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Keywords: *bloom, bud, floriculture, morphological, phonological.*

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Evaluation of Pot Type Marigold (*Tagetus Patula*) Varieties for Commercial Value Traits at Three Different Locations of Kathmandu Valley, Nepal

Januka Dahal [α], Sabina Tiwari [σ], Suchit Shrestha [ρ] & Umed Kumar Pun [ω]

Abstract- Marigold has special values in Nepal as elsewhere. Especially during light festival (Depawali) huge quantity of this flower is consumed for home decoration. Consumer' prefers higher longevity, contrasting colors and variation in size whereas producers prefer higher yielding and types preferred by the consumers. Local varieties are monotonous, not compact and low yielding. Looking at the market demand, field trials were conducted to evaluate contrasting pot type marigold genotypes for vegetative growth, floral quality and yield attributes at three different locations (Bhaktapur, Kathmandu and Lalitpur district) of Nepal in 2019. These trials were designed in Randomized Complete Block (RCBD) with 11 pot type marigold genotypes (Sun Orange, Sun Gold, Sun Yellow, M-45 Orange, M-45 Gold, M-45 Yellow, SO-1 Orange, SO-1 Gold, SO-1 Yellow, K-Yellow and FO9 Orange) replicated three times. Genotypes M-45 Orange and FO9 Orange were taller in plant height and well spreading canopy type. Genotypes SO-1 Orange, SO-1 Yellow, SO-1 Gold and K-Yellow were dwarf type and had less spreading canopy. These highly spreading and spread not being able to cover vase type marigold varieties are not suitable for pot plantation by nursery growers. We found that varieties such as M-45 Gold (among gold color), M-45 Yellow (among yellow color) and Sun Orange (among orange color) were suitable for pot plantation due to good plant height, proper spreading type, enough number of nodes and branches, good number of flowers per plant, suitable flower diameter, flower weight and pedicel length.

Keywords: bloom, bud, floriculture, morphological, phonological.

I. Introduction

Floriculture is becoming one of the prominent sectors in Nepalese economy nowadays. But, use of flowers such as marigold has its long history in Nepal especially in the temples while worshiping god and goddess and during festivals like Deepawali (festival of light and sweets) when houses are decorated with garlands of marigold and for many other special occasions. Marigold is one of the most important flowers in Nepal because of its cultural and religious values. Marigold (*Tagetes patula*) can either be annual or perennial herbaceous ornamental plant under the family of Asteraceae. It is also called as French marigold. Marigold can grow up to 5 - 18 inches high (Dixit *et al.,* 2013). This type of marigold grows well in pots and is also used for edging flower beds in a garden and mass planting in the field. Marigold cultivation is becoming popular among flower nurseries and it is also becoming one of the most valuable pot flowering crops as it is easy to cultivate with wider adaptability. It requires mild climate for proper growth. It flowers within short crop duration producing wide range of attractive shapes, colors, sizes and long shelf life. Marigold flower is also used for extraction of 1-linauol, 1-linylaetate and 1-lemoene which is used as medicine for curing ulcer (Narsude *et al.,* 2010). Apart from this, it is also used for extracting essential oil that contains antioxidants (Perez *et al.,* 2006).

Varietal characterization and identification of specific traits have great role in any crops that helps in ensuring quality seeds and good management practices (Pramila *et al.,* 2011). Classification of different morphological traits is considered as the best method to characterize varietal differences that help to evaluate seed quality and varietal performance (Singh and Singh, 2006). With the improvement in the Nepalese economy, people started to invest on home gardening, roof-top gardening and landscaping. However, growing flower in a little space and small pots for home use especially for daily worship was a cultural practice in Nepal since time immemorial. Many nurseries have been recently established to supply the plantlets (seedlings) to the customer. But, the technical advancement in the floriculture sector is still a major issue in Nepal. Availability of suitable genotype with wider adaptability and improved traits has been a major problem in marigold which is an integral part of the garden. The local popular varieties are of low yielding, poor flower quality in terms of color, texture, uniformity (more than 50% off-type flowers. Even some hybrid varieties that are imported and growing in Nepal are not of high quality and have issue in uniformity. In addition to this seeds of currently growing hybrids are not easily accessible.

