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Stimulatory effect of different Plant Growth Regulators on Cosmos seed Production in New Alluvial Zone

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ABSTRACT: Cosmos is one of the important flowers in India. Seed is also important to get quality production and prime seed produces better production. With the above consideration, the present investigation was carried out with composite genotype of cosmos seeds. The different concentrations of plant growth regulators were sprayed to the plants with an objective to enhance seed yield and yield attributing characters. The different treatments were control (T_0), GA_3 @ 50 ppm (T_1), GA_3 @ 100 ppm (T_2), GA_3 @ 150 ppm (T_3), Kinetin @ 25 ppm (T_4), Kinetin @ 75 ppm (T_5), IBA @ 100 ppm (T_6), IBA @ 400 ppm (T_7). The research work was conducted at Horticulture Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India during Rabi season of 2019-20 and 2020-2021. All the treatments resulted in improved seed yield and yield attributing characters compared with unsprayed; however, highest size of flowers was recorded in IBA @ 100 ppm. So, it could be considered as the best performer different plant growth regulator considering flower diameter. Highest seed yield was recorded in IBA @ 400 ppm (219.6 g m^{-2} in 1^{st} year and 220.267 g m^{-2} in 2^{nd} year) and in same concentration of IBA (i.e @ 400 ppm) number of seed $plant^{-1}$ was also highest. So, IBA @ 400 ppm could be recommended in seed production as it was the best performer plant growth regulator in cosmos.

Keywords: Cosmos, Gibberellic Acid, Kinetin, Indole-Butyric Acid, seed yield.

INTRODUCTION

Cosmos from the family of Asteraceae is an annual, herbaceous ornamental crop. The genus name Cosmos comes from the Greek word ‘kosmos’ that literally means ‘beauty’ with a “root idea of orderliness; hence an ornament or beautiful thing” (Bailey, 1924). Members of the Cosmos family find its origin in the tropical and subtropical world especially Mexico which is also center of diversity of other 40 species. Infact Melchert (1976) described the Cosmos species as ‘pantropical’. Cosmos genera plants are diploid with a chromosome no. of 2n=24 except *C. caudatus* which is tetraploid. Asteraceae is one among the largest families of flowering plants which contains a whooping 1620 genera and more than 23,600 species. Members of the Asteraceae family can be distinguished by their flowers (florets) in heads (capitula) surrounded by bracts. The small, single-seeded fruit often with a plumose pappus aids in wind dispersal. Though, Cosmos genera have awns instead of feathery pappus. The Cosmos plant is found almost in every continent except Antarctica. Early herbarium specimen records take us back as long as 1886 where it escaped cultivation in Puerto Rico. Nowadays it is a common roadside weed there. In Europe it was transported via galleons and grown in botanical gardens. In Africa Cosmos was introduced in South Africa by way of contaminated horse feed imported through Mexico during Boer war (1902) and got naturalized there. In Asia-Pacific the plant probably reached via galleon trade directly from Mexico. *Cosmos caudatus* was used as a vegetable on board the galleons and *Cosmos sulpheureus* was introduced as an ornamental flower. In Asia it grows in temperate regions like China and Taiwan and in tropical regions like India, Nepal, Bhutan etc. The cosmos plant can grow in tough conditions like poor soil, less organic matter, hot weather and dry conditions. Self-sowing is also observed in these genera. Plants die, disperse the seed in the soil. Different traits like ability to seed freely, self- compatibility, tolerance to tropical climates and its ability to grow in range of soils aids in its spread. Seeds have an essential function in reproduction of higher plants and often facilities of dispersal of the species. But the availability of quality cosmos seed in the market is very less. The spray of 10 ppm kinetin at 35 DAS along with Boron in chickpea exhibited higher performance in increasing plant height by 19.8% over control. The number of flowers plant^{-1} increased with kinetin (12%) sprays compared to control (Menaka *et al.*, 2018). Sachin *et al.* (2021) reported that use of IBA @ 3000 ppm in apple clonal rootstocks resulted in reduced number of the days taken for first leaf initiation, enhanced the sprouting percentage of cuttings, and also maximum survival percentage of the cuttings. Ashwini *et al.* (2021) reported that in Finger millet variety ML-365 revealed Gibberellic acid 50 ppm showed significantly higher plant height, number of grains/finger and grain yield. Kumar and Sharma (2021) found that in pigeon pea optimum grain yield was obtained by treating them with GA_3 @ 75 ppm at flower initiation stage. Although optimum net return was achieved by the foliar application of GA_3 @ 50 ppm at flower initiation & pod initiation stages. Gaurha *et al.* (2021) showed that in lichi maximum plant height at 30, 60, 90, 120, 150 and 180 DAT in 50 ppm GA_3 followed by 30 ppm GA_3. In lemon maximum plant height, more chlorophyll content in leaves was recorded by treatment GA_3 @ 25 ppm (Das *et al.*, 2021). Verma *et al.* (2021) found that 75 ppm of GA_3 showed maximized plant height (cm), fruit length (cm), fruit diameter (cm), fruit volume (cc), fruit weight per plant (g) and yield (q ha^{-1}) in strawberry. GA_3, IBA, Kinetin have been chemically identified in developing seeds they reach the highest levels known in plant organs. The simultaneous occurrence of peak values in hormone content and certain morphological and biochemical changes (Biswas *et al*., 2020; Singh *et al*., 2021). It is obvious that such correlations do not prove that hormones are causally involved in specific aspects of seed growth and development. Therefore, attempts have been made to test the causality of correlative evidence by environmental, chemical, or genetic manipulation of endogenous hormone levels on cosmos.

