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Studies on flowering behaviour of double type varieties of African marigold (*Tagetes erecta* L.) in different seasons under Uttarakhand conditions

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ABSTRACT: A field experiment was carried out to evaluate double type or petaloid male sterile varieties of African marigold (*Tagetes erecta* L.) for their growth, flowering behaviour and yield characters in different seasons *viz*.. summer, rainy and winter under *tarai* conditions at Model Floriculture Centre, G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, India during February, 2019 - February 2020 with five varieties i.e., Arka Agni, Arka Bangara, Arka Bangara -2, Bidhan Marigold -1 and Bidhan Marigold -2 . During summer season maximum plant height (42.04 cm), plant spread (30.66 cm), number of branches per plant (42), earliest flower bud appearance, flower diameter (7.22 cm), fresh weight of flower (8.35g), dry weight of flower (1.19g), number of flowers (80.20), flower yield per plant (677.03 g), flower yield per hectare (42.30 tonnes) and were recorded in Arka Bangara -2. During rainy season, the highest plant height (117.63 cm), plant spread (94.90 cm), number of branches per plant (46.15), fresh weight of flower (8.15 g), dry weight of flower (1.63 g), number of flowers (81.22), flower yield per plant (676.77 g) and flower yield per hectare (42.42 tonnes), were recorded in Bidhan Marigold 1 and earliest flower bud appearance (41.81 days) was recorded in Bidhan Marigold 2. During winter season, the highest plant spread (46.75 cm), number of branches per plant (40.10), fresh weight of flower (7.61g), dry weight of flower (1.08 g), number of flowers per plant (80.95), flower yield per plant (616.01 g), flower yield per hectare (38.49 tonnes) were recorded in Arka Agni and earliest flower bud appearance (43.9 days), maximum plant height (63.02 cm) and flower diameter (7.42 cm) were recorded in Arka Bangara 2.

Key words: Double type marigold, petaloid male sterile, summer and rainy seasons, *Tagetes erecta* L., winter

The petaloid types of male sterile lines of marigold which are commonly known as double type of marigold are characterized with the presence of only ray florets (female) and lack of disc florets. The petaloid male sterile genotypes cannot be propagated by sexual means i.e., *via* seeds for true to type cultivars due to absence of male part in the flowers. Being an annual plant, marigold enters into reproductive stage from vegetative stage in a short time, hence to obtain quality planting material, maintenance of mother plant material in vegetative stage for a longer duration is of great concern. Double types of varieties are being preferred more by the consumers. They are used in breeding programs as female parent as well as by growers as variety for production of globular type of flowers which are preferred more by consumers because of desirable traits such as longer blooming period, more compact and attractive flowers, more shelf life etc. Therefore, to meet the demand of flowers in a particular season growing of suitable genotypes is necessary to ensure higher flower yield and quality and hence, there is a need to evaluate different genotypes for their growth, flowering behavior and yield characters in different seasons *viz*., summer, rainy and winter.

MATERIALS AND METHODS

The present study on flowering behaviour of double type varieties of African marigold (*Tagetes erecta* L.) in different seasons under Uttarakhand conditions was conducted in February 2019- February 2020 at Model Floriculture Centre, G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, India. The soil at Pantnagar comes under mollisols. The soil of experimental plot was sandy loam with adequate drainage and optimum water holding capacity. The experiment was laid out in randomised block design (RBD) with four replications. The experiment constituted of 20 plots, each plot with a dimension of 2 m ×2 m. The gross

plot size was 120 m² and the net plot size was 80 m². The number of plants per plot was 25 with a spacing of 40 cm x 40 cm. The planting material used the for the study consisted of five varieties of African marigold i.e., Arka Agni, Arka Bangara, Arka Bangara -2, Bidhan Marigold -1 and Bidhan Marigold-2. Stem cuttings were planted for rooting on 15th February, 2019 (for summer season planting), 15th June (for rainy season planting) and 15th September, 2019 (for winter season planting) in portrays and were transplanted in the field after 30 days. All the recommended cultural operations were carried out during the course of study. Data recoded on various growth flowering and yield parameters were analysed statistically and presented in Tables 1-3.

