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Response of gerbera (*Gerbera jamesonii*) to different levels of phosphorus and potassium

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Abstract

Effect of phosphorus and potassium on growth and flowering of Gerbera (*Gerbera Jamesonni*)" was investigated at Horticulture farm, the Agricultural University Peshawar during 2011. The experiment was laid out in Randomized Complete Block Design (RCBD) with two factors and repeated thrice. Phosphorus levels (0, 7.5, 10 and 12.5 g m^{-2}) and potassium levels (0, 10, 12.5, 15 g m^{-2}) were applied to Gerbera. More plant height (31.72 cm), number of leaves $plant^{-1}$ (29.76), flowers blooming period (183.18), plant canopy (33.59 cm), number of flowers $plant^{-1}$ (16.63), flower stalk length (25.37 cm), flower diameter (8.05 cm) and vase life (7.32) were recorded in plants received 12.5g phosphorus m^{-2}, while more days to first flowering (85.50) were noted in the control treatment. The findings further revealed that more plant height (30.04 cm), number of leaves $plant^{-1}$ (28.08), flowers bloom period (182.05), plant canopy (31.00 cm), number of flowers $plant^{-1}$ (15.68), flower stalk length (22.87 cm), flower diameter (7.30 cm) and vase life (7.00 days) were noted in plants treated with 15 K_2O g m^{-2}, while days to first flowering (88.00) were noted in control plots. As the interaction between phosphorus and potassium are concerned, most growth and flowering attributes performed best when treated with 12.5 g P and 15 g K_2O m^{-2}. It is concluded that the combination of 12.5 g P m^{-2} and 15 g K_2O m^{-2} influenced most of growth and flowering parameters of Gerbera.

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Introduction

Gerbera (*Gerbera jamesonii*) commonly known as Transvaal Daisy or African Daisy, a prominent member of Asteraceae family and is native to South African and Asiatic regions. There are about 70 species of Gerbera (Norberto, 2010). It is a chief cut flower cultivated all over the world under extensive range of climatic conditions. The ideal day temperature for cultivation is 22-25 ^{o}C and night is 12-16 ^{o}C (Pandey, 2010). Gerbera flowers are available in an extensive variety of colors such as white, purple, red, yellow, orange, pink, and crimson.

Phosphorous (P or P_2O_5) is one of the major and crucial limiting factors in determining the yields of flower crops. Deficiency of phosphorus may adversely affect the plant in maintaining full supply of nitrogen and potassium. Excess application of phosphorus may result in various nutritional problems including calcium and zinc deficiency (Chaitra, 2006). Potassium (K_2O) is an important nutrient, plays numerous essential roles in plant nourishment. Potassium activates enzymes involved in photosynthesis, where its essential function on CO_2 fixation is clearly demonstrated with isolated intact chloroplasts (Borgatto *et al*., 2002). Appropriate potassium nutrition tolerates peripheral stress such as drought, frost, high light intensity and heat. Additionally, appropriate potassium discourages disease incidence and insect damages because of proficient consumption of other nutrients such as nitrogen and phosphorous (Mikkelsen, 2008). Nitrogen, Phosphorus and Potash fertilization can not only increase economic return of the investment through better yield and quality rather it minimizes environmental dangers (Hera, 1996). The balanced doses of nitrogen, phosphorus and potassium play a key role in the increment of the vegetative growth, favorable for the synthesis of peptide bonds, protein and carbohydrates metabolism, necessary for the plant growth and flower development (Boodly and Meyer, 1965). Keeping in view the importance of different nutrients for better growth and flower production of Gerbera, the present experiment was conducted to find out optimum phosphorus and potassium levels for promoting growth and flowering of Gerbera.

Materials and methods

Plant material

The study was carried out at Horticulture Farm, the Agricultural University Peshawar during Spring 2011. Randomized Complete Block Design (RCBD) with two factors was used as experimental design. The experiment consisted of total sixteen treatments and each treatment was repeated three times.

Fresh seeds of the Gerbera (*Gerbera jamesonii*) were brought from reputed seed store, Lahore, Pakistan and sown in January, 2011, and transplantation to experimental site was carried out in March, 2011 when seedling attained the size of 3-4 true leaves. Row to row distance was 60 cm while it was 30 cm between the two plants.

