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EFFECT OF PLANT GROWTH REGULATORS ON THE FLOWERING PARAMETERS AND SHELF LIFE OF AFRICAN MARIGOLD (*TAGETES ERECTA* L.) CV. PUSA NARANGI GAINDA

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ABSTRACT

A field experiment was carried out in RBD two factors with three replications at Research farm, Department of Horticulture, School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema during 2021-22, experimental factors include two time of application such as (i) application at 25 DAT, (ii) application at 50 DAT, and seven sprays of PGRs such as Control, two doses apiece of MH (1000 ppm and 2000 ppm), GA_3 (150 ppm and 250 ppm) and B-9 (50 ppm and 100 ppm). The results showed that time of application, it was obtained that application at 25 days after transplanting (DAT) provided significant effect on early first flower bud initiation, first flower opening, 50% flowering, the maximum flower diameter, In-situ life of flower and shelf life of flower. Among the different Plant Growth Regulators, early first flower bud initiation, first flower opening, 50% flowering, flower diameter, and Shelf life was registered with GA_3 @ 250 ppm except In-situ life of flower which was noted with B-9 @ 100 ppm.

Keywords **:** B-9, flowering parameters, growth regulators, *Tagetes erecta,* shelf life.

Introduction

The African marigold (*Tagetes erecta* L.), has its origins in Central and South America, particularly Mexico. It is a diploid (2n=24) member of the Asteraceae (previously Compositae) family and a member of the genus Tagetes. There is a high demand for marigold for decorative purposes at different religious and social gatherings, loose flowers, garlands, and garden displays. In the United States, however, marigold powder and extract are the only approved colours in poultry feed. The orange and yellow colour of marigold flower is due to the presence of lutein pigment, so marigold flower is added to the poultry diet to enhance the yellow colour of the egg yolk and broiler skin. Recently the marigold flower is the marketable source of lutein; petals of marigold are luxuriant in esters of lutein fatty acids and lutein, representing more than 90% of the pigments identified in Tagetes plant (Becerraa *et al.,* 2020). Mainly two factors such as management and genetic factors affect plant growth and yield, although regulating plant growth using PGRs is the third most important advance in agro-technology for improving growth and flowering parameters in flowering plants. (Kumar *et al.,* 2015).

The total area under floriculture in India was 305 thousand hectares, in which the total production of loose flowers was 2301 thousand tons and the production of cut flowers was 762 thousand tonnes. Tamil Nadu is the top state in loose flower area and production with an area of 32,000 hectares and production of 247,300 tonnes, followed by Karnataka with an area of 27,000 hectares and production of 203,900 tonnes. West Bengal is the top state in the production of cut flowers with a production of 23919.0 lakhs. In India, marigold cultivation in an area of 1502 hectares, production 225.30 lakh tonnes and productivity 15 tonnes/ha. (NHB, 2019-20). The main objectives of experiment were to see the effect of PGRs on flowering parameters and shelf life of *Tagetes erecta* L. cv. Pusa Narangi Gainda. GA_3 is presently considered a main phytohormone regulator of flowering (Sheng and Zhang, 2022).

Materials and Methods

An experiment was conducted Rabi session of 2021-22 at the research cum instructional farm of the School of Agricultural Sciences and Rural Development: Nagaland University, Medziphema, which is located at an altitude of 305 meters above sea level at latitude 25°45'43'N and longitude 93°53'04'E. The climatic condition of the experimental site was a typically humid sub-tropical zone with a mean temperature between 12.53℃ to 26.24 ℃ and average rainfall (12.21 mm) from December 2021 to April 2022. The soil of the experimental field comes under the soil order of alfisols and was categorized as clayey loam soil. The soil samples were collected randomly from the experimental field to determine their fertility status. The soil was collected from a depth of 0-15 cm using a soil auger. After which the sample was dried, ground and sieved, and analyzed, the results thus obtained are presented in Table 1.