RESULTS AND DISCUSSION

Vegetative Growth Parameters

Plant height (cm)

The perusal of data (Table 1) revealed that there was significant variation among the genotype with respect to plant height at all stages of plant growth i.e., 60 and 90 DAT, for all the seasons. For summer season, at 60 DAT, maximum plant height (20.62 cm) was found in Arka Bangara -2 followed by Arka Agni (17.89 cm) and minimum (14.51 cm) was recorded in Arka Bangara. At 90 DAT, maximum plant height (42.04 cm) was recorded in Arka Bangara 2 followed by Bidhan Marigold -1 (40.40 cm) which were *at par* with each other and minimum (30.82 cm) was recorded in Arka Bangara. These results are in conformity with the findings of Naik *et al.* (2019a) in African marigold for summer season. For rainy season, at 60 DAT, maximum plant height (94.20 cm) was recorded in Bidhan Marigold 1 followed by Arka Bangara (85.51cm) and minimum plant height (63.14 cm) was recorded in Bidhan Marigold -2. At 90 DAT, maximum plant height (117.63 cm) was recorded in Bidhan Marigold -1 followed by Arka Bangara- 2 (110.33 cm) and minimum plant height (96.63 cm) was recorded in Bidhan Marigold -2. Similar findings were recorded by Jain and Gupta (2004) in African marigold in July planted crop. For winter season, at 60 DAT, highest plant height (44.62 cm) was recorded in Arka Agni which was *at par* with Arka Bangara 2 (43.11 cm) and lowest plant height (28 cm) was recorded in Bidhan Marigold 2. At 90 DAT, highest plant height (63.02 cm) was recorded in Arka Bangara -2 which was *at par* Arka Agni (61.49 cm) and lowest plant height (43.01 cm) was recorded in Bidhan Marigold -2. The findings of Kumar (2019) and Nagaraju (2017) in African marigold for winter season supports the above mentioned data. Mahantesh *et al.* (2018) advocated that variation in plant height among the genotypes might be due to genotypic differences in phenotypic expression of plant height and variations in different genotype-environmental interaction effects on plant height.

Plant spread (cm)

The plant spread of all randomly tagged plants was measured in the North-South and East-West directions by stretching a meter scale at 60 and 90 DAT and the average mean of these observations was taken for calculating the plant spread expressed in cm. The data presented in Table 1 revealed that there was significant variation among varieties with respect to plant spread at all stages of plant growth i.e., 60 and 90 DAT, for all the seasons. The differences in plant spread were found statistically significant at all stages of plant growth. For summer season, at 60 DAT, maximum plant spread (15.95 cm) was recorded in Arka Bangara -2 which was *at par* with Bidhan Marigold -2 (14.19 cm) and minimum plant spread (11.56 cm) was recorded in Arka Bangara. At 90 DAT, maximum plant spread (30.66 cm) was recorded in Arka Bangara -2 which was *at par* with Bidhan Marigold -1 (28.86 cm) and minimum plant spread (25.13 cm) was recorded in Arka Bangara. The findings of present investigation are relatable with the observations recorded by Ismail *et al.* (2013) in Mexican marigold. For rainy season, at 60 DAT, maximum plant spread (67.11cm) was noticed in Bidhan Marigold 1 followed by Arka Bangara 2 (56.05 cm) and minimum plant spread (32.19 cm) was noticed in Arka Agni. At 90 DAT, maximum plant spread (94.90 cm) was noticed in Bidhan Marigold -1 which was *at par* with Arka

Bangara- 2 (91.39 cm) and minimum plant spread (58.50 cm) was noticed in Arka Agni. Similar findings were recorded by Kumar (2019) in African marigold during rainy season. For winter season, at 60 DAT, maximum plant spread (27.64 cm) was recorded in Arka Agni which was *at par* with Arka Bangara 2 (25.02 cm) and minimum plant spread (19.05 cm) was recorded in Arka Bangara. At 90 DAT, maximum plant spread (46.75 cm) was recorded in Arka Agni followed by Arka Bangara 2 (42.14 cm) and minimum plant spread (37.11cm) was recorded in Arka Bangara. The above results are in conformation with the findings of Lakshmi *et al. (*2014) in African marigold. The variation in the varieties for plant spread may be due to genetic and environmental interaction as well as due to difference in the genetic makeup of the varieties (Narsude *et al.*, 2010).

