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Evaluation of *Zinnia elegans* growth and flowering to different levels of Nitrogen with constant dose of Potassium

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Abstract

Nutrient deficiency in soil is main hurdle in the floriculture industry. Different treatments (T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8 and T_9) were tested to optimize suitable fertilizer dose for high flower production of *Zinnia elegan* cv. Dreamland. We had observed less days to flowering in T_6, high number of flowers plant^{-1}, fresh and dry flower weight, plant height, number of primary and secondary shoots plant^{-1}, fresh shoots weight plant^{-1}, number of leaves plant^{-1}, leaf area and primary root diameter in T_8, but these parameters were non-significant with T_7, while maximum flower diameter, stem diameter, dry stem weight, fresh and dry leaves weight, number of roots, fresh and dry roots weight plant^{-1}, root length in T_7. The T_7 (N= 20g m^{-2} + 20g Km^{-2}) produced significant results for higher flower production and growth of *Zinnia elegans* cultivar Dream land under agro-climatic condition of Peshawar.

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Introduction

Zinnia (*Zinnia elegans*) belongs to the family Asteraceae have a prominent role in the floriculture industry and are champions of the season among the summer annual flowers (Choon, 2000). Zinnia have multiple colors in the flower, extensively used as cut flowers, in beds, borders, containers, cottage garden landscapes or as background plants, attract butterflies, hummingbirds, and other birds (Johnson & Kessler, 2007). Zinnia is a summer season flower in Pakistan. These brilliantly-coloured flowers are available from May to October in Peshawar (Shah *et al*. 2014). Quality flowers production required special care in term of nutrients, water and other culture practices. Among the plant nutrients nitrogen has important role. Nitrogen helps in the protein synthesis and formation of protoplasm, chlorophyll, enzymes, nucleic acids, NAD and NADP coenzyme etc. Inadequate supply of nitrogen to plants leads to lowering of respiratory rates and reduction in growth, late and less or no flowering and poor development of foliage and roots. Deficiency of nitrogen also leads to deposition of excess amount of lignin on cell-walls; cells become smaller and thick walled (Verma & Verma, 2008). Previously we have applied different levels of potassium to *Zinnia elegans*cv. Dreamland and find out that 20 g potassium m^{-2} showed significant effect on the flowers and morphology of zinnia (Shah *et al*. 2014). Nitrogen influences the consumption of K and other minerals in all plants (Haque and Jakhro, 2005). It means that nitrogen and potassium are inter-related with each other and an increase in supply of nitrogen to plant ultimately help plants to consume more potassium in large amount. In other words higher potassium levels offset damaging effects of high nitrogen levels. So balance dose of fertilizer favor more number of lateral shoots, good plant body, which have direct relationship with quality and more flower production. Keeping in view the importance of optimum nitrogen level with respect to potassium, the current study was designed to see the impact of different levels of nitrogen with recommended dose of potassium (Shah *et al*. 2014) on the growth characteristics and flowers of *Zinnia elegans* agro-climatic conditions of Peshawar, Pakistan.

Materials and methods

Experimental site, field preparation and soil analysis

The study was performed at Horticultural Nursery, Department of Horticulture, the University of Agriculture Peshawar in year 2010. Field was ploughed thoroughly and well decomposed Farm Yard Manure (FYM) was supplied at 20 tons ha^{-1}. Before fertilizer application, soil sample up to 25cm depth were taken randomly from different parts of the experimental plots and their composite sample was analyzed for soil texture (silt loam), $CaCO_3$ (21%), organic matter (0.14%), pH (8.02), EC (0.43d Sm^{-1}), N (0.24%), K_2O (24mg kg^{-1}) and P (12.84mg kg^{-1}).

Plant materials, experimental design and nutrients application

Seeds of zinnia cv. Dreamland were sown in 10 inches earthen pots and transplanted to experimental field at 2-3 true leaves stage. The experiment was laid out in Randomized Complete Block Design (RCBD) with different treatments i.e. T_1 (control), T_2 (N = 10 g m^{-2}), T_3 (N = 20g m^{-2}), T_4 (N = 30g m^{-2}), T_5 (N= 40g m^{-2}), T_6 (N= 10g m^{-2} + 20 g Km^{-2}), T_7 (N= 20g m^{-2} + 20g K m^{-2}), T_8 (N= 30g m^{-2} + 20g K m^{-2}), T_9 (N= 40g m^{-2} + 20g K m^{-2}). The experimental field was divided in 3-blocks having uniform conditions in each block, having 2.1 x 0.9m^2 area. Nitrogen was applied in split dose; half dose was before transplanting at time of field preparation and half dose before flower bud formation in form of urea. Potassium was applied one day before transplanting at time of field preparation in form of potassium sulphate. A recommended dose of phosphorus 20 gram per square meter was applied to all treatment as a basal dose (Javid *et al*. 2005) in form of single super phosphate.

