Original Revised Research Paper

EFFECT OF DIFFERENT COMBINATIONS OF NPK AND BIOFERTILIZERS ON ZINNIA (*Zinnia elegans* J.)

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ABSTRACT

The experiment was carried out to study the effect of different combinations of NPK and biofertilizers on zinnia (*Zinnia elegans* J.) at SKUAST – K, Shalimar, Srinagar, Jammu and Kashmir. The experiment was laid out in Randomised Block Design with three replications. The experiment consist of three levels of chemical fertilizers (NPK @ 28:16:10, 21:12:7.5, and 14:8:5 g/m^2) along with different combinations of biofertilizers [Azotobacter, PSB (Phosphorous Solubilizing Bacteria), KSB (Potassium Solubilizing Bacteria), Azotobacter + PSB, Azotobacter + PSB + KSB].The results reviled that treatment combination of (NPK 21:12:7.5 g/m^2 + Azotobacter + PSB + KSB) recorded maximum plant height (125.32 cm), number of primary branches (9.73), plant spread (66.55 cm^2), minimum days taken to anthesis (48.88 days), maximum flowering duration (42.42 days), seed yield per plant (21.19 g) respectively compared to control.

Keywords: Anthesis, Azotobacter, Biofertilizers, Flowering, Zinnia

INTRODUCTION

Zinnia is a genus of plants of the sunflower tribe (Asteraceae) within the daisy family (Linnaeus, 1759). They are native to scrub and dry grassland in an area stretching from the South-western to South America, with a centre of diversity in Mexico. Members of

the genus are notable for their solitary long-stemmed flowers that come in a variety of bright colours. The genus name honours German master botanist Johann Gottfried Zinn.

Zinnia elegans, known as youth-and-age, zinnia is a popular garden flower, usually grown from seed and preferably in fertile, humus-rich and well-drained soil, in an area with full sun. Zinnias flower are champion of season among summer annual flowers. Zinnia is originated from Mexico; the Spanish referred it as "mal de ojos" (meaning sickness of the eyes). Modern Zinnia has been developed from species *Zinnia elegans* Jacq. Zinnia range in height from 15-100 cm. zinnia leaves are sandpapery in texture, contrary, generally stalk less (sessile), pale to middle green in colour and having different forms (linear and ovate). Zinnias may be used as cut flowers, in beds, container, border and background or as cottage; garden plants attracts birds, butterflies and hummingbirds.

Zinnia requires appropriate nutrition for its proper growth and development to be sufficiently green, vigorous and to produce abundant flowers of adequate size and colour intensity with good lasting qualities (Joiner and Gruis, 1961). Nitrogen is one of the most important nutritional elements for plants and is essential for all biological processes that occur in plant's primary life. Plant growth is not possible without nitrogen and in conditions of low level of nitrogen plant remain small (Alkurdi, 2014). Among the important plant food ingredients, potassium is an essential element, a backbone to plants life which play vital roles in plant life. It increases root growth and improves drought resistance (Shah *et al.*, 2014). Though the chemical fertilizers are important source of nutrients, they are not only costly but growing concerns of environmental pollution and limitation of non-renewable resources may introduce additional constraints. The use of chemical fertilizer also poses a major threat to sustain soil health and crop productivity. At present we are not in a position to abandon the use of chemical fertilizers completely, so the best option available is to use these fertilizers in lesser amount along with other nutrients sources. To minimise the use of these inputs (chemical fertilizers) without effecting the overall production and the ecosystem, it is necessary to use eco-friendly, economical and easily available biofertilizers for the development of more efficient fertility management programme. These are cost effective and renewable source of plant nutrients to supplement the chemical fertilizers for sustainable floriculture. Incorporation of biofertilizers in combination with chemical fertilizers can completely prevent the detrimental effect of current practice (Maurya and Beniwal, 2003).

