The Pharma Innovation Journal 2022; 11(6): 827-830

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(6): 827-830

www.thepharmajournal.com
Received: 01-02-2022
Accepted: 08-05-2022

Anshuman Singh
Research Scholar, Department of Horticulture, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Ashok Kumar
Associate Professor, Department of Horticulture, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Abhinav Kumar
Assistant Professor, Department of Horticulture, Bhagwant University, Ajmer, Rajasthan, India

Corresponding Author:
Anshuman Singh
Research Scholar, Department of Horticulture, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Studies on the effect of bio-inoculants and gibberellic acid on vegetative growth of African marigold (*Tagetes erecta* L.) Cv. Pusa Narangi Gainda

Anshuman Singh, Ashok Kumar and Abhinav Kumar

Abstract
A field experiment was carried out to study the effect of bio-inoculants and Gibberellic acid on vegetative growth and flowering of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda" at the Main Experiment Station, Department of Floriculture & Landscape, Acharya Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) during the years 2019-20 and 2020-21. The experiment was conducted in Randomized Block Design (Factorial) with 12 treatments replicated thrice to assess the effect Bio-Inoculants and Gibberellic Acid on Vegetative Growth of African Marigold. Results reveal that the application of Azotobacter by soil treatment 4L/ha and Gibberellic acid 200 ppm had left significant response on the growth of marigold. The maximum plant height, primary branches per plant, secondary branches per plant, plant spread, Plant basal diameter was obtained with the combination application of A_3 (Azotobacter by soil treatment 4L/ha) and G_4 (Gibberellic acid 200 ppm) whereas the minimum values were recorded in control. Interaction effect of both the treatment was found non-significant.

Keywords: Azotobacter, gibberellic acid, growth, flowering, marigold

Introduction

African marigold (*Tagetes erecta* L.) is one of important annual flower known for its aesthetic value and long blooming period. It belongs to family Asteraceae, a native of Central and South America especially Mexico. In India marigold was introduced by the Portugeses (Kalpan, 1960) [4]. In India, the present area under marigold cultivation is 55890 ha with a production of 5.1 lakh MT. Karnataka is the largest state in area of marigold in India with production of 74,900 MT from an area of 9100 ha. Madhya Pradesh ranks first in production (85,070 MT) from an area of 7780 ha.

Marigold can be grown in all seasons of which rainy and winter season crops are the main crops under eastern U.P. condition. The name genus *Tagetes* was derived from Etruscan *Tagetes* which refers to the ease with which plants of the genus come out each year either by seeds produced in the previous year, or by the stems which regrow from the stump already in place. The most commonly cultivated species of *Tagetes* are known variously as African marigold (*Tagetes erecta*), French marigold (*Tagetes patula*), Signet marigold (*Tagetes tenuifolia*) and mini marigold (*Tagetes minuta*).

The plants of Mexican marigold reach heights of between 50 and 100 cm. The root is cylindrical with fibrous and shallow branching system. The stem is striated, sometimes ridge, smooth or slightly with villi, cylindrical, oval and herbaceous to slightly woody, with resin channels in the bark, which are aromatic when squeezed. Opposite leaves at the bottom alternate at the top, up to 20 cm long, pinnate, composed of 11 to 17 leaflets, lanceolate to linear-lanceolate, up to 5 cm long and 1.5 cm wide, acute to acuminate, serrated to sub-holders, the lower ones of each leaf frequently setiform (in the form of threads), the superiors are sometimes completely setiform; with abundant round glands.

Microbial inoculants of selective micro-organisms like azotobacter which is free-living nitrogen fixing bacteria, help in improving soil fertility by the way of accelerating biological nitrogen fixation from atmosphere nearly 25 to 30 l nitrogen per hectare, solubilization of the insoluble nutrient in soil, generate little quantity of PGRs decomposing plant residues and stimulating plant growth and production by producing Phyto hormones, enhancing the uptake of plant nutrients by plant roots and thus help in sustainable crop production through maintenance of soil productivity.

Application of plant growth regulator in floriculture played important role in vegetative propagation, inhibition of abscission, prevention of bud dormancy, growth control, and promotion of flowering, prolonging the vase life of flowers and retarding senescence. Gibberellic acid play important role in elongation of shoot, flower induction, flower and seed development and mobilization of storage reserves. Gibberellic acid was found to be very effective in manipulating growth and flowering in chrysanthemum (Gautam *et al.*, 2006) [3].

