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Influence of organic potash on the vegetative attributes and corm production of gladiolus cultivars.

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Keeping in view the significant role of organic potassium and its potential effects on vegetative attributes and corm production of gladiolus, an experiment was conducted during 2018 to study "The influence of organic potash on the vegetative attributes and corm production of gladiolus cultivars". Experimental design was randomized complete block with two factors i.e., Potash levels and gladiolus cultivars. Potash levels (control, 80, 100, 120 kg ha^{-1}) were allotted to main plots, while gladiolus cultivars (Magma, Bangladesh and Rose Supreme) were kept in subplots. The significant findings of the experiment showed that among various cultivars; cv. Rose supreme resulted in better performance as compared to Bangladesh and Magma. Rose supreme took minimum days to plant emergence (13.1 days), maximum number of leaves plant^{-1} (8.08), leaf area plant^{-1} (915.05 cm^2), weight of daughter corm (23.51 g), daughter corm diameter (4.09 cm) and number of cormels plant^{-1} (24.92). Results pertaining to organic potash levels revealed that application of organic potash at 100 kg ha^{-1} resulted in maximum number of leaves (8.33), leaf area (924.29 cm^2), weight of daughter corm (22.77), diameter of daughter corm (3.98 cm) and number of cormels plant (22.02) that was statistically at par to the application of organic potash at 120 kg ha^{-1}. It is recommended that organic potash at 100 kg ha^{-1} could be used for enhanced vegetative attributes and better corm production in gladiolus. Among various cultivars, cv. Rose supreme was found superior for the vegetative and corm related variables as compared to cv. Magma and cv. Bangladesh.

Keywords: Organic production, Gladiolus, cultivars, potash, vegetative attributes

INTRODUCTION

Gladiolus (*Gladiolus grandiflorus*L.) famous as queen of the bulbous plants (John and Peter, 2008) belongs to family Iridaceae. The word gladiolus is derived from Latin word "Gladius" which mean sword due to its sword-shaped leaves and commonly known as "Sword Lily" or "Glade" (Bose et al. 2003). Gladiolus is the 2nd most important cut flower in Pakistan after rose while Internationally Gladiolus ranked 8th in position with the potential to generate handsome revenue from export in the trade of cut flower (Khan et al.2017). Gladiolus has a diverse range of cultivars and the flowers are available in various colors, shapes and sizes. Its glorious inflorescence with a diversity of colors makes it beautiful for use in pots, flower beds and for cut flowers. It grows best in deep, well-drained sandy loam soil having pH 5.5 to 6.5 (Fatihullah and Bostan, 2018). Optimal nutrients supply is one of the most important factors, for proper growth and development of a plant. Nitrogen, phosphorus and potassium are the major nutrients that play very important role in enhancing vegetative growth, flower yield and quality attributes (Khan and

Ahmad, 2004). Potassium (K) is one of the most important macro-nutrients which greatly affect the growth of gladiolus. After nitrogen and phosphorus most of the soils are lacking in potassium (Salisbury and Ross, 1992). Potassium works as a catalyst in most of the biosynthetic reactions in photosynthesis. Potassium is also involved in amino acids production and helps the plants to fight against diseases. Potassium deficiency causes a reduction in the length of flower stem, delay in flowering, yellowing of leaves (Wilfret, 1980). Potassium plays significant role in various plants physiological processes e.g., germination of seed, phloem transport, cation-anion balance, protein synthesis, photosynthesis, energy transfer, osmoregulation, enzyme activation, nutrient balance and stress resistance (Marschner, 2012). Potassium plays crucial role in metabolism of plant enzymes activity and enhancing the translocation of assimilates and protein synthesis which increase the growth, flowering and bulb yield (Behairy et al. 2015). Potassium increases the accumulation of water in the underground plant parts which promotes larger size of corms and cormels (Mahadik and Chopde, 2015).