Fertilizers

Di-ammonium Phosphate (DAP) was used as a source for phosphorus while Sulphate of Potash (SOP) used for potassium. Different levels of phosphorus 0, 7.5, 10.0, 12.5 g m^{-2} and potassium 0, 10.0, 12.5, 15.0 g m^{-2} were applied to various treatments in the experiment. At the time of transplanting the full dose of phosphorous and potassium was applied in a circular band of about 5-6 cm around each plant. The flowers were harvested when the central whorl of petals were in completely open condition.

Study Parameters

Various parameters related to vegetative and flowering attributes such as plant height (cm), number of leaves plant-^{1}, plant canopy (cm), days to first flowering (Days), blooming Period (Days), number of flowers plant-^{1}, flower stalk length (cm), flower diameter (cm) and vase life of cut flower (Days) were studied. Three Gerbera plants randomly selected were tagged and used for recording the desired parameters.

Statistical Analysis

The recorded data was analyzed statistically by using

a statistical package MSTATC (Steel and Torrie, 1980).

Results and discussion

Plant Height (cm)

The analysis of data indicated that phosphorus and potassium levels and their interaction had significant effect on Gerbera plant height (Table 1).

Table 1. Effect of phosphorus and potassium on plant height, number of leaves and plant canopy (cm) of Gerbera.

Parameters	Plant height (cm)	Number of leaves plant^{-1}	Plant canopy (cm)
Phosphorous levels (g m-2)			
0	22.38 d	21.14 c	21.53 c
7.5	25.77 c	23.43 b	26.29 b
10.0	26.99 b	25.85 ab	30.58 a
12.5	31.72 a	29.76 a	33.17 a
LSD at α 0.05	2.274	3.105	2.908
Potassium levels (g m^{-2})			
0	23.71 d	21.18 c	23.44 c
10.0	25.30 c	24.87 bc	26.96 b
12.5	27.81 b	26.05 b	30.59 a
15.0	30.04 a	28.08 a	31.00 a
LSD at α 0.05	2.274	3.105	2.908
Significance Level	Interaction (Phos × Pot)		
C × G	S	S	S

The mean values for phosphorus showed that more plant height (31.72 cm) was recorded in the plants received 12.5 g P m^{-2} which was statistically different from the rest of the treatments, followed by 26.99 cm in plants got 10 g P m^{-2}, while the least plant height (22.38 cm) was observed in untreated plants. The application of potassium significantly influenced Gerbera plant height. More plant height (30.04 cm) was obtained from the plants fertilized with 15 g K_2O m^{-2}, followed by 27.81cm in plants supplied with 12.5 g K_2O m^{-2}, while less plant height (23.71 cm) noted in control treatment. The interaction between phosphorus and potassium showed a significant effect on plant height of Gerbera. The plants fertilized with 12.5-15 g P-K_2O m^{-2} gained more plant height (37.39 cm), while the least plant height (20.23 cm) was recorded in untreated plants.

The plant height of Gerbera had favored by the application of phosphorus and potassium (Fig 1). The application of phosphorus and potassium significantly influenced the Gerbera plants height. The trend in current study showed that the plant height was increased significantly by increasing the concentration of fertilizers. The results of the present study are in lined with the findings of Renuka *et al.,* (2005), who concluded that more plant height was observed in the Gerbera plants receiving optimum levels of phosphorus and potassium. The findings of Memon (2001) also supported the current results and reported that phosphorus is the structural component of numerous compounds like nucleic acid and phospholipids. Moreover, it also plays a vital part in the metabolism of energy, which is related to the growth and development of the plants. In addition, Pal and Ghosh (2010) are also agreed that potassium had a significant effect on the growth of Marigold.

Number of Leaves Plant^{-1}

The perusal of results indicated that phosphorus, potassium as well as their interaction had a significant effect on number of leaves plant^{-1} (Table 1).

The mean values of data showed that highest number of leaves plant^{-1} (29.76) was observed in plants received 12.5 g P m^{-2}, closely followed by plants produced 25.85 number of leaves in the plants treated with 10 g P m^{-2}. On the other hand, the least number of leaves plant^{-1} (21.14) recorded in untreated plants. The mean data indicated that highest number of leaves plant^{-1} (28.08) was noticed in the plants supplied with 15 g K_2O m^{-2} which was statistically different from the rest of the treatments, followed by 26.05 leaves plant^{-1} in plants supplied with 12.5 g K m^{-2}, whereas lowest number of leaves plant^{-1} (21.18) recorded in untreated plants.