Materials and Methods

The experiment was laid out in Randomized Block Design (Factorial) with three replications and twelve treatments at Main Experimental Station, Horticulture, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya during the year 2019-2020 and 2020-21. Geographically, it is situated in typical saline alkali belt of Indo-gangetic plains of eastern U.P. at 26.47-0 N latitude, 88.120 E longitudes and at an altitude of 113 meter from mean sea level. The region enjoys sub humid and subtropical climate receiving a mean annual rainfall of about 1215 mm out of which about 85% is concentrated from mid-June to end of September. The treatments are A_1(Control), A_2 (Azotobacter by root treatment 0.25g/15 plants), A_3(Azotobacter by soil treatment 4L/ha), G_1(Control) G_2 (Gibberellic acid 100 ppm spray at 30 DAT), G_3 (Gibberellic acid 150 ppm spray at 30 DAT), G_4 (Gibberellic acid 200 ppm spray at 30 DAT), A_1G_1(Control), A_1G_2 (Gibberellic acid 100 ppm spray at 30 DAT), A_1G_3 (Gibberellic acid 150 ppm spray at 30 DAT), A_1G_4 (Gibberellic acid 200 ppm spray at 30 DAT), A_2G_1 (Azotobacter by root treatment @ 0.25%), A_2G_2 (Azotobacter by root treatment 0.25% +100ppm gibberellic acid at 30DAT) A_2G_3 (Azotobacter by root treatment 0.25% +150ppm gibberellic acid at 30DAT) A_2G_4 (Azotobacter by root treatment@0.25% + 200ppm gibberellic acid at 30DAT) A_3G_1 (Azotobacter by soil treatment @4l/ha), A_3G_2 (Azotobacter by soil treatment @ 4l/ha +100ppm gibberellic acid at 30DAT), A_3G_3 (Azotobacter by soil treatment @ 4l/ha +150ppm gibberellic acid at 30DAT), A_3G_4 (Azotobacter by soil treatment @ 4l/ha +200ppm gibberellic acid at 30DAT).

The first year (2019-20) and Second year (2020-21), marigold seeds were sown in raised beds measuring 120×60×10cm. during the last week of September. A mixture of garden soil and coarse sand was used to enclose the seed beds. Seeds were sown in a clean line with a 4-5cm gap. After seeding, the nursery beds were covered by paddy straw as a mulch. Light irrigation provided at regular interval. Within 4-5 days of seeding, the seeds germinated, and the mulch layer was removed. The seedlings were hardened by withholding water for two to three days before being lifted. Watering was done in the morning, however, to help seedlings be lifted smoothly.

The plants of marigold were maintained healthy by using appropriate culture practice during the course of investigation and five plants were randomly selected from each plot and were tagged for recording various observations on plant height, primary branches per plant, secondary branches per plant, plant spread, Plant basal diameter of marigold. The obtained data had statistically analysed adopting procedure as given by Panse and Sukhatme (1985) [11].

Results and Discussion

The statistical analysis of data (Table-1) revealed that plant height at 30 DAT influenced with application of azotobacter during both the experimental years (2019-20 and 2020-21). The application of azotobacter through the soil application (4l/ha) was found significantly superior to the control and root treatment (0.25%). The highest plant height (48.00 cm, 48.29 cm during 2019-20 and 2020-21 respectively) at 30 DAT was recorded with A_3 (Azotobacter by Soil Treatment 4 l/ha), followed by A_2 (Azotobacter by Root Treatment 0.25%) whereas, the lowest plant height (43.91 cm, 44.31 cm during 2019-20 and 2020-21 respectively) was recorded in plant treated with A_1 (control). The application of gibberellic acid also significantly influenced plant height. The highest plant height after 30 days of planting (48.40 cm, 49.35 cm during 2019-20 and 2020-21 respectively) was recorded with treatment G_4 (GA_3 200 ppm at 30 DAT) followed by treatment G_3 (GA_3 150 ppm at 30 DAT) whereas, the minimum value (42.03 cm, 42.31 cm during 2019-20 and 2020-21 respectively) was noted in G_1. The interaction between the azotobacter and GA_3 on the plant height was found non-significant during both years (2019-20 and 2020-21).