The following parameters were studied. The parameters days to flowering, number of flowers $plant^{-1}$, flower diameter (cm), fresh and dry flower weight (g), plant height (cm), number of primary and secondary shoots $plant^{-1}$, stem diameter (cm), fresh and dry weight (g), number of leaves $plant^{-1}$, leaf area (cm^2), fresh and dry leaf weight (g), number of roots $plant^{-1}$, root length (cm), main root diameter (cm) and fresh and dry roots weight (g) were studied.

Statistical analysis

The data was analyzed through a statistical package named Statistix 8.1. The data were subjected to analysis of variance technique and means were compared using least significant test ($P \leq 0.05$).

Results and discussion

Flower Production

The fertilizers showed significant ($P \leq 0.05$) effect on the all the flowers characteristics (Fig. 1). Zinnia plants delayed flowering and took ~54 days to give flowers in the plots with application of 30-20g N-K_2O m^{-2} (T_8), while early flowers were recorded in the plants treated with T_6 and T_7 (Fig. 1A).

Nitrogen encourages more vegetative growth, dominating reproductive phase and zinnia took long to go to reproductive phase. According to Oyewole and Mera (2010) nitrogen increases juvenile period and delay crop maturity. Increase in nitrogen levels delayed flowering. Potassium plays a significant role in the transport of water and nutrients in plant xylem. When the potassium supply is increase, the transportation of nitrates, phosphates also increase (Bajwa & Rehman, 2005).

Nitrogen influences the consumption of P, K and other mineral in all plants (Haque & Jakhro, 2005). It means that nitrogen and potassium are inter-related with each other and an increase in supply of nitrogen to plant ultimately help plants to consume more potassium in large amount, so optimum levels of both nutrients are required for early flower production in plants. The imbalance of N and K may increase the potential of plant to focus on vegetative growth rather than reproductive growth and as result delays flowering.

The current study also showed that induce early flowers in zinnia needs optimum dose of nitrogen and potassium. Highest number of flowers $plant^{-1}$ was recorded in T_8 (~30) and T_7 (~29), while lowest number of flowers $plant^{-1}$ in T_4 (~15) and T_5 (~18) (Fig. 1B). The results of the current study are in concord with Javid *et al.* (2005) who studied the effect of fertilizer on performance of zinnia.

According to them number of flower was highest in plants receiving 30-20 g N-K_2O m^{-2}. Joiner and Gruis (1959) who have conducted experiment on effect of nitrogen and potassium levels on zinnia and marigold stated that at low potassium level and increasing nitrogen, decreased number of flowers produced.

According to them higher potassium levels offset damaging effects of high nitrogen levels. As balance dose of fertilizer favor more number of lateral shoots which have direct relationship with flower production. The flower diameter was increased in the plants treated with T_7 (10.13cm), while decreased (6.557cm) in control treatment (T_1) with respect to other treatments (Fig. 1C).

This may be due to that balance dose of fertilizer increase vegetative growth, which are co-related with protein and carbohydrate metabolism, which are essential for flower development (Meyer, 1973), while the adequate supply of nitrogen improves the flower size. The graph shows that maximum fresh and dry flower weight was perceived at T_8 (13.33g and 2.24g respectively) and T_7 (12.9g and 2.13g respectively), while lowest fresh and dry flower weight (5.87 g and 0.56g respectively) was recorded in the plots (control) without application of N and K fertilizers (Fig. 1D).

The finding of the current study are in close agreement reported by Shafi *et al.* (2002) who stated that flower weight increases with application of balance level of fertilizers and decrease with increasing level of nitrogen beyond the balance doze with Potassium and phosphorous. Potassium uptake usually precedes dry matter production (Fageria *et al.* 2010), while nitrogen influences the utilization of potassium in plants (Haque and Jakhro, 2005).

For optimum flower production there is need of balance nutrients. So our experimental results revealed that application of nitrogen and potassium with constant dose of phosphorous have increase the dry weight of zinnia flower with increases in other growth attributes.