Table 2. Effect of phosphorus and potassium on plant height, number of leaves and plant canopy (cm) of Gerbera.

Parameters	Days to flowering	Flower longevity	Number of flowers plant^{-1}
		Phosphorous levels (g m^{-2})	
0	88.50 c	174.44 b	10.27 d
7.5	87.08b c	177.87 a	12.02 c
10.0	85.50 b	178.55 a	14.46 b
12.5	80.50 a	183.18 a	16.63 a
LSD at α 0.05	5.96	8.68	0.664
		Potassium levels (g m-2)	
0	88.00 c	172.90 b	8.48 d
10.0	85.83 bc	178.42 a	14.21 c
12.5	85.33 b	180.82 a	15.01 b
15.0	82.42 a	181.90 a	15.68 a
LSD at α 0.05	5.96	8.68	0.664
Significance Level	Interaction (Phos × Pot)		
C × G	NS	NS	S

The mean values for interaction between phosphorus and potassium depicted a significant effect on number of leaves of Gerbera. However, more number of leaves plant^{-1} (34.67) was noticed in the plants fertilized with 12.5 g P -15 g K_2O m^{-2} in combination, whereas less number of leaves plant^{-1} (19.57) observed in untreated plants. Significant differences with regard to number of leaves were seen among different treatment combinations. Phosphorus and potassium had greatly influenced the number of leaves plant^{-1} (Fig 2). The height of plant showed positive correlation with balanced doses of fertilizers simultaneously, high levels of phosphorus and potash application encourage the lateral growth, number of branches and number of leaves (Khan *et al.,* 1999). The findings of the present study are in close agreement with the results of those reported by Renuka *et al.* (2005) who got more number of leaves plant^{-1} by applying optimum doses of phosphorus and potassium to Gerbera plants. In addition, Henry (1982) also observed that plant vegetative growth enhanced substantially by the treatment of nitrogen, phosphorus and potassium.

Plant canopy (cm)

The analysis of variance showed that phosphorus and potassium as well as their interaction had significant effect on plant canopy (Table 1). The means data indicated that maximum plant canopy (33.59 cm) was observed in the plants those received 12.5 g P m^{-2}, followed by 30.58 cm in the plants fertilized with 10 g P m^{-2}, whereas the least plant canopy (21.53 cm) was observed in untreated plants. The mean values of data indicated that more plant canopy (31.00 cm) was obtained from the plots applied with 15 g K_2O m^{-2} which was at par with plants fertilized with 12.5 g K_2O m^{-2} (30.51 cm), while minimum plant canopy (23.44 cm) was observed in unfertilized plants. Additionally, the plant canopy of Gerbera was significantly

influenced by interaction between phosphorus and potassium. The greatest plant canopy (38.11cm) was noticed in the plants applied with 12.5 g P and 12.5 g K_2O m^{-2} in combination, whereas the smallest plant canopy (21.43 cm) was noticed in the control treatment. A significant trend was noted among selected levels of phosphorus and potassium on plant canopy of the Gerbera (Fig 3). As levels of fertilizers increased, the width of the plant increases significantly. Belorker *et al.* (1992) supported the current study that potassium took part in rapid cell division and differentiation and also involved in formation of peptide bond, and protein and in metabolism of carbohydrate, enhanced the plant growth. Phosphorus and potash found to be involved in maximum increase in uptake of nutrient by virtue of more photosynthesis resulting in more chlorophyll formation help in increasing the plant canopy. Moreover, the potassium enhances the synthesis and translocation of carbohydrate, whereas, phosphorus encourages cell walls and length of plant (Henry, 1982). The present results are in line with findings of Samoilkenkoi (1983) who concluded that high rates of fertilizers encourage more branches ultimately increased the canopy of plant.

Table 3. Effect of phosphorus and potassium on plant height, number of leaves and plant canopy (cm) of Gerbera.

