

Original Research Article

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## Response of Pinching and Gibberellic Acid on Growth and Physiological Characteristics of African Marigold

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### ABSTRACT

An experiment was carried out at Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat (Assam) during 2015-17. The experiment was laid out in Factorial Randomized Block Design with three replications comprising 15 treatment combinations of five different concentration of gibberellic acid (GA<sub>3</sub> 0ppm, 50ppm, 100ppm, 150ppm and 200ppm) and three pinching levels *viz.*, no pinching, pinching at 20 days and 40 days after transplanting (DAT). The result indicated that the important growth and physiological characters were significantly influenced by gibberellic acid and pinching treatments. The application of GA<sub>3</sub> at 200 ppm recorded significantly higher plant height (85.36cm), number of branches/plant (39.72 branches/plant), total leaf number (183.43), number of flowers (63.80) and flower yield per hectare (10.19t). Among the pinching treatments, pinching at 40 DAT recorded significantly maximum number of branches (40.55 branches/plant), total leaf number (180.54), number of flowers (62.78) and flower yield per hectare (10.20t); whereas maximum plant height (86.61 cm) was found under no pinching. As far as physiological characters are concerned, relative water content (67.96%), root shoot ratio (0.31), root volume (70.92cc), total chlorophyll content (1.34mg g<sup>-1</sup>FW), and self-life of flower (7.38 days) was also improved with the application of 200ppm GA<sub>3</sub>. Among the pinching treatments, pinching at 40 DAT recorded maximum root volume (69.77cc), total chlorophyll content (1.36mg g<sup>-1</sup>FW), and self-life of flower (7.21 days).

### Keywords

Pinching, GA<sub>3</sub>,  
Marigold, Growth  
and physiological  
characteristics

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### Introduction

Assam with wide agro-climatic diversity is one of the leading states for commercial cultivation of loose flowers among which the most important is African marigold grown at a large scale mainly in the Kamrup district. The major problems of marigold cultivation in Assam are lack of off season production technology, lack of proper scientific

cultivation knowledge and very poor post-harvest handling practices. The African marigold is an annual flowering crop with tall and profuse branching habit. It produces large-size quality flowers of different colours, which fetches high prices in the market. However, apical dominance causes delay in flowering. Long and weak stems are some of problems causing yield loss. It has been felt that standard horticultural practices *e.g.* pinching

and gibberellic acid spray can play an important role in the improvement of flowering and yield of marigold. In marigold, the flowering and yield is mainly dependent on number of flower bearing branches which can be manipulated by checking vertical growth of plants and encouraging side shoots by means of apical bud pinching. Gibberellic acid is used to overcome the growth limiting factors to harness maximum benefit from flower production for increasing the yield. Although, marigold is grown by a large number of farmers in India, yet a very little research work has been done on this crop with special reference to the effect of pinching and gibberellic acid on growth and physiological characteristics aspects. Keeping in view the above facts, an experiment was undertaken with the objectives to find out optimum pinching time and effective concentration of GA<sub>3</sub>.

### **Materials and Methods**

The experiment was conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2016-2017. The experimental area is located at 26°47'N latitude, 94°12'E longitude and at an altitude of 86.6 meter above mean sea-level. Jorhat is located within the Upper Brahmaputra Valley agro-climatic zone of Assam and is characterized by a subtropical climatic condition with hot and humid summer and relatively dry and cool winter.

The soil in the farm is sandy loam with pH (4.82), organic matter (0.53 %), available nitrogen (165.11Kg/ha), available phosphorus (48.92 kg/ha) and available potassium (89.54kg/ha). During growing period mean maximum (31.1°C) and minimum (22.3°C) temperature, relative humidity (81.56 %) and rain fall (111.14mm) was recorded. Fifteen different treatment combinations of five levels

of gibberellic acid (GA<sub>3</sub> @ 0ppm, 50ppm, 100ppm, 150ppm and 200ppm) and three pinching levels *viz.* no pinching, pinching at 20 days and pinching at 40 days after transplanting was laid out in randomized block design with three replication on African marigold cv. Pusa Narangi Gaiinda. Twenty five days old uniform and healthy seedling were transplanted at the spacing of 45×45 cm on October 25, 2016. 10 kg FYM, 10 g each N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O per square meter was applied in experimental block. The full dose of well rotten FYM, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O and half dose of N was mixed in beds before transplanting. The remaining dose of N was applied one month after transplanting.