At 60 DAT, the highest plant height (63.59 cm during both years 2019-20 and 2020-21 respectively) was recorded with A_3 (Azotobacter by Soil Treatment 4 l/ha), followed by A_2 (Azotobacter by Root Treatment 0.25%) whereas, the lowest plant height 58.05, 58.48cm during 2019-20 and 2020-21 respectively) was recorded in plants treated with A_1 (control). The foliar application of gibberellic acid also has a positive significant response on plant height. The highest plant height after 60 days of planting (64.24, 64.18 cm during 2019-20 and 2020-21 respectively) was recorded with treatment G_4 (200 ppm at 30 DAT) followed by G_3 (GA_3 150 ppm at 30 DAT) whereas, the minimum value (55.63, 55.76 cm during 2019-20 and 2020-21 respectively) was noted in G_1 (Control). The interaction of between the azotobacter and GA_3 on the plant height was found non-significant during both years (2019-20 and 2020-21).

At 90 DAT, the highest plant height (73.71, 74.21 during years 2019-20 and 2020-21 respectively) was recorded with A_3 (Azotobacter by Soil Treatment 4 l/ha), followed by A_2 (Azotobacter by Root Treatment 0.25%) whereas, the lowest plant height (67.89, 68.08 cm during 2019-20 and 2020-21 respectively) was recorded in plants treated with A_1 (control). Which might be attributed to the fact that the conjoint application of Azotobacter and PSB along with reduced dose of chemical fertilizers would have increased the total beneficial microbial population in the rhizosphere of the plant roots which in turn resulted in an increased leaf area by increasing the availability of nutrients (P, K, Zn, Cu etc.) as well as plant growth hormone production (Kaushal, 2006 and Tilak, 1993) [5]. The application of gibberellic acid also has a significant effect on plant height. The highest plant height after 90 days of planting (77.93, 78.33 cm during 2019-20 and 2020-21 respectively) was recorded with treatment G_4 (GA_3 200 ppm at 30 DAT) followed by G_3 (GA_3 150 ppm at 30 DAT) whereas, the minimum value (62.98, 62.76 cm during 2019-20 and 2020-21 respectively) was noted in G_1 (Control). higher concentration of GA3 is most effective in multiplication of cells as well as elongation of young tissues whereas the lower concentration was less desirable. The promotive effect of gibberellins on growth may be by increasing the auxin level of tissue or enhance the conversion of tryptophan to IAA, which cause cell division and cell elongation (Kuraishi and Muir).The interaction between the azotobacter and GA_3 on the plant height was found non-significant during both years (2019-20 and 2020-21).

At 120 DAT, the highest plant height (90.52, 90.86 during years 2019-20 and 2020-21 respectively) was recorded with A_3 (Azotobacter by Soil Treatment 4 l/ha), followed by A_2 (Azotobacter by Root Treatment 0.25%) whereas, the lowest plant height (79.08, 79.55 cm during 2019-20 and 2020-21 respectively) was recorded in plants treated with A_1 (control). Plant height was also significantly influenced by the application of gibberellic acid. The highest plant height after 120 days of planting (92.89, 93.41 cm during 2019-20 and 2020-21 respectively) was recorded with treatment G_4 (GA_3 200 ppm at 30 DAT) followed by G_3 (GA_3 150 ppm at 30 DAT) whereas, the minimum value (73.22, 73.00 cm during 2019-20 and 2020-21 respectively) was noted in G_1 (Control). The interaction between the azotobacter and GA_3 on the plant height was found non-significant during both years (2019-20 and 2020-21).