Parameters	Flower stalk length	Flower diameter (cm)	Vase life
Phosphorous levels (g m^{-2})			
0	18.31 d	5.87d	4.75 d
7.5	20.29 c	6.60c	5.65 c
10.0	21.64 b	6.78b	6.50 b
12.5	25.37 a	8.05a	7.30 a
LSD at α 0.05	3.09	1.005	0.766
Potassium levels (g m^{-2})			
0	20.75 c	6.18d	5.18 c
10.0	20.35 d	6.85c	5.88 bc
12.5	21.64 b	6.98b	6.15 b
15.0	22.87 a	7.30a	7.00 a
LSD at α 0.05	3.09	1.005	0.766
Significance Level		Interaction (Phos × Pot)	
C × G	S	S	NS

Days to first flowering

From the mean Table, it is cleared that the days taken to first flowering of Gerbera significantly influenced by different levels of phosphorus and potassium, while their interaction was non-significant (Table 2). The mean values for phosphorus showed that more days to first flowering (88.50) was observed in control treatment, while less to first flowering (80.50) was noticed in the plants supplied with 12.5 g P m^{-2}. The mean values for potassium indicated that maximum number of days to first flowering (88.00) was obtained from the untreated plants while minimum number of days to first flowering (82.42) was obtained from the plants fertilized with 15 g K_2O m^{-2}. There was an inverse effect of increasing phosphorus and potassium levels on days taken to emergence of first flowering as to influence the vegetative growth of the plant. The concentration of phosphorus and potassium have dominant role in flowering of plant and responsible for better reproductive growth of plants. It is evident from the findings that when the plants are fertilized with an optimum dose of P and K fertilizers resulted in better growth of vegetative and reproductive attributes Gerbra plants. The findings are supported by Baloch *et al.* (2004), who found that the number of days before the emergence of first flower decreased, by the application of higher doses of NPK fertilizers.

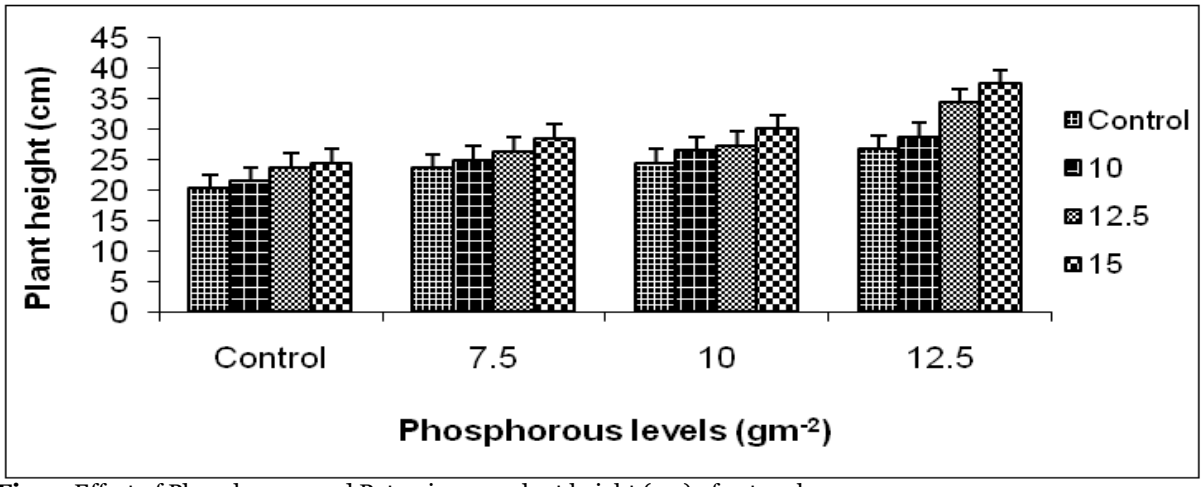

Fig. 1. Effect of Phosphorous and Potassium on plant height (cm) of cut gerbera.