Hand sprayer was used to spray gibberellic acid uniformly. Gibberellic acid treatment was applied twice at first and third weeks after transplanting while the control plants were sprayed with distilled water. Regarding pinching treatments, 4-5 cm terminal portion of growing tip was nipped out as per treatments' time mentioned above.

Observation on growth parameters like plant height, number of branches, number of leaves per plant, days to flower bud, number of flowers per plant and yield per hectare was recorded and presented in Table 1. Various physiological characteristic *viz.*, relative water content (RWC), root shoot ratio, root volume, chlorophyll content and self-life were also recorded and presented in Table 2.

Five plants were selected randomly and tagged for different treatments in each replication for taking observations. The days to first flower bud formation was counted from date of transplanting and other physiological parameters were calculated using standard procedures. The statistical analysis was carried out to know the variance for each parameter and effect of treatments using the standard procedure.

## Results and Discussion

### Effect of pinching

The data presented in Table 1 revealed that pinching treatments responded different growth parameters. Significantly maximum reduction in plant height (72.01cm) was recorded in pinching at 40 DAT followed by pinching at 20 DAT (76.90cm). The treatment no pinching had recorded significantly maximum plant height (86.61cm). However, number of branches (40.55), number of leaves per plant (180.54), days taken to flower bud opening (49.67 days), number of flowers/plant (62.78), yield of flowers/ hectare (10.20t) were recorded significantly maximum with pinching at 40 DAT followed by pinching treatment at 20 DAT. While, minimum number of branch (22.66), total leaf number (174.35), days taken to flower bud formation (43.86 days), number of flower per plant (51.46) and flower yield per hectare (9.19t) was noticed under the control (no pinching) treatment. The similar results were quoted by Sharma *et al.*, (2006), Rathore *et al.*, (2011), Pushkar and Singh (2012) and Badge *et al.*, (2013) in marigold. Regarding the physiological characteristics maximum RWC (68.50%), maximum root length : shoot length (0.31) and minimum root volume (66.89cc), total chlorophyll content (1.13mg g<sup>-1</sup>FW) and self-life (5.12 days) was registered under no pinching treatment. Whereas, minimum RWC (65.73%), minimum root length : shoot length (0.26) and maximum root volume (69.77cc), total chlorophyll content (1.36mg g<sup>-1</sup>FW) and self-life (7.21 days) was found under the treatment pinching at 40 DAT followed by pinching at 20 DAT. The reduction in the plant height in pinched plant was mainly due to the removal of apical meristematic tissue which inhibited the apical dominance and diverted plant metabolites from vertical growth to horizontal growth which might have favoured in increasing the number of branches and ultimately the flower yield. These results

are in close agreement with the findings of Ramdevputra *et al.*, (2009), Srivastava *et al.*, (2002), Rathore *et al.*, (2011) in marigold and Shinde *et al.*, (2010) in chrysanthemum.

### Effect of gibberellic acid

During the experimental period, gibberellic acid treatment resulted in outstanding increase in all vegetative growth parameters studied under the experiment. The growth parameters such as height of plant (85.36cm), number of branches/plant (39.72), number of leaves per plant (183.43), number of flowers per plant (63.80), yield of flowers per ha (10.19t) were recorded significantly maximum with the application of gibberellic acid 200 ppm followed by application of gibberellic acid 150 ppm and 100 ppm and minimum height of plant (73.56cm), number of branches/plant (25.82), total number of leaves per plant (169.87), number of flowers per plant (50.68), yield of flowers per ha (9.01t) were recorded in control treatment (gibberellic acid 0ppm).

