	85.69	136.95	74.15	33.60	330.39
ms7 x Safari Queen	83.20	134.19	80.01	35.78	333.18
ms10 x Spray Boy	87.92	153.22	97.59	41.64	380.37
ms10 x French Bonita	74.61	135.09	83.53	33.30	326.53
ms10 x Bonita Bolero	84.52	132.91	80.51	31.02	328.96
mean	57.78	96.96	60.31	24.28	239.33
C.D 0.05	9.60	12.49	11.28	8.02	29.51

$CD_{0.05}$ for:

Genotypes = 5.27

Pickings = 2.10

Genotypes x Pickings = 10.51

4.10 TOTAL NUMBER OF PICKINGS

In all the genotypes, total number of flower per pickig declined greatly after third picking, therefore only 4 pickings were done.

4.11 FLOWER YIELD PER SQUARE METER

The results pertaining to flower yield/m^2 are presented in Table 11. It is evident from the data that flower yield/m^2 varied significantly among various genotypes.

An inquisition of data (Table 11) shows that out of 25 genotypes 'ms_{10} x Spray Boy' recorded the maximum flower yield/m^2 (6.08 kg). It was found to be statistically at par with genotypes 'ms_6 x Sunkist' (5.61 kg) and 'ms_7 x Bonita Bolero' (5.60 kg). On the contrast, genotype 'Harmony Boy' had registered minimum flower yield/m^2 (1.30 kg). It was, however, found to be at par with genotypes 'Single Petal Red' (1.41 kg), 'French Bonita' (1.42 kg), 'Bonita Bolero' (1.65 kg) and 'Spray Boy' (1.65 kg).

A comparison among inbred lines shows that 'FM-786' has recorded maximum value (2.31 kg) for flower yield/m^2, whereas, minimum flower yield/m^2 was found in genotype 'Harmony Boy' (1.30 kg). Among hybrids maximum flower yield/m^2 was registered in 'ms_{10} x Spray Boy' (6.08 kg), whereas minimum flower yield/m^2 was observed in genotype 'ms_6 x French Bonita' (4.14 kg).

Out of the four pickings, for all the genotypes, maximum flower yield/m^2 (1551.35 g) was registered in second picking. The flower yield/m^2 in the third picking was found as 964.89 g whereas in the first picking 924.53 g flower yield/m^2 was recorded.

The interaction between genotypes and pickings shows that maximum flower yield/m^2 was recorded in 'ms_{10} x Spray Boy' (2451.49 g). It was found to be at par with genotypes 'ms_6 x Sunkist' (2307.63 g), 'ms_4 x FM-786' (2301.25

g) and 'ms_5 x FM-786' (2288.05 g). On the other hand, flower yield/m^2 was observed in genotype 'Spray Max' (150.42 g) and it was found to be at par with all the 10 inbred lines in fourth picking.

In second picking genotype 'ms_{10} x Spray Boy' recorded maximum flower yield/m^2 (2451.49 g) which was found to be at par with genotypes 'ms_6 x Sunkist' (2307.63 g), ms_4 x FM-786' (2301.25 g) and ms_5 x FM-786' (2288.05 g). On the other hand, minimum flower yield/m^2 was recorded in genotype 'Harmony Boy' (502.41 g) and it was found to be at par with genotypes ''Double Dwarf Lemon' (694.16 g), 'Safari Queen' (689.85 g), 'Bonita Bolero' (633.44 g), 'French Bonita' (584.38 g) and 'Single Petal Red' (558.15 g).

For first picking genotype 'ms_7 x Bonita Bolero' (1439.00 g) registered maximum flower yield/m^2. It was found to be at par with genotypes 'ms_{10} x Spray Boy' (1406.79 g), 'ms_6 x Sunkist' (1387.66 g), 'ms_7 x Spray Max' (1370.98 g), ms_4 x FM-786' (1359.87 g), 'ms_{10} x Bonita Bolero' (1352.30 g) and 'ms_7 x Safari Queen' (1331.20 g). On the other hand, minimum flower yield/m^2 was recorded in genotype 'French Bonita' (270.02 g). It was found to be at par with genotypes 'Single Petal Red' (322.67 g), 'Harmony Boy' (388.97 g), 'Bonita Bolero' (414.12 g), 'Double Dwarf Lemon' (414.93 g), 'Spray Boy' (421.17 g) and 'Spray Max' (423.72 g).