It is clear from the Table-1, indicated that the application of azotobacter and gibberellic acid on the marigold plant has significantly influenced the number of leaves per plant. The maximum number of leaves per plant (85.02 and 85.15), primary branches per plant (15.72 and 15.72), secondary branches per plant (20.55 and 20.95), largest plant spread (47.11 and 46.75) and basal diameter (1.49 and 1.50 cm) during the years 2019-20 and 2020-21), were counted in plants treated with the A_3 (Azotobacter by Soil Treatment 4 l/ha), followed by A_2 (Azotobacter by Root Treatment 0.25%) and the minimum value was observed in plants treated with A_1 (Control). The advancement in the vegetative attributes through the application of azotobacter because of Azotobacter is an aerobic free-living bacterium that plays a significant role in soil nitrogen fixation. It also produces antifungal antibiotics; synthesizes and secretes plant growth components such as thiamin, riboflavin, pyridoxine, nicotinic acid, and IAA (Indole Acetic Acid), gibberellins, and vitamin B, as well as inhibiting dangerous fungi and promoting crop growth. It also improves plant water uptake. PSB, on the other hand, increases phosphorus availability and promotes root growth. It also secretes organic acids such as formic, acetic, propionic, lactic, glycolic, fumaric, and succinic acids, as well as vitamins and growth promoters such as IAA and gibberellins, which might also promote plant growth. It has capability to fix nitrogen non-symbiotically may describe its potential to increase plant height and the number of leaves per plant. The effect was observed because nitrogen is a major component responsible for increasing vegetative development Azotobacter produces growth-promoting compounds and increases nutrient availability across the rhizosphere, resulting in an increase in the number of branches per plant, plant spread and basal diameter. The results are in conformity with the findings of Pandey *et al.* (2017) [10] in dahlia (*Dahlia variabilis* L.) cv. S.P. Kamala. Tiwari (2018) [13] in African Marigold.

Similarly, plants treated with G_4 (GA_3 200 ppm at 30 DAT) have the maximum number of leaves per plant (83.11 and 83.46), primary branches per plant (14.52 and 15.66), secondary branches per plant (19.92 and 20.70), largest plant spread (47.04 and 47.11) and basal diameter (1.49 and 1.49 cm) during the both years 2019-20 and 2020-21. The minimum number of primary branches per plant (11.66, 10.51 during the years 2019-20 and 2020-21) was observed in the G_1 (control). The better growth parameters of the plants might be due to the increased efficiency of growth regulators after 25 days is related to the usage of growth regulators at the juvenile stage, which stimulates rapid growth in the first few weeks.GA_3 causes active cell division and elongation increases tissue auxin levels and improves tryptophan to IAA conversion, all of which lead to active cell division and elongation (Abel and Theologis 1996) [1]. Growth may also be aided by osmotic uptake of water and nutrients under the effect of GA_3, which maintains swelling force against cell wall weakening, allowing the plant to grow better.

The present findings were also in agreement with the findings of Delvadia *et al.* (2009) [2] in Gaillardia cv. Lorenzana; Sarkar *et al*. (2018) [12] described the positive response of the foliar application of GA_3 on the vegetative growth of African marigold; the plant spread, increase primary branched might be due to increased main axis count and plant height extension induced by hyper elongation of internodal length. Through improved increased primary branches that develop from latent buds resulted in optimal plant spread. The data suggest that GA_3 spraying enhances plant spreading, which is confirmed by results by Gautam *et al.* (2006) [3]. The elimination of apical dominance by the pinching we did may clarify because GA_3 increased cell division and cell expansion, promoted protein synthesis, and stimulated secondary branching. Similar results were also reported by Anuradha *et al.* (2017) [14] in African Marigold cv Culcatta Orange; Markam *et al.* (2017) [9].

The interaction effect of azotobacter and gibberellic acid was found non-significant during both the years (2019-20 and 2020-21). The beneficial combined effect of the of azotobacter and GA_3 was also reported by several researchers which have conformity results with the present findings *viz.* Soil treatment with azotobacter and foliar spray of GA_3 150 ppm have the best plant growth Kumar *et al.* (2016) [7]; Tiwari *et al*. (2018) [13] in African marigold

Table 1: Effect of bio-inoculants and Gibberellic acid on plant height of African marigold cv. Pusa Narangi Gainda