MATERIALS AND METHODS

The present investigation was carried out at floriculture research farm, division of Floriculture and Landscape Architecture. Sher-e-Kashmir University of Agriculture Science and Technology, Shalimar, Srinagar, during year 2017-2018 / 2018-2019. The experimental farm is located between 34^{O} 05′ N latitude and 74^{O} 98′ E longitude at an altitude of 1587 meters above mean sea level. The climate is temperate-cum-mediterranean and continental type characterized by hot summer and severe winters. The average annual precipitation is 944.6 mm, and more than 80% precipitation received from western disturbances. Three levels of chemical fertilizers (NPK @ 28:16:10, 21:12:7.5, and 14:8:5 g/m^2) along with different combinations of biofertilizers [Azotobacter, PSB (Phosphorous Solubilizing Bacteria), KSB (Potassium Solubilizing Bacteria), Azotobacter + PSB, Azotobacter + PSB + KSB]. Chemical fertilizers were added one day before transplanting, whereas seedlings were treated by dipping root portion of seedlings in solution prepared by mixing biofertilizers in 1000ml water for 30 minutes before transplanting, biofertilizers viz. Azotobacter, PSB and KSB were procured from SKUAST- K Wadura, Sopore. Biofertilizers application was done through seedling dip method. Transplanting was done during 4^{th} week of May, treated seedlings were planted by maintaining spacing of 30 × 40 cm thus accommodating twelve plants. Harvesting was done during 3^{rd} week of November, five plants are randomly selected from each unit plot for collecting data. The experiment comprises of 18 different treatment combinations laid out in Randomized Block Design (RBD) replicated thrice.

RESULTS AND DISCUSSION

PLANT HEIGHT AT HARVEST (cm)

The result of analysis for plant height is presented in table 1. Among different treatment combination (NPK 21:12:7.5 g/m^2 + Azotobacter + PSB + KSB) recorded maximum plant height (125.32 cm) which was statistically superior to other combination of NPK and biofertilizers. The possible reason for increase in plant height is that combined application of biofertilizers along with (NPK 21:12:7.5 g/m^2) resulted in better nutrition which leads to increased photosynthetic activity, enhanced cell division and enlargement as nitrogen is important constituent of nucleic acid and it might have increased the synthesis of carbohydrates, amino acids etc. From which phytohormones like auxins, gibberellins and cytokines have been synthesized and phosphorous being an essential component of protoplasm and chlorophyll, cause conversion of photosynthates into phospholipids resulting

in adequate vegetative growth thus increased plant height at harvest. Biofertilizers produce several growth promoting hormones (auxins, cytokinins and gibberellins etc.) in addition to increasing the availability of nitrogen, phosphorous and potash to the plants resulting in better plant growth. Similar results of increase in plant height at harvest due to combined application of biofertilizers with reduced dose of NPK have been reported by Chaitra and Patil (2007), Patil and Agasimani (2013) and Kiran *et al.,* (2014) in China Aster; Verma *et al.,* (2011) in chrysanthemum and Airadevi (2012) in annual chrysanthemum.

NUMBER OF PRIMARY BRANCHES PER PLANT

The perusal of pooled data presented in Table 1 clearly shows difference in number of primary branches per plant due to different combination of NPK and biofertilizers. Among different treatments T_{12} (NPK 21:12:7.5 g/m^2 + Azotobacter + PSB + KSB) recorded maximum number of primary branches per plant (9.73). The increase in number of primary branches per plant with treat might be due to formation of nitrogenous compounds such as proteins, amino acids, nucleic acids, various enzymes and coenzymes which were responsible for cell division and cell enlargement and the role of phosphorous in structural component as in phospholipid and in translocation of food material this results might be due to role of Azotobacter in nitrogen fixation and production of growth promoting substances such as IAA and gibberellins which lead to more no of primary branches per plant. Similar result with increase in number of primary branches with inoculation of Azotobacter and PSB (Phosphorous solubilizing bacteria) in African marigold has been reported by Gupta *et al* (1999) and Panchal *et al* (2010) in annual chrysanthemum