MATERIALS AND METHODS

The research work was conducted at Horticulture Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India during Rabi season of 2019-20 and 2020-2021. The composite genotype of cosmos was taken as the experimental material for the present investigation, obtained from AICRP on floriculture, BCKV. The trial was carried out to evaluate the effect of foliar application with different plant growth regulators like Gibberellic Acid, Kinetin and Indole-Butyric Acid with different concentrations on *Cosmos* sp. The field trial was conducted to elucidate the effect of foliar application of GA_3, IBA, and Kinetin over the untreated plants/control (T_0) on flowering, plant growth, seed production in synthetic variety of Cosmos. The treatments were GA_3 @ 50 ppm (T_1), GA_3 @ 100 ppm (T_2), GA_3 @ 150 ppm (T_3), Kinetin @ 25 ppm (T_4), Kinetin @ 75 ppm (T_5), IBA @ 100 ppm (T_6), IBA @ 400 ppm (T_7). Composite genotypes of cosmos seeds were raised in individual plots following standard agronomic practices and intercultural operations. The soil of the experimental site is medium fertile, well drained and sandy loam in texture. The seeds were sown in field at spacing of 30 cm x 20 cm with three replications in 3m × 2m plot. Standard agronomic practices and intercultural operations were followed for raising seedlings in individual plots. Recommended fertilizer was applied in the main plot. Foliar application of GA_3 @ 100 ppm was done at 25 days after transplanting (Ray and Bordolui, 2020). Five plants were randomly tagged at the early crop growth stage and observations on different traits were recorded like, plant height (cm), days to bud initiation, days to 50% flowering, flower diameter (cm), number of flowers plant^{-1}, number of seeds flower^{-1}, number of seeds plant^{-1}, test weight (g) and seed yield (g m^{-2}).

RESULTS AND DISCUSSION

Influence of different plant growth regulators on performance of Cosmos:
Assessment of influence of different plant growth regulators as foliar application was made over two consecutive years for different quality parameters was made during 2019-20 and 2020-21. Significant variations were observed most of the parameters among the effect of different plant growth regulators.