Number of branches per plant

Observations pertinent to number of branches per plant recorded at 60 and 90 DAT for all three seasons, have been presented in Table 1. The differences in number of branches per plant were found statistically significant. For summer season, at 60 DAT, maximum number of branches per plant (13.78) were recorded in Arka Bangara -2 followed by Bidhan Marigold -2 (11.70) and minimum (9.30) in Arka Bangara. At 90 DAT, maximum number of branches per plant (42.00) were recorded in Arka Bangara 2 followed by Bidhan Marigold -2 (38.30) and minimum number of branches per plant (33.77) were recorded in Arka Bangara. Similar variations for number of branches per plant were also observed by Kaushal *et al.* (2014) in China aster and Naik *et al.* (2019a) in African marigold during summer season. For rainy season, at 60 DAT, highest number of branches per plant (28.80) were recorded in Bidhan Marigold -1 followed by Arka Bangara 2 (26.10) which were *at par* with each other and lowest number of branches per plant (16.70) were recorded in Arka Agni. At 90 DAT, highest number of branches per plant (46.15) were recorded in Bidhan Marigold -1 *at par* with Arka Bangara 2 (44.60) and lowest number of branches per plant (29.10) were recorded in Arka Agni. These results are in agreement with the findings of Singh *et al.* (2015) in African marigold during rainy season. For winter season, at 60 DAT, maximum number of branches per plant (23.1) were recorded in Arka Agni followed by Arka Bangara -2 (19.9) and minimum number of branches per plant (15.5) were recorded in Arka Bangara. At 90 DAT, maximum number of branches per plant (40.1) was recorded in Arka Agni which was *at par* with Arka Bangara 2 (38.50) and minimum number of branches per plant (33.45) were recorded in Arka Bangara. These results are in affirmations with the findings of Mohanty *et al.* (2015) and Nagaraju (2017) in African marigold during winter season.

Floral Parameters

Days to first flower bud appearance

A cursory glance over the data presented in Table 2 revealed that days to first flower bud appearance were found statistically significant among all the varieties of African marigold studied for all seasons. For summer season, minimum (37.50 days) days to first flower bud appearance in Arka Bangara- 2 followed by Arka Bangara (39.17 days) and it were recorded maximum (42.10 days) in Arka Agni. The findings are in agreement with that of Kumar (2019) and Naik *et al.* (2019b) in African marigold. For rainy season, minimum days to first flower bud appearance (41.81 days) was recorded in Arka Bangara 2 which was *at par* with Bidhan Marigold -2 (43.62 days) and maximum days to first flower bud appearance (52.64 days) was recorded in Arka Agni. The above results are in close affirmation with the findings of Kumar (2019) and Naik *et al.* (2019b) in African marigold during rainy season. For winter season, minimum days to first flower bud appearance (43.9 days) was recorded in Arka Bangara -2 which was *at par* with Arka Bangara (46.1 days) and maximum days to first flower bud appearance (52.8 days) was recorded in Bidhan Marigold 2. The findings of Kumar (2019) in African marigold for winter season are in conformation with the present investigation. The days taken for first flower bud appearance is an important character, which signifies the earliness or late flowering habit of any genotype. Variation for late or early flowering seems to be the

genetically controlled character in the varieties.

Days taken to first harvest

The data presented in Table 2 revealed that days taken to first harvest was found statistically significant for all the varieties of African marigold studied during all three season. The minimum days to first harvest (47.05 days) was noticed in Arka Bangara -2 which was *at par* Arka Bangara (47.62 days) and it was maximum (51.70 days) in Arka Agni. These results are relatable with finding of Ghosh and Pal (2008) in African marigold. For rainy season, Minimum days to first harvest (53.41 days) was recorded in Arka Bangara 2 which was *at par* with Bidhan Marigold -1 (55.18 days) and Bidhan Marigold 2 (54.80 days) and maximum days to first harvest (62.59 days) was recorded in Arka Agni. Relatable findings were recorded by Prakash *et al.* (2016) in African marigold. For winter season, minimum days to first harvest (52.65 days) was recorded in Arka Bangara -2 which was followed by Arka Bangara (57 days) and maximum days to first harvest (61.57 days) was recorded in Bidhan Marigold -1. The above results are in agreement with the findings of Mahantesh *et al.* (2018) in African marigold for during winter season. Variation for early and late harvesting seems to be the genetically controlled character in genotypes.