Treatment	Plant Height 30DAT (cm)		Plant Height 60DAT (cm)		Plant Height 90DAT (cm)		Plant Height 120DAT (cm)		Number of leaves per plant.		Number of Primary branches per plant.)		Number of secondary branches per plant		Plant spread (cm)		Plant basal diameter (cm)	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
A_1	43.91	44.31	58.05	58.48	67.89	68.08	79.08	79.55	62.69	62.55	10.14	10.75	15.39	16.40	40.17	39.92	1.40	1.40
A_2	45.50	46.45	58.88	59.67	71.19	71.14	82.75	83.93	75.16	72.15	14.08	14.02	18.50	18.40	42.08	42.33	1.43	1.44
A_3	48.00	48.29	63.59	63.59	73.71	74.21	90.52	90.86	85.02	85.15	15.72	15.72	20.55	20.95	47.11	46.75	1.49	1.50
S.Em±	0.919	0.895	1.285	1.159	1.253	1.312	2.496	2.435	1.400	2.117	0.406	0.419	0.520	0.624	1.556	1.489	0.026	0.021
C.D.(P=0.05)	2.695	2.626	3.768	3.398	3.674	3.849	7.322	7.142	4.106	6.210	1.190	1.229	1.526	1.829	4.564	4.366	NS	0.063
G_1	42.03	42.31	55.63	55.76	62.98	62.76	73.22	73.00	64.85	64.22	11.66	10.51	14.85	15.16	37.56	37.44	1.39	1.39

G_2	45.92	46.46	59.70	60.23	69.39	69.89	82.74	84.37	71.85	70.69	13.22	13.52	18.59	18.50	43.44	43.22	1.43	1.43
G_3	46.85	47.27	61.14	62.16	73.40	73.60	87.63	88.32	77.37	74.76	13.85	14.30	19.22	19.97	44.44	44.22	1.45	1.46
G_4	48.40	49.35	64.24	64.18	77.93	78.33	92.89	93.41	83.11	83.46	14.52	15.66	19.92	20.70	47.04	47.11	1.49	1.49
S.Em±	1.061	1.034	1.483	1.338	1.446	1.515	2.883	2.812	1.616	2.445	0.469	0.484	0.601	0.720	1.797	1.719	0.029	0.025
C.D.(P=0.05)	3.112	3.032	4.351	3.924	4.242	4.444	8.454	8.247	4.741	7.170	1.374	1.420	1.762	2.112	5.270	5.041	NS	0.072
$A_1 G_1$	36.55	36.48	51.55	51.75	58.33	58.29	68.33	68.39	57.66	57.81	8.66	8.73	12.66	13.33	37.00	36.00	1.36	1.37
$A_1 G_2$	45.66	45.85	58.55	58.66	67.33	67.48	81.55	82.29	62.33	62.81	9.67	10.66	15.89	16.33	40.33	40.33	1.40	1.39
$A_1 G_3$	46.11	46.48	61.00	61.51	71.55	71.37	82.33	83.03	64.33	63.85	10.89	11.33	16.33	17.66	41.00	40.67	1.41	1.41
$A_1 G_4$	47.33	48.44	61.11	62.00	74.33	75.20	84.11	84.47	66.44	65.73	11.33	12.28	16.67	18.26	42.33	42.67	1.43	1.42
$A_2 G_1$	44.33	45.12	57.44	57.33	65.27	64.48	72.33	72.28	64.44	62.85	12.11	10.48	15.44	15.48	37.67	38.00	1.39	1.39
$A_2 G_2$	44.55	45.88	57.55	58.48	70.50	71.33	78.33	82.33	70.55	65.83	14.44	14.33	18.67	18.59	42.00	42.00	1.42	1.43
$A_2 G_3$	46.22	46.94	58.22	60.33	72.33	72.48	84.33	84.61	79.33	72.78	14.44	15.18	19.44	19.33	43.00	43.33	1.44	1.45
$A_2 G_4$	46.89	47.84	62.33	62.55	76.64	76.29	96.00	96.48	86.33	87.15	15.33	16.08	20.44	20.22	45.67	46.00	1.46	1.48
$A_3 G_1$	45.22	45.33	57.89	58.18	65.33	65.51	79.00	78.33	72.44	72.00	14.22	12.33	16.44	16.67	37.67	38.33	1.41	1.41
$A_3 G_2$	47.55	47.66	63.00	63.55	70.33	70.86	88.33	88.49	82.66	83.44	15.55	15.56	21.22	20.59	42.00	47.33	1.48	1.48
$A_3 G_3$	48.22	48.40	64.22	64.62	76.33	76.96	96.22	97.33	88.44	87.66	16.22	16.40	21.89	22.91	43.00	48.67	1.51	1.52
$A_3 G_4$	51.00	51.77	69.27	68.00	82.83	83.52	98.55	99.28	96.55	97.49	16.89	18.61	22.66	23.62	45.67	52.67	1.57	1.58
S.Em±	1.838	1.791	2.569	2.317	2.505	2.625	4.993	4.870	2.800	4.235	0.812	0.838	1.040	1.247	3.112	2.977	0.051	0.043
C.D.(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Conclusion