Therefore, we aimed to evaluate contrasting marigold genotypes for commercially valuable traits (vegetative growth, floral quality and yield attributes) at different locations of the Kathmandu Valley with similar agro-climatic condition, Nepal in the main cropping

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season of the year 2019. The main objective of this study was to identify the best genotype with desirable traits such as more numbers of flowers per plant, uniformity of flower in terms of size, color, texture and long shelf life (longevity after harvest).

II. Materials and Methods

This research was conducted at the three locations (Bhaktapur, Lalitpur and Kathmandu districts) of the Kathmandu Valley, Nepal (Fig., 1) during summer season, 2019. The experimental sites were situated between 27°42'14.40" N latitude and 85°18'32.40" E longitude with an elevation of 1400 masl. The experimental sites have mild and warm climate condition with less rainfall in winter season and high rainfall in summer season. The average annual rainfall amount to 1400 mm with an average winter temperature of around 11°C and average summer temperature of around 28°C.

Composite soil samples were taken from the pot mixture of soil, ash and oilcake that was prepared for planting marigold from all three locations. Pot mixture was made by mixing soil, ash and oilcake at the ratio of 2:1:0.03 (i.e., 100 kg of 2:1 mixture of soil and ash mixed with 1 kg of oilcake). Soil analysis was carried out in the laboratory of the Karma Group of Companies at Sitapila, Kathmandu to determine soil pH and soil EC. At Kathmandu, Lalitpur and Bhaktapur the pot mixture had pH 6.8 and 0.85 $mScm^{-1}$ EC, pH 7.0 and 1.29 $mScm^{-1}$ EC and pH 7.1 and 1.70 $mScm^{-1}$ EC respectively.

The experiment was laid out on Randomized Complete Block Design (RCBD) during August - November, 2019. The experimental material consisted of eleven F1 hybrids of marigold collected from different sources. The details of the eleven genotypes and their sources are presented in the Table 1. The experiment was conducted with 3 replications having 33 total numbers of plots. Each plot had 4 pots of dimension 10 inches upper diameter, 5 inches lower dimeter and 9 inches height. In total, 132 pots were used in the experiment in each location. The randomization of treatment (genotypes) was done by creating random numbers in the MS Excel sheet using [RAND()] command.

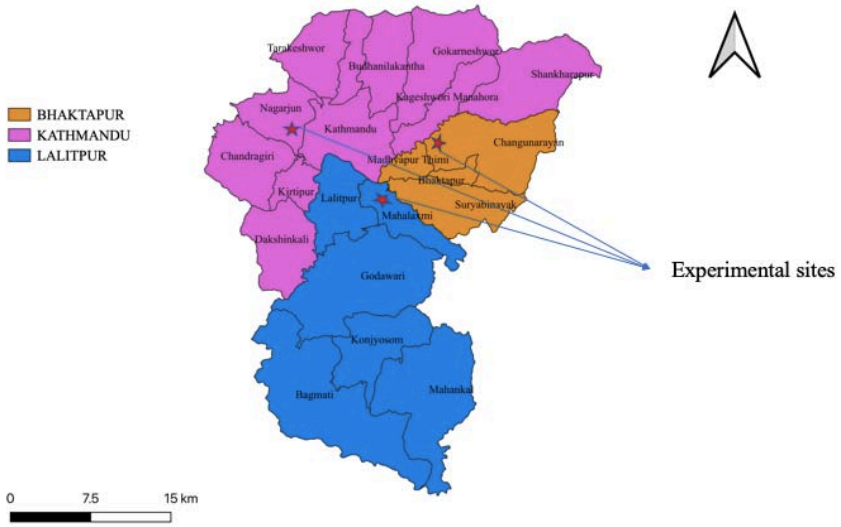


Fig. 1: Administrative map showing different locations of the field experiments in Bhaktapur, Kathmandu and Lalitpur districts of the Kathmandu Valley, Nepal

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Table 1: Description of the marigold genotypes and their source used in the study as treatments