On the contrast, for third picking, maximum flower yield/m^2 was observed in genotype 'ms_{10} x Spray Boy' (1561.42g), and it was found to be statistically at par with genotypes 'ms_5 x FM-786' (1521.33 g), 'ms_4 x Harmony Boy' (1518.17 g) and 666.28 g respectively, whereas genotype 'Harmony Boy' registered minimum flower yield/m^2 in both third (323.25 g) and fourth pickings (150.42 g).

Table 11. Performance data of different Marigold genotypes (flower yield per plant per picking (g) and total flower yield per sq. m (kg)

Genotypes	Yield 1st picking (g)	Yield 2nd picking (g)	Yield 3rd picking (g)	Yield 4th picking (g)	Total flower yield/m^2 (kg)
Safari Queen	437.60	689.85	463.18	241.50	1.83
Spray Boy	421.17	715.88	323.25	194.51	1.65
Single Petal Red	322.67	558.15	364.91	166.51	1.41
Spray max	423.72	722.69	556.58	230.18	1.93
Harmony Boy	286.67	502.41	367.42	150.42	1.30
Bonita Bolero	414.12	633.44	411.29	193.20	1.65
Sunkist	537.42	772.83	537.75	227.69	2.07
French Bonita	270.02	584.38	398.97	163.25	1.42
Double Dwarf Lemon	414.93	694.16	531.97	166.44	1.80
FM-786	590.45	955.21	528.06	234.99	2.31
ms_4 Harmony Boy	1282.51	2084.65	1518.18	488.04	5.37
ms_4 x French Bonita	1070.03	2172.83	1335.93	498.00	5.08
ms_4 x FM- 786	1359.87	2301.25	1419.32	596.36	5.53
ms_5 x FM- 786	1150.88	2288.05	1521.33	621.84	5.58
ms_6 x Sunkist	1387.66	2307.63	1364.63	540.52	5.61
ms_6 x Spray Boy	1156.40	2028.03	1135.89	411.41	4.73
ms_6 x FM-786	1170.74	1980.50	1255.28	401.58	4.92
ms_6 x French Bonita	1074.62	1704.47	988.25	376.22	4.14
ms_7 x Sunkist	1145.50	1838.11	1061.50	393.43	4.44
ms_7 x Bonita Bolero	1439.00	2171.41	1385.95	609.21	5.60
ms_7 x Spray Max	1370.98	2191.25	1186.43	537.61	5.29
ms_7 x Safari Queen	1331.20	2147.05	1280.10	572.53	5.33
ms_{10} x Spray Boy	1406.79	2451.49	1561.42	666.28	6.08
ms_{10} x French Bonita	1193.70	2161.45	1336.48	532.77	5.22
ms_{10} x Bonita Bolero	1352.30	2126.59	1288.23	496.25	5.23
mean	924.53	1551.35	964.89	388.43	3.82
C.D $_{0.05}$	154.53	199.92	193.11	127.90	0.49

$CD_{0.05}$ for:

Genotypes = 84.14

Pickings = 33.66

Genotypes x Pickings = 168.28

4.12 PARAMETERS OF VARIABILITY

The different parameters of variability viz., mean, range, coefficient of variability (genotypic and phenotypic), heritability (broad sense), genetic advance and genetic gain were worked out and values obtained are given in Table 12.

In general, phenotypic coefficient of variation (PCV) was higher in magnitude than the genotypic coefficient of variation (GCV). Higher phenotypic and genotypic coefficient of variation were reported for weight of flowers per picking (47.02% and 46.37%) and followed by flower yield per square meter (46.98% and 46.29%) and flower weight (37.21% and 36.61%).

Moderate phenotypic and genotypic coefficients were recorded for plant height (22.41% and 21.24%) followed by plant spread (19.20% and 17.69%), flower size (17.46% and 16.82%) and number of flowers per plant (16.10% and 15.60%). Heritability in a broad sense varied from 81% to 97% (Table 12). The heritability estimates for all the characters, were high. The single flower weight and weight of flowers per picking showed significantly high heritability 96% and 97% respectively. The estimates of genetic gain (genetic advance expressed as percentage of population mean) were high in nature and varied from 19.34% to 94.19% (Table 12). These were comparatively high for weight of flowers per plant and flower yield per square meter, 94.19% and 93.97% respectively. Minimum genetic gain was noticed for days taken to flowering (19.34%).