The excessive use of fertilizers can cause deterioration in water quality, increase heavy metal in soil with potential threat to environment and human health (Gimeno-Garcia et al. 1996). Chemical fertilizers are rapidly lost through evaporation or by leaching in water thus causing hazardous environmental effects as well as disturb soil flora and fauna (Kumari et al. 2014). Organic fertilizer is highly decomposed product with a compost or manure base usually made from animal or plant waste. Organic fertilizers increase the water holding capacity, modifies the physical, chemical and micro-biological characteristics of the soil. It also improves the soil structure and helps to build the organic matter of the soil. Therefore, organic fertilizer is the best solution for addressing these problems. Organic fertilizer is slow released fertilizer which can avoid leaching and available throughout the growing period to the plant. Various cultivars perform differently due to their genetic make-up and response to diverse agro-climatic conditions. Therefore, it is necessary to evaluate and find out most suitable cultivar for a particular region. So, considering the concept for eco-friendly technology, easily available and cost effective, organic fertilizers seem to be a possible option for sustained agriculture. Organic Potash has the potential to play important role in enhancing vegetative attributes, flowers and corms production of gladiolus. Keeping in view the importance of organic potash for production of gladiolus, a project was designed with the following objectives:

- To find the optimum concentration of organic potash for better production of gladiolus.
- To evaluate different gladiolus cultivars for better production under the agro-climatic conditions of Peshawar.
- To study the interaction between gladiolus cultivars and organic potash.

MATERIALS AND METHODS

An experiment on “response of gladiolus cultivars to organic potash levels” was carried out at Ornamental Horticulture Nursery, The University of Agriculture Peshawar, during 2018. The experiment was laid out in randomized complete block design (RCBD) having two factors (split plot management) i.e., Different levels of organic potash (placed in main plots) and various cultivars (kept in sub-plots). Treatments were repeated three times. The corms were planted at a distance of 20 cm and 40 cm apart in rows (Ahmad and Rab, 2019). The soil samples were collected prior to planting of corms and analyzed for various physio-chemical properties at Soil and Environmental Lab, The University of Agriculture Peshawar.

Table 1: Physio-chemical properties of Soil

Property	Nitrogen ($mgKg^{-1}$)	Phosphorus ($mg\ Kg^{-1}$)	Potassium ($mg\ Kg^{-1}$)	Organic Matter	pH	EC
Quantity	0.184	6.22	62.3	0.73	7.80	0.80

Phosphorus was applied at the time of sowing while nitrogen was applied in two split doses (first at the time of sowing and 2nd at 4th leaf stage). Inorganic potassium at the rate of 100 kg ha^{-1} was applied to control plots. While three levels of organic potassium at the rate of 80, 100 and 120 kg ha^{-1} were applied to other plots according to treatments. For inorganic potash, Sulfate of Potash

(SOP) was used as a source, while NKS was used as source for organic potash. NKS contains Nitrogen (4%), Potassium (30%) and Sulfur (1%). Urea and DAP were used as sources for nitrogen and phosphorus respectively.

All the cultural practices including weeding, hoeing, irrigation etc. were carried out uniformly according to the need of the plants.

Main Plot (Organic potash levels kg/ha)	**Subplot (Gladiolus cultivars)**
L_1 = 100 (Control/Inorganic)	C_1 = Magma
L_2 = 80	C_2 = Bangladesh
L_3 = 100	C_3 = Rose Supreme
L_4 = 120	

Data were recorded on days to plant emergence, number of leaves plant^{-1}, leaf area (cm^2), diameter of daughter corm (cm), weight of daughter corm (g) and number of cormels plant^{-1}.

Statistical analysis

The data were subjected to analysis of variance as per procedure appropriate for randomized complete block design (Jan *et al.*, 2009). The least significant difference (LSD) test was used for means comparison.