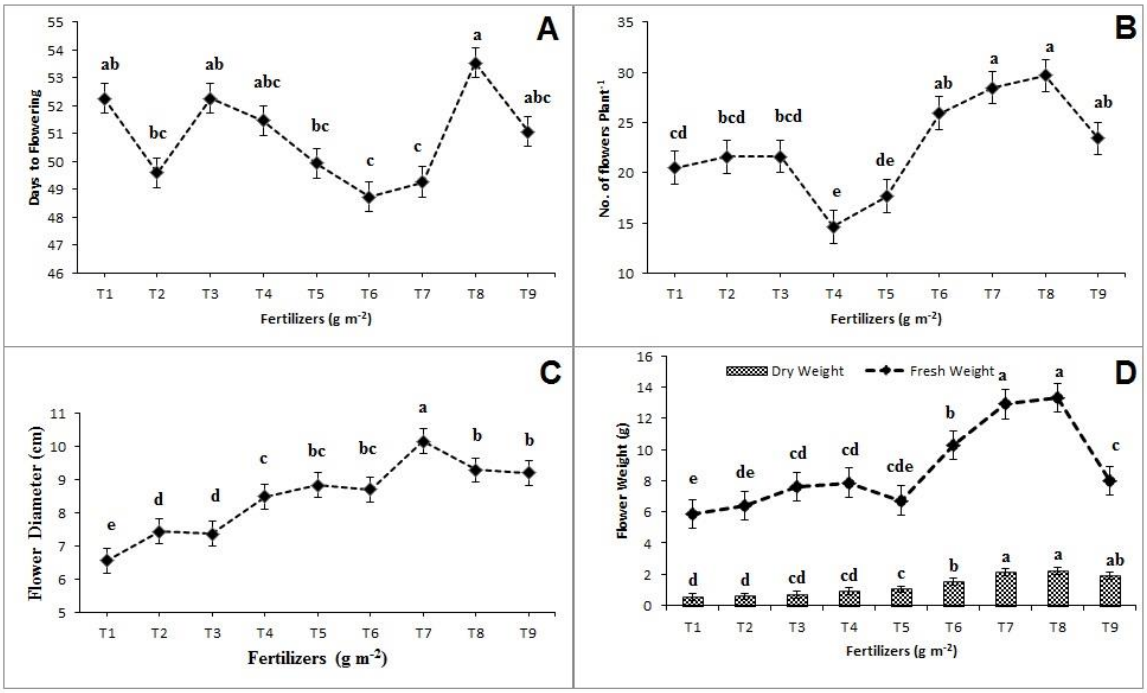

Fig. 1. Effect of different levels of nitrogen with constant dose of potassium on flower production of *Zinnia elegans* cv. Dream land. (A) Effect of fertilizers treatments on days to flowering: LSD value (P <0.05) = 2.8001 (B) Effect of fertilizers treatments on number of flowers plant^{-1}: LSD value (P <0.05) = 4.5556 (C) Effect of fertilizers treatments on flower diameter: LSD value (P <0.05) = 0.6548 (D) Effect of fertilizers treatments on fresh and dry flower weight: LSD value (P <0.05) = 0.4127 and 0.4127 respectively. The results represent the mean ± SE from three independent biological experiments.

Stem Growth

Higher plant was recorded in T_8 (42.67cm), while lower in the T_1 (20.67cm) (Fig 2A). The highest number of primary and secondary shoots plant^{-1} was recorded at T_8 (~13 and ~26 respectively) and T_7 (~12 and ~25 respectively), while lowest was in T_1 (~6 and ~12 respectively) (Fig. 2B). During the study wider stem diameter (1.25cm) was recorded in the plants treated with T_7, while lower (0.86 cm) in the plants treated with T_1 (Fig. 2C). Heaviest fresh (15.613g) and dry (4.25g) stem weight was recorded in T_8 and T_7 respectively, while lightest weight (7.46g and 2.33g) was in T_1 (Fig. 2D). Nitrogen is the main element in the protein synthesis, nucleic acid, to increase respiratory rates which promote plant growth and increase plant height (Verma & Verma, 2008) and to grow healthy stem. Inadequate supply of potassium to plants result in reduced length of stem internodes and reduced stem diameter (Wakhloo, 1975) due to reduced activity of the cambium. Therefore affect the plant height/body.

These results has an agreement with those reported by Javid *et al.* (2005) who recorded the maximum plant height of zinnia at same dose. The optimum level of nitrogen with higher dose of potassium, results maximum stem development in the zinnia. The balance level of nutrients has positive effect on the plant growth and development, and it improved plant vigor, vegetative growth and increased number of branches per plant as well as plant stems thickness.