4.13 CORRELATION STUDIES

Flower yield per square meter had significant positive association with plant height, plant spread, duration of flowering, flower size, flower weight, number of flowers per plant and weight of flowers per picking, whereas, flower yield was found to be negatively correlated with days taken to bud formation and days taken to flower formation.

Plant height and plant spread showed a positive significant correlation with flower weight, number of flowers per plant, weight of flowers per plant and flower yield.

Days taken to bud formation had shown a positive correlation with number of days taken to flowering.

Table 12. Estimates of Phenotypic and Genotypic coefficients of variability, Heritability, Genetic advance and Genetic gain for different traits

Character	Mean	Range	Coefficient of variation		Heritability (%)	Genetic advance	Genetic Gain (%)
			P.C.V (%)	G.C.V (%)			
Flower yield/m^2 (kg)	3.84	1.41-6.08	46.98	46.29	92.00	3.61	93.97
Plant height (cm)	46.74	32.95 – 68.80	22.41	21.24	89.00	19.39	41.48
Plant spread (cm)	39.71	27.82 – 52.34	19.20	17.69	84.00	13.33	33.57
Days taken to bud formation	38.14	28.91 – 46.89	12.63	12.23	93.00	9.39	24.39
Days taken to flowering	46.61	36.94 – 56.76	10.37	9.87	93.00	9.01	19.34
Duration of flowering (days)	52.16	40.96 – 62.00	13.08	12.32	88.00	12.48	23.93
Flower size	4.80	3.09 – 6.37	17.46	16.82	92.00	1.71	33.39
Single flower weight (g)	2.79	1.20 – 3.89	37.21	36.61	96.00	2.07	74.22
Number of flowers per plant	84.83	53.70 –100.89	16.10	15.60	93.00	25.58	31.16
Weight of flowers per picking (g)	300.23	90.65 –383.98	47.02	46.37	97.00	226.61	94.19

Duration of flowering was positively correlated with flower size, flower weight, number of flowers per plant, weight of flowers per plant and flower yield per square meter.

Flower size showed positive significant correlation with flower weight, number of flowers per plant, weight of flowers per picking and flower yield per square meter.

Table 13. Simple correlation between different morphological and floral characters in French marigold

	FY/m^2	**PH**	**PS**	**DTBF**	**DTFF**	**DOF**	**FS**	**FW**	**NFPP**
PH	0.555*								
PS	0.823*	0.800*							
DTBF	-0.013	0.330	0.205						
DTFF	-0.278	0.274	-0.128	0.830*					
DOF	0.747*	0.171	0.545*	-0.386	-0.551*				
FS	0.688*	0.242	0.430*	0.007	-0.467*	0.559*			
FW	0.984*	0.732*	0.919*	0.252	-0.251	0.845*	0.601*		
NFPP	0.922*	0.537*	0.815*	0.004	-0.349	0.709*	0.666*	0.778*	
WFPP	1.000*	0.551*	0.821*	-0.015	-0.280	0.746*	0.689*	0.984*	0.922*

*** Significant at 5%**

1. FY/m^2 = Flower yield per square meter
2. PH = Plant height
3. PS = Plant spread
4. DTBF = Days taken to bud formation
5. DTF = Days taken to flowering
6. DOF = Duration of flowering
7. FS = Flower size
8. FW = Flower weight
9. NFPP = Number of flowers per plant
10. WTPP = Weight of flowers per picking

Chapter-5

DISCUSSION

Experimental evidences collected during the course of the investigation to elucidate the performance of various genotypes of French marigold in relation to their growth and flower yield parameters have been discussed here. An attempt has been made to examine and evaluate the important observations in terms of cause and effect relationships. In the present investigation, a total of twenty five genotypes were critically evaluated to study their growth and flower yield parameters to select superior genotypes for cultivation under Nauni, Solan, conditions. The salient findings of the present investigation have been discussed trait-wise as under:

Plant height and spread

Plant height varied significantly among the genotypes at all the stages of plant growth. Genotype 'ms_7 x Bonita Bolero' recorded maximum plant height (68.80 cm), while minimum was recorded in genotype 'French Bonita' (32.95 cm). Like plant height, plant spread also showed significant variation with regards to different genotypes. Plant spread varied from 27.82 cm to 52.34 cm. Maximum spread was observed in 'ms_{10} x Spray Boy', whereas, minimum was registered in genotype 'Bonita Bolero'. The plant height and spread are the varietal traits and variation among the genotypes is attributed to the genetic makeup of the plant. Variation in plant height and spread, due to varieties and genotypes have also been observed by Nalawadi (1982) and Rao et. al. (2005) in marigold. The results get further support from the findings of Kanamadi and Patil (1993) in chrysanthemum. Variation in plant height and spread have also experimentally substantiated by Maynard and David (1987), who reported that availability of congenial environment to express the dominant gene in the genotypes might be the reason for this variation. They further reported that increase in these vegetative characters is attributed to the favourable effect of

nitrogen on chlorophyll content of leaves that might have increased the synthesis of carbohydrates and amino acids.

Days taken to visible bud formation and flowering

Number of days taken to first flower bud appearance and flowering signifies the earliness or late flowering habit of genotype. Both habits are helpful in determining the availability of flowers for a longer period. (Behera et. al. 2002). Among genotypes, 'ms_6 x Spray Boy' was the earliest in bud formation and flowering (28.91 and 36.94 days) respectively. Variation in days to flowering has also been documented by several workers (Howe and Waters, 1990; Kanamadi and Patil, 1993). The marked variation for these parameters is attributed to genetic makeup of the genotypes. Further, more dry matter accumulation due to favourable climatic conditions might be the reason behind earliness in these traits (Chandrasekhara Rao and Reddy, 2002) in marigold and Dhiman (2003) in chrysanthemum. A wide variation in days to flowering in different genotypes of chrysanthemum has also been reported by Kanamadi and Patil (1993).

Duration of flowering

Blooming period of flowers is an important criterion for selection of a particular genotype. The genotypes under study showed a wide variation in duration of flowering. Maximum duration of flowering was observed in 'ms_6 x FM-786' (62.00 days), while, it was minimum in 'Harmony Boy' (40.96 days). The variability in duration of flowering has been attributed to genetic makeup of the plant. The results corroborate with the findings of Hemlata et. al. (1992).

Number of flowers per plant

In the present experiment genotypes showed significant effect on number of flowers per plant. Genotype 'ms_{10} x Spray Boy' (100.23) was floriferous in nature and produced maximum number of flowers per plant as compared to others. Our results are in close conformity with the findings of Sharga et. al. (1975) who also recommended that among French group cvs Producing 100 and more flowers can be selected for commercial flower production. Such variations among genotypes can be attributed to genetic factors. The results are also

supported by the findings of Reddy et. al. (1988) in African marigold and Hemlata et. al. (1992) and Dhiman (2003) in chrysanthemum.

Flower size and Flower weight

As far as flower size is concerned, it was found maximum in 'ms_6 x Spray Boy' (6.37 cm) whereas, maximum single flower weight was recorded in 'ms_7 x Bonita Bolero' (3.89 g). In contrast, minimum flower size (3.09 cm) and flower weight (1.20 g) recorded in genotypes 'Double Dwarf Lemon' and 'Single Petal Red', respectively. This variation may be attributed to the inherent genetic and environmental factors. The results are in confirmation with the findings of Dilta et. al. (2005) in chrysanthemum and Anuradha et. al. (1990).

Weight of flowers per picking and flower yield per square meter

Differences were significant among the French marigold genotypes for weight of flowers per picking and flower yield per square meter. It was found to be maximum in genotype 'ms_{10} x Spray Boy' (380.37 g and 6.08 kg/m^2) respectively. The varietal differences might be attributed to the genotypic variation. Further, increased flower yield could be attributed to larger flower size and flower weight per plant in this genotype. These results are in accordance with the findings of Dhiman (2003) in chrysanthemum and Poornima et. al. (2006) in China aster. It has also been observed that out of the four pickings, maximum flower yield was recorded in second picking followed by third picking. The fourth picking showed the least flower yield. This variation could be attributed to the developmental stages of the plants.

A gradual increase in number of flowers per plant was observed from first picking to second picking. The plant shows a transition from vegetative to flowering stage during the first picking. The plants attained maturity and therefore, showed increased yields during second picking. Flower yield per sq. m in third picking was comparatively less yield and highly reduced in the fourth picking, shows the decline in growth of the plants with age.