Treatment	Variety	Flower Color	Flower shape	Petals	Company
T-1	Sun Orange	Orange	Flat	Flat	Ameriseed International Co., Ltd.
T-2	Sun Gold	Gold	Flat	Semi-tube	Ameriseed International Co., Ltd.
T-3	Sun Yellow	Yellow	Flat	Semi-tube	Ameriseed International Co., Ltd.
T-4	M-45 Orange	Orange	Flat	Flat	Karma International Seeds
T-5	M-45 Gold	Gold	Flat	Semi-tube	Karma International Seeds
T-6	M-45 Yellow	Yellow	Flat	Semi-tube	Karma International Seeds
T-7	SO1 Orange	Orange	Round	tube	Karma International Seeds
T-8	SO1 Gold	Gold	Round	tube	Karma International Seeds
T-9	SO1 Yellow	Yellow	Round	tube	Karma International Seeds
T-10	K-Yellow	Yellow	Flat	Flat	Karma International Seeds
T-11	FO9 Orange	Orange	Flat	Flat	Karma International Seeds

Seeds were sown on tray of 128 holes on the 2nd August, 2019. Seedlings at the two pairs of true leaf stage were transplanted on prepared pots on the 20th August, 2019. A light irrigation was provided just after transplanting for better anchorage of marigold seedlings. Pots with dead plants (shocked) were re-transplanted within a week after transplanting. All the intercultural operations like weeding and hoeing were carried out when necessary. Optimum irrigation was provided on daily basis through water pipe. Weekly spray schedule was followed as per package of practice of Karma Groups of Companies which included spray of plant nutrients (primary, macro and micro), fungicides and insecticides.

Three randomly selected pots from each plot were observed for commercially valuable traits such as plant height (cm), plant spread (cm), number of primary branches, stem diameter (cm), number of nodes, internodal length (cm), days to first flower bud formation, days to color formation on flower, days to complete bloom, number of flowers per plant, flower diameter (cm), flower depth (cm), flower weight (g) and pedicel length (cm).

All observed and measured data were encoded in Microsoft excel (MAC version 16.16.15) for data curation and management. Few parameters were estimated in the Microsoft excel using simple calculation methods. R-program (version 3.5.2) was used for statistical data analysis. Statistical tools such as One-way ANOVA was used to check significant differences between treatments and Least Significance Difference (LSD) at 0.05 significant level ($\alpha 0.05$) was used to compare differences between treatment means.

III. Result

Plant height and plant spread influenced significantly ($p \leq 0.01$) due to the varieties at all locations and mean of all locations. The combined analysis showed that plant height of M-45 Orange was maximum (50.48 cm) and was significantly different ($p \leq 0.01$) than other varieties except FO9 Orange (49.44 cm). Similar case was observed on plant spread too, where FO9 Orange (39.46 cm) and M-45 Orange (38.12 cm) were observed with highest plant spread and were significantly different ($p \leq 0.01$) than other varieties. The minimum height and spread were observed in the variety SO1 Gold (29.92 cm and 25.61 cm respectively) which was statistically not different from the varieties SO1 Orange and SO1 Yellow. Number of primary branches and number of nodes per plant also differed significantly ($p \leq 0.01$) because of ma rigold varieties at all locations. Numbers of primary branches were highest in all varieties (mean – 16.74) at the location Lalitpur. Among varieties M-45 Yellow was observed with highest number of primary branches (16.18) and nodes (10.10), however these varieties were statistically not different with other varieties. The minimum numbers of primary branches were observed in the variety SO1 Gold (10.40) and minimum numbers of nodes were observed on the variety SO1 Yellow (6.59) and both were statistically similar to other varieties.

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Table 2: Mean plant height and plant spread of marigold varieties at different location of Kathmandu valley