PLANT SPREAD (cm^2)

Perusal of pooled data presented in Table 2 clearly shows that (NPK 21:12:7.5 g/m^2 + Azotobacter + PSB + KSB) recorded maximum plant spread (66.55 cm^2) result clearly showed that the combined application of biofertilizers (Azotobacter, PSB and KSB) along with NPK @ 21:12:7.5 g/m^2 proved to be beneficial for robust growth of plant as compared to other treatments this may be attributed to the possible role of nitrogen in improving structural parameters as it is an important constituent of protein and the role of phosphorous in structural component as in phospholipid and in absorbing and in translocation of food

material. Moreover, biofertilizers viz. Azotobacter, PSB and KSB proved to be beneficial as they fix atmospheric nitrogen in soil and also secrete growth promoting substances like auxins which stimulate the plant metabolic activity and photosynthetic efficiency leading to better growth of plant, above result are in conformity with the findings of Panchal *et al* (2010).

DAYS TAKEN TO ANTHESIS

Perusal of pooled data presented in Table 2 clearly shows that (NPK 21:12:7.5 g/m^2 + Azotobacter + PSB + KSB) recorded minimum days taken to anthesis (48.88 days). The reason for earliness of flowering can be proper uptake of nutrient and production of growth promoting substances like auxins, gibberellins, vitamins and organic acids by the biofertilizers further phosphorous is an important element and essential for initiation of flowering and PSB is known to increase the availability of phosphorous resulting in early flowering similar result for early flowering by combined application of NPK along with biofertilizers are reported by Kiran *et al.,* 2014, Chitra and Patil (2007)

FLOWERINF DURATION (days)

The perusal of pooled data presented in table 3 reviled that (NPK 21:12:7.5 g/m^2 + Azotobacter + PSB + KSB) recorded maximum flowering duration (42.42 days). This might be ascribed to the proper uptake of nutrients by the plants with inoculation of biofertilizers. Azotobacter, PSB and KSB plays important role as they helps in better nitrogen fixation, increased availability of phosphorous and its greater uptake, better root growth and uptake of nutrients. More photosynthesis enhanced food accumulation which might have resulted in increase in flowering duration subsequently higher number of flowers per plant this result can be supported by the findings of Chitra and Patil (2007), Sharma *et al*., (2009), Mittal *et al*., (2010) in African marigold; Panchal *et al.,* (2010)

SEED YIELD PER PLANT (g)

(NPK 21:12:7.5 g/m^2 + Azotobacter + PSB + KSB) recorded maximum seeds yield per plant (21.19 g), as shown in table 3, Biofertilizers are helpful in increasing the nutrient supplies to the plants and also in increasing the efficacy of chemical fertilizer applied. The biofertilizers improve the soil health which is reflected in increased plant growth and

development. Thus, for higher yields of quality flower and for better and healthy seed production, application of biofertilizers are the supplemental application to be included in the integrated plant nutrition management. The result of present study are in close conformity with the finding of Sharma *et al.,* (2009) in china aster. Increase in Phosphorous availability due to application of PSB result in significant increase in seed yield per plant this might be due to more dry matter production by the plant which exhibit superior vegetative growth, results are in concordance with the findings of Sehrawat *et al.,* (2003). Whereas potassium along with application of KSB also plays an important role in photosynthesis, it also regulates the opening and closing of stomata, and therefore regulate CO_2 uptake, which ultimately results in better seed production.

CONCLUSION

Integrated nutrient management enhance the availability of applied as well as native soil nutrients. Application of (NPK 21:12:7.5 g/m^2 + Azotobacter + PSB + KSB) significantly improves vegetative, flowering and seed parameters compared to control.

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Figure. 1. Bio fertilizer treatment to seedling.

Figure. 2. Crop at vegetative stage

Figure. 3. Fully bloomed Flower

Table 1. Effect of different combinations of NPK and biofertilizers on plant height (cm) and number of primary branches per plant in zinnia (*Zinnia elegans* j.)

