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Effect of NP fertilizers on the growth and flower production of Zinnia (*Zinnia elegans* L.)

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The effect of different NP levels on the growth and flower production of *Zinnia elegans* L. were investigated. The experiment was conducted at Sindh Agriculture University Tandojam during the year 2007 evaluating six NP levels (10+10, 10+20, 30+10, 30+20, 50+10 and 50+20 g/1.5 m^2). Highest NP rate of 50+20 g/1.5 m^2 took 50.66 days to emergence of first flower bud, 59.66 days for opening of first flower, 7.33 days life of flower, 11.33 branches $plant^{-1}$, 12.66 flowers $plant^{-1}$ and plant height of 68.22 cm. The NP at 50+10 g/1.5 m^2 took 52.33 days to emergence of first flower bud, 60.33 days to opening of first flower, 6.66 days average life of flower, 10.33 branches $plant^{-1}$, 11.33 flowers $plant^{-1}$ and plant height of 61.31 cm. Zinnia fertilized with 30+20 g N+P/1.5 m^2 took 55.00 days to emergence of first flower bud, 62.33 days to opening of first flower, 6.33 days average life of flower, 9.00 branches $plant^{-1}$, 10.33 flowers $plant^{-1}$ and plant height of 53.66 cm. Reduced NP levels to 30+10 g, 10+20 g and 10+10 g/1.5 m^2 resulted in considerable negative effect on all the growth and flowering related parameters of zinnia. There was inverse effect of increasing NP levels on days taken to emergence of first flower bud and opening of first flower, while linear positive effect of increasing NP rates on flower life, number of branches and flowers $plant^{-1}$ and plant height. However, NP application at 50+10 g/1.5 m^2 proved to be an optimum level for zinnia flower production, because differences in almost all the growth and production related parameters between 50+20 g/1.5 m^2 and 50+10 g/1.5 m^2 were ststistically non-significant.

Key words: Zinnia, NP levels, flower production

Introduction

Zinnia (*Zinnia elegans* L.) is originated from Mexico and considered as a warm climate plant. The leaves are lance-shaped and sandpapery in texture, and height ranges from 15 cm to 1 meter. Zinnia is a genus of 20 species of annual and perennial plants of family Asteraceae, originally from scrub and dry grassland in an area stretching from the American Southwest to South America,

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but primarily Mexico, and notable for their solitary long-stemmed flowers that come in a variety of bright colors. Zinnia leaves are opposite and usually stalkless, with a shape ranging from linear to ovate, and pale to middle green in color. The flowers have a range of appearances, from a single row of petals, to a dome shape, with the colors white, chartreuse, yellow, orange, red, purple, and lilac. Zinnias are popular garden flowers, usually grown from seed, and preferably in fertile, humus-rich, and well-drained soil, in an area with full sun. They will reseed themselves each year. Over 100 cultivars have been produced since selective breeding started in the 19th century. Zinnias seem especially favored by butterflies, and many gardeners add zinnias specifically to attract them.The name of the genus derives from the German botanist Johann Gottfried Zinn (Wikipedia, 2007).

Zinnias have been a favorite of gardeners for generations, and this interest has led to the development of hundreds of cultivars in a range of sizes and plant forms, from spreading, dwarf plants to 4-foot giants. The graceful narrow-leaved or creeping zinnia is useful for naturalizing in rock gardens, containers, and hanging baskets. Dwarf plants start at 6 inches tall, while taller cultivars grow up to 3 feet tall. Narrow-leaved zinnia is used for bedding or for mass plantings as edging or filler plants (Kessler, 2008). When well grown, gradually acclimatize young plants to outdoor conditions for a few weeks before planting out after all risk of frost, 23-30 cm (9-12 in) apart, special care is needed not to damage the root system (Stephen, 2004).

In the landscape, zinnias are tolerant of all except wet, poorly aerated soils that can cause root rot. Exposure to full sun, proper plant spacing, good air movement, and avoiding overhead irrigation decrease the occurrence of several diseases including powdery mildew, leaf spots, and bacterial blights. With drip irrigation, the foliage stays dry, and there is reduced splashing of disease that can be spread from leaf to leaf or from plant to plant. Though tall cultivars of zinnia are planted for cut flowers, this publication will focus on zinnias commonly grown for greenhouse production in either market flats or in containers and used primarily as bedding or flowering pot plants (Kessler, 2008).