Table 1 : Initial soil fertility of the experimental field

Parameters	Values	Status	Methods employed
Soil pH	5.5	Acidic	Digital pH meter
Organic carbon (%)	1.54	High	Walkley and Black,1934
Available Nitrogen (Kg ha^{-1})	298	Medium	Alkaline Potassium Permanganate methods (Subbiah and Asija,1956)
Available phosphorus (Kg ha^{-1})	48.5	High	Bray's method (Bray and Kurtz, 1945)
Available potassium (Kg ha^{-1})	90.4	Medium	Flame photometer (Hanway and Heidal, 1952)

PGRs solutions

A field trail was laid out in a RBD (randomized block design) with seven treatments and two factors; time of application (25 DAT and 50 DAT) and different Plant growth regulators (MH 1000 ppm and 2000 ppm, GA_3 150 ppm and 250 ppm, B-9 50 ppm and 100 ppm), replicated for 3 times. 1000 ppm MH was prepared by taken 1 g powder of MH in 1 L of distilled water and 2000 ppm MH was prepared by taken 2 g powder of MH in 1 L of distilled water. 150 ppm GA_3 was prepared by taken 0.15 g of GA_3 powder in 1 L of distilled water and 250 ppm GA_3 was prepared by taken 0.25 g of GA_3 powder in 1 L of distilled water. 50 ppm B-9 was prepared by taken 0.05 g of B-9 powder in 1 L of distilled water and 100 ppm B-9 was prepared by taken 0.10 g of B-9 powder in 1 L of distilled water.

Crop husbandry

Seeds of *Tagetes erecta* cv. Pusa Narangi Gainda were sown in flower pots. Soil mixture comprising of garden soil, sand, and well-decomposed FYM in the ratio of 1:1:1 was mixed thoroughly and added into the pots, followed by sowing. Light irrigation was done immediately after sowing. Seedlings were transplanted to main the field at 30 DAS. In addition, the application of well-rotted Farmyard manures @ 20 t/ha, the chemical fertilizers were also applied at the rate of 120 kg N, 100 kg P_2O_5, and 100 kg K_2O per hectare. Well-rotted Farmyard manure was mixed thoroughly at the time of bed preparation. Nitrogen was applied in two split doses i.e., 50 percent N at the time of bed preparation, and remaining 50 percent N was applied at 45 DAT as a top dressing in form of urea. A full dose of P_2O_5 and K_2O was applied upon final bed preparation, P_2O_5 in form of SSP and K_2O in form of MoP. Good cultural practices were followed during the entire crop period.

Data analysis

The observations on flowering parameters were noted and statistically analysed by applying the technique of analysis of variance using factorial randomized block design (Gomez and Gomez, 1985). The level of significance of the F-test and t-test were kept at 5 per cent (P=0.05).

Results and Discussion

Days to first flower bud initiation

Data noted on days to first flower bud initiation as effected by plant growth regulators and times of application and their interactions, represented in (Table 2) showed a marked influence on bud initiation. An observation of the data also showed that among the time of application, the minimum number of days to first flower bud initiation (52.37 days) was noted with spray scheduled at 25 DAT (T_1) and a greater number of days to first flower bud initiation (53.50 days) was noted when sprayed at 50 DAT (T_2). It is evident from the data that a minimum number of days to first flower bud initiation (50.50 days) was noted with foliar application of 250 ppm GA_3 (G_4) however; a maximum number of days to first flower bud initiation (55.55 days) was noted with control (G_0). Interaction between the time of application and plant growth regulators was found to be significant. Lesser number of days to first flower bud initiation (48.86 days) was noted with 250 ppm GA_3 at 25 DAT. While a maximum number of days to flower bud initiation (55.87 days) was noted with control at 50 DAT. Early budding and flowering with GA_3 application may be due to an increase in the endogenous gibberellins level in the plants, as gibberellins are well known for inducing early budding and flowering in several crops. The major changes in flowering parameters can be explained by the fact that GA_3 was quite effective in reducing the juvenile period of plants because of its higher capacity for cell division and cell elongation which cause early maturity in plants. The interruption of days to first flower bud initiation in marigold with the spray of MH might be due to lesser meiotic activity and inhibition of biosynthesis of GA_3-like substances as stated by (Arti *et al*., 2019). Comparable findings were also stated by Anuradha *et al.* (2017) in *Tagetes erecta* cv. Culcatta Orange.

Days to first flower opening

Data about the effect of times of application and different Plant growth regulators and their interactions on days to first flower opening of *Tagetes erecta* were represented (in Table 2). Perusal of the data showed that time of application also had a perceptible effect, recording the minimum days to first flower opening (64.00 days) at 25 DAT (T_1) and a greater number of days to first flower opening (65.14 days) with spray scheduled at after 50 days of transplanting (T_2). It is evident from the data that Plant growth regulators had a profound influence on the days of first flower opening. The minimum number of days to first flower opening (60.70 days) was noted with foliar application of 250 ppm GA_3 (G_4) however the maximum days to first flower opening (68.95 days) was noted in control (G_0). Interaction between the time of application and plant growth regulators was found to be significant. Lesser number of days to first flower opening (59.06 days) was noted with 250 ppm GA_3 at 25 DAT. While maximum days to first flower opening (69.26 days) were noted with control at 50 DAT. Early initiation of flowering with GA_3 application might be due to early production of florigen in GA_3-treated plants, as GA_3 is a component of florigen that is involved in flower initiation in the plant system. GA_3 treatment increased photosynthesis and respiration along with enhanced CO_2 fixation that promotes early flowering in Chrysanthemum. Comparable results were stated by Mishra (2017) *Tagetes erecta* cv. Pusa Narangi Gainda.