Plant height (cm): Significant difference was observed in plant height after application of different growth regulators with different concentration in 1st year. Among the treatments, lowest plant height was noted for control plot (101.667 cm) during 2019-20 preceded by IBA @ 400 ppm and Kinetin @ 25 ppm, while it was highest for Kinetin @ 75 ppm followed by GA_3 @ 50 ppm (Table 1). But non-significant variation was observed in IBA @ 400 ppm and Kinetin @ 25 ppm. Similar type of result was observed in second year (2020-2021), only change in magnitude (Table 1). Second year also significant difference was observed among the different plant growth regulators for plant height. But non-significant difference was observed in between GA_3 @ 100 ppm and GA_3 @ 150 ppm; GA_3 @ 50 ppm and Kinetin @ 75 ppm; Kinetin @ 25 ppm and IBA @ 400 ppm in 2nd year. It is to be noted that plant height was accelerated with the application of different growth regulators and it is directly related with the enhancement in different growth regulators concentration i.e., increased plant height took place with the use of different growth regulators concentration.

Days to bud initiation: Days to bud initiation significantly difference observed after application of different growth regulators with different concentration in 1st year. Among the treatments, longest duration days to bud initiation was noted for control plot (50.133 days) during 2019-20 followed by GA_3 @ 50 ppm, while it was minimum for IBA @ 100 ppm preceded by IBA @ 400 ppm, though both Control Plot and GA_3 @ 50 ppm; GA_3 @ 100 ppm and GA_3 @ 150 ppm; Kinetin @ 75 ppm and Kinetin @ 25 ppm performed at par with each other i.e these different concentrations of plant growth regulators were non-significant difference for this trait (Table 1). It is to be noted that days to bud initiation was accelerated with the application of different growth regulators and it is directly related with the enhancement in different growth regulators concentration i.e., consistent reduction in days to bud initiation took place with the use of different growth regulators concentration. But in 2nd year non-significant difference was observed in days to bud initiation after application of different growth regulators with different concentration. Among the treatments, longest time taken in control plot (52.667 days) during 2020-21 followed by GA_3 @ 100 ppm, while different concentration of plant growth regulators were non-significant difference for this trait (Table 1).

Days to 50% flowering: In case of days to 50% flowering significant difference was observed after application of different growth regulators with different concentration in 1st year. Among the treatments, longest duration to 50% flowering was noted for Control Plot (59.933 days) during 2019-20 followed by GA_3 @50 ppm, while it was minimum for IBA @ 100 ppm preceded by Kinetin @ 75 ppm, though both Control Plot and GA_3 @ 50 ppm; GA_3 @ 100 ppm, GA_3 @ 150 ppm and Kinetin @ 25 ppm; Kinetin @ 75 ppm, IBA@100ppm and IBA @ 400ppm performed at par with each other (Table 1). It is to be noted that lesser time was taken for days to 50% flowering by the application of different growth regulators and it is directly related with the enhancement in different growth regulators concentration; consistent reduction in days to 50% flowering took place with the use of different growth regulators concentration. Significant difference was not observed for this parameter in 2nd year also. Among the treatments, longest duration to 50 % flowering was noted for control plot (63.667 days) during 2020-21 followed by GA_3 @150 ppm, while it was minimum for IBA @ 100 ppm preceded by IBA @ 400 ppm and Kinetin @ 75 ppm (Table 1). It is to be noted that lesser time to 50% flowering was accelerated with the application of different growth regulators and it is directly related with the enhancement in different growth regulators concentration; consistent reduction in days to 50% flowering took place with the use of different growth regulators concentration.

Table 1: Variation in plant height (cm), Days to bud initiation (Days) and Days to 50% flowering of Cosmos after different plant growth regulators application.