Minimum days taken for flower bud formation (44.33 days) was recorded under gibberellic acid 200ppm treatment followed by gibberellic acid 150ppm, 100ppm, 50ppm and maximum days taken for flower bud formation (49.71 days) was noticed in control plants. Thus, it was found that plant growth parameters increased with increase in gibberellic acid concentrations. This was due to the fact that gibberellic acid increased the growth of plant by increasing intermodal length and cell enlargement and enhanced the apical dominance indirectly by increasing auxin content. The increasing leaf area might be due to increasing plant height and number of branches. Similar results were recorded by Taygi and Kumar (2006), Swaroop *et al.*, (2007); Ramdevputra *et al.*, (2009); Ramesh Kumar *et al.*, (2010); Amit Kumar *et al.*, (2012), Badge *et al.*, (2013) in marigold (Fig. 1-4).

**Table.1** Response of pinching and gibberellic acid on growth of African marigold

Treatment	Plant height (cm)	Number of secondary branches	Number of leaves per plant	Days to flower bud opening	Number of flower per plant	Flower yield per ha (t)
<b>Factor A-Pinching(P)</b>						
P <sub>0</sub> -No pinching	86.61	22.66	174.35	43.86	51.46	9.19
P <sub>1</sub> -Pinching at 20 DAT	76.90	31.51	177.37	47.81	56.70	9.38
P <sub>2</sub> -Pinching at 40 DAT	72.01	40.55	180.54	49.67	62.78	10.20
<b>SE(d)±</b>	0.63	0.90	0.32	0.71	0.83	0.008
<b>C.D. (P=0.05)</b>	1.35	1.92	0.70	1.51	1.77	0.73
<b>Factor B-Gibberellic acid (G)</b>						
G <sub>0</sub> -GA <sub>3</sub> 0 ppm	73.56	25.82	169.87	49.71	50.68	9.01
G <sub>1</sub> -GA <sub>3</sub> 50 ppm	75.12	28.03	174.67	48.57	53.70	9.32
G <sub>2</sub> -GA <sub>3</sub> 100 ppm	76.26	29.21	178.12	46.92	55.27	9.62
G <sub>3</sub> -GA <sub>3</sub> 150 ppm	82.22	35.08	181.01	46.03	61.45	9.82
G <sub>4</sub> -GA <sub>3</sub> 200 ppm	85.36	39.72	183.43	44.33	63.80	10.19
<b>SE(d)±</b>	0.82	1.16	0.42	0.91	1.07	0.01
<b>C.D. (P=0.05)</b>	1.75	2.48	0.90	1.95	2.28	0.94
<b>Interaction effect (AxB)</b>						
<b>SE(d)±</b>	1.42	2.02	0.73	1.58	1.85	0.01
<b>C.D. (P=0.05)</b>	NS	NS	NS	NS	NS	NS