Days taken to 50% flowering per plant

The effect of time of application and Plant growth regulators on the number of days taken to 50 percent flowering per plant of marigold cv. Pusa Narangi Gainda is presented in (Table 2); which reveals a significant influence on days to 50% flowering per plant by the time of application, Plant growth regulators, and their interactions. It is evident from the data that among the time of application, minimum days to 50% flowering per plant (81.93 days) was noted with spray scheduled at 25 DAT (T_1) and a greater number of days to 50% flowering per plant (83.04 days) was noted when applied at 50 DAT (T_2). Further examination of the data also showed that minimum days to 50% flowering per plant (77.30 days) was noted with foliar application of 250 ppm GA_3 (G_4) whilst; maximum days to 50% flowering per plant (88.62 days) was noted in control (G_0). The interaction effect between the time of application and plant growth regulators was found to be significant. Lesser number of days to 50% flowering per plant (75.67 days) was noted with foliar application of 250 ppm GA_3 at 25 DAT. While a maximum number of days to 50% flowering per plant (89.00 days) was noted with control at 50 DAT. This early 50 percent flowering with GA_3 lends support to the previous discussion on the flowering parameters viz., early first flower bud initiation, and early first flower opening. Comparable findings were stated by Anuradha *et al.* (2017; Kalaimani *et al.* (2017) in African marigold.

Flower diameter

A cursory glance of data in (Table 2) extrapolated that flower diameter was significantly influenced by the time of application and Plant growth regulators. As regards the effect of time of application, a large flower diameter (6.37 cm) was noted when Plant growth regulators were sprayed at 25 DAT (T_1) and a smaller flower diameter (6.11 cm) was produced when sprayed at 50 DAT (T_2). It is apparent from the data that maximum flower diameter (7.31 cm) was noted with foliar application of 250 ppm GA_3 (G_4) and minimum flower diameter (5.54 cm) was noted with control (G_0). The interaction effect between the time of application and plant growth regulators failed to exert any significant effect on flower diameter. The increment in flower diameter with GA_3 application might be due to enhanced cell division and cell enlargement, promotion of protein synthesis coupled with higher dry matter build up. Large diameter can be induced through an increased number of florets as a result of good nutrition during the reproductive phase. All these factors ultimately contributed to well partitioning of photosynthates to reproductive sinks under the control of GA_3. Comparable findings were also stated by Arti *et al.* (2019) in African marigold cv. Lemon Yellow and Kumar *et al.* (2020) in marigold.

In-situ flower life

Data noted on in-situ flower life (days) was significantly influenced by time of application and different Plant growth regulators, and their interactions, as summarized in (Table 2). It is apparent from the data that among the time of application, the longest in-situ flower life (43.73 days) was noted with spray schedule at 25 DAT (T_1) and the shortest in-situ life (42.46 days) was noted when applied at 50 DAT (T_2). Further scanning of the data showed that the longest in-situ flower life (44.80 days) was noted with foliar application of 100 ppm B-9 (G_6) whilst; the shortest in-situ life (40.51 days) was noted with control. The interaction effect between the time of application and plant growth regulators was found to be significant. Maximum in-situ flower life (45.36 days) was noted by foliar application of 100 ppm B-9 sprayed at 25 DAT and minimum In-situ flower life (40.66 days) was noted by control sprayed at 50 DAT. This increase in the duration of flowering in marigold due to B-9 application, this might have kept the plants more sturdy, fresh and green for a longer period and this might have maintained the supply of flowering inducing hormones for a longer period and might have increased the duration of flowering (Dutta *et al.,* 1993) in chrysanthemum. Comparable results were stated by (Kumar *et al.,* 2020) in marigold. An increase in flowering duration with the application of B-9 may be due to the alleviation of the detrimental effects of senescence by modulating the activity of enzymatic antioxidants and improving the antioxidant system, which helped in sustaining plant growth and flowering. Khan *et al.* (2007) found better-quality flowering character when growth regulators were applied at 25 DAT might be due to higher photosynthetic ability since the juvenile phase as well as better absorption of nutrients through improved growth leading to the development of higher C: N ratio resulting improved floriferousness.