Sr. No.	Treatment	1st year	2nd year	1st year	2nd year	1st year	2nd year
		Plant height	Plant height	Days to bud initiation	Days to bud initiation	Days to 50% flowering	Days to 50% flowering
1.	Control Plot	101.667	97.000	50.133	52.667	59.933	63.667
2.	GA_3 @ 50 ppm	119.733	115.233	49.067	50.333	59.000	58.333
3.	GA_3 @ 100 ppm	110.667	108.900	45.867	51.667	56.600	57.667
4.	GA_3 @ 150 ppm	113.933	104.667	44.933	46.667	55.533	60.000
5.	Kinetin @ 25 ppm	104.733	103.033	44.400	44	55.133	57.000
6.	Kinetin @ 75 ppm	121.467	115.26	43.267	43.333	53.133	54.333
7.	IBA @ 100 ppm	111.667	106.333	40.067	41.333	52.533	53.333
8.	IBA @ 400 ppm	103.200	104.600	42.400	44.333	53.867	55.000
C.V		**0.898**	**4.018**	**1.782**	**12.648**	**1.850**	**9.714**
SEd		**0.813**	**3.507**	**0.823**	**4.832**	**0.841**	**4.278**
SEm(±)		**0.575**	**2.480**	**0.582**	**3.417**	**0.595**	**3.025**
C.D (0.05)		**1.761**	**7.594**	**2.239**	**NS**	**1.822**	**NS**

Number of flowers plant^{-1}: Number of flowers plant^{-1} significantly varied after application of different growth regulators with different concentration in both the year. Among the treatments, least flowers per plant was noted for control plot (40.933 nos) during 2019-20 preceded by GA_3 @ 50 ppm, while it was maximum for IBA @ 100 ppm followed by GA_3 @ 150 ppm (Table 2). Similar trend was observed during 2020-21 (Table 2). Shirzad *et al.* (2012) also found that in pumpkin IBA 100 ppm had significant effects on number of flower/plant. It is to be noted that number of flower per plant was accelerated with the application of different growth regulators and it is directly related with the enhancement in different growth regulators concentration i.e., consistent increase in no. of flowers per plant took place with the use of different growth regulators concentration.

Flower diameter (cm): For both the year significant difference observed in flower diameter after application of different growth regulators with different concentration. Among the treatments, shortest flower diameter was noted for control plot (7.263 cm) during

2019-20 followed by GA_3 @ 100 ppm and @ 150 ppm, while it was maximum for IBA @ 100 ppm (8.382 cm), closely followed by Kinetin @25 ppm, IBA @400 ppm and GA3 @ 50 ppm (Table 2). GA_3@ 50 ppm, Kinetin@ 75 ppm, Kinetin@ 25 ppm, IBA @ 100 ppm and IBA @ 400 ppm showed the non-significant variation for this trait during 2019-2020. But during 2020-21, among the treatments, lowest flower diameter was noted for control plot (6.733 cm) preceded by GA_3 @ 150 ppm and @ 100 ppm, while it was maximum for IBA @ 100 ppm (8.433 cm) followed by GA_3 @ 50 ppm, Kinetin @25 ppm, Kinetin @75 ppmand IBA @400 ppm (Table 2). But Kinetin@ 75 ppm, Kinetin@ 25 ppm, and IBA @ 100 ppm showed the non-significant variation for this treatment during 2020-2021. Similar type of result was observed by Shirzad *et al.* (2012). It is to be noted that the flower diameter was accelerated with the application of different growth regulators and it is directly related with the enhancement in different growth regulators concentration i.e., consistent enlargement of flower diameter took place with the use of different growth regulators concentration.