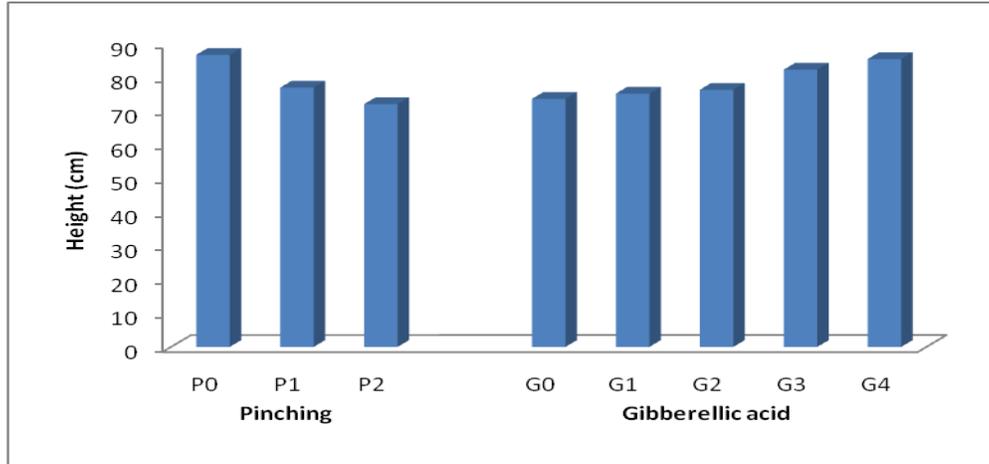
NS: Not Significant

**Table.2** Response of pinching and gibberellic acid on physiological characteristics of African marigold

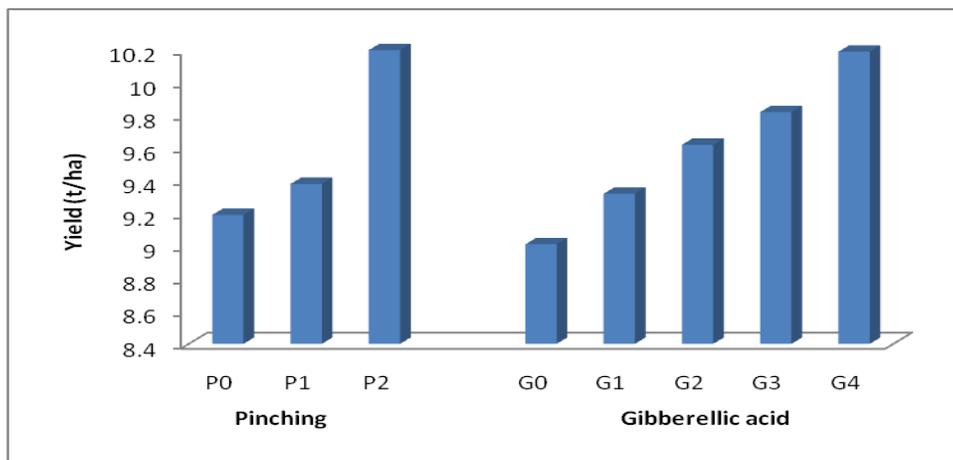
Treatment	RWC%	Root length: shoot length	Root volume (cc)	Chlorophyll content (mg g <sup>-1</sup> FW)	Self-life (Days)
<b>Factor A-Pinching(P)</b>					
P <sub>0</sub> -No pinching	68.50	0.31	66.89	1.13	5.12
P <sub>1</sub> -Pinching at 20 DAT	66.44	0.29	68.29	1.28	6.06
P <sub>2</sub> -Pinching at 40 DAT	65.73	0.26	69.77	1.36	7.21
<b>SE(d)±</b>	0.01	0.02	0.12	0.004	0.24
<b>C.D. (P=0.05)</b>	0.03	0.05	0.26	0.009	0.52
<b>Factor B-Gibberellic acid (G)</b>					
G <sub>0</sub> -GA <sub>3</sub> 0 ppm	65.37	0.25	65.66	1.15	5.20
G <sub>1</sub> -GA <sub>3</sub> 50 ppm	66.69	0.27	67.13	1.20	5.58
G <sub>2</sub> -GA <sub>3</sub> 100 ppm	66.91	0.29	68.49	1.29	6.07
G <sub>3</sub> -GA <sub>3</sub> 150 ppm	67.51	0.30	69.40	1.31	6.44
G <sub>4</sub> -GA <sub>3</sub> 200 ppm	67.96	0.31	70.92	1.34	7.38
<b>SE(d)±</b>	0.01	0.02	0.16	0.005	0.32
<b>C.D. (P=0.05)</b>	0.04	0.01	0.34	0.01	0.68
<b>Interaction effect (AxB)</b>					
<b>SE(d)±</b>	0.03	0.03	0.28	0.009	0.55
<b>C.D. (P=0.05)</b>	NS	NS	NS	NS	NS

