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Studies on Influence of Gibberellic acid (GA_3) on Growth, Seed Yield and Quality of Zinnia (*Zinnia elegans* Jacq.)

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ABSTRACT

A field experiment was conducted to study the influence of gibberellic acid (GA_3) on growth, seed yield and quality in zinnia (Zinnia elegans Jacq.) The experiment was planned with 14 treatment combinations involving two GA_3 concentrations, seven stages of application of GA_3 and a common control. The application of GA_3 at 200 ppm recorded significantly higher number of branches per plant (17.41), number of seeds per flower (48.22), seed yield per plant (2.91 g) and per hectare (1.332 q), thousand seed weight (7.57 g) and germination (85.14 %). Spraying of GA_3 at both flower initiation and 50 per cent flowering stages recorded significantly higher number of branches per plant (18.26), number of seeds per flower (50.13), seed yield per plant (3.36 g) and per hectare (1.542 q), thousand seed weight (7.73 g) and germination (87.99 %). The interaction effect of GA_3 200 ppm and its application at both flower initiation and 50 per cent flowering stages recorded significantly higher number of branches per plant (18.66), number of seeds per flower (52.86), seed yield per plant (3.46 g) and per hectare (1.583 q), thousand seed weight (7.86 g) and germination (90.66%). The results suggest that interaction effect of GA_3 at 200 ppm and its application at both flower initiation and 50 per cent flowering stages resulted in higher growth, seed yield and quality parameters in zinnia.

Key words: *Zinnia elegans, Gibberellic acid, Seed yield and Seed quality.*

INTRODUCTION

Zinnia is a genus of 20 species of annual and perennial flowering plant of family Asteraceae, with chromosome number 2n = 24. The wild form is a coarse, upright, bushy plant up to 10 to 100 cm height, with solitary daisy like flower head on long stems. Flowers are single, semi-double or double forms and ray florets are female and disc florets are bisexual flowers. Zinnia is also known as Mexican marigold. It is a true American native that originated from Mexico and Central America. It is popular among garden flowers because of its large, variable coloured blooms. They make excellent for landscape gardening and also compact varieties are suitable for hanging baskets, window boxes and containers. Zinnias are used as cut, dry and dyed flowers for use in vase, making decorative items and in flower arrangements.

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The cut blooms remain fresh for several days *i.e.* 5-7 days in vase. At present there is a great scope for export of annual zinnia seeds. Being the minor flower crop, cultivation of zinnia has received attention only in recent years. In the absence of scientific information with regard to comprehensive agronomic package for seed production, lack of intensification of research work, lack of knowledge and availability of quality seeds to the flower growers it is difficult to reckon and realize the objective of higher flower and seed yield in zinnia. The quality of seed either for seed multiplication or for general flower production depends on several factors which influence the planting value of seed.

Growth regulators play an important role in morphology and physiology of the plants and their effect varies with plant, species, variety, concentration and stages of application. Among the growth regulators like auxins, gibberellins, cytokinins and ethylene, GA_3 is one of the most important growth stimulating substance and its main function include cell elongation and cell division in the subapical meristematic region allowing for increased plant height, bigger leaves and bigger root system[3]. Not only application of GA_3 but the number of sprays and its right stage of application also play a vital role in harnessing the plant growth, yield and seed quality parameters. When applied at vegetative stage induces increase in plant growth parameters due to increased mitosis markedly in meristematic region and thus increases the seed yield because of enhanced vegetative growth and dry matter accumulation. GA_3 applied at flowering stage increases the number of flowers due to the acceleration of axillary buds into new shoots providing extra sites for more flowers, more number of seeds per flower, increased dry matter accumulation in the seeds and thus enhances seed yield and quality[10]. Taking into consideration of the above mentioned uses, efforts to make availability of quality seeds to the growers with the application of GA_3 was taken up in this investigation.

MATERIAL AND METHODS

Seeds of zinnia were obtained from Floriculture Unit, Department of Horticulture, University of Agricultural Sciences, Dharwad. A field experiment was conducted to study the influence of GA_3 on growth, seed yield and quality of zinnia during *Kharif* 2014 at Water and Land Use Management Institute (WALMI), Dharwad. The field experiment consisted of two GA_3 concentrations (C) *viz.*, C_1 - 100 ppm, C_2 - 200 ppm as Factor - I and seven stages of application (S) *viz.*, S_1 - 15 days after transplanting, S_2- Flower initiation, S_3 - 50 per cent flowering, S_4 - S_1+ S_2, S_5 - S_1 + S_3, S_6 - S_2 + S_3, S_7 - S_1+ S_2 +S_3 as Factor -II and common control. The experiment was laid out in a factorial randomized block design.

