Effect of Pinching and Levels of Gibberellic Acid on Growth, Flowering and Yield of African Marigold (*Tagetes erecta* l.)

H. P. Pandey[1], K. Mishra[1], S. S. Pant[1] and U. Pun[2]

ABSTRACT

A field experiment was conducted to evaluate the plant growth and yield of African marigold cv. Calcutta Local through pinching practice and using different level of GA_3 in the Abloom Flora Farm of Gunjanagar, Chitwan from March to August, 2013. The experiment was conducted in two factorial randomized complete block design with two pinching levels (pinching and non-pinching practices) and five GA_3 levels (0, 50, 100, 150 and 200 ppm). Result showed a significant effect of pinching and levels of gibberellic acid on plant growth and flower yield. Pinching also significantly increased the number of branches, plant spread, number of flower per plant, yield per plant (299.33 g) and yield per hectare (12.04 t/ha). Earlier days to flower initiation was observed in non-pinching. Gibberellic acid at 50,100,150 and 200 ppm significantly increased the plant height, number of branches, plant spread and number of flower per plant, flower yield per plant and yield per hectare over control. Earlier days to flower initiation was found with increase in GA_3 level. Among all levels, GA_3 at 200 ppm was significantly superior due to its maximum flower yield (14.64 t/ha).

Key words: Gibberellic acid, pinching, growth, flower yield and African marigold.

INTRODUCTION

Marigold is one of the commercially exploited flower crops that belong to the family Compositae and genus Tagetes. The two main popularly grown species in marigold are *Tagetes erecta* L. and *Tagetes patula* L. which have their origin in Mexico and South Africa respectively. *Tagetes erecta* L. is popularly known as "African marigold" while *Tagetes patula* L. as "French marigold." Marigold as compared to other flowering annuals is easily adaptable to various conditions of growing and has fairly good keeping quality. It is propagated by seeds and comes up well in all types of soil. It is a hardy annual plant and attains more than 100 cm height within its life span. The flowers of these species are generally large in size with bright shades, ranging from yellow to orange and are the best for combination in any flower arrangement. Nepalese have traditionally been using flowers or bunch of flowers to offer god and goddess or as a garland to the deities or fellow human being or as floral decoration during festivals (Pun, 2004). Small and marginal farmers can get good economic benefit from marigold cultivation during normal and off season (Adhikari and Pun, 2011). Marigold is grown for cut flowers, making garlands, decoration during several social and religious functions, besides its use in landscape gardening.

Apart from its significance in ornamental horticulture, it has been valued for other purposes too. The aromatic oil extracted from marigold, is called as "tagetes oil". It is used in preparation of high grade perfumes and also used as an insect repellant. It is also being grown as a trap crop in agriculture against nematodes. Recently dried flower petals of marigold are important source of carotenoids and which is used as poultry feed in order to improve the colour of egg yolk as well as broiler's skin. There are two common methods of propagation of marigold i.e.

[1] Institute of Agriculture and Animal Science, Rampur, Chitwan, Nepal
[2] Himalayan Flora Enterprises Pvt. Ltd., Lalitpur, Nepal

by seeds and by cuttings. Plants raised from seeds are tall, vigorous and heavy yielder and hence, seed propagation is preferred to cuttings.

Cultivation of marigold is attracting flower growers due to its easy culture and short duration to produce marketable flowers and gaining popularity amongst flowers dealers due to its wide spectrum of attractive color, shape, size and good keeping quality (Arora, 1998). Pinching in marigold, during its vegetative stage, is supposed to increase number of branches which ensures the higher production of flower along with uniform size and excellent quality flower. While gibberellic acid (GA_3) is supposed to increase flower quality and maintains uniformity in flower size and number. It is also supposed to promote plant growth and increased number of primary and secondary branches which eventually ensures higher production of flower. Doddagoudar *et al*. (2002) observed that exogenous foliar application of growth regulators stimulate flowering, pollination, fertilization and seed setting to get maximum yield.

MATERIALS AND METHODS

The experiment was conducted in silty loam soil (pH 6.26, 0.18% Total N, 73 kg ha^{-1} P_2O_5, 262 kg ha^{-1} K_2O and 1.74% organic matter) in Abloom Flora Farm, Gunjanagar-5, Chanauli, Chitwan, Nepal during March to August, 2013. The experiment was laid out in a two factorial randomized complete block design with two pinching level (pinching and non-pinching practices) and five GA_3 levels (0, 50, 100, 150 and 200 ppm). Thus, there were all together 10 treatments and replicated thrice. The treatments were randomly allocated by using random number table (Gomez and Gomez, 1984).Total experimental area was 329 m^2 (23.5m ×14m). Space between replication and plot was 1m and 0.5m respectively. The individual plot size was 3m × 2m i.e. 6m^2. The row to row distance was 60 cm and plant to plant distance was 40 cm. There were 5 rows in each plot and 5 plants in each row. There were all together 25 plants in each plot and inner 5 plants were selected for observation.