Optimum use of chemical fertilizers for plants like zinnia is always confusing for the common grower. Generally farm yard manure is applied, because well rotten manure has balanced NP with no burning risk like Urea or DAP. However, NP in the liquid form can also be sprayed to produce lush green foliage and more attractive flowers. Poultry manure is also suggestible for good zinnia growth, while processed NPK fertilizers for soil application also proved good results. Slow-release, 12-6-6 fertilizer also proved promising for zinnia growth and flowering, while in an experiment about 1 kg N for an area of 100 square feet proved optimum results. According to Baloch (1994) among different

N levels (100, 150, 200 and 300 kg ha^{-1}) good plant growth, maximum numbers of flowers, branches, weight of flowers were obtained from the zinnia fertilized with 300 kg N ha^{-1}. Bhattacharjee and Mukherjee (1984) recommended N rate at 20, 30 or 40 kg ha^{-1}, P_2O_5 at 30, 40 or 50 and K_2O at 40 kg ha^{-1} for flower production in zinnia.

Zinnias can be fertilized by a variety of sources. Stephen (2004) found that the poultry manure is the most effective manure for Zinnia to grow taller. The average height for the nine plants, after 18 days in poultry manure was 52.67 mm. Processed fertilizer (NPK) was the second most effective where after 18 days the average plant height was 47.13 mm. Plants in potting soil had an average height of 43 mm after 18 days, while during this period the average height for plants in FYM was 38 mm. To ascertain the proper combination level of nitrogen and phosphorus, the study was carried out to investigate the influence of different NP levels on the growth and flowering of Zinnia under agro-ecological conditions of Tandojam.

Materials and methods

For this study, the whole plot was properly worked and leveled for even distribution of water. Thereafter, the plot was divided into 18 beds measuring 1.50 m x 1.00 m (1.5 m^2). Each bed was separated by developing 30 cm bund, and these sub-plots/beds were prepared in such a way to be irrigated feasibly and uniformly. The zinnia seedlings were transplanted at a distance of 30 cm between rows and 20 cm between plants. Treatments included NP levels of 10+10, 10+20, 30+10, 30+20, 50+10 and 50+20 g/1.5 m^2. The nitrogen fertilizer was applied in the form of Urea (46% nitrogen), and phosphorus in the form of single super phosphate (SSP). Both the fertilizers i.e. nitrogen and phosphorus were applied by using fertigation method. The flower beds were kept clean, and a periodical weeds removal practice was carried out to avoid any possible constraint against the experimental process. Thus, all the cultural practices were performed uniformly in all the beds. The observations recorded on the basis of five selected zinnia plants in each sub-plot. The plants were selected at random and these plants were marked by different labels to avoid any confusion and mixup of the representative plants. The observations on emergence of first flower bud and opening of first flower and later life of the flower were cautiously recorded at the field. The data thus recorded were tabulated, and then averages were worked out. Statistical analysis of the data was done to discriminate the superiority of treatment means, by employing L.S.D (Least Significant Differences) test, as per the statistical methods developed by Gomez and Gomez (1984) through Mstat-C Computer package.

Results

Days taken to emergence of first flower bud

Zinnias receiving NP fertilizers at lowest rate of 10+10 g/1.5 m^2 exprienced the emergence of first flower bud in 60 days, followed by NP levels of 10+20 and 30+10 g/1.5 m^2 where the first flower bud emergence was recorded in 58.00 and 56.33 days, respectively. Similarly, the increasing NP levels at 30+20 and 50+10 g/1.5 m^2 further delayed the emergence of first flower bud i.e. 55.00 days and 52.33 days, respectively. However, the highest NP rate of 50+20 g/1.5 m^2 took minimum number of days (50.66) to emergence of first flower bud.

Days taken to opening of first flower

The plants fertilized with lowest NP rates of 10+10 g/1.5 m^2 gave a maximum number of days (66.00) to opening of first flower, followed by 10+20 and 30+10 g/1.5 m^2 where the opening of first flower was recorded in 64.66 and 63.66 days, respectively. Results further indicated that increasing NP levels of 30+20 and 50+10 g/1.5 m^2 delayed the opening of first flower considerably to 62.33 days and 60.33 days, respectively. However, the highest NP level of 50+20 g/1.5 m^2 took lowest number of days (59.66) to opening of first flower.