Diameter of flowers

It is evident from the data presented in the Table 2 that there was statistically significant variation among different varieties of African marigold studied during all three seasons. For summer season, the maximum diameter of flower (7.22 cm) was recorded in Arka Bangara -2 which was *at par* with Arka Agni (6.95 cm) and Arka Bangara (6.78 cm) and while minimum diameter (4.40 cm) was recorded in Bidhan Marigold - 2. These results are in conformity with the findings of Kumar (2019) in African marigold. For rainy season, maximum diameter (7.77 cm) was noticed in Arka Bangara -2 which was *at par* with Arka Bangara (6.97 cm) and Arka Agni (6.52 cm) and minimum diameter of the flower (5.13 cm) was noticed in Bidhan Marigold 2. The findings recorded by Raju *et al*. (2006) in French marigold and Keditsu (2013) in gerbera are in agreement with the above mentioned data. For winter season, maximum diameter of the flower (7.42 cm) was recorded in Arka Bangara 2 which was *at par* with Arka Bangara (6.78 cm) and minimum diameter of the flower (4.59 cm) was recorded in Bidhan Marigold 2. The results of the present study are in accordance to the findings of Kumar (2019) in African marigold during winter season. The deviation in flower diameter might be due to the genotypic character or genotypic expression of the genotypes in the prevailing environmental conditions Naik *et al.* (2019b).

Fresh weight of flower

The data on fresh weight of flower has been presented in Table 2 which reveals that there was significant variation among the tested varieties of African marigold studied during all seasons. For summer season, it was recorded maximum (8.35 g) in Arka Bangara -2 followed by Arka Agni (7.77 g) and it was minimum (5.80 g) in Arka Bangara. These results corroborate with the findings of Kumar (2019) in African marigold Kharayat (2015) in chrysanthemum. For rainy season, maximum fresh weight (8.15 g) was recorded in Bidhan Marigold -1 which was *at par* with Arka Bangara (8.13 g) and minimum fresh weight of flower (6.46 g) was recorded in Arka Bangara -2. The findings are in agreement with the investigation done by Raju *et al*. (2006) in French marigold. For winter season, highest fresh weight of flower (7.61 g) was recorded in Arka Agni followed by Arka Bangara 2 (7.14 g) and lowest fresh weight of flower (6.57 g) was recorded in Arka Bangara. The findings of this character confirm well with the results of Samantaray and Priyadarshini (2018) in African marigold. This variation in flower weight among varieties might be attributed to the higher water and carbohydrates level in the flower. The ultimate effect of all these factors result into strong and long flower stalks, large sized buds or flower and finally increase in flower weight.

Dry weight of flower

The data pertinent to dry weight of flower has been

presented in Table 2. The difference in dry weight of flower was found statistically significant for all the varieties of African marigold studied for all seasons. For summer season, maximum dry weight of flowers (1.19 g) was recorded in Arka Bangara 2 which was *at par* with Arka Agni (0.69 g) while it was minimum (0.48 g) in Arka Bangara. The results are in agreement with the findings of Kumar (2019) in African marigold. The result of present investigation exhibited significant variation in dry weight of flower. For rainy season, maximum dry weight of flower (1.63 g) was recorded in Bidhan Marigold -1 followed by Arka Bangara (1.05 g) and minimum dry weight of flower (0.67 g) was recorded in Bidhan Marigold -2. The difference dry weight of flower might be due to inherent characters of the individual genotypes as stated by Mahantesh *et al.* (2018). For winter season, maximum dry weight of flowers (1.08 g) was recorded in Arka Agni which was *at par* with Arka Bangara 2 (1.07 g) and minimum fresh weight of flower (0.74 g) was recorded in Arka Bangara. The findings of this character are relatable with the results of Nagaraju (2017) in African marigold for winter season crop. Such variations in dry weight of s flowers among the different varieties might be due to genetical factor.