RESULTSAND DISCUSSION

Vegetative attributes of gladiolus as influenced by Organic potash levels and cultivars

Days to plant emergence:

Data regarding days to plant emergence in response to different potash levels and gladiolus cultivars are presented in Table 2. Statistical analysis showed that days to plant emergence were significantly influenced by gladiolus cultivars, however, organic potash and interaction between cultivars & organic potash had no significant effect on days to plant emergence. Data regarding various cultivars showed that cv. Rose Supreme took least days (13.14) to plant emergence whereas cv. Magma took maximum days to plant emergence (22.1) that was statistically similar to cv. Bangladesh (21.5).

The variation in days to emergence of corm among various cultivars might be due the genotypic differences or it might be due to the environmental conditions prevailed during sprouting period of corms that could have contributed to different genotype-environment interactions (Al-Humaid, 2004). Variations in days to plant emergence in different genotypes had previously reported by Zubair et al. (2006) and Chourasia et al. (2015). Kumar et al. (2017) also reported that cv. Rose Supreme is an early sprouting cultivar of gladiolus.

Number of leaves plant^{-1}

The statistical analysis revealed that various gladiolus cultivars and organic potash had significantly affected number of leaves plant^{-1}. However, interaction between organic potash and cultivars was non-significant. The mean data concerning various cultivars (Table 2) showed that cv. Rose Supreme resulted in maximum number of leaves (8.08) that was statistically similar to cv. Bangladesh, while cv. Magma produced least number of leaves (7.25). Among various potash levels, organic potash at 100 kg ha^{-1} resulted in maximum number of leaves plant^{-1} (8.33) of gladiolus. However, it was statistically at par with the number of leaves (8.22) in plants of plots where organic potassium was applied at 120 kg ha^{-1}. While organic potassium at 80 kg ha^{-1} resulted in least number of leaves (7.00) that were statistically similar to the number of leaves (7.44) observed in control plots where inorganic potash was applied at 100 kg ha^{-1}.

Organic potassium acts as an enzyme activator that enhances growth and development of plant (Helgi and Rolfe, 2005). Potassium plays an important role in photosynthesis, regulate opening and closing of stomata thus maintains carbon dioxide and water balance hence the sufficient supply of potassium helps to enhance the vegetative growth of the plant including number of leaves (El-Naggar and El-Nasharty, 2016).

Leaf area plant^{-1} (cm^2)

The analysis showed that gladiolus cultivars and organic potash significantly affected leaf area of gladiolus. However, interaction between organic potash and cultivars was non-significant. The mean data for various cultivars (Table 2) showed that cv.

Table 2:Days to plant emergence (DTPE), Number of leaves plant^{-1} (NL), Leaf area (LA), Weight of daughter corm (WDC) , Daughter corm diameter (DCD), and Number of cormels plant^{-1} (NC) of Gladiolus affected by Organic Potash Levels and cultivars.

Potash levels (K) (kg/ha)	DTPE	NL^{-1}	LA (cm^2)	WDC (g)	DCD (cm)	NC

100 (Control/Inorganic)	19.00	7.44ab	864.71a	20.23ab	3.92b	19.43bc
80	18.16	7.00b	686.18b	18.26b	3.40c	16.37c
100	18.58	8.33a	924.29a	22.77a	3.98ab	22.02ab
120	19.88	8.22a	901.48a	24.24a	4.16a	23.79a
LSD	NS	0.93	95.7	4.03	0.18	3.07
Gladiolus cultivars (C)						
Magma (Red)	22.14a	7.25b	793.21b	19.74c	3.65c	9.14c
Bangladesh (White)	21.44a	7.91a	824.24b	20.87b	3.86b	27.15a
Rose Supreme (Pink)	13.14b	8.08a	915.05a	23.51a	4.09a	24.92a
LSD	3.53	0.62	43.54	1.07	0.18	1.90
Significance	**	*	**	**	**	**
Interaction Kx C	NS	NS	NS	NS	NS	**NC**