Table 2: Variation in Flowersplant^{-1} and Flower diameter (cm) of Cosmos after different plant growth regulators application

Sr. No.	Treatment	1st year	2nd year	1st year	2nd year
		Number of flowers plant^{-1}	Number of flowers plant^{-1}	Flower diameter (cm)	Flower diameter (cm)
1.	Control Plot	40.933	37.667	7.263	6.733
2.	GA_3 @ 50 ppm	49.467	47.667	8.132	8.367
3.	GA_3 @ 100 ppm	52.733	50.667	7.885	7.567
4.	GA_3 @ 150 ppm	74.867	72.000	7.867	7.067
5.	Kinetin @ 25 ppm	64.133	55.667	8.280	8.333
6.	Kinetin @ 75 ppm	62.533	61.667	8.338	8.267
7.	IBA @ 100 ppm	74.933	73.333	8.382	8.433
8.	IBA @ 400 ppm	72.200	67.333	8.152	7.8
C.V		**1.281**	**7.217**	**1.784**	**4.932**
SEd		**0.643**	**3.432**	**0.117**	**0.315**
SEm(±)		**0.455**	**2.427**	**0.083**	**0.223**
C.D (0.05)		**1.393**	**7.217**	**0.254**	**0.682**

Number of seed flower^{-1}: Number of seed flower^{-1} varied significantly after application of different growth regulators with different concentration in both the year. Among the treatments, minimum number of seed per flower was noted for control plot (22.067) during 2019-20 preceded by Kinetin @ 25 ppm, while it was maximum for GA_3 @ 100 ppm followed by GA_3 @ 50 ppm, though both Control Plot and Kinetin @ 25 ppm; GA_3 @ 50 ppm and GA_3 @ 100 ppm and IBA @ 400 ppm performed at par with each other (Table 3). But during 2020-21, among the treatments, lowest number of seed per flower was noted for control plot (19.667 nos.) preceded by Kinetin @ 25 ppm, while it was highest for GA_3 @ 100 ppm (39.333 nos.) followed by IBA @ 400 ppm, though both Kinetin @ 25 ppm, Kinetin @ 75 ppm and IBA @ 100 ppm performed at par with each other (Table 3). It is to be noted that number of seed per flower was accelerated with the application of different growth regulators. Similar effects were reported by Biswas *et al.* (2021) for aster and Ray and Bordolui (2020) for marigold resulted in increased number of seed flower^{-1} after foliar application of GA_3.

Number of seed plant^{-1}: Significant difference observed in number of seed per plant after application of different growth regulators with different concentration in both the year. Among the treatments, highest no. of seed per plant was observed in IBA @ 400 ppm followed by GA_3 @ 150 ppm and lowest no. of seed per plant was noted for control plot (1246) preceded by Kinetin @ 25 ppm during 2019-20 (Table 3). It is to be noted that no. of seed per plant was accelerated with the application of different growth regulators and it is directly related with the enhancement in different growth regulators concentration i.e., consistent increase in no. of seed per plant took place with the use of different growth regulators concentration. Similar trend was observed during 2020-21for number of seed per plant after application of different growth regulators with different concentration (Table 3). Similar effects were reported by El-Shraiy and Hegazi *et al.* (2009). It is to be noted that number of seed per plant was accelerated with the application of different growth regulators.

Table 3: Variation in number of seed flower^{-1} and number of seed plant^{-1} of Cosmos after different plant growth regulators application

Sr. No.	Treatment	1st year	2nd year	1st year	2nd year
		No. seed flower^{-1}	No. seed flower^{-1}	No. Seed plant^{-1}	No. Seed plant^{-1}
1.	Control Plot	22.067	19.667	1246	1443.333
2.	GA_3 @ 50 ppm	38.800	36	1907.4	2052.667
3.	GA_3 @ 100 ppm	40.4	39.333	2125.7	2194.000
4.	GA_3 @ 150 ppm	36.933	34.667	2740	2289.333
5.	Kinetin @ 25 ppm	23.733	21.000	1521.4	1511.000
6.	Kinetin @ 75 ppm	29.533	27.333	1845.4	1798.000
7.	IBA @ 100 ppm	25.133	26.333	1883.7	1760.667
8.	IBA @ 400 ppm	40	36.333	2879.4	2456.667
C.V		**2.501**	**15.267**	**5.085**	**14.234**
SEd		**1.155**	**3.752**	**83.804**	**225.263**
SEm(±)		**0.817**	**2.653**	**59.258**	**159.285**
C.D (0.05)		**4.410**	**8.126**	**181.483**	**487.823**