The land was brought to a good tilth by two deep ploughing. Before leveling of experimental plot, weeds and left over crop residues were removed. Weeding and removing of left over residues was followed by digging and leveling. The raised bed of 5.00 m length x 1.00 m breadth and 15 cm height was prepared for raising the seedlings. Nursery bed was applied with 50 Kg of well decomposed FYM, 170 gram of DAP, 100 gram of urea and 130 gram of MOP was mixed thoroughly in the soil before sowing of seed in the nursery. The seeds of African marigold cv. Calcutta Local obtained from the Abloom Flora Farm were sown in 7 cm apart lines after treating with Captan at 2 g per kg of seed and covered with straw still the completion of seed germination. The water was given regularly in the evening still the seedlings were ready for transplanting. Seedlings were allowed to grow in the nursery for 30 days and transplanting was done in the experimental plot in evening time. Well decomposed FYM was applied in the plots @ 20 mt/ha two weeks before planting. Half dose of nitrogen and full dose of phosphorus and potash @ 160: 60: 60 kg NPK/ha were applied as basal dose. The remaining half dose of nitrogen was top dressed one month after seedlings transplanting. Nitrogen was applied through urea (46% N) and potash through murate of potash (60% K_2O) respectively. Recommended doses of phosphorus were applied through diammonium phosphate (46% P_2O_5 and 18% N).

GA_3 was weighed with the help of digital balance. Four different concentrations viz., 50, 100, 150 and 200 ppm of gibberellic acid (GA_3) were prepared manually with distilled water just before their use. In a few ml of 95 per cent absolute alcohol 0.05 g of GA_3 was dissolved and diluted with distilled water to make 1 liter of GA_3 solution of 50 ppm. The concentrations of 100, 150 and 200 ppm solution were prepared with same procedure. Pinching was done one month after seedlings transplanting and gibberellic acid was sprayed at the same day by using knapsack sprayer. In control treatment distilled water was sprayed at the same time. Pinching

was done to remove the apical portion of plant. 3-4cm apical portion was cut with the help of scissor.

The recorded data were entered, tabulated and processed in Excel. The recorded data on different parameters were analyzed by using MSTAT-C software and the means were separated using Duncan's Multiple Range Test (DMRT). The marigold flower were harvested when 75% petal were unfolded. Plant height, plant spread, number of branches, days to flower initiation, days to 50% flowering, fresh weight flower, dry weight of flower, number of flower per plant, yield per plant and yield per hectare were recorded.

RESULTS AND DISCUSSION

Plant growth

Effect of pinching and levels of gibberellic acid on growth of marigold showed a significant influence on plant height, plant spread and number of branches (Table 1). Plant height of marigold was recorded significantly higher in non-pinching treatment (115.8 cm) in comparison with pinching treatment (111.4 cm) at harvest stage. The higher plant height noticed with non pinching treatment was mainly due to the fact that plants were not pinched and grew to their original height without reduction. Decrease in plant height with increased number of leaves and branches due to pinching was reported in marigold (Sehrawat *et al.,* 2003 and Tomar *et al*., 2004), in coriander (Iyyanngouda, 2003), in fenugreek (Sudarshan, 2004), in chrysanthemum (Singh and Baboo, 2003 and Grawal *et al*., 2004) and in carnation (Pathania *et al.,* 2000 and Kumar and Singh, 2003). Significantly higher plant height was recorded in GA_3 sprayed treatment as compared to control at various days after transplanting. At harvest stage significantly higher plant height was recorded in GA_3 200 ppm sprayed treatment (119.8 cm) in comparison with GA_3 50ppm (111.2 cm) and control treatment (106.4 cm) but was at par with GA_3 150 ppm (117.3 cm) and GA_3 100 ppm sprayed treatment (113.3 cm). The increase in plant height and number of branches per plant with application of GA_3 seems to be due to enhanced cell division and cell enlargement, promotion of proteins synthesis coupled with higher dry matter accumulation in the plant. Stimulation of branching may be attributed to the breakage of apical dominance. Similar results were reported by Lal and Mishra (1986) in aster and marigold, Shetty (1995) and Doddagoudar (2002) in China aster and Lone *et al.* (2005) in chilli.