Rose Supreme resulted in maximum leaf area (915.05 cm^2), followed by cv. Bangladesh (824.24 cm^2). While cv. Magma red had minimum leaf area (793.21 cm^2). Similarly, mean data of organic potash levels (Table 1) showed that maximum leaf area (924.29 cm^2) was observed in plants of plots fertilized with organic potash at 100 kg ha^{-1}, which was statistically similar to leaf area (901.48 cm^2) recorded in response to organic potash at 120 kg ha^{-1} and control. However minimum leaf area (686.18 cm^2) was obtained from the plants which received organic potash at 80 kg ha^{-1}.

Difference in leaf area might be due to the genetic makeup of the cultivars and adaptability of cultivars to the prevailing environmental conditions (Reshma et al. 2017). Similar results were also found by Kumar and Yadav (2005) and Swaroop *et al.* (2011) in gladiolus plants. It is reported that organic fertilizers improve the structure and properties of soil while potassium plays a vital role in stomata opening and closing, which helps in regulation of moisture in cells, improves cell growth, division and photosynthesis thus increases the area of leaf (Sober et al. 1981; Becker and Siddhuraju, 2003). The current results are in line with the finding of Tolan and Zeevaart (1992) who reported that organic fertilizer promoted vegetative growth. Azizi (1998) and Asif et al. (2007) also reported that the average leaf area was increased with the increasing levels of potassium application. Farooq et al. (2018) found that potassium application at 90 kg ha^{-1} significantly increased leaf area of gladiolus.

Weight of daughter corm (g)

The analysis of data showed that gladiolus cultivars and organic potash levels had significant effect on weight of daughter corm. While the interaction between cultivars and organic potash level was non-significant. Average data pertaining to various cultivars (Table 1) showed that the maximum weight of daughter corm (23.51 g) was recorded in cv. Rose Supreme, followed by cv. Bangladesh (20.87 g). While minimum weight of daughter corm (19.74 g) was recorded in cv. Magma. The average data pertaining organic potash level (Table1) showed that maximum weight of daughter corm (24.77 g) was observed in the plants that received the highest level of organic potash i.e., 100 kg ha^{-1}, which was statistically similar to organic potash when applied at 120 kg ha^{-1} whereas minimum weight of daughter corm (18.26 g) was recorded in plants that received organic potash at 80 kg ha^{-1}.

Corms are the underground storage organs of gladiolus plants that also act as plant propagule (Farooq et al. 2018; Ahmad and Rab, 2019). The production of more weight of daughter corm in cv. Rose supreme may be due to the good vegetative growth of plants (This is evident from the results that cultivar Rose Supreme produced maximum number of leaves, leaf area with more chlorophyll content) and resulted in an enhanced photosynthetic activity with translocation of more photosynthates to the sink i.e., corm (Sultana et al. 2005). The other possible reason may be due to hereditary characteristics of the cultivars. Rahul et al. (2011) also reported variations in weight of corms in response to various cultivars of gladiolus. The better effect of organic potash on daughter corm weight might be due to the fact that organic potash increased the concentrations of organic carbon, nitrogen, phosphorus and potassium in the soil (Kaur et al. 2005). Potassium increases the availability of other nutrients and improves source sink relationship and hence accumulation of more food reserved in storage organs (Kashyap, 2010). Potassium also increases water accumulation in the underground plants parts which results in higher weight of corm (Mahadik and Chopda, 2015). Findings of current experiment revealed that

that significantly highest diameter was observed in plants supplied with 100 and 120 kg ha^{-1} of organic potassium. Application of potassium significantly improves the corms weight (Barman et al. 2005). El-Desuki et al. (2006) also reported an increase in onion bulb weight with superior quality in plots supplied with optimum amount of potassium.