	Plant Height (cm)				Plant Spread (cm)			
Variety	1	2	3	Combined	1	2	3	Combined
Sun Orange	40.55^{d}	40.33^{c}	40.88^{bc}	40.59^{bc}	34.11^{cd}	32.55^{b}	31.83^{cde}	32.83^{b}
Sun Gold	37.16^{e}	37.00^{d}	38.72^{cd}	37.62^{c}	31.05^{e}	26.55^{d}	34.16^{b}	30.59^{bcd}
Sun Yellow	43.50^{c}	43.77^{ab}	39.44^{bcd}	42.24^{b}	37.11^{b}	29.22^{c}	33.91^{bc}	33.41^{b}
M-45 Orange	57.33^{a}	42.33^{abc}	51.77^{a}	50.48^{a}	40.44^{a}	33.22^{ab}	40.72^{a}	38.12^{a}
M-45 Gold	36.88^{e}	42.11^{bc}	37.44^{d}	38.81^{c}	33.05^{de}	28.38^{c}	31.94^{bcde}	31.12^{bc}
M-45 Yellow	44.03^{c}	44.22^{a}	40.94^{b}	43.06^{b}	35.16^{bc}	32.11^{b}	32.94^{bcd}	33.40^{b}
SO1 Orange	29.67^{f}	33.11^{e}	31.55^{e}	31.44^{d}	25.02^{g}	25.05^{e}	32.55^{bcd}	27.54^{def}
SO1 Gold	29.44^{f}	28.11^{g}	32.22^{e}	29.92^{d}	24.05^{g}	22.61^{f}	30.16^{e}	25.61^{f}
SO1 Yellow	30.38^{f}	31.00^{f}	28.66^{f}	30.01^{d}	25.83^{g}	23.38^{f}	31.16^{de}	26.79^{ef}
K-Yellow	29.47^{f}	33.33^{e}	33.00^{e}	31.93^{d}	28.94^{f}	25.38^{de}	33.11^{bcd}	29.14^{cde}
FO9 Orange	54.00^{b}	42.00^{bc}	52.33^{a}	49.44^{a}	41.33^{a}	34.33^{a}	42.72^{a}	39.46^{a}
Mean	39.31	37.93	38.82	38.69	32.38	28.44	34.11	31.64
LSD	2.28***	2.02***	2.18***	3.01***	2.03***	1.29***	2.32***	3.16***
SEM	0.78	0.69	0.74	1.86	0.69	0.44	0.79	1.95
CV	3.4	3.14	3.31	8.32	3.69	2.68	4	10.67

Means separated by different letter(s) within the column are significantly different. 1= Bhaktapur, 2= Kathmandu and 3 = Lalitpur, ns, *, **, *: non-significance and significance at 5, 1 and 0.01% level, respectively*

Table 3: Mean number of primary branches and nodes of different varieties at different location of Nepal

	Number of primary branches				Number of nodes			
Variety	1	2	3	Combined	1	2	3	Combined
Sun Orange	13.77^{ab}	13.77^{a}	18.11^{b}	14.33^{abc}	9.11^{bc}	7.77^{cd}	10.77^{a}	9.22^{ab}
Sun Gold	11.33^{de}	13.66^{a}	18.77^{b}	14.14^{abcd}	8.77^{cd}	8.22^{bc}	11.11^{a}	9.37^{ab}
Sun Yellow	14.00^{ab}	12.33^{ab}	20.33^{a}	16.03^{ab}	9.22^{bc}	9.55^{a}	10.11^{ab}	9.62^{ab}
M-45Orange	14.33^{a}	11.77^{bc}	16.66^{c}	13.97^{abcd}	10.70^{a}	7.55^{cde}	8.22^{cd}	8.85^{b}
M-45 Gold	12.11^{cd}	11.55^{bc}	16.66^{c}	13.51^{bcde}	9.55^{bc}	7.88^{bcd}	9.88^{abc}	9.11^{ab}
M-45 Yellow	14.88^{a}	11.11^{bcd}	20.00^{a}	16.18^{a}	10.00^{ab}	8.88^{ab}	11.44^{a}	10.10^{a}
SO1 Orange	10.44^{ef}	10.92^{bcd}	14.00^{d}	11.74^{def}	7.55^{e}	6.88^{def}	7.88^{d}	7.44^{d}
SO1 Gold	9.77^{fg}	10.77^{cd}	14.55^{d}	11.14^{ef}	6.22^{f}	6.44^{fg}	7.77^{d}	6.81^{d}
SO1 Yellow	8.66^{g}	10.66^{cd}	12.66^{e}	10.40^{f}	6.11^{f}	5.77^{g}	7.88^{d}	6.59^{d}
K-Yellow	11.55^{cde}	9.88^{de}	14.33^{d}	12.18^{cdef}	7.77^{de}	6.66^{efg}	8.55^{bcd}	7.66^{cd}
FO9 Orange	12.77^{bc}	9.11^{e}	18.03^{b}	14.12^{abcd}	9.22^{bc}	7.88^{bcd}	9.00^{bcd}	8.70^{bc}
Mean	12.15	11.42	16.74	13.44	8.58	7.6	9.33	8.5
LSD	1.39***	1.49***	1.07***	2.57***	1.17***	1.04***	1.78***	1.51***
SEM	0.47	0.5	0.36	1.59	0.39	0.36	0.6	0.71
CV	6.72	7.64	3.74	20.46	8	8.11	11.18	14.45