Life of single flower (days)

Zinnias fertilized with highest NP level of 50+20 g/1.5 m^2 resulted the flowers with maximum life (7.33 days), followed by the NP levels of 50+10 and 30+20 g/1.5 m^2, where the zinnia plants produced flowers with average life of 6.66 and 6.33 days, respectively. The plants received lower NP levels of 30+10 and 10+20 g/1.5 m^2 resulted flowers with decreased life of 5.33 and 4.66 days, respectively. However, the lowest NP level of 10+10 g/1.5 m^2 produced zinnia flowers with minimum life of 4.33 days.

Number of branches plant^{-1}

The zinnia plants fertilized with highest NP level of 50+20 g/1.5 m^2 produced significantly maximum number of branches (11.33) plant^{-1}, followed by the NP levels of 50+10 and 30+20 g/1.5 m^2, where the zinnia plants produced 10.33 and 9.00 branches plant^{-1}, respectively. The zinnias received 30+10 and 10+20 g/1.5 m^2 produced 8.33 and 7.00 average number of branches plant^{-1}, respectively. However, the lowest NP level of 10+10 g/1.5 m^2 produced minimum number of branches (6.00) plant^{-1}.

Table 1. Mean values for growth and flower production of *Zinnia elegans* L. as affected by various NP combination levels.

Treatments	Days to emergence of 1st flower bud	Days to opening of 1st flower	Average life of flower (days)	No. of branches per plant	No. of flowers per plant	Plant height (cm)
T1=10g N+10g P/1.5m^2	60.00 a	66.00 a	4.33 c	6.00 c	6.00 d	38.77 f
T2=10g N+20g P/1.5m^2	58.00 ab	64.66 b	4.66 c	7.00 b	8.00 c	42.21 e
T3=30g N+10g P/1.5m^2	56.33 bc	63.66 c	5.33 bc	8.33 b	9.33 b	45.11 d
T4=30g N+20g P/1.5m^2	55.00 c	62.33 d	6.33 ab	9.00 b	10.33 b	53.66 c
T5=50g N+10g P/1.5m^2	52.33 d	60.33 e	6.66 a	10.33 a	11.33 a	61.33 b
T6=50g N+20g P/1.5m^2	50.66 de	59.66 f	7.33 a	11.33 a	12.66 a	68.22 a
S.E.±	0.3626	0.1427	0.1774	0.3651	0.3549	0.3756
LSD 0.05	1.5240	0.5992	0.7458	1.5340	1.4920	1.5790
LSD 0.01	2.0880	0.8209	1.0220	2.0020	2.0000	2.1630
CV%	3.26	4.56	7.52	10.32	9.04	3.78

Values followed by same letters do not differ significantly at 0.05 probability level.

Number of flowers plant^{-1}

Zinnias supplied with highest NP rates of 50+20 g/1.5 m^2 produced remarkably higher number of flowers (12.66) plant^{-1}, followed by the NP levels of 50+10 and 30+20 g/1.5 m^2, where the zinnia plants produced 11.33 and 10.33 flowers plant^{-1}, respectively. The plants received NP fertilizers at the rates of 30+10 and 10+20 g/1.5 m^2 produced 9.33 and 8.00 average number of flowers plant^{-1}, respectively. However, the lowest NP level of 10+10 g/1.5 m^2 produced least number of flowers (6.00) plant^{-1}.

Plant height (cm)

Zinnia elegans fertilized with highest NP level of 50+20 g/1.5 m^2 grew to a maximum height of 68.22 cm, followed by NP levels of 50+10 and 30+20 g/1.5 m^2 with average plant height of 61.31 and 53.66 cm, respectively. The lower NP levels of 30+10 and 10+20 g/1.5 m^2 produced plants of 45.11 and 42.11 in height, respectively. However, the lowest NP level of 10+10 g/1.5 m^2 produced least plant height of 38.77 cm.