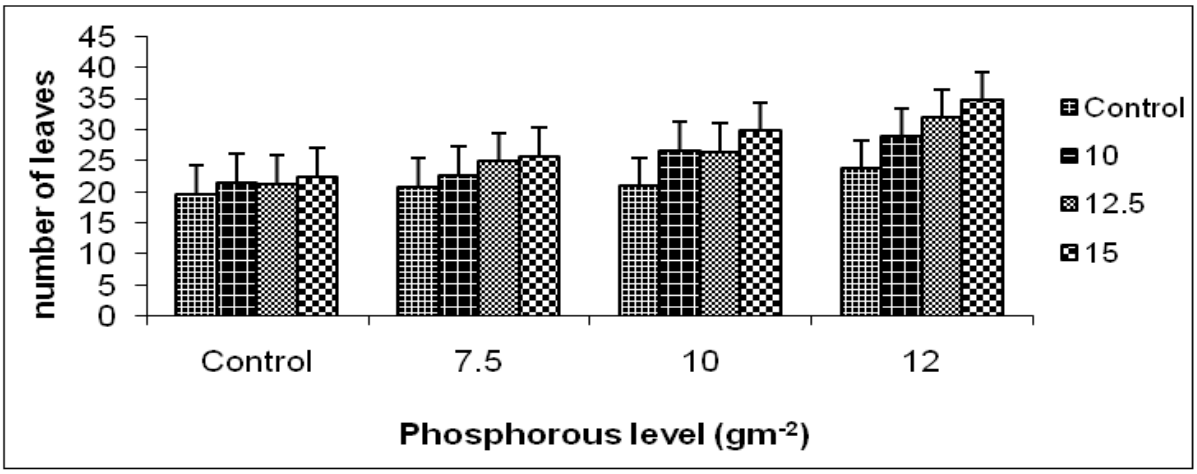

Fig. 2. Effect of Phosphorous and Potassium on number of leaves of cut gerbera.

Blooming Period (Days)

The analysis of data shows that phosphorus and potassium had significant effect on flower longevity, while their interaction was non-significant (Table 2). The mean values for phosphorus showed that maximum flower longevity (183.18 Days) was observed in the plants supplied with 12.5 g P m^{-2}, closely followed by 178.55 Days in plants fertilized with 10.0 g P m^{-2}, while minimum flower longevity (174.44 Days) was observed in control treatment. The application of potassium depicted a significant response to flower longevity. Maximum flower longevity (182.05 Days) was obtained when plants fertilized with 15 g K_2O m^{-2} closely followed by 180.82 Days in plants fertilized with 12.5 g K_2O m^{-2}, while minimum flower longevity (172.90 Days) was obtained from the unfertilized plants. The positive impact of mounting phosphorus and potassium levels on duration of flowering was noticed during the experimental results. Phosphorus and potassium concentrations have a positive effect in flower stay of plant and responsible for superior reproductive growth of plants. The results clearly showed that higher doses of phosphorus and potassium fertilizers significantly increased the flower longevity of Gerbera plants. The findings of this experiment are in series with the results of Knight (2007) who found that the flower longevity increased by the application of higher doses of NPK fertilizers.

Number of flowers plant^{-1}

The analyzed data clearly indicated that phosphorus, potassium and their interaction had significant effect on the number of flowers plant^{-1} (Table 2). The means data for phosphorus showed that more number of flowers plant^{-1} (16.63) why not 17.00 as half flower

mean - nothing was observed in the plants received 12.5 g P m^{-2} which was statistically different from the rest of the treatments followed by 14.46 flower $plant^{-1}$ in the plants supplied with 10 g P m^{-2}, whereas less number of flowers $plant^{-1}$ (10.27) was observed in untreated plants. The application of potassium significantly increased the number of flower plant-2 of Gerbera. However, more number of flowers $plant^{-1}$ (15.68) was obtained in the plants fertilized with 15 g K_2O m^{-2}, statistically varied from the rest of the treatments. It was followed by 15.01 flowers $plant^{-1}$ from the plants fertilized with 12.5 g K_2O m^{-2}, while least number of flowers $plant^{-1}$ (8.48) was obtained from the control plots.