Means separated by different letter(s) within the column are significantly different. 1= Bhaktapur, 2= Kathmandu and 3 = Lalitpur, ns, *, **, *: non-significance and significance at 5, 1 and 0.01% level, respectively.*

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All observed phenological parameters (days to flower bud formation and days to flower blooming) were found significantly different ($p \leq 0.01$) in terms of varieties. Moreover, there was a significantly different ($p \leq 0.01$) relation among varieties in combined mean of all locations. The combined analysis showed that (Table 4) variety FO9 Orange (25.48 days) took the shortest duration for the formation of flower bud and was statistically similar to the varieties SO1 Yellow, SO1 Gold, SO1 Orange and Sun Yellow. Variety M-45 Gold (28.96 days) took the longest duration for the formation of flower bud but was not significantly different than the varieties Sun Orange, Sun Gold, Sun Yellow, M-45 Orange, M-45 Yellow and K-Yellow. Looking at the mean values, marigold took shortest duration for flowering at Bhaktapur location (44.81 days) and longest at Kathmandu (49.76 days).

Variety SO1 Yellow (44.03 days) took the shortest duration for flowering and was not statistically different than varieties FO9 Orange, K-Yellow, SO1 Gold and M-45 Orange. Variety Sun Yellow (51.06 days) took the longest duration for flowering by not being significantly different from varieties Sun Orange, Sun Gold, M-45 Gold and M-45 Yellow.

Table 4: Mean days to flower bud formation and days to flowering of marigold varieties at different location of Nepal

	Days to flower bud formation				Days to flowering			
Variety	1	2	3	Combined	1	2	3	Combined
Sun Orange	30.88^{b}	26.66^{ab}	28.66^{a}	28.74^{ab}	47.44^{bc}	50.88^{cd}	49.44^{bc}	49.25^{ab}
Sun Gold	29.11^{cd}	25.66^{bc}	27.55^{ab}	27.44^{abc}	47.88^{b}	50.33^{d}	49.22^{bc}	49.14^{ab}
Sun Yellow	32.22^{a}	24.66^{cd}	28.27^{ab}	28.38^{ab}	52.44^{a}	50.33^{d}	50.40^{a}	51.06^{a}
M-45Orange	23.77^{e}	27.66^{a}	25.88^{c}	25.77^{c}	37.44^{f}	54.33^{a}	46.22^{e}	46.00^{cde}
M-45 Gold	30.44^{b}	27.66^{a}	28.77^{a}	28.96^{a}	43.88^{de}	52.77^{ab}	48.55^{cd}	48.40^{abc}
M-45 Yellow	30.66^{b}	26.77^{ab}	28.77^{a}	28.74^{ab}	48.11^{b}	52.22^{bc}	49.66^{ab}	50.00^{ab}
SO1 Orange	30.00^{bc}	24.22^{cde}	27.55^{ab}	27.26^{abc}	45.11^{de}	50.00^{d}	47.77^{d}	47.62^{bcd}
SO1 Gold	30.33^{bc}	23.18^{de}	27.00^{bc}	26.84^{bc}	$45.55c^{d}$	45.11^{ef}	45.53^{e}	45.40^{cde}
SO1 Yellow	28.00^{d}	23.00^{e}	25.88^{c}	25.62^{c}	43.44^{e}	44.44^{f}	44.22^{f}	44.03^{e}
K-Yellow	28.66^{d}	27.00^{ab}	28.00^{ab}	27.88^{ab}	43.44^{e}	46.37^{e}	44.55^{f}	44.79^{de}
FO9 Orange	23.11^{e}	27.33^{a}	26.00^{c}	25.48^{c}	38.11^{f}	50.55^{d}	44.44^{f}	44.37^{e}
Mean	28.83	25.81	27.49	27.38	44.81	49.76	47.28	47.28
LSD	1.28***	1.56***	1.31***	2.09**	1.96***	1.56***	0.96***	3.10***
SEM	0.43	0.53	0.45	1.28	0.67	0.53	0.32	1.91
CV	2.61	3.55	2.81	8.15	2.57	1.84	1.19	7.01