Number of flowers per plant

The data pertaining to number of flowers per plant are presented in Table 3 which revealed that there was significant variation among all the genotypes of African marigold studied for all three seasons. For summer season, the numbers of flowers per plant were maximum in (80.20) Arka Bangara 2 followed by Bidhan Marigold -2 (70.62) and it was minimum (62.87) in Arka Bangara followed by Bidhan Marigold -1 (67.52). Relatable variation in number of flowers per plant was also observed by Kharayat (2015) and Kumar (2019) in African marigold. For rainy season, highest number of flowers per plant (83.40) were recorded in Bidhan Marigold 1 which was *at par* with Bidhan Marigold 2 (81.22) and lowest number of flowers per plant (30.50) were recorded in Arka Agni. Similar variations were also recorded in the investigation done Kumar (2019) and Thakur *et al.* (2019) in African marigold and Parit *et al*. (2015) in chrysanthemum for rainy season. For winter season, maximum number of flowers per plant (80.95) were recorded in Arka Agni which was *at par* with Arka Bangara 2 (77.87) and minimum number of flowers per plant were recorded in Arka Bangara (68.02). The above results are in conformation with the findings of Samantaray and Priyadarshini (2018) and Nagaraju (2017) in African marigold for winter season. The increase in number of flowers per plant might be attributed to more number of leaves resulting in production and accumulation of maximum photosynthates which ultimately lead to production of more number of flowers.

Flower yield

A cursory glance over the data presented in Table 3 revealed that the differences in flowers yield was found statistically significant for all the varieties of African marigold studied during all seasons. For summer season, maximum flower yield per plant (677.03 g) was recorded in Arka Bangara -2 which was followed by Arka Agni (529.43 g) whereas it was minimum (364.09 g) in Arka Bangara. Maximum flower yield (22.74 t/ha) was recorded in Arka Bangara-2 which was followed by Arka Agni (33.07 t/ha) and minimum flower yield (22.74 t/ha) was recorded in Arka Bangara. Variation in flower yield was also observed previously by Kumar (2019) in African marigold. For rainy season, maximum flowers yield (678.77 g) were recorded in Bidhan Marigold -1 which was followed by Arka Bangara 2 (518.59 g) and minimum flower yield (204.88 g) was recorded in Arka Agni. Maximum flower yield ((42.42 t/ha) was recorded in Bidhan Marigold -1 which was followed by Arka Bangara -2 (33.95 t/ha) and minimum flower yield (14.22 t/ha) was recorded in Arka Agni. Findings relatable to the present investigation were recorded by Sharma *et al.* (2003) and Kumar (2019) in African marigold. For winter season, maximum flower yield (616.01 g) was recorded in Arka Agni which was followed by Bidhan Marigold -1 (560.24g) and minimum flower yield (446.28 g) was recorded in Arka Bangara. Maximum flower yield (38.49 t/ha) were recorded in Arka Agni which was followed by Bidhan Marigold 1 (35.01 t/ha) and minimum flower yield

(27.88 t/ha) was recorded in Arka Bangara. The results of the above mentioned data are relatable with the findings of Samantaray and Priyadarshini (2018) in African marigold. The variation in flower yield might be due to genetic makeup and environmental conditions.

CONCLUSION

On the basis of the findings it can be concluded that, Arka Bangara -2 for summer, Bidhan Marigold -1 for rainy and Arka Agni for winter season are most suitable varieties of African marigold for obtaining remunerative flower yield under *tarai* conditions of Uttarakhand.

REFERENCES

Ghosh, P. and Pal, P. (2008). Performance of *Tagetes erecta* Linn. cv. 'Siracole' as influenced by planting time and spacing under West Bengal conditions. *Natural Product Radiance*, 7(5): 437-443.

Ismail, Rasha F., Kandeel, Awaad M., Ibrahim, Ayman K. and Omer, Elsayed A. (2013). Effect of planting date and plant spacing on growth, yield and essential oil of Mexican marigold (*Tagetes lucida* L.) cultivated in Egypt. *Journal of Applied Science Research*, 9(1): 330-340.

Jain, Ritu and Gupta Y.C. (2004). Effect of planting dates, sources and levels of nitrogen on growth, flowering and seed yield in African marigold (*Tagetes erecta* Linn.). *Journal of Ornamental Horticulture,* 7 (1): 85-89.

Kaushal, S., Dilta, B.S., Chaudhary, S.V.S., Sharma, B.P. and Gupta Y.C. (2014). Effect of planting dates on growth and flowering of China aster (*Callistephus chinensis* L.). *International Journal of Farm Sciences,* 4(1): 60-71.

Keditsu, R. (2013). Performance of open field gerbera in response to planting time. *African Journal of Agricultural Research*, 8(23): 3068-3074.

Kharayat, S. (2015). Effect of planting dates on loose flower production in different genotypes of chrysanthemum (*Dendranthema grandiflora* "Tzvelev"). Thesis, M.Sc. Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.), Pp 1-67.