Parameters of variability

A wide range of variability was observed in the experimental materials. However, the information based on the range provides rough estimates of the degree of the variation present in the material and is more reliable if based on coefficients of variability. The estimates of phenotypic and genotypic coefficients of variability gave a clear picture of amount of variations present in the available germplasm. Phenotypic coefficients of variability were higher in magnitude than the genotypic coefficients of variability for all the characters studied, though difference was very less. This indicates the role of environment in the expression of genotype. Similar results were reported by Misra and Saini (1990) and John et. al. (2002) in gladiolus. Coefficients of variability varied in magnitude from character to character (either low or moderate or high). Therefore, it indicated that there was a great diversity in the experimental material used.

The PCV and GCV was found to be highest for the weight of flowers per picking, flower yield per square meter and flower weight. This reflects greater genetic variability among the genotypes for these characters for making further improvement by selection. Whereas, moderate PCV and GCV were recorded for plant height, followed by plant spread, number of flowers per plant. This shows that coefficients of variation were moderate to high for all the flowering attributes. These results got the support from the findings of Barigidad et. al. (1992) in chrysanthemum and Patnaik and Mohanty (2002) in African marigold.

GCV by itself is not a correct measure to know the heritable variations present and should be considered together with heritability estimates to get the best picture of the amount of advance to be expected from the selections (Burton, 1952). Estimates of broad sense heritability for the characters under study were ranged from 84% (plant spread) to 97% (weight of flowers per picking). The single flower weight and weight of flowers per picking showed significantly high heritability 96% and 97% respectively. High heritability estimates are helpful in making selection of superior genotypes on the basis of quantitative characters. However, Johnson et. al.(1955) suggested that heritability estimates along with genetic gain is more useful than the heritability value alone in predicting the

result for selecting the best individual. In present study the characters, viz., flower yield/m^2 (kg), single flower weight (g) and weight of flowers per picking (g) had high heritability along with high genetic gain, and this association is owing to additive gene effects (Panse, 1957). High heritability with medium genetic gain was found for plant height, plant spread, flower size, number of flowers per plant. Therefore selection for these characters could also be effective. The results are in support with Poornima et. al. (2006).

Flower yield per square meter was positively and significantly associated with plant height, plant spread, duration of flowering, flowers size, weight of single flower and number of flowers per plant. Significant association of yield with different characters has also been reported by Raghava et. al. (1992) and Behera and Sirohi (1999) in chrysanthemum, Bhat (1995) in gerbera over one season and Sreenivasulu et. al. (2013) in China aster.

Number of flowers per plant was positively and significantly associated with plant height, plant spread, duration of flowering, flower size and flower weight. These results were in confirmation with the findings of Bhanupratap et. al. (1999) and Sreenivasulu et. al. (2013) in China aster.

Chapter-6

SUMMARY AND CONCLUSION

The present studies entitled, "Evaluation of genotypes of French marigold (*Tagetes patula* L.) under Nauni, Solan conditions" were carried out at the experimental farm of the Department of Floriculture and landscaping, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.). The study was conducted on a group of 25 genotypes including 10 inbred lines and 15 hybrids of French marigold. The experiment was laid out in a randomized block design (RBD) with three replications of each genotype in a plot of size 1m x 1 m accommodating 16 plants per square meter. The observations were recorded for plant height (cm), plant spread (cm), days taken to bud formation, days taken to flowering, duration of flowering (days), number of flowers per plant, flower size (cm), total number of flowers per picking, total number of pickings, flower weight (g), weight of flowers per picking (g) and flower yield per square meter (kg).

The analysis of variance showed highly significant variations among the genotypes for all the traits under study.

Growth and flower yield parameters

The genotype 'ms_7 x Bonita Bolero' recorded maximum plant height (68.80 cm), and it was found to be at par with genotype 'ms_{10} x Bonita Bolero' (67.67 cm). Minimum plant height was found in genotype 'French Bonita' (32.95 cm) and it was found to be statistically at par with genotypes 'Single Petal Red' (33.38 cm), 'Spray Boy' (35.59 cm), 'Double Dwarf Lemon' (35.87 cm), 'Sunkist' (36.10 cm) and 'Bonita Bolero' (39.16 cm).