Discussion

The findings from the present study indicated that the highest NP rate of 50+20 g/1.5 m^2 took 50.66 days to emergence of first flower bud, 59.66 days to opening of first flower, 7.33 days life of flower, 11.33 branches plant^{-1}, 12.66 flowers plant^{-1} and plant height of 68.22 cm. The NP at 50+10 g/1.5m^2 took

52.33 days to emergence of first flower bud, 60.33 days to opening of first flower, 6.66 days average life of flower, 10.33 branches plant^{-1}, 11.33 flowers plant^{-1} and plant height of 61.31 cm ; while the lowest N+P level of 10+10 g/1.5 m^2 took 60.00 days to emergence of first flower bud, 66.00 days to opening of first flower, 4.33 days average life of flower, 6.00 branches plant^{-1}, 6.00 flowers plant^{-1} and 38.77 cm plant height. There was inverse effect of increasing NP levels on days taken to emergence of first flower bud and opening of first flower, while linear positive effect of increasing NP rates on flower life, number of branches and flowers plant^{-1} and plant height. However, NP application at 50+10 g/1.5 m^2 proved to be an optimum level for zinnia flower production, because differences in almost all the growth and production related parameters between 50+20 and 50+10 g/1.5 m^2 were ststistically non-significant. These results are further supported by the findings of Baloch (1994) who tested N at the rate of 100, 150, 200 and 300 kg ha^{-1} and reported that plant growth, maximum numbers of flower, branches, weight of flower and plant were obtained from plant fertilized with 300 kg N ha^{-1}. Similarly, Maynard *et al.* (2003) studied *Zinnia elegans* and reported that NPK fertilizer at 10-10-10 can produce the highest cut flower yield. From a study in Pakistan, Abbasi *et al.* (2004) reported that the highest rates of P and K fertilizers significantly increased the size and shelf life of cut flowers, while Gonzalez and Pasian (2004) suggested fertilization to zinnia within 1 week post-transplant with Peters 20-10-20 at 200 ppm N and at 3 week intervals throughout July. Conducting study in Pakistan, Khan *et al.* (2004) found that emergence of first flower in *Zinnia elegans* delayed while number of flowers plant^{-1}, size of flowers and blooming period generally decreased at higher level of nitrogen, while N application at 20 and 10 g pot^{-1} were most effective in improving the vegetative and floral characteristics.

In a similar study Khan and Ahmed (2004) reported that the number of days before the emergence of first flower decreased, whereas the number of flower per plant, flower size and becoming period increased with increasing rates of N up to 10 g/pot and increased and decreased, respectively, with further increase in the N rate. Similarly, Omaha (2004) mentioned that Zinnia performed best in rich when soil media mixed a high phosphorous, low nitrogen fertilizer within the soil, while Ziaf *et al.* (2004) found that the number of days before the emergence of first flower decreased, whereas the number of flowers plant^{-1} was increased with increasing N up to 10 g/pot. In another study in Pakistan, Javid *et al.* (2005) evaluated *Zinnia elegans* and concluded that greatest plant height, number of lateral shoots, number of leaves, leaf area, number of flower per plant, and 100-seed weight were obtained with 30 + 20 + 20 g NPK, while Larik *et al.* (2005) reported that

maximum plant height (74.50 cm), branches per plant (16.50), leaves per branch (17.75), blooming period (55.00 days), flowers per plant (15.05) and flower weight (13.25 g) were recorded with the application of 60 g N + 15 g K_2O_5/4 m^2.

Under similar soil and climatic conditions in India, Ramesh (2006) concluded that the plant height and the total number of branches $plant^{-1}$ in Zinnia increased steadily with increasing NPK fertilizer rates, while Knight (2007) examined N rate at 20, 30 or 40 kg ha^{-1}, P_2O_5 at 30, 40 or 50 and K_2O at 40 kg ha^{-1} and plant growth, number of flowers, flower size and flower longevity were best with the highest NPK rates. The above comparison of the findings of past research and results of the present investigation showed a concurrence and agreement with the exception of Zinnia cultivars, which is obviously a difference in zinnias planted in different parts of the world. However, in case of all the growth and flower production parameters, there was a similarity for NP application rates and consequent production performance of Zinnias.

Conclusions

It was concluded that there was linear positive effect of increasing NP rates on flower life, number of branches per plant, flowers per plant and plant height of *Zinnia elegans*, while inverse effect on days to emergence of first flower bud and opening of first flower. However, NP application at 50+10 g/1.5 m^2 proved to be an optimum level for zinnia flower production, because differences in almost all the growth and production related parameters between 50+20 and 50+10 g/1.5 m^2 were ststistically non-significant.

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