The effect of pinching and levels of gibberellic acid on plant spread was significant at full bloom stage. Significantly higher plant spread (71.68 cm) was noticed in pinching treatment at full bloom stage in comparison with non-pinching treatment (67.38). Similarly plant spread was significantly higher in GA_3 200 ppm (72.83 cm), GA_3 150 ppm (71.92 cm) and GA_3 100 ppm (69.17 cm) whereas significantly lower plant spread was noticed in control treatment (66.28 cm) and GA_3 50 ppm (67.45 cm). Similar result was obtained by Ramdevputra *et al.* (2009). Significantly higher number of primary branches was recorded in pinching treatment (15.18) in comparison with non-pinching treatment (12.94). Similarly, significantly higher number of primary branches was recorded in GA_3 200 ppm sprayed treatment (15.63) in comparison with GA_3 100 ppm (13.93), GA_3 50 ppm (13.13) and control (13.03) but was at par with GA_3 150 ppm sprayed treatment (14.57). Pinching resulted in increased number of branches per plant which might be attributed to the breaking of apical dominance and sprouting of auxillary buds. Similar findings were reported by Singh and Arora (1980) in African marigold, Pathania (2000) and Kumar and Singh (2003) in Carnation and Sen and Naik (1977) in chrysanthemum.

Table 1. Effect of pinching and levels of gibberellic acid on vegetative characteristics of marigold in Gunjanagar-5, Chitwan, Nepal (2013)

Treatment	Vegetative characteristics		
	Plant height (cm)	Plant spread (cm)	No of primary branches
Pinching			
Pinching	111.40[b]	71.68[a]	15.18[a]
Non-Pinching	115.80[a]	67.38[b]	12.94[b]
$LSD_{0.05}$	4.16*	2.24*	0.87**
SEm±	1.40	0.76	0.29
GA3 levels			
0 ppm	106.4[c]	66.28[b]	13.03[c]
50 ppm	111.20[bc]	67.45[b]	13.13[bc]
100 ppm	113.30[ab]	69.17[ab]	13.93[bc]
150 ppm	117.30[ab]	71.92[a]	14.57[ab]
200 ppm	119.80[a]	72.83[a]	15.63[a]
$LSD_{0.05}$	5.564**	3.55*	1.37**
SEm±	1.873	1.19	0.46
CV%	4.78	4.21	8.06
Mean	113.60	69.53	14.06

Treatments means followed by the common letter (s) within column are non-significantly different among each other based on DMRT at 5% level of significance. * denotes significant at 5% level and ** denotes significant at 1% level of significance.

Days to flowering

Pinching and levels of gibberellic acid on days to flowering of marigold was found significant. Earlier days to flower initiation was observed in non- pinching treatment (42.80 days) in comparison with pinching treatment (46.27 days). Similarly significantly early flowering was recorded in GA_3 200 ppm sprayed treatment(40.83 days) in comparison with control (48.17 days) but was at par with GA_3 150 ppm sprayed treatment (43.83 days), GA_3 100ppm (44.17 days) and GA_3 50ppm (45.67 days). days to 50 percent flowering was recorded earlier in non-pinching treatment (50.47 days) in comparison with pinching treatment (55.20 days). Similarly, days to 50 percent flowering was recorded earlier in GA_3 200 ppm sprayed treatment (49.17 days) in comparison with control treatment (57.00 days) but was at par with GA_3 150 ppm (51.83 days), GA_3 100 ppm (52.67 days) and GA_3 50 ppm (53.50 days).

Pinched plants took more (56.12) number of days to 50 per cent flowering compared to non pinched plants (51.70 days). The delayed flowering due to pinching was also observed by Malleshappa (1984) in China aster, Grewal *et al.* (2004) in chrysanthemum and Naik (2003) in marigold, which might be due to removal of apical portion of the plants. The newly emerged shoot took longer time to become physiologically mature and thus resulted in delayed to 50% flowering.