Kumar, D. (2019). Studies on vegetative propagation and flowering behavior of petalous male sterile genotypes of marigold (*Tagetes erecta* L.) in different seasons. Thesis, M.Sc. Indian Agricultural Research Institute, New Delhi, 81p.

Lakshmi, P., Rajesh, D.K.,Sheetal, L., Nomita D.B., Singh, A. and Jamwal, S. (2014). Studies on effects of planting dates and spacing in African marigold (*Tagetes erecta* L.). *Progressive Horticulture*, 46 (1): 149-152.

Mahantesh, K.K., Prashanth, P., Chandrashekhar, R., Saidaih, P., Siddappa and Umesh, B. C. (2018). Evaluation of different African marigold (*Tagetes* species Linn.) genotypes for vegetative, floral and yield attributes under Southern Telangana condition. *International Journal of Chemical Studies*, 6(5): 3311-3315.

Mohanty, C.R., Mohanty, A. and Parhi, R. (2015). Effect of planting dates and pinching on growth and flowering in African marigold cv. 'Siracole'. *The Asian Journal of Horticulture*, 10(1): 95-99.

Nagaraju, K.P. (2017). Studies on the effect of planting dates on growth and yield of African marigold (*Tagetes erecta* L.) cultivars. Thesis, M.Sc. Dr. Y.S.R. Horticultural University, Andhra Pradesh, Pp 1-113.

Naik, P.V., Seetaramu, G.K., Patil, M.G., Tejaswani, Sadanand, G.K., Shivashankara, K.S. and Kalmath, B.S. (2019a). A study on evaluation of marigold genotypes for growth parameters under upper Krishna project command area in Karnataka State. *International Journal of Chemical Studies*, 7(4): 1562-1566.

Naik, P.V., Seetaramu, G.K.,Tejaswani, Patil, M.G., Sadanand, G.K., Shivashankara, K.S. and Kalmath, B.S. (2019b). Evaluation of marigold genotypes for flowering and quality parameters under upper Krishna project command area in Karnataka State. *International Journal of Chemical Studies*, 7(4): 1567-1570.

Narsude, P.B., Kadam, A.S. and Patil, V.K. (2010). Studies on the growth and yield attributes of different African marigold (*Tagetes erecta* L.) genotypes under Marathwada conditions. *The Asian Journal of Horticulture*, 5 (2): 284-286.

Parit S.B., Kulkarni, B.S. and Patil, S.R. (2015). Effect of photoperiod on growth, flowering, yield and quality of chrysanthemum cultivars under Northern dry zone of Karnataka. *Acta Horticulture*, DOI: 10.17660.1104.11.

Prakash, S., Anitha, P., Giridharan, M.P., Rajagopalan, A. and Rao Sudarshan G.V. (2016). Impact of seasons and pinching on growth and flowering in African marigold (*Tagetes erecta* L.). *Journal of Tropical Agriculture*, 54 (1): 50-54.

Raju, D.V.S., Singh, K.P. and Kishan S. (2006). Performance of French marigold (*Tagetes patula* L.) in different planting months under Delhi conditions. *Journal of Ornamental Horticulture*, 9(3): 215-217.

Samantaray and Priyadarshini (2018). Evaluation and selection of African marigold (*Tagetes erecta* L.) genotypes suitable for commercial cultivation under coastal plain zone of Odisha. Thesis, M.Sc. Orrisa University of Agriculture and Technology, Bhubaneshwar, Pp 1-81.

Sharma, A.K., Ravinder, S. G., Y.C. and Sud, G. (2003). Effect of planting time on growth and flower yield of marigold (*Tagetes erecta* L.) under sub- mountain low hills of Himachal Pradesh. *Indian Journal of Agricultural Sciences*, 73(2): 94-96.

Singh, A. K., Kumar, U. and Kumar, A. (2015). Effect of planting date and spacing on performance of marigold (*Tagetes erecta* L.) cv. Pusa Narangi under North Bihar agro ecological conditions. *International Journal of Forestry & Crop Improvement*, 6(1): 16-20.

Thakur, P., Dilta, B.S., Gupta, Y.C., Kumar, P. and Mehta, D.K. (2019). Effect of planting dates, mulching and application of GA_3 on growth and flower yield of marigold (*Tagetes erecta* L.) cv. 'Pusa Narangi Gainda'. *International Journal of Current Microbiology and Applied Sciences*, 8(4): 3028-3039.

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