The results of this study are in accordance with Shafi *et al.* (2002) and Javid *et al.* (2005). Plants respond to the higher nitrogen dose by producing wider and heavy plant body by producing large number of shoots and Potassium enhance meristematic activity (Verma & Verma, 2008) and transport photosynthate from leaves (Khalil & Jan, 2002).

Which result in vegetative growth of plant body and number of lateral shoots. Nitrogen is required for the formation of protoplasm,

protein synthesis and essential for carbohydrate use within plants (Verma & Verma, 2008). Potassium is required for nitrogen uptake and protein synthesis in the plants (Abbas & Hussain, 2010).

So the plant deficient in the nitrogen and potassium will have low growth and development with ultimately effect the fresh stem weight.

So overcome this problem plant need a balance dose of fertilizer to supply optimum nutrients to plant. Excess supply of nitrogen promotes more vegetative growth and succulence in plant body which is because of protoplasm is highly hydrated (Haque & Jakhro, 2005). So the plant has more hydrated will have less dry matter so that why zinnia plant so show more dry weight at 20-20g N-K_2O m^{-2}.

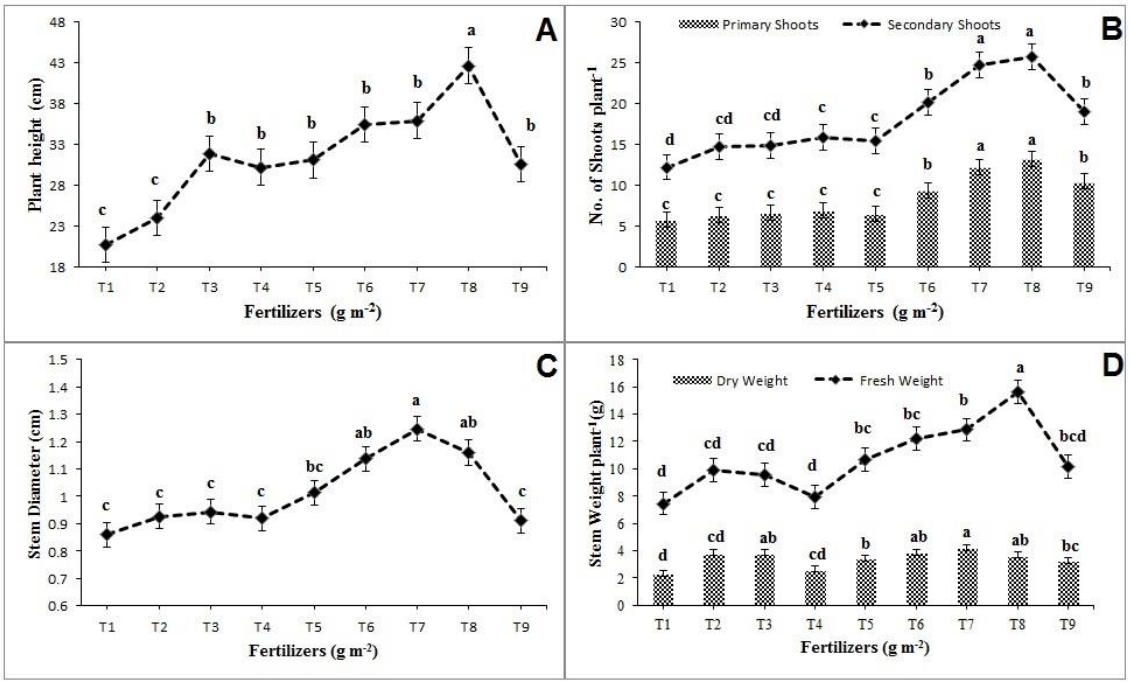

Fig. 2. Effect of different levels of nitrogen with constant dose of potassium on stem growth of *Zinnia elegans* cv. Dream land. (A) Effect of fertilizers treatments on plant height: LSD value (P <0.05) = 6.1135 (B) Effect of fertilizers treatments on number of primary and secondary shoots plant^{-1}: LSD value (P <0.05) = 1.2295 and 2.8420 respectively (C) Effect of fertilizers treatments on stem diameter: LSD value (P <0.05) = 0.1847 (D) Effect of fertilizers treatments on fresh and dry stem weight: LSD value (P <0.05) = 2.7222 and 0.7378 respectively. The results represent the mean ± SE from three independent biological experiments.