Details of treatment	Plant height (cm)			Number of primary branches per plant		
	2017	2018	Pooled	2017	2018	Pooled
NPK 28:16:10 g/m^2	118.14	118.64	118.39	6.83	6.83	6.83
NPK 28:16:10 g/m^2 + Azotobacter	119.53	121.02	120.28	7.76	7.90	7.83
NPK 28:16:10 g/m^2 + PSB	118.53	119.26	118.90	7.33	7.40	7.36
NPK 28:16:10 g/m^2 + KSB	117.60	118.66	118.13	7.33	7.46	7.40
NPK 28:16:10 g/m^2 + Azotobacter + PSB	121.08	122.57	121.82	7.86	8.00	7.93
NPK 28:16:10 g/m^2 + Azotobacter + PSB + KSB	122.87	124.05	123.46	9.46	9.50	9.48
NPK 21:12:7.5 g/m^2	117.23	118.09	117.66	6.93	7.03	6.98
NPK 21:12:7.5 g/m^2 + Azotobacter	121.03	122.97	122.00	8.96	9.16	9.06
NPK 21:12:7.5 g/m^2 + PSB	120.36	122.13	121.25	8.90	9.03	8.96
NPK 21:12:7.5 g/m^2 + KSB	120.16	121.04	120.60	7.66	7.83	7.75

NPK 21:12:7.5 g/m^2 + Azotobacter + PSB	122.95	124.49	123.72	9.00	9.13	9.06
NPK 21:12:7.5 g/m^2 + Azotobacter + PSB + KSB	124.43	126.21	125.32	9.66	9.80	9.73
NPK 14:8:5 g/m^2	116.46	117.32	116.89	5.66	5.70	5.68
NPK 14:8:5 g/m^2 + Azotobacter	118.13	120.21	119.17	7.03	7.20	7.11
NPK 14:8:5 g/m^2 + PSB	117.66	118.23	117.95	7.00	7.20	7.10
NPK 14:8:5 g/m^2 + KSB	116.86	117.53	117.20	6.33	6.46	6.40
NPK 14:8:5 g/m^2 + Azotobacter + PSB	119.88	121.08	120.48	8.00	8.13	8.06
NPK 14:8:5 g/m^2 + Azotobacter + PSB + KSB	120.96	122.90	121.93	8.43	8.63	8.53
C.D$_{(p\leq0.05)}$	**1.662**	**2.21**	**1.78**	**1.15**	**1.10**	**1.11**

Table 2. Effect of different combinations of NPK and biofertilizers on plant spread (cm^2) and days taken to anthesis in zinnia (*Zinnia elegans* j.)

Details of treatment	**Plant spread (cm^2)**			**Days taken to anthesis**		
	2017	**2018**	**Pooled**	**2017**	**2018**	**Pooled**
NPK 28:16:10 g/m^2	58.88	59.21	59.04	52.00	51.59	51.79
NPK 28:16:10 g/m^2 + Azotobacter	59.03	59.37	59.20	51.67	51.30	51.48
NPK 28:16:10 g/m^2 + PSB	61.10	61.77	61.43	51.00	50.84	50.92
NPK 28:16:10 g/m^2 + KSB	59.43	59.97	59.70	51.33	51.06	51.20
NPK 28:16:10 g/m^2 + Azotobacter + PSB	60.13	61.43	60.78	50.67	50.26	50.46
NPK 28:16:10 g/m^2 + Azotobacter + PSB + KSB	64.10	64.17	64.13	49.67	49.52	49.59
NPK 21:12:7.5 g/m^2	55.13	55.40	55.27	53.00	52.66	52.83
NPK 21:12:7.5 g/m^2 + Azotobacter	61.77	62.13	61.95	51.00	50.73	50.87
NPK 21:12:7.5 g/m^2 + PSB	63.30	63.67	63.48	50.33	50.54	50.44
NPK 21:12:7.5 g/m^2 + KSB	61.27	61.60	61.43	50.67	50.46	50.56
NPK 21:12:7.5 g/m^2 + Azotobacter + PSB	65.30	65.83	65.57	50.00	49.77	49.89
NPK 21:12:7.5 g/m^2 + Azotobacter + PSB + KSB	66.30	66.80	66.55	49.00	48.76	48.88