Means separated by different letter(s) within the column are significantly different. 1= Bhaktapur, 2= Kathmandu and 3 = Lalitpur, ns, *, **, *: non-significance and significance at 5, 1 and 0.01% level, respectively.*

Number of flowers per plant was found significantly different ($p \leq 0.01$) in marigold varieties at all locations. Highest numbers of flowers were observed at the location Kathmandu (26.4) and lowest numbers of flowers were observed at the location Bhaktapur (15.62). The combined analysis showed that (Table 5) minimum numbers of flowers were found at the variety SO1 Yellow (11.17) and was significantly different than other varieties except SO1 Gold (13.89). More number of flowers were found on the variety M-45 Orange (27.62) but was statistically similar to the varieties M-45 Yellow (27.18), Sun Yellow (26.51), Sun Orange (24.48) and FO9 Orange (25.18).

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Table 5: Mean number of flowers per plant of marigold varieties at different location of Nepal

	Number of flowers/plant			
Variety	1	2	3	Combined
Sun Orange	14.33^{c}	34.11^{a}	25.00^{bc}	24.48^{a}
Sun Gold	14.11^{c}	23.44^{cd}	18.00^{de}	18.51^{bc}
Sun Yellow	22.00^{ab}	30.88^{b}	26.66^{ab}	26.51^{a}
M-45Orange	22.77^{ab}	31.66^{ab}	28.44^{a}	27.62^{a}
M-45 Gold	14.11^{c}	25.85^{c}	19.33^{d}	19.76^{b}
M-45 Yellow	23.66^{a}	30.77^{b}	27.11^{ab}	27.18^{a}
SO1 Orange	9.88^{d}	22.00^{d}	15.77^{ef}	15.88^{bc}
SO1 Gold	8.44^{de}	18.77^{e}	14.44^{f}	13.89^{cd}
SO1 Yellow	7.55^{e}	14.40^{f}	11.55^{g}	11.17^{d}
K-Yellow	13.44^{c}	23.77^{cd}	18.33^{d}	18.51^{bc}
FO9 Orange	21.44^{b}	30.77^{b}	23.33^{c}	25.18^{a}
Mean	15.62	26.04	20.73	20.80
LSD	1.86***	3.14***	2.43***	4.67***
SEM	0.64	1.07	0.82	2.88
CV	7.01	7.09	6.89	23.98

Means separated by different letter(s) within the column are significantly different. 1= Bhaktapur, 2= Kathmandu and 3 = Lalitpur, ns, *, **, *: non-significance and significance at 5, 1 and 0.01% level, respectively.*

Flower diameter varied significantly ($p \leq 0.01$) due to the varieties at all locations. But combined analysis of the varieties mean showed that non-significant relation of flower diameter with varieties. Flower diameter of the variety M-45 Orange was highest at all locations (8.74 cm at Bhaktapur, 6.07 cm at Kathmandu and 9.18 cm at Lalitpur) however it is not significantly different with many other varieties. Variety SO1 Gold was found with minimum floral diameter (6.54 cm, 4.98cm and 7.96 cm) and is not statistically different with other varieties. Flower depth was significantly different ($p \leq 0.05$) according to varieties only at the location Bhaktapur and Lalitpur. Depth of the variety M-45 Orange was maximum (5.58 cm) and depth of SO1 Gold was minimum (4.81 cm) at the location Bhaktapur. Likewise, depth of SO1 Orange was highest (5.56 cm) and SO1 Gold was lowest (5.13 cm) at the location Lalitpur.

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Table 6: Mean flower diameter and flower depth of marigold varieties at different location of Nepal