On the basis of above studies, it may be concluded that the application of Azotobacter and GA_3 (Soil treatment with Azotobacter + spray of GA_3 200 ppm after 30 days of transplanting) may significantly improve the vegetative growth (plant height, primary branches per plant, secondary branches per plant, plant spread, plant basal diameter) of the marigold plants. it can be recommended to obtained higher production and maximum return for marigold growers of Eastern Uttar Pradesh.

References

1. Abel S, Theologis A. Odyssey of auxin. In: Estelle M, Weijers D, Ljung K. and Leyser O. (Eds.) Perspective in Biology. Cold Spring Harbor Press, Leibniz-Institut Fuer, Germany, 1996, pp. 1-13.
2. Delvadia DV, Ahlawat TR, Meena BJ. Effect of different GA3 concentration and frequency on growth, flowering and yield in Gaillardia (*Gaillardia pulchella* Foug.) cv. Lorenzian. J Hortl. Sci. 2009;4(1):81-84.
3. Gautam SK, Sen NL, Jain MC, Dashora LK. Effect of plant growth regulators on growth, flowering and yield of chrysanthemum cv. Nilima. Orrisa J of Hort. 2006;34(1):36-40.
4. Kaplan L. Historical and ethno botanical aspects of domestication in Tagetes. Econ. Bot. 1960;14:200-202.
5. Kaushal S, Dilta BS, Chaudhary SVS, Gupta YC. Effect of planting dates on growth and flowering of China aster (*Callistephus chinensis* L.). International Journal of Farm Sciences. 2014;4(1):60-71.
6. Kumar A, Kumar A. Effect of bio-fertilizers and nutrients on growth and flower yield of summer season African marigold (*Tagetes erecta* L.) Plant Archives. 2018;17(2):1090-1092.
7. Kumar N, Kumar J, Singh JP, Kaushik H, Singh RK. Effect of GA_3 and azotobacter on growth and flowering in African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda. The Asian J of Hort. 2016;11(2):382-386.
8. Kuraishi S, Muir RM. The mechanism of gibberellin action in the dwarf pea. Pl. Cll. Physiol. 1964;5:259.
9. Markam PS, Shukla Neeraj, Sharma, Gaurav Ram, Deo Shankar, Pali GP. Effect of plant growth regulators and Cultivars on Flowering and yield of African Marigold (*Tagetes erecta* L.) in Chhattisgarh Plains. Journal of Plant Development Sciences. 2017;9(4):353-357.
10. Pandey SK, Kumari S, Singh D, Singh VK, Prasad VM. Effect of Biofertilizers and Organic Manures on Plant Growth, Flowering and Tuber Production of Dahlia (*Dahlia variabilis* L.) Cv. S.P. Kamala, Int. J Pure App. Biosci. 2017;5(2):549-555.
11. Panse VG, Sukhatme BV. Statistical Method for Agricultural Workers, IInd. Ed., Indian Council of Agricultural Research, New Delhi, 1985.
12. Sarkar D, Saud BK, Mahanta P, Kalita NPB, Talukdar MC. Response of Pinching and Gibberellic Acid on Growth and Physiological Characteristics of African Marigold Int. J Curr. Microbiol. App. Sci. 2018;7(3):1666-1672.
13. Tiwari Harendra, Kumar Mukesh, Naresh RK. Effect of nutrient management and gibberellic acid on growth, flowering and nutrients availability in post-harvested soil of Marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda. IJCS. 2018;6(4):510-514.
14. Anuradha WR, Sateesh PR, Kumar Naveen, Priyanka KT, Kulakarni SB. Effect of Growth Regulators on Vegetative, Flowering and Flower Yield Parameters in African Marigold cv Culcatta Orange. Int. J Pure App. Biosci. 2017;5(5):636-640.