Laboratory studies were carried in the Seed Research Laboratory, National Seed Project, University of Agricultural Sciences, Dharwad. three replications were used to determine thousand seed weight (g) and seed germination (%).The data were subjected to statistical analysis as per the method outlined by Panse and Sukhatme[6].

RESULTS AND DISCUSSION

The application of GA_3 at 200 ppm (C_2) recorded significantly higher number of branches per plant (17.41) in field further seed quality traits *viz.*, number of seeds per flower (48.22), seed yield per plant (2.91 g) and per hectare (1.332 q), thousand seed weight (7.57 g) and seed germination (85.14 %) were also recorded higher when compared to control (Table 1, 2 and 3). The increase in number of branches might be due to the promotion of horizontal growth (branching) apart from vertical growth. The findings are in close conformity with findings of Swaroop *et al.*[9] in African marigold. Significantly higher values recorded for all yield parameters might be due to reduction in the juvenile period of plants, because of GA_3's higher capacity of cell division and cell elongation resulted in early maturity and also due to better crop growth, more number of branches which increased the number of flowers per plant and ultimately enhanced the seed yield. The findings of Manjunath *et al.*[4] in pumpkin is in conformity with the results. Increase in seed quality parameters might be due to increase in individual seed weight which resulted in an increase in germination percentage. These

results are in conformation with Sunitha[7] in African marigold.

GA_3 application at both flower initiation and 50 per cent flowering stages (S_6) recorded significantly higher number of branches per plant (18.26), number of seeds per flower (50.13), seed yield per plant (3.36 g) and per hectare (1.542 q), thousand seed weight (7.73 g) and seed germination (87.99 %) (Table1, 2 and3) Increase in growth parameters may be attributed to appropriate stage of GA_3 application which increases cell wall extensibility due to increased mitosis in the meristematic region of the shoot tip. The results are in line with Natesh *et al*.[5] in chilli. Application of GA_3 at suitable stage of plant growth might have increased the number of flowers due to the acceleration of axillary buds into new shoots providing extra sites for more flowers and more number of seeds per flower thus increasing the seed yield per plant, per plot and per hectare. It is in accordance with the finding of Surendra *et al*.[8] in okra. Increase in seed quality parameters might be due to suitable stage of GA_3 application which led to greater accumulation of food reserves, resulting in higher seed quality parameters. Similar results were reported by Natesh *et al*.[5] in chilli.

The interaction effect of GA_3 200 ppm and its application at both flower initiation and 50 per cent flowering stages (C_2S_6) recorded significantly higher number of branches per plant (18.66), number of seeds per flower (52.86), seed yield per plant (3.46 g) and per hectare (1.583 q), thousand seed weight (7.86 g) and seed germination (90.66%) (Table 1, 2 and 3) Increasing number of GA_3 sprays at appropriate stage of plant growth meight have caused rapid cell elongation and cell division in growth portion of the plant due to increase in photosynthetic activity, efficient translocation and utilization of photosynthates thus increasing the growth parameter. Increase in yield parameters could be ascribed to increased supply of metabolites such as carbohydrates and nutrients during seed formation. The results are in agreement with findings of Kanwar and Khandelwal[2] in African marigold. Increase in seed quality parameters might be due to adequate supply of food reserves to resume embryo macromolecules to be utilized in growth promoting processes and thus increase in individual seed weight which resulted in an increase in germination percentage. Similar results were reported by Godappalavar[1] in tomato.

Results conclude that GA_3 at 200 ppm at both flower initiation and 50 per cent flowering stages showed improved growth, seed yield and quality parameters in zinnia.