Test weight (g): Non-significant difference observed in test weight after application of different growth regulators with different concentration in both the year. Among the treatments, highest test weight was noted for IBA @ 100 ppm (6.948 g) followed by GA_3 @ 150 ppm, while it was lowest for control plot (6.203 g) preceded by GA_3 @ 100 ppm during 2019-20 (Table 4). Similar trend was recorded during 2020-21, only little bit change of the magnitude.

Seed Yield (g m^{-2}): Significant difference was observed in seed yield (g m^{-2}) after application of different growth regulators with different concentration in both the year. Among the treatments, highest seed yield was noted for IBA @ 400 ppm (219.6 g m^{-2}) followed by IBA @ 100 ppm, while it was lowest for control plot (109.433 gm) preceded by Kinetin @ 25 ppm during 2019-20, though both Control Plot and Kinetin @ 25 ppm; GA_3 @ 50 ppm, GA_3 @ 100 ppm and GA_3 @ 150 ppm performed at par with each other (Table 4). During 2020-21 among the treatments, highest yield plot^{-1} was noted for IBA @ 400 ppm (220.267 g m^{-2}) followed by GA_3 @ 150 ppm, while it was lowest for control plot (111.733 gm) preceded by Kinetin @ 25 ppm (Table 4). Similar effects were reported by Shirzad *et al.* (2012). It was observed that higher seed yield (g m^2) was accelerated with the application of different growth regulators.

Table 4: Variation in seed yield (g m^{-2}) and test weight (g) of Cosmos after different plant growth regulators application.

Sr. No.	Treatment	1st year	2nd year	1st year	2nd year
		Test weight (g)	Test weight (g)	Seed Yield (g m^{-2})	Seed Yield (g m^{-2})
1.	Control Plot	6.203	5.967	109.433	111.733
2.	GA_3 @ 50 ppm	6.743	6.383	150.600	151.367
3.	GA_3 @ 100 ppm	6.400	6.187	148.333	154.733
4.	GA_3 @ 150 ppm	6.980	6.710	177.500	185.633
5.	Kinetin @ 25 ppm	6.827	6.620	111.467	122.567
6.	Kinetin @ 75 ppm	6.707	6.443	129.467	139.233
7.	IBA @ 100 ppm	6.948	6.830	165.333	179.467
8.	IBA @ 400 ppm	6.835	6.467	219.6	220.267
C.V		**2.613**	**5.161**	**16.273**	**1.771**
SEd		**3.374**	**0.275**	**7.514**	**2.191**
SEm(±)		**2.386**	**0.195**	**5.313**	**1.549**
C.D (0.05)		**7.307**	**NS**	**6.755**	**4.744**

CONCLUSION

According to the size of flowers, highest was recorded in IBA @ 100 ppm. So, it could be considered as the best performer different plant growth regulator considering flower diameter. Seed yield was recorded highest in IBA @ 400 ppm (219.6 g m^{-2} in 1st year and 220.267 g m^{-2} in 2nd year) and in same concentration of IBA (i.e @ 400 ppm) number of seed plant^{-1} was also highest. So, IBA @ 400 ppm could be considered as the best performer plant growth regulator considering its seeds yield. Concomitant consideration of seed yield and its important attributes may indicate to recommend foliar application of different plant growth regulator for enhancement in seed yield. Similar to the seed yield and its attributes, plant growth and development have been noticed to be positively influenced by different plant growth regulator concentrations, may lead to recommend foliar application of IBA @ 400 ppm for commercial cultivation of cosmos seed.

Flowering stage

Maturity stage

FUTURE SCOPE

There is a scope to study the biochemical effect of other plant growth regulators in cosmos.

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Conflict of Interests. None.

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