	Flower diameter (cm)				Flower depth (cm)			
Variety	1	2	3	Combined	1	2	3	Combined
Sun Orange	8.35^{abc}	5.45^{ab}	8.92^{ab}	7.57	5.38^{abc}	3.60	5.38^{abc}	4.79
Sun Gold	8.16^{abc}	5.67^{ab}	8.90^{abcd}	7.57	4.97^{cd}	3.78	5.16^{bc}	4.64
Sun Yellow	8.09^{abc}	5.28^{ab}	8.40^{cde}	7.25	5.38^{abc}	3.77	5.24^{bc}	4.80
M-45Orange	8.74^{a}	6.07^{a}	9.18^{a}	8.00	5.58^{a}	4.03	5.54^{a}	5.05
M-45 Gold	8.41^{ab}	5.73^{ab}	8.92^{abc}	7.69	5.17^{abcd}	3.90	5.31^{abc}	4.79
M-45 Yellow	8.07^{abc}	4.92^{b}	8.38^{de}	7.12	5.03^{bcd}	3.46	5.30^{abc}	4.60
SO1 Orange	7.22^{de}	6.03^{a}	9.11^{a}	7.45	5.26^{abcd}	4.20	5.56^{a}	5.01
SO1 Gold	6.54^{e}	4.98^{b}	7.96^{e}	6.49	4.81^{d}	3.64	5.13^{c}	4.52
SO1 Yellow	7.63^{cd}	5.55^{ab}	8.45^{bcde}	7.21	4.98^{cd}	3.55	5.18^{bc}	4.57
K-Yellow	7.78^{bcd}	4.90^{b}	8.31^{e}	7.00	5.46^{ab}	3.57	5.4^{abc}	4.81
FO9 Orange	8.42^{ab}	6.03^{a}	9.07^{a}	7.84	5.62^{a}	3.87	5.42^{ab}	4.97
Mean	7.95	5.51	8.69	7.38	5.25	3.77	5.33	4.78
LSD	0.77***	0.91***	0.53***	1.44	0.46*	0.47	0.27*	0.75
SEM	0.26	0.31	0.18	0.89	0.16	0.16	0.09	0.47
CV	5.68	9.68	3.55	20.81	5.17	7.38	3.01	16.93

Means separated by different letter(s) within the column are significantly different. 1= Bhaktapur, 2= Kathmandu and 3 = Lalitpur, ns, *, **, *: non-significance and significance at 5, 1 and 0.01% level, respectively.*

Flower weight and pedicel length were significantly different ($p \leq 0.01$) according to the varieties at all location. These parameters were also strongly influenced ($p \leq 0.01$) by the mean of varieties. According to the combined analysis (Table 7) variety M-45 Orange produced the heaviest flower (21.05 g) and was statistically similar to the varieties M-45 Gold (20.44 g) and Sun Gold (19.13 g). Minimum weight of flower was found on the variety SO1 Gold (14.64 g) by being statistically similar to the varieties K-Yellow (15.05 g) and Sun Yellow (16.07 g). Likewise, longest pedicel length was observed on the variety M-45 Orange (5.63 cm) which was significantly different than other varieties except FO9 Orange (5.41 cm). Shortest pedicel length was observed on the variety SO1 Gold (3.39 cm) and was significantly different ($p \leq 0.01$) than varieties M-45 Orange, FO9 Orange and Sun Orange (4.26 cm).

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Table 7: Mean flower weight and pedicel length of marigold varieties at different location of Nepal

	Flower weight (g)				Pedicel length (cm)			
Variety	1	2	3	Combined	1	2	3	Combined
Sun Orange	16.14^{c}	20.07^{ab}	18.81^{d}	18.34^{bcd}	4.27^{c}	3.18^{cd}	5.32^{bc}	4.26^{b}
Sun Gold	16.70^{bc}	19.01^{bc}	21.68^{ab}	19.13^{abc}	3.51^{e}	3.90^{bc}	3.83^{e}	3.74^{bc}
Sun Yellow	13.78^{def}	14.69^{g}	19.74^{bcd}	16.07^{ef}	4.23^{cd}	3.67^{cd}	4.37^{de}	4.09^{bc}
M-45Orange	19.02^{a}	21.17^{a}	22.95^{a}	21.05^{a}	6.24^{a}	4.71^{a}	5.95^{ab}	5.63^{a}
M-45 Gold	19.06^{a}	20.66^{a}	21.60^{ab}	20.44^{ab}	3.60^{de}	3.62^{cd}	4.72^{cd}	3.98^{bc}
M-45 Yellow	14.79^{cde}	16.28^{f}	18.87^{d}	16.65^{def}	3.64^{cde}	3.76^{bcd}	5.16^{bcd}	4.19^{b}
SO1 Orange	13.67^{def}	16.40^{ef}	21.44^{abc}	17.17^{cde}	3.30^{e}	3.16^{d}	5.36^{bc}	3.94^{bc}
SO1 Gold	12.15^{f}	15.68^{fg}	16.08^{e}	14.64^{f}	3.02^{e}	3.42^{cd}	3.73^{e}	3.39^{c}
SO1 Yellow	15.43^{cd}	18.56^{cd}	20.77^{abcd}	18.25^{cd}	3.08^{e}	3.62^{cd}	4.45^{de}	3.72^{bc}
K-Yellow	13.01^{ef}	16.28^{f}	15.86^{e}	15.05^{ef}	3.47^{e}	3.64^{cd}	3.81^{e}	3.64^{bc}
FO9 Orange	18.31^{ab}	17.60d^{e}	19.07^{cd}	18.33^{bcd}	5.42^{b}	4.45^{ab}	6.37^{a}	5.41^{a}
Mean	15.64	17.86	19.72	17.74	3.98	3.74	4.82	4.19
LSD	1.91***	1.21***	2.45***	2.14***	0.67***	0.73**	0.8***	0.73***
SEM	0.65	0.41	0.83	1.32	0.23	0.25	0.27	0.45
CV	7.19	4.01	7.32	12.92	9.94	11.45	9.74	18.62