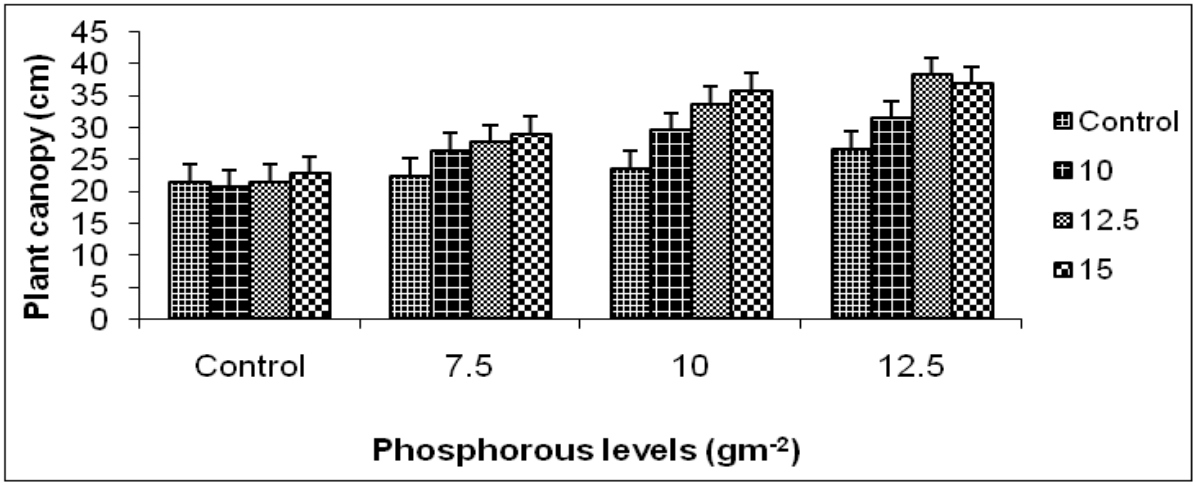

Fig. 3. Effect of Phosphorous and Potassium on plant canopy (cm) of cut gerbera.

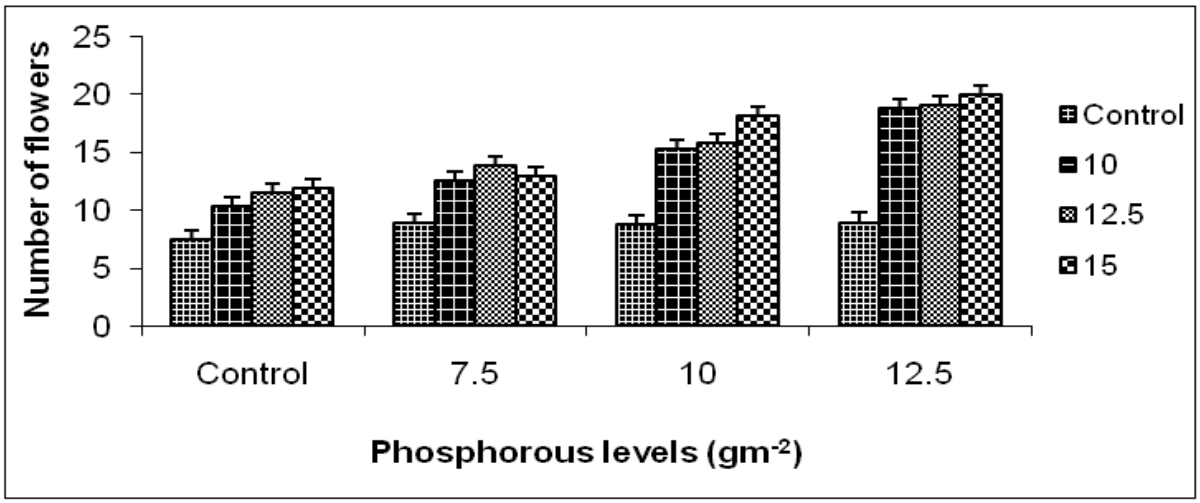

Fig. 4. Effect of Phosphorous and Potassium on number of flower of cut gerbera.

The mean values for interaction of the phosphorus and potassium indicated that more number of flowers $plant^{-1}$ (19.88) was obtained in the plants fertilized with 12.5 g P and 15 g K_2O m^{-2} in combination, whereas less number of flowers $plant^{-1}$ (7.43) was obtained in the plots where phosphorus and potassium were not applied. The current study evaluated that number of flowers $plant^{-1}$ were maximum where P and K levels were higher. An optimum level (12.5 g P and 15 g K_2O m^{-2}) of phosphorus and potassium enhanced the vegetative and reproductive growth of Gerbera (Fig 4). The present findings are in close agreement with the results of Knight (2007) who examined the best number of flowers with the highest application of NPK. Javid *et al.* (2005) also supported that numbers of flowers increased when highest doses of the NPK fertilizers were used. Boodly & Meyer (1965) reported

that concentration of nitrogen, phosphorus and potassium in proper proportion responsible for the enhancement of the vegetative growth. They also indicated that when the vegetative growth is increased, it favors the synthesis of peptide bond, protein and carbohydrate metabolism, necessary for development of flower.