NPK 14:8:5 g/m^2	52.43	53.63	53.03	54.33	53.98	54.16
NPK 14:8:5 g/m^2 + Azotobacter	54.20	54.57	54.38	52.67	53.17	52.92
NPK 14:8:5 g/m^2 + PSB	55.00	56.57	55.78	51.00	50.44	50.72
NPK 14:8:5 g/m^2 + KSB	53.67	54.23	53.95	52.67	52.40	52.53
NPK 14:8:5 g/m^2 + Azotobacter + PSB	57.13	57.47	57.30	51.33	51.00	51.16
NPK 14:8:5 g/m^2 + Azotobacter + PSB + KSB	59.77	60.50	60.13	50.67	50.39	50.53
C.D$_{(p\leq0.05)}$	**5.20**	**4.86**	**4.91**	**1.30**	**1.40**	**1.27**

Table 3. Effect of different combinations of NPK and biofertilizers on flowering duration (days) and seed yield per plant in zinnia (*Zinnia elegans* j.)

Details of treatment	**Flowering duration (days)**			**Seed yield per plant (g)**		
	2017	**2018**	**Pooled**	**2017**	**2018**	**Pooled**
NPK 28:16:10 g/m^2	38.33	38.37	38.35	13.89	14.07	13.98
NPK 28:16:10 g/m^2 + Azotobacter	37.67	37.80	37.74	15.68	16.42	16.05
NPK 28:16:10 g/m^2 + PSB	39.67	39.87	39.77	17.30	18.15	17.72
NPK 28:16:10 g/m^2 + KSB	38.33	38.50	38.42	16.93	17.84	17.38
NPK 28:16:10 g/m^2 + Azotobacter + PSB	40.67	40.87	40.77	18.12	19.01	18.56
NPK 28:16:10 g/m^2 + Azotobacter + PSB + KSB	41.67	41.83	41.75	19.60	20.39	19.99
NPK 21:12:7.5 g/m^2	37.67	37.87	37.77	12.34	12.11	12.22
NPK 21:12:7.5 g/m^2 + Azotobacter	39.00	39.23	39.12	17.27	17.90	17.59
NPK 21:12:7.5 g/m^2 + PSB	40.33	40.60	40.47	18.78	19.57	19.17
NPK 21:12:7.5 g/m^2 + KSB	39.67	39.80	39.73	18.21	19.18	18.69
NPK 21:12:7.5 g/m^2 + Azotobacter + PSB	41.67	42.00	41.83	20.12	21.03	20.58
NPK 21:12:7.5 g/m^2 + Azotobacter + PSB + KSB	42.33	42.50	42.42	20.86	21.51	21.19
NPK 14:8:5 g/m^2	35.00	35.00	35.00	10.56	11.04	10.80

NPK 14:8:5 g/m^2 + Azotobacter	36.33	36.53	36.43	12.73	13.35	13.04
NPK 14:8:5 g/m^2 + PSB	37.67	37.90	37.78	13.87	14.47	14.17
NPK 14:8:5 g/m^2 + KSB	37.00	37.20	37.10	13.55	14.29	13.92
NPK 14:8:5 g/m^2 + Azotobacter + PSB	38.67	38.90	38.78	14.94	15.87	15.40
NPK 14:8:5 g/m^2 + Azotobacter + PSB + KSB	39.00	39.17	39.08	16.79	17.70	17.24
C.D$_{(p\leq0.05)}$	**1.12**	**1.15**	**1.12**	**1.37**	**1.38**	**1.31**

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