Plant spread was found to be the maximum in genotype 'ms_{10} x Spray Boy' (52.34 cm), it was found to be at par with genotype 'ms_{10} x Bonita Bolero' (47.88 cm). Genotype 'Bonita Bolero' had shown minimum plant spread (27.82 cm) and it was found to be at par with genotypes 'Spray Boy' (28.90 cm), 'Sunkist' (30.21 cm), 'French Bonita' (30.30 cm), 'Safari Queen' (30.50 cm) and 'Spray Max' (32.07 cm).

Genotype 'ms_6 x Spray Boy' was the earliest and took 28.91 days to bud formation and 36.94 days to flowering. It was at par with days taken to bud formation recorded in genotypes 'ms_4 x Harmony Boy' (30.04 days) and 'ms_4 x French Bonita' (30.79 days). Number of days taken to bud formation was found to be maximum for the genotype 'ms_{10} x Spray Boy' (46.89 days) which was found to be at par with 'Double Dwarf Lemon' (46.30 days) and 'Harmony Boy' (44.76 days). Genotype 'Double Dwarf lemon' took maximum days to flowering (56.76 days), which was at par with genotype 'Harmony Boy' (52.30 days)

Maximum duration of flowering (62.00 days) was recorded in genotype 'ms_6 x FM-786' which was statistically at par with 'ms_6 x French Bonita' (60.39 days), 'ms_7 x Bonita Bolero' (59.68 days), 'ms_4 x French Bonita' (59.03 days), 'ms_{10} x Bonita Bolero' (58.98 days), 'ms_7 x Spray Max' (58.42 days). Duration of flowering was found to be minimum in genotype 'Harmony Boy' (40.96 days) which was at par with genotype 'Bonita Bolero' (41.61 days) 'Spray Max' (42.66 days), 'Double Dwarf Lemon' (43.53 days) and 'FM-786' (43.63 days).

As regards flower size genotype 'ms_6 x Spray Boy' has the largest sized flowers (6.37 cm). It was found to be statistically at par with flower size recorded in 'ms_{10} x Bonita Bolero' (6.26 cm), 'ms_4 x French Bonita' (6.17 cm), 'ms_{10} x French Bonita' (6.12 cm), 'ms_4 x FM-786' (6.04 cm) and 'ms_7 x Spray Max' (6.03 cm). Among genotypes, smallest flowers were found in genotype 'Double Dwarf Lemon' (3.09 cm).

Maximum single flower weight (3.89 g) was recorded in genotype 'ms_7 x Bonita Bolero', it was found to be at par with genotypes 'ms_5 x FM-786' (3.85 g), 'ms_{10} x Spray Boy' (3.79 g), 'ms_7 x Spray Max' (3.77 g), 'ms_6 x Sunkist' (3.77 g), 'ms_4 x Harmony Boy' (3.76 g), 'ms_4 x FM-786', (3.73 g) and 'ms_4 x French Bonita' (3.60 g). Genotype 'Single Petal Red' recorded minimum weight of a flower (1.20 g), which was at par with genotype 'Harmony Boy' (1.28 g) and 'French Bonita' (1.33 g).

Number of flowers per plant was found to be highest for the genotype 'ms_{10} x Spray Boy' (100.23). The same genotype recorded maximum yield with respect to total weight of flowers per plant (380.37 g). It was found to be

statistically at par with 'ms_4 x FM-786' (354.80 g), 'ms_7 x Bonita Bolero' (350.35 g) and 'ms_6 x Sunkist' (350.03 g). Total weight of flowers was found to be minimum in genotype 'Harmony Boy' (88.08 g).

As regards flower yield maximum flower yield per square meter (6.08 kg) was recorded in genotype 'ms_{10} x Spray Boy' It was found to be statistically at par with genotypes 'ms_6 x Sunkist' (5.61 kg) and 'ms_7 x Bonita Bolero' (5.60 kg).

Parameters of variability

High phenotypic and genotypic coefficient were reported for weight of flowers per picking (47.02% and 46.37%) and followed by flower yield per square meter (46.98% and 46.29%) and single flower weight (37.21% and 36.61%), indicating wide range of variations and offered better scope for improvement through selection. Plant height, plant spread and number of flowers per plant showed moderate phenotypic and genotypic coefficients of variability, showing more influence of environment on these characters. Hence, selection is not effective in such cases. High heritability estimates coupled with high genetic gain were observed for weight of flowers per plant and flower yield per square meter indicating that these characters are under non-additive gene effect and were more reliable for effective selection. High heritability with moderate genetic gain was recorded for number of flowers per plant and plant height, showing that these characters are under non additive gene effects and selection for these characters will be less effective.

