**Original Research Article**

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

## Abstract

The experiment was carried out to study the effect of different combinations of NPK and biofertilizers in on zinnia (*Zinnia elegans* J.). 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 other humming birds hummingbirds.

Zinnia requires appropriate nutrition for its proper growth and development to be sufficiently green, vigorous and produce abundant flowers of adequate size and color intensity with good lasting qualities (Joiner and Gruis, 1961). Though the chemical fertilizers are an 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 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, KSB). Seedlings were treated by dipping root portion of seedlings in solution prepared by mixing biofertilizers in 1000ml water for 30 minutes before transplanting. Treated seedlings were plant by maintaining spacing of 30 × 40 cm thus accommodating nine plants. Five plants are randomly selected from each unit plot for collecting data and the mean value of all the parameters were analysed by Duncan’s multiple range test (DMRT) AT 5% level of probability. He 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 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). He 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… has been reported by Gupta *et al* (1999), Panchal *et al* (2010)

## 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 Azotobacter PSB and KSB along with… NPK 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). It is because nitrogen, phosphorous and potassium leads to increase in growth parameters and translocation and accumulation of photosynthates might be the reason for increase in flowering duration result got support from Airadevi (2012)

**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, 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 has many different roles in plant: in photosynthesis, potassium regulates the opening and closing of stomata, and therefore regulate CO2 uptake. Potassium trigger activation of enzymes and essential for production of Adenosine Triphosphate (ATP).

## CONCLUSION

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

**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$_{(p\leq 0.05)}$** | **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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