Diameter of Daughter corm (cm)

The statistical analysis of the data showed that corm diameter was significantly influenced by gladiolus cultivars and organic potash levels, however their interactions was non-significant. Average data relating various cultivars (Table 1) showed that maximum daughter corm diameter (4.09 cm) was recorded in cv. Rose Supreme, followed by cv. Bangladesh (3.86 cm). Minimum daughter corm diameter (3.65 cm) was recorded in cv. Magma. Similarly mean data relating to organic potash levels (Table 1) showed that maximum daughter corm diameter (4.16 cm) was recorded in plants that received highest organic potash at 120 kg ha^{-1}, which was at par with organic potash at 100 kg ha^{-1} with corm diameter of 3.98 cm. While, minimum daughter corm diameter (3.40 cm) was recorded in plants that received organic potash at 80 kg ha^{-1}.

Superiority of the cv. Rose Supreme with respect to diameter of corm and weight of corms over other cultivars might be due to utilization of available food material for the development of corms. It may also be due to the genetic makeup of the cultivar. Kumar, (2017) reported the maximum corm diameter was recorded in cv. Candyman (6.46) and minimum was recorded in cv. Dull Queen (3.27) of gladiolus. Sankari et al. (2012) also observed variations in corm diameter due to various cultivars. Maximum diameter of corms was recorded in plots fertilized with organic potash at 120 and 100 kg ha^{-1}. This may be due to the fact that organic fertilizers are the potential sources of plant nutrients. It improves the activity of micro-organisms that restore the soils natural nutrients cycle and promote growth by increasing the supply of adequate plant nutrients for proper growth and development of crop (Zhang et al. 2011).

Number of cormels $plant^{-1}$

The statistically analyzed data showed that number of cormels $corm^{-1}$ was significantly affected by gladiolus cultivars and organic potash levels. However, their interaction was non-significant. Average data regarding various cultivars (Table 1) showed that cv. Bangladesh produced more numbers of cormels $corm^{-1}$ (27.15) which was statistically similar to the number of cormels produced by the cv. Rose Supreme. However, cv. Magma produced the lowest number of cormels $corm^{-1}$ (9.14). The average data regarding organic potash levels (Table 1) showed that highest number of cormels $corm^{-1}$ (23.79) was recorded in plants that received the highest level of organic potash at 120 kg ha^{-1}, which was statistically similar to the number of cormels produced by plants that received organic potash at 100 kg ha^{-1}. Minimum number of cormels $corm^{-1}$ (16.37) were obtained in plants that received lowest level of organic potash i.e., 80 kg ha^{-1}.

More number of cormels $corm^{-1}$ productions in a particular cultivar as compared to other cultivars may be attributed to the genetic makeup of that cultivar (Jhon et al. 1996). Rani et al. (2007) and Hossain et al. (2011) also reported the same results on variation in number of cormels $corm^{-1}$ in gladiolus. Increased in number of cormels $corm^{-1}$ might be due to the fact that potassium has a vital role in several biosynthetic and metabolic processes, it also improved the plant resistance to various diseases by the synthesis of amino acids that lead to the better growth and production of the plant (Prajapati and Modi, 2012). Singh et al. (1997) and Barman et al. (1998) also reported an increase in numbers of cormels $corm^{-1}$ with the application of potassium.

CONCLUSIONS

Among different cultivars of gladiolus, cv. “Rose Supreme” proved superior and could be recommended for better vegetative growth and corm production of gladiolus under the agro-climatic conditions of Peshawar.

Application of organic potash at 100 kg ha^{-1} is recommended for enhanced vegetative attributes and corm production in gladiolus.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

The main idea/theme of the experiment was given by Masood Ahmad (MA). He designed the experiment and supervised the whole research from start till completion and writing of this manuscript. MR executed the experiment, did data collection, data analysis and provided assistance in writing of the manuscript. AMK, AM, FA and GN helped in the analysis and interpretation of data as well as technical writing of the manuscript. SA and NA helped in field data collection, soil analysis and in write-up of the manuscript. All authors have read and approved the final version.

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