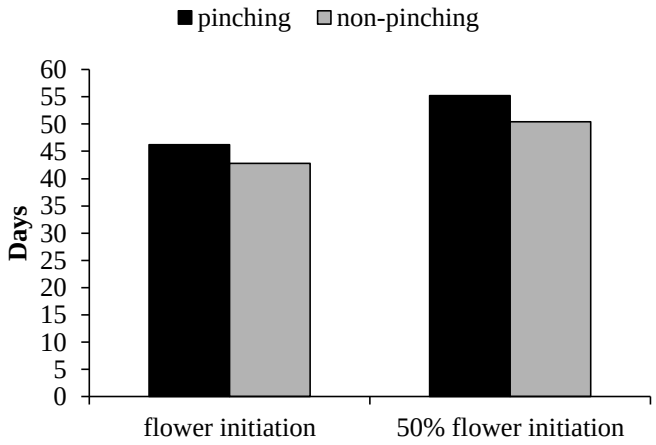

Fig: 1. Effect of pinching on days to flowering of marigold in Gunjanagar-5, Chitwan, Nepal.

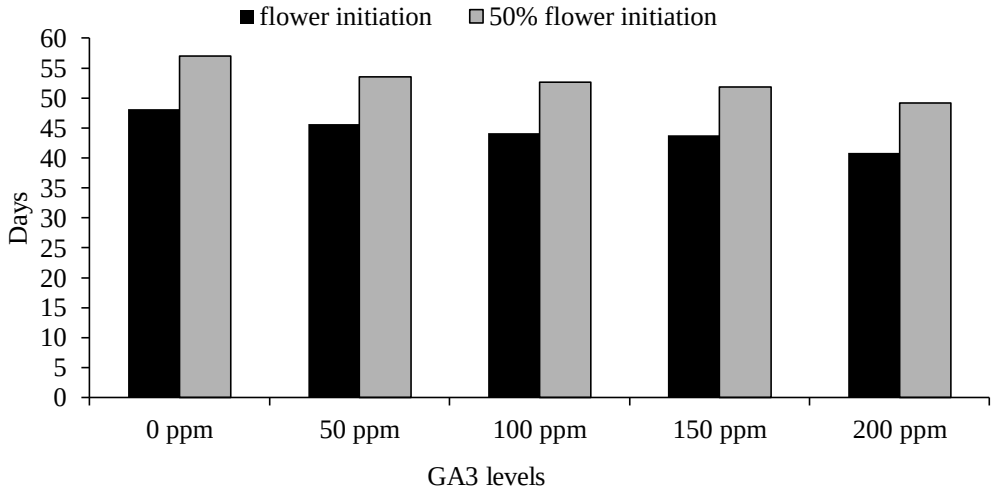

Fig: 2. Effect of gibberellic acid on days to flowering of marigold in Gunjanagar-5, Chitwan, Nepal.

Flower characteristics and yield

Pinching significantly influenced the fresh weight, diameter, depth and number of flower per plant, yield per plant and yield per hectare. Similarly levels of gibberellic acid also significantly influenced number of flower per plant, yield per plant and yield per hectare. Highest fresh weight of flower was recorded in non- pinched treatment (5.207 g) in comparison with pinched treatment (4.673 g).

Diameter of flower was recorded higher in non-pinching treatment (4.8 cm) in comparison to pinching treatment (4.352 cm). Similarly, depth of flower was also recorded higher in non-pinching treatment (2.653 cm) in comparison with pinching treatment (2.480 cm). Higher number of flower per plant was recorded in pinching treatment (63.87) in comparison with non-pinching treatment (49.60)). Similarly, highest number of flower per plant was recorded in GA_3 200 ppm sprayed treatment (67.7) in comparison to GA_3 150 ppm (59.8), GA_3 100 ppm (57.3), GA_3 50 ppm (52.5) and control (46.3). Similar results were obtained by Kumar *et al.* (2010) in African marigold.

Maximum number of flower per plant was recorded in pinching treatment (63.9) in comparison to non-pinching treatment (49.6)). Similarly, maximum number of flower per plant was

recorded in GA_3 200 ppm sprayed treatment (67.7) in comparison to GA_3 150 ppm (59.8), GA_3 100 ppm (57.3), GA_3 50 ppm (52.5) and control treatment (46.3). Similar results were obtained by Kumar *et al.* (2010) in African marigold. The increase in number of flower in pinched plant might be due to the fact that it checked apical dominance and diverted extra energy in to the production of more number of branches and flowers. Similar results were observed by Jhon and Paul (1995) in chrysanthemum, Srivastava *et al.* (2002) in marigold, Khandelwal *et al.* (2003), Tomar *et al.* (2004) and Naresh and Singh (2012) in marigold.