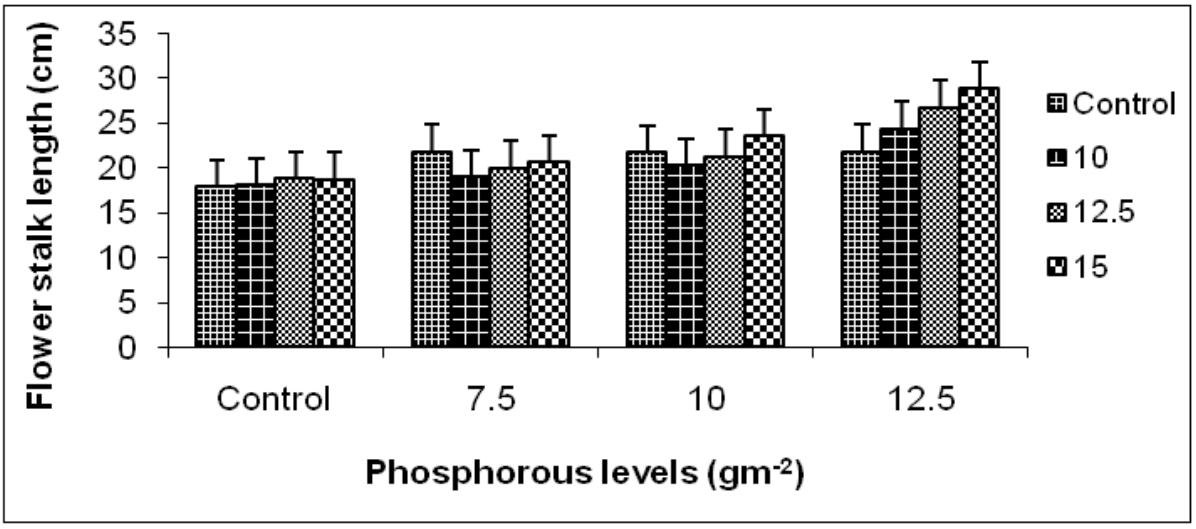

Fig. 5. Effect of Phosphorous and Potassium on flower stalk length (cm) of cut gerbera.

Flower Stalk Length (cm)

The analysis of data showed that phosphorus, potassium, and their interaction had a significant effect on flower stalk length of Gerbera (Table 3). The means values for phosphorus showed that highest flower stalk length (25.37 cm) was noticed in the plants fertilized with 12.5 g P m-2, followed by 21.64 cm in the plants supplied with 10 g P m-2, whereas lowest flower stalk length (18.31cm) was observed in untreated plants. The statistical analysis for potassium indicated that the longest flower stalk (22.87 cm) was noted in the plants fertilized with 15 g K_2O m^{-2}, followed by 21.64 cm from the plants supplied with 12.5 g K_2O m_{-2}, whereas the shortest flower stalk (20.35 cm) was obtained from the plants supplied with 10 g K^2O m^{-2}. The mean values for interaction of phosphorus and potassium showed that the tallest flower stalk (28.73 cm) was noted in the plants fertilized with 12.5 g P and 15 g K_2O m^{-2} in combination, while the shortest flower stalk (17.83 cm) was noticed in the control plots. The results clearly indicated that the highest phosphorus and potassium levels produced the flowers with longest stalk length. A linear positive effect had noticed with regard to flower stalk length. As phosphorus and potassium fertilizers concentration increases the length of stalk also increased (Fig 5). The results of current study are in agreement with the findings of Suwaree *et al.* (2009) who obtained best flower stalk length with application of chemical fertilizers. This might be due to the structural role of phosphorus and potassium in life of plants. Memon (2001) mentioned that like nitrogen, phosphorus also plays a structural role in the synthesis of many compounds, particularly nucleic acid and phospholipids. Furthermore, it also has a vital role in the metabolism of energy. Taize and Zeiger (1991) also mentioned that potassium found to have a dominant role in a number of catalytic roles. Without the presence of potassium numerous enzymes do not perform their functions efficiently. The role of phosphorus could not be denied in activity of many enzymes.

Flower Diameter (cm)