Leaf Growth

Maximum number of leaves plant^{-1} (~389) and leaf area (18.013cm^2) was recorded at T_8, while minimum number of leaves plant^{-1} (~218) and leaf area (9.607cm^2) at T_1 (Fig. 3A & 3B). Nitrogen is essential for synthesis of protein and nucleic acid to grow plant healthy leaves. Nitrogen and Potassium are considering most essential for the growth and development of plant and promote rapid plant growth. Application of balance dose of nutrients will increase plant growth and vigor and thus increases in number of leaves plant^{-1}.

This may be because of nitrogen increase leaf cell number and cell size which overall increase the production of leaf (Meyer, 1973). Potassium increases the translocation and synthesis of carbohydrate. Optimum dose of nitrogen and potassium will promote more leaf area to provide photosynthesis activity for vigorous and healthy plant growth. These results are an agreement with Khan *et al.* (2007), Shafi *et al.* (2002) and Javid *et al.* (2005) who find out that increase in fertilizers have significant effect on number of leaves plant^{-1} and leaf area.

The experiment results showed that maximum fresh (0.713g) and dry (0.209g) leaf weight was recorded at T_7, while lower fresh (0.404g) and dry (0.055g) leaf weight in the plants treated with T_1 (Fig. 3C). Nitrogen is a part of all proteins and enzymes, of chlorophyll a and chlorophyll b. Nitrogen deficient plant have low chlorophyll content, relatively low quantities of light are absorbed. As result very few carbohydrates are made per unit time, growth and fresh leaf weight are likely to be low (Edmond *et al.* 1975).

The plants deficient with potassium effect the rate of photosynthesis and rate of ATP production, and the entire process dependent on ATP are inhibited (Bajwa & Rehman, 2005). So for the optimum fresh leaf weight there is need of balance nutrients. The experimental result revealed that application of fertilizer has increase the leaf dry weight. The result is also in line with (El-Naggar, 2009). According to him the increase may be due to the effect of nutrients elements at suitable and adequate concentrations in promoting the vegetative growth and dry matter accumulation.

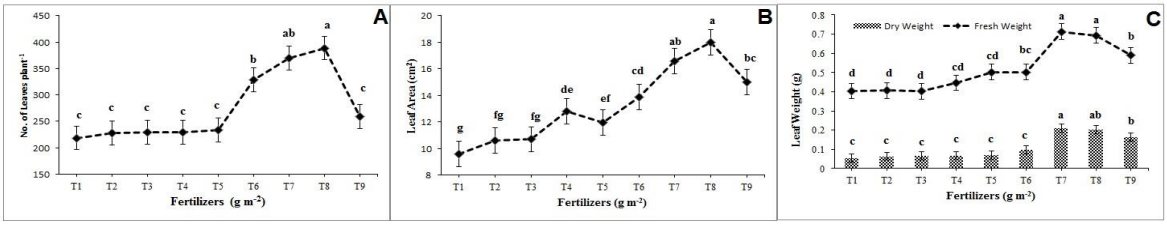

Fig. 3. Effect of different levels of nitrogen with constant dose of potassium on leaf growth of *Zinnia elegans* cv. Dream land. (A) Effect of fertilizers treatments on number of leaves plant^{-1}: LSD value ($P < 0.05$) = 49.902 (B) Effect of fertilizers treatments on leaf area: LSD value ($P < 0.05$) = 1.9122 (C) Effect of fertilizers treatments on fresh and dry leaf weight: LSD value ($P < 0.05$) = 0.0892 and 0.0435 respectively. The results represent the mean ± SE from three independent biological experiments.