Yield per plant was recorded highest in pinching treatment (299.3 g) in comparison with non-pinching treatment (253.9 g). Similarly, higher yield per hectare was recorded in pinching treatment (12.0 t/ha) in comparison with non-pinching treatment (10.1 t/ha). Yield per plant was recorded higher in GA_3 200 ppm sprayed treatment (350.20 g) in comparison with GA_3 150 ppm (306.4 g), GA_3 100 ppm (274.6 g), GA_3 50 ppm (247.7 g) and control (204.2 g). Similarly, significantly higher yield per hectare was recorded in GA_3 200 ppm sprayed treatment (14.6 t/ha) in comparison with GA_3 150 ppm (12.5 t/ha), GA_3 100 ppm (10.9 t/ha), GA_3 50 ppm (9.4 t/ha) and control (7.8 t/ha) respectively. Similar results were obtained by Kumar *et al.* (2011) in African marigold.

Table 1. Effect of pinching and levels of gibberellic acid on flower characteristics and yield of marigold in Gunjanagar-5, Chitwan, Nepal (2013)

Treatments	Flower characteristics and yield					
	Fresh weight of flower (g)	Diameter of flower (cm)	Depth of flower (cm)	Number of flower per plant	Flower yield per plant (g)	Yield per hectare(t/ha)
Pinching						
Pinching	4.67^{b}	4.35^{b}	2.48^{b}	63.87^{a}	299.33^{a}	12.04^{a}
Non-Pinching	5.21^{a}	4.80^{a}	2.65^{a}	49.60^{b}	253.95^{b}	10.10^{b}
$LSD_{0.05}$	0.53*	0.25**	0.15*	4.19**	17.59**	0.73**
SEm±	0.18	0.08	0.05	1.41	5.92	0.25
GA_3 levels						
0 ppm	4.38	4.46	2.45	46.33^{d}	204.20^{d}	7.80^{e}
50 ppm	5.18	4.51	2.53	52.50^{cd}	247.70^{c}	9.41^{d}
100 ppm	4.88	4.55	2.70	57.33^{bc}	274.60^{c}	10.96^{c}
150 ppm	5.02	4.74	2.57	59.83^{b}	306.40^{b}	12.55^{b}
200 ppm	5.23	4.62	2.57	67.67^{a}	350.20^{a}	14.64^{a}
$LSD_{0.05}$	NS	NS	NS	6.63**	27.81**	1.15**
SEm±	0.28	0.13	0.08	2.23	9.36	0.39
CV%	13.99	7.19	7.77	9.63	8.29	8.59
Mean	4.94	4.58	2.57	56.73	276.64	11.07

Treatments means followed by the common letter (s) within column are non-significantly different among each other based on DMRT at 5% level of significance. . * denotes significant at 5% level and ** denotes significant at 1% level of significance.

CONCLUSION

The result showed that marigold cultivation in Chitwan is feasible. It can be concluded that, pinching of marigold showed marked influenced on the growth, phenology and yield parameters. Similarly levels of gibberellic acid also showed marked influenced on the plant growth, flowering and yield parameters of marigold. GA_3 200 ppm showed the better performance in all parameters of marigold which were recorded in this experiment. Pinching along with GA_3 200 ppm showed the maximum yield of marigold.

ACKNOWLEDGEMENT

Authors want to extend sincere gratitude to Abloom Flora Farm of Gunjanagar, Chitwan, Agriculture and Forestry University for providing financial support and IAAS Rampur, Chitwan for their help.

LITERATURE CITED

Adhikari, D. and U. Pun. 2011. Response of marigold (*Tagetes erecta*) varieties to winter planting in Chitwan, Nepal. *In*: Proceedings of the 7th National Horticulture Seminar, 12-14 June 2011, Khumaltar, Lalitpur, Nepal. pp. 216-220.

Arora, J. S. 1998. Marigold. In: Commercial flowers. T. K. Bose and L. P. Yadav (eds.), Naya Prokosh, India. pp. 713-731.

Doddagoudar, S. R., B. S.,Vyakaranahal, M. Shekhargouda, A. S. Naliniprabhakar, and V. S. Patil. 2002. Effect of mother plant nutrition and chemical spray on growth and seed yield of china aster cv. Kamini. *Seed Research*, 30(2): 269 – 274.

Gomez, W. A. and A. A. Gomez. 1984. Statistical procedure for agricultural research. An international rice research institute book. A Wiley-Interscience publication.