Correlation studies

Flower yield per square meter had significant positive association with plant height, plant spread, duration of flowering, flower size, flower weight, number of flowers per plant and weight of flowers per picking, whereas, flower yield was found to be negatively correlated with days taken to bud formation and days taken to flower formation.

CONCLUSION

Based upon the present studies, it can be concluded that genotypes 'ms_{10} x Spray Boy' was found to be best amongst all the twenty five genotypes with respect to flower yield per square meter. Other genotypes which showed a flower yield of more than 5kg/m^2 include ms_4 x Harmony Boy, ms_4 x French Bonita, ms_4 x FM-786, ms_5 x FM-786, ms_6 x Sunkist, ms_7 x Bonita Bolero, ms_7 x Spray Max, ms_7 x Safari Queen, ms_{10} x French Bonita, ms_{10} x Bonita Bolero.

Chapter-7

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Title of Thesis	**:**	**"Evaluation of genotypes of French marigold (*Tagetes patula* L.) under Nauni, Solan conditions"**
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ABSTRACT

The present studies entitled "Evaluation of genotypes of French marigold (*Tagetes patula* L.) under Nauni, Solan conditions" were carried out at experimental farm of Department of Floriculture and Landscaping, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during March 2013 to July 2013 to evaluate different genotypes of French marigold. The experiment was laid out in a RBD with three replications. Twenty five genotypes of French marigold were evaluated for various growth and yield parameters. Analysis of variance showed significant difference among all the genotypes for all the characters under study. Maximum plant height (68.80 cm) and flower weight (3.89 g) was obtained in genotype 'ms_7 x Bonita Bolero'. Genotype 'ms_{10} x Spray Boy' recorded maximum plant spread (52.34 cm), number of flowers per plant (100.23), flower weight per plant (380.37 g) and flower yield per square meter (6.08 kg). The genotype 'ms_s x Spray Boy' recorded maximum flower size (6.37 cm), minimum days taken to bud formation (28.91) and minimum days taken to flowering (36.94). Maximum duration of flowering was recorded for the genotype 'ms_6 x FM-786' (62.00 days). Weight of flowers per picking, flower yield per square meter and flower weight exhibited high coefficient of variation, high heritability and high genetic gain. Flower yield per square meter had significant positive association with plant height, plant spread, duration of flowering, flower size, flower weight, number of flowers per plant and weight of flowers per picking. The genotypes 'ms_{10} x Spray Boy' and 'ms_s x Spray Boy' were promising as they had many desirable traits.

Signature of Major Advisor **Signature of student**

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APPENDIX-I

Mean monthly meteorological data of Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) for the period of March 2013 to February 2014.

	Rainfall (mm)	Temperature (°C)		Humidity (%)
		Maximum	Minimum	
March, 2013	85.60	25.20	8.30	53.00
April	5.40	26.90	11.50	39.00
May	45.90	32.10	20.70	46.00
June	252.30	28.60	18.50	70.00
July	152.50	28.18	19.65	77.35
August	120.40	27.70	19.42	76.96
September	65.40	27.88	15.63	65.03
October	8.70	26.20	12.40	67.01
November	9.40	23.51	4.68	52.93
December	22.20	19.90	2.14	48.06
January, 2014	59.00	17.67	2.68	55.97
February	107.80	17.31	4.12	64.61

APPENDIX - II

Analysis of variance for various characters in French marigold

Characters / Source	df	Mean Sum of Squares									
		Plant height	Plant spread	Days taken to bud formation	Days taken to flowering	Duration of flowering	Number of flowers per plant	Flower size	Weight of flowers per picking	Flower weight	Yield/m^2
Genotypes	24	307.22*	156.944*	68.040*	66.18*	129.25*	502.91*	1.11*	37591.01*	3.18*	9.58*
Replications	2	4.33	2.76	1.011	2.94	2.59	4.82	0.12	876	0.09	0.28
Errors	48	11.14	8.812	1.491	2.22	5.20	10.52	0.08	335.87	0.03	0.09
Total	74	105.92	56.69	23.06	22.98	45.36	170.05	0.42	12433.21	1.05	3.17

*** Significant**

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(Preeti Sharma)