Roots Growth

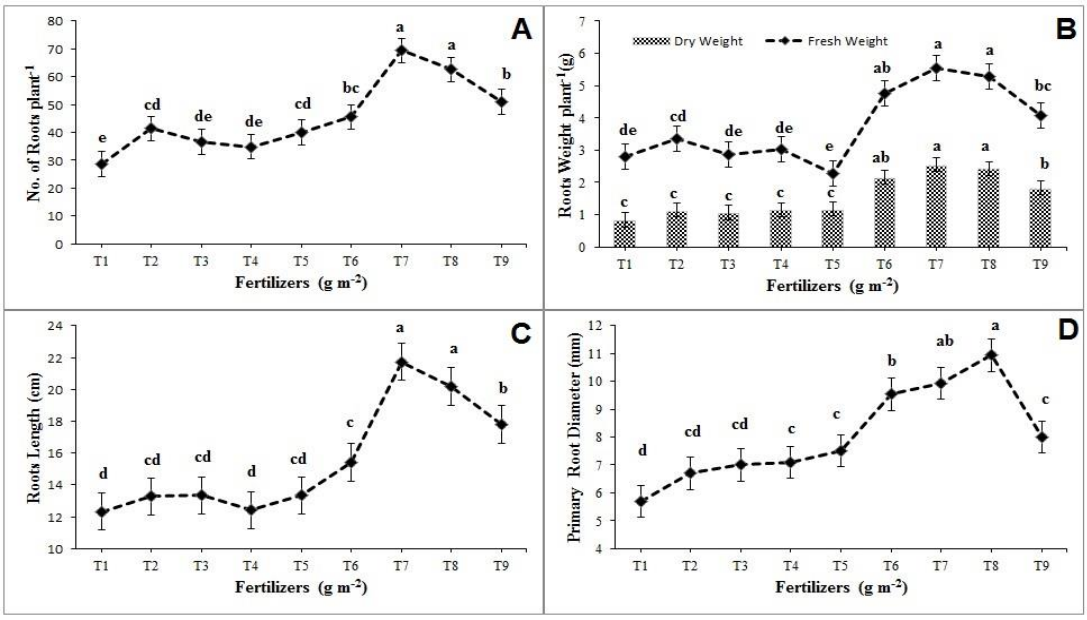

Fig. 4. Effect of different levels of nitrogen with constant dose of potassium on root growth of *Zinnia elegans* cv. Dream land. (A) Effect of fertilizers treatments on number of roots plant^{-1}: LSD value ($P < 0.05$) = 8.1938 (B) Effect of fertilizers treatments on fresh and dry roots weight plant^{-1}: LSD value ($P < 0.05$) = 0.9653 and 0.4338 respectively (C) Effect of fertilizers treatments on roots length: LSD value ($P < 0.05$) = 2.3970 (D) Effect of fertilizers treatments on primary root diameter: LSD value ($P < 0.05$) = 0.1355. The results represent the mean ± SE from three independent biological experiments.

The data showed that fertilizers have significant ($P \leq 0.05$) effect on the number of roots plant^{-1}, root length, main root diameter and fresh and dry roots weight (Fig. 4). The maximum number of roots plant^{-1} (69.43), root length (21.733cm), fresh (5.53g) and dry (2.54g) roots weight was recorded in the plots treated with T_7, while the minimum for all parameters in T_1. The thick root diameter (10.93mm) was observed in the plants treated with T_8, while thin (5.7mm) in the plants treated with T1 (Fig. 4D). The result may be due to that optimum level of nitrogen with potassium and constant dose of phosphorous help in the proliferation of roots. Plant with excess nitrogen have abundance of foliage and usually have less number of roots (Salisbury & Ross, 1985). Nitrogen is essential for root development and expansion and the soil deficient with potassium will decrease the root elongation and thickness, which will affect the absorption of other nutrient elements (Alam & Naqvi, 2003). The experimental result revealed that zinnia roots respond positively to the fertilizer application. The excess amount of fertilizer causes burning and root hair death, effect negatively the root growth (Tisdale *et al.* 1985) and have adversely effect on the fresh root weight. Al-Karaki (2000) reported that potassium concentrations in the growing medium increase root dry matter. These results also in line with Shafi *et al.* (2002) whose research on *Gaillardia pulchella* revealed that increase in nitrogen level with constant dose of Potassium and phosphorous from a critical level adversely affected number of roots per plant. Khan *et al.* (2007) mentioned that optimum level of nitrogen and potassium with constant dose of phosphorous help in maximum root length.

Conclusion

It is concluded that less days to flowering was observed in T_6 (N= 10g m^{-2} + 20g K m^{-2}), high number of flowers plant^{-1}, fresh and dry flower weight, plant height, number of primary and secondary shoots plant^{-1}, fresh shoots weight plant^{-1}, number of leaves plant^{-1}, leaf area and primary root diameter in T_8 (N= 30g m^{-2} + 20g K m^{-2}), but these parameters were non-significant with T_7, while maximum flower diameter, stem diameter, dry stem weight, fresh and dry leaves weight, number of roots, fresh and dry roots weight plant^{-1}, root length in T_7 (N= 20g m^{-2} + 20g K m^{-2}). The T_7 produced significant results for higher flower production and growth of *Zinnia elegans* cultivar Dream land under agro-climatic condition of Peshawar.

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