The analysis of data showed that phosphorus and potassium as well as their interaction had a significant effect on the diameter of Gerbera flower (Table 3). More flower diameter (8.05 cm) noted in the plants fertilized with 12.5 g P m^{-2}, followed by 6.78 cm in the plants received 10 g P m^{-2}, whereas less

flower diameter (5.87 cm) was observed in unfertilized plants. The mean values of data for potassium indicated that more flower diameter (7.30 cm) was observed in the plants fertilized with 15 g K^2O m^{-2}, followed by 6.98 cm from the plants supplied with 12.5 g K^2O m^{-2}, while the least flower diameter (6.18 cm) was obtained from untreated plants. The mean of interaction of the factors showed that maximum flower diameter (9.37 cm) was noticed in the plots applied with 12.5 g P and 15 g K_2O m^{-2}. The results of the current experiment indicated that P and K concentrations significantly influenced the size of flower. The most inferior performance had noticed in plants supplied with least P and K fertilizers, whereas best sized flowers had produced by the plants supplied with the highest doses of P and K fertilizers (Fig 6). The results of current study are in line with the findings of Javid *et al.* (2005) who also got maximum sized flowers of Zinnia with the highest levels of NPK fertilizers. Boodly & Meyer (1965) supported that concentration of nitrogen, phosphorus and potassium in proper proportion responsible for the enhancement of the vegetative growth. When vegetative growth is increased, it favors the synthesis of peptide bond, protein and carbohydrate metabolism. These compounds are necessary for development of flower.

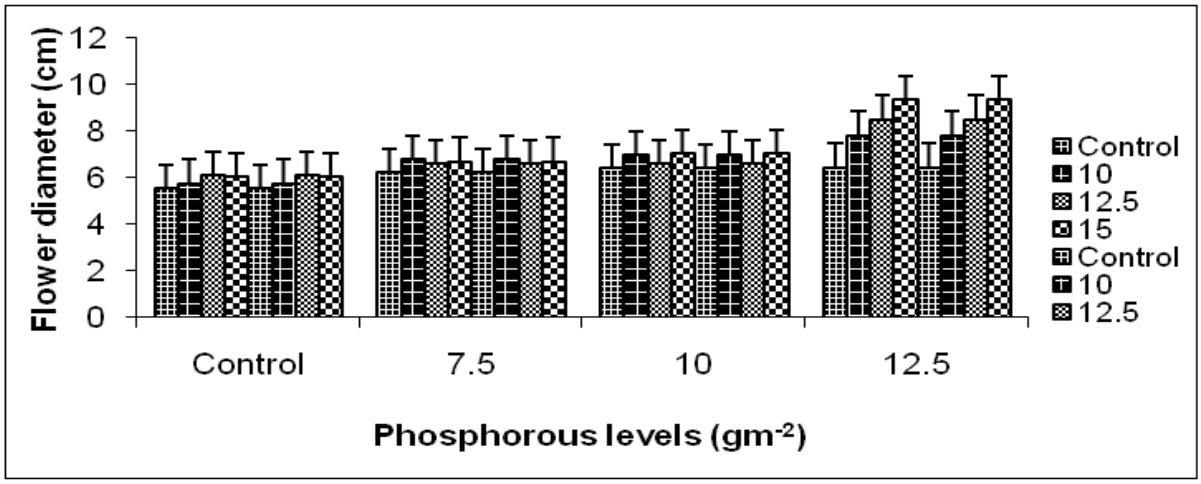

Fig. 6. Effect of Phosphorous and Potassium on flower diameter (cm) of cut gerbera.

Vase Life

The analysis of data showed that phosphorus and potassium had significant effect on vase life of Gerbera cut flower while their interaction was non-significant (Table 3). The longest vase life (7.3) was observed in the plots fertilized with 12.5 g P m^{-2} which was significantly different from all other treatments, while the shortest vase life (4.75) was observed in untreated plants. The analysis of variance for potassium indicated that the longest vase life of cut flower (7.0) was obtained in the plants treated with 15 g K_2O m^{-2}, while the shortest vase life of cut flower (5.18) noted in control plots. Vase life of the flowers had significantly affected by the application of phosphorus and potassium fertilizers. Inferior vase life was observed in the plots where fertilizers were not applied. Superior quality and extended vase life of flowers were noticed in the plots supplied with the highest rates of phosphorus and potassium. The current findings are in line with the conclusion of Baloch *et al.* (2010) who observed the longest flower life in plants with the highest nitrogen and phosphorus fertilizers. Knight (2007) also got the best vase life of flowers with the highest NPK rates. On the other hand, current findings contradict the results reported by Rebort *et al* (1990), who observed that potassium and nitrogen fertility did not affect flower size, quality, or vase life in their two year experimentation.

Conclusions and Recommendations

It is concluded that the application of 12.5-15 g P-K_2O m^{-2} as a combined dose provided the best results on the vegetative and reproductive growth of Gerbera

and the same is recommended for better growth and flowering of Gerbera under Peshawar conditions.

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