NS: Not Significant

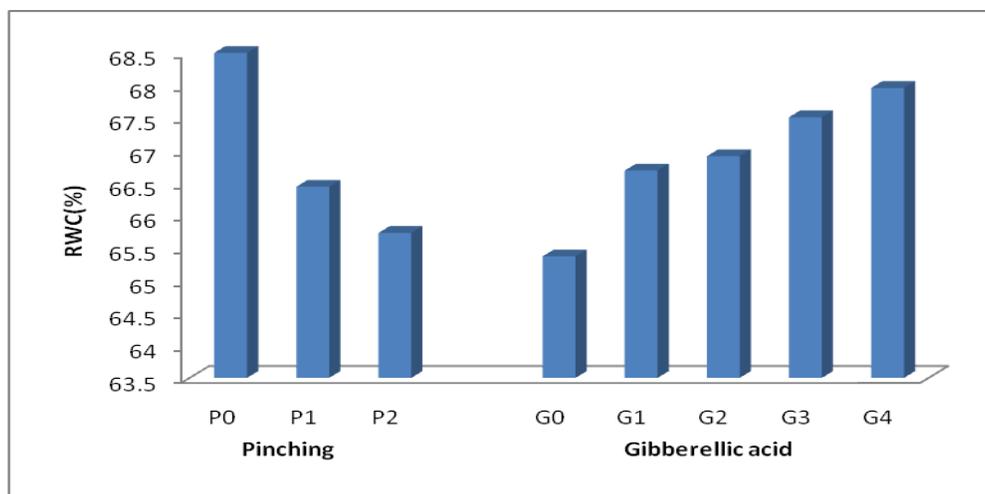
**Fig.1** Plant height (cm)



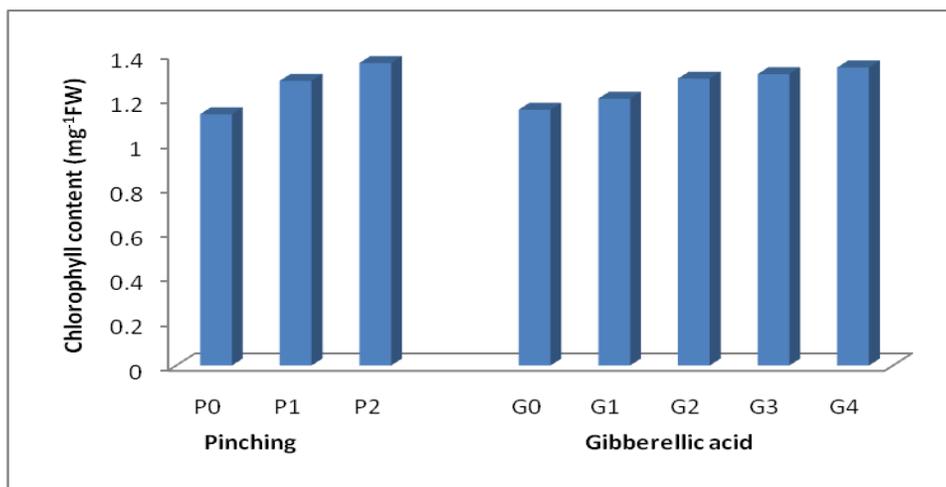
**Fig.2** Flower yield per hectare (t)



**Fig.3** Relative Water Content (RWC %) of petals



**Fig.4** Total chlorophyll content (mg g<sup>-1</sup> FW)



The data presented in Table 2 clearly showed that significantly maximum RWC (67.96%), root length : shoot length (0.31), root volume (70.92cc), total chlorophyll content (1.34mg g<sup>-1</sup>FW) and self-life (7.38days) were registered under the application of gibberellic acid 200 ppm followed by gibberellic acid 150 ppm, gibberellic acid 100 ppm and gibberellic acid 50 ppm. The minimum RWC (65.37%), root length: shoot length (0.25), root volume (65.66cc), total chlorophyll content (1.15mg g<sup>-1</sup>FW) and self-life (5.20days) were recorded in control treatment. This might be due to greater dry matter accumulation which was certainly suggestive to better photosynthetic activity, other metabolite activities and uptake of nutrients from soil. Therefore, the growth promoting substances might have positive influence on the yield of flowers. Similar results were reported by Ramdevputra *et al.*, (2009) in marigold, Ramalingam (2008), Kumar *et al.*, (2012) in rose and by Shinde *et al.*, (2010) in chrysanthemum.

### Interaction effect

The data presented in Tables 1 and 2 exhibit non-significant differences for all growth and yield parameters due to an interaction of the

pinching and application of gibberellic acid.

Utilization of GA<sub>3</sub> in marigold during different crop growth stages proved beneficial. From the above experiment it may be concluded that GA<sub>3</sub> at 200 ppm during first and third weeks after transplanting as foliar spray and pinching at 40 days after transplanting may be recommended for good growth and physiological characteristics of African marigold.

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