Table 1. Influence of GA_3 concentration and stage of application on number of branches per plant at 90 days after transplanting (DAT) and number of seeds per flower in zinnia

Treatments		Number of branches per plant at 90 DAT			Number of seeds per flower		
		GA_3 Concentration (C)		Mean of S	GA_3 Concentration (C)		Mean of S
		C_1 - 100 ppm	C_2- 200 ppm		C_1 - 100 ppm	C_2- 200 ppm	
Stage of application (S)	S_1 - 15 days after transplanting	15.20	16.26	15.73	39.13	45.20	42.16
	S_2 - Flower initiation	15.93	17.00	16.46	44.20	45.33	44.76
	S_3 - 50% flowering	15.73	16.26	15.99	44.13	45.26	44.69
	S_4 - S_1 + S_2	17.46	18.20	17.83	46.46	52.26	49.36
	S_5 - S_1 + S_3	17.40	18.00	17.70	46.20	48.40	47.30
	S_6 - S_2 + S_3	17.86	18.66	18.26	47.40	52.86	50.13
	S_7 - S_1 + S_2 + S_3	17.20	17.86	17.53	45.60	48.26	46.93
Mean of C		16.68	17.46	17.07	44.73	48.22	46.47
Control		14.66			35.93		
For comparing means of		S.Em±		CD at 5%	S.Em±		CD at 5%
GA_3 concentration (C)		0.12		0.35	0.68		1.98
Stage of application (S)		0.14		0.42	0.97		2.81
C x S		0.20		0.59	1.17		3.41
Treatment x Control		0.25		0.73	1.49		4.33

Table 2. Influence of GA_3 concentration and stage of application on seed yield per plant (g) and seed yield per hectare (q) in zinnia

Treatments		Seed yield per plant (g)			Seed yield per hectare (q)		
		GA_3 Concentration (C)		Mean of S	GA_3 Concentration (C)		Mean of S
		C_1 - 100 ppm	C_2- 200 ppm		C_1 - 100 ppm	C_2- 200 ppm	
Stage of application (S)	S_1 - 15 days after transplanting	1.90	2.02	1.96	0.875	0.925	0.900
	S_2 - Flower initiation	2.00	2.82	2.41	0.916	1.290	1.103
	S_3 - 50% flowering	1.90	2.20	2.05	0.875	1.008	0.942
	S_4 - S_1 + S_2	3.10	3.30	3.20	1.425	1.517	1.471
	S_5 - S_1 + S_3	3.09	3.28	3.18	1.416	1.500	1.458
	S_6 - S_2 + S_3	3.27	3.46	3.36	1.500	1.583	1.542
	S_7 - S_1 + S_2 + S_3	2.90	3.27	3.08	1.333	1.500	1.417
Mean of C		2.59	2.91	2.75	1.191	1.332	1.262
Control		1.82			0.833		
For comparing means of		S.Em±		CD at 5%	S.Em±		CD at 5%
GA_3 concentration (C)		0.03		0.09	0.013		0.039
Stage of application (S)		0.05		0.15	0.018		0.053
C x S		0.09		0.25	0.022		0.065
Treatment x Control		0.12		0.36	0.027		0.079

Table 3. Influence of GA_3 concentration and stage of application on thousand seed weight (g) and seed germination percentage in zinnia

Treatments		Thousand seed weight (g)			Seed germination (%)		
		GA_3 Concentration (C)		Mean of S	GA_3 Concentration (C)		Mean of S
		C_1 - 100 ppm	C_2- 200 ppm		C_1 - 100 ppm	C_2- 200 ppm	
Stage of application (S)	S_1 - 15 days after transplanting	7.23	7.33	7.28	80.00	81.00	80.50
	S_2 - Flower initiation	7.30	7.43	7.36	80.33	81.33	80.83
	S_3 - 50% flowering	7.30	7.36	7.33	80.33	81.00	80.66
	S_4 - S_1 + S_2	7.56	7.80	7.68	85.00	88.33	86.66
	S_5 - S_1 + S_3	7.56	7.63	7.59	84.66	87.00	85.83
	S_6 - S_2 + S_3	7.60	7.86	7.73	85.33	90.66	87.99
	S_7 - S_1 + S_2 + S_3	7.53	7.60	7.56	83.33	86.66	84.99
Mean of C		7.44	7.57	7.50	82.71	85.14	83.92
Control		7.11			79.66		
For comparing means of		S.Em±		CD at 1%	S.Em±		CD at 1%
GA_3 concentration (C)		0.02		0.09	0.21		0.83
Stage of application (S)		0.04		0.17	0.29		1.13
C x S		0.07		0.28	0.34		1.33
Treatment x Control		0.10		0.39	0.42		1.65

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