Table 2 : Effect of plant growth regulators on the flowering parameters and shelf life of African marigoldcv. Pusa Narangi Gainda

Treatments	Days to first flower bud initiation	Days to first flower opening	Days taken to 50% flowering per plant	Flower diameter (cm)	In-situ flower life (days)	Shelf life (days)
T_1(25 DAT)	52.37	64.00	81.93	6.37	43.73	5.06
T_2 (50 DAT)	53.50	65.14	83.04	6.11	42.46	4.94
SEm(±)	0.109	0.107	0.114	0.116	0.121	0.072
C.D at 5%	0.319	0.313	0.333	0.340	0.352	0.209
G_0 (Control)	55.55	68.95	88.62	5.54	40.51	3.90
G_1(1000 ppm MH)	53.33	65.53	84.10	5.83	42.19	4.58
G_2(2000 ppm MH)	54.23	66.45	84.85	6.00	42.34	5.06
G_3 (150 ppm GA_3)	51.00	61.20	77.80	6.90	43.02	5.36
G_4(250 ppm GA_3)	50.50	60.70	77.30	7.31	44.03	5.51
G_5(50 ppm B-9)	53.37	64.96	82.77	6.00	44.76	5.23
G_6(100 ppm B-9)	52.60	64.20	82.00	6.13	44.80	5.34
SEm(±)	0.058	0.057	0.061	0.062	0.064	0.038
C.D at 5%	0.170	0.167	0.178	0.182	0.188	0.112

Interaction (TxG)						
T_1G_0	55.23	68.63	88.23	5.58	40.66	3.99
T_1G_1	53.06	65.27	84.00	6.03	43.14	4.77
T_1G_2	54.13	66.33	84.73	5.97	43.37	5.10
T_1G_3	49.53	59.73	76.33	7.16	43.60	5.40
T_1G_4	48.86	59.06	75.67	7.41	44.72	5.56
T_1G_5	53.26	64.86	82.67	6.11	45.23	5.26
T_1G_6	52.53	64.13	81.93	6.29	45.36	5.32
T_2G_0	55.87	69.26	89.00	5.49	40.37	3.82
T_2G_1	53.60	65.80	84.20	5.83	41.24	4.38
T_2G_2	54.33	66.56	84.96	5.72	41.31	5.02
T_2G_3	52.46	62.67	79.26	6.64	42.44	5.33
T_2G_4	52.13	62.33	78.93	7.20	43.33	5.46
T_2G_5	53.46	65.07	82.86	5.88	44.30	5.19
T_2G_6	52.66	64.27	82.07	5.97	44.23	5.36
SEm (±)	0.154	0.151	0.0161	0.165	0.170	0.10
C.D at 5%	0.451	0.442	0.470	NS	0.498	NS

T= Time of application, G= Plant growth regulators

Shelf life

The data on the average shelf life of flowers of marigold as influenced by time of application different Plant growth regulators presented in (Table 2) showed a marked influence on shelf life. The maximum shelf life of flowers (5.06 days) was noted at application after 25 days of transplanting (T_1) and the minimum shelf life of flowers (4.94 days) was noted at 50 DAT (T_2). Further examination of the data showed that among different PGRs, the maximum shelf life of flowers (5.51 days) was noted with foliar application of 250 ppm GA_3 (G_4), and the minimum shelf life of flowers (3.90 days) was noted with control (G_0). The interaction effect between the time of application and the plant growth regulators was found to be non-significant. The maximum extension of shelf life might be due to the overall modifying effect on the vegetative and reproductive growth of the plant. Comparable findings were stated by Kumar *et al*. (2020) in marigold cv. Pusa Narangi Gainda.

Conclusion

Out of the time of application, it can be inferred from the current research work that PGRs spraying at 25 DAT had a stronger impact on the flowering parameters and shelf life of African marigold cv. Pusa Narangi Gainda. In the case of Plant growth regulators, foliar spray with GA_3 @ 250 ppm was found to be the best treatment in most of the parameters of flowering and shelf-life except in-situ flower life, where B-9 @ 100 ppm exhibited better results. Since the above conclusions are made based on the result of a one-year investigation, a further study on a Comparable line would be required in order to give a more reliable recommendation.

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