Grawal, H. S., R. Kumar and H. Singh. 2004. Effect of nitrogen, planting time and pinching on flower production in chrysanthemum (*Dendrenthema grandiflora* Ramat.) cv. Flirt. Journal of Ornamental Horticulture 7 (2): 196 – 199.

Jhon, A. Q. and T. M. Paul. 1995. Influence of spacing and pinching treatments on growth and flower production in chrysanthemum (*Chrysamthemum morifolium* cv. Flirt). Progressive Horticulture 27 (1-2): 57 – 61.

Khandelwal, S. K., N. K. Jain and P. Singh. 2003. Effect of growth retardants and pinching on growth and yield of Agrican marigold (*Tagetes crecta* L.). Journal of Ornamental Horticulture 6 (3): 271– 273.

Kumar, A., J. Kumar, M. Braj, J. P. Singh, R. and R. Nathi. 2011. Effect of plant growth regulators on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda. Asian Journal of Horticulture 6 (2): 418-422.

Kumar, R. and K. Singh. 2003. Effect of growth regulator and shoot tip pinching on carnation. Journal of Ornamental Horticulture 6 (2): 134-136.

Kumar, R., M. Ram and G. S. Gaur. 2010. Effect of GA_3 and ethrel on growth and flowering of African marigold cv. Pusa Narangi Gainda. Indian Journal of Horticulture 67: 362-366.

Lone, M. T., K. Haripriya and T. Maheshwari. 2005. Influence of plant growth regulators on growth and yield of chilli (*Capsicum annuum* L.) cv. K-2. Crop Research 29 (1): 111–113.

Naik, H. 2003. Stability analysis and standardization of production technology for flower and xanthophyll yield in marigold (*Tagetes* spp.). Ph.D. Thesis, University of Agricultural Sciences, Dharwad.

Naresh, C. P. and A. K. Singh. 2012. Effect of Pinching and Growth Retardants on Flowering and Yield of African marigold (Tagetes erecta L.) var. Pusa Narangi Gainda. International Journal of Horticulture 2 (1): 1-4.

Pathania, N. S., O. P. Sehgal and Y. C. Gupta. 2000. Pinching for flower regulation in Sim carnation. Journal of Ornamental Horticulture 3 (2): 114-117.

Pun, U.K. 2004. Commercial cut flower production in Nepal and status of four important cut flowers. Journal of Institute of Agriculture and Animal Sciences 25: 17-21.

Ramdevputra, M. V., H. N. Deshmukh, A. M. Butani, J. J. Savaliya, A. G. Pansuriya and D. R. Kanzaria. 2009. Effect of different gibberellic acid (GA_3) concentrations on growth, flowering and yield of African marigold. Asian Journal of Horticulture 4(1): 82-85.

Sehrawat, S. K., D. S. Dahiya., S. Singh and G. S. Rana. 2003. Effect of nitrogen and pinching on growth, flowering and yield of marigold (*Tagetes erecta* L.) cv. African gaint double orange. Haryana Journal of Horticultural Sciences 32 (1 &2): 59 – 61.

Sen, S. K. and J. Naik. 1977. Growth and flowering response of pinched and unpinched chrysanthemum to growth regulator treatment. Indian Journal of Horticulture 33: 86-90.

Shetty, S. 1995. Effect of GA_3 and Cycocel on maturity, seed yield and quality in China aster (*Callistephus chinensis* L. Nees). M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Bangalore.

Singh, J. and J. S. Arora. 1980. Effect of spacing and pinching on growth and flower production of marigold (*Tagetes erecta* L. cv. African Gaint Double Orange). *In*: Proceeding of National Seminar on Production Technology for Commercial Flower Crops, Tamil Nadu Agricultural University, Coimbatore, pp. 85- 87.

Singh, M. K. and R. Baboo. 2003. Response of nitrogen, potassium and pinching levels on growth and flowering in chrysanthemum. Journal of Ornamental Horticulture 6 (4): 390 – 393.

Srivastava, S. K., H. K. Singh and A. K. Srivastava. 2002. Effect of spacing and pinching on growth and flowering of 'Pusa Narangi Gainda' marigold (*Tagetes erecta* L.) Indian Journal of Agricultural Sciences 72 (10): 611 – 612.

Sudarshan, J. S. 2004. Influence of apical bud pinching, chemical spray and physiological maturity on seed yield and quality of fenugreek. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad.

Tomar, B. S., B. Singh, H. C. S. Negi and K. K. Singh. 2004. Effect of pinching on seed yield and quality traits in African marigold. Journal of Ornamental Horticulture 7 (1): 124 – 126.