Means separated by different letter(s) within the column are significantly different. 1= Bhaktapur, 2= Kathmandu and 3 = Lalitpur, ns, *, **, *: non-significance and significance at 5, 1 and 0.01% level, respectively.*

IV. Discussion

Phenological traits (days to achieve reproductive stage in our study) such as days to formation of flower bud and days to flower bloom determines the precocity of genotypes. This is also an important character to determine the earliness or lateness of the variety. All eleven varieties took more than 20 days for flower bud formation from the transplanting day. These eleven varieties showed varying phenological traits depending up on genotype and location. Similar kind of variation among varieties and location were also revealed by Kurakula *et al.* (2018), Imandi and Reddy (2017), *Kalaimani et al.* (2017) and Umesh *et al.,* (2018). This might be due to environmental variations in different location and genotypic variations among the varieties.

Morphological parameters such as plant height and plant spread explains canopy structure of the plant and is also known as plant architecture. Number of primary branches explains canopy structure, and number of nodes explains plant height character. These parameters are important to characterize plant type.

Parameters such as plant height, plant spread, number of primary branches, and number of nodes are related to the plant vigor and bushiness of plant. Pot culture of marigold for ornamental purpose, bushy structure with medium plant height that covers the vase is preferred by customers. Variation on observed morphological traits was due to genotype and environment. Similar variation on morphological traits especially on vegetative parts were also reported by the Mahantesh *et al.* (2018), Umesh *et al.* (2018), Mansour *et al.* (2015), Palei *et al.* (2014), Choudhary *et al.* (2014), Gupta *et al.* (2014) and Rolaniya *et al.* (2017).

Number of flowers per plant has significant role in determining suitability of variety for planting. Variation in number of flowers per plant due to genotype and location were also observed by Kumar et al. (2019), Sharma et al. (2017), Kurakula et al. (2018), Khanal (2014), *Kalaimani et al.* (2017) and Umesh *et al.* (2018).

Floral traits such as flower diameter, flower depth, flower weight and pedicel length determines the shape, size and attractiveness of flower. Our observation on variation of these floral traits due to genotype, location and interaction between genotype and location was in line with the findings of Kurakula *et al.* (2018), Choudhary *et al.* (2014), Lohar *et al.* (2018), Hemlata and Singh (2017), Gupta *et al.* (2014), Mahantesh *et al.* (2018) and Umesh *et al.* (2018).

V. Conclusion

This study showed that varieties M-45 Orange and FO9 Orange are not suitable for pot cultivation as these varieties were taller and had longer pedicel length than required. These types of varieties were susceptible to lodging and pedicel breakage. In contrast, varieties SO-1 Gold, SO-1 Orange, SO-1 Yellow and K- Yellow were short (dwarf) and less spreading due to these characters, such type of plants do not look bushy and

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do not cover the pot and therefore looks not attractive. In addition, these varieties had less number of flowers in general. Varieties M-45 Gold and M-45 Yellow are promising among Gold and Yellow series. These varieties had good plant spread, higher number of primary branches and nodes. Duration to flowering was less (short duration) in these varieties. These varieties had higher number of flowers per plant, higher flower diameter, heavier flower weight and less pedicel length. Among orange series, Sun Orange is recommended because of its medium size (plant height) more number of flowers and other suitable floral traits.

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