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Influence of Spike Removal and NPK Levels on Corm Growth and Development of Gladiolus

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Abstract

An experiment to evaluate the influence of spike removal and NPK (mix fertilizer) levels on corm growth and development of gladiolus were conducted at Horticultural Research Farms, Department of Horticulture, The University of Agriculture Peshawar, Pakistan. The experiment was laid-out in Randomized complete block Design in split plot arrangement with two factors i.e. NPK (mix fertilizer) levels at the rate of 0, 50, 100 and 150 kg ha^{-1} and spike removal that is control (no removal), spike removal at spike emergence stages and spike removal at flower opening stages. Different growth and yield parameters were observed. Data analysis showed that NPK (mix fertilizer) levels, spike removal stages and their interaction had a significant influence on almost all the studied parameters in gladiolus plants. Results revealed that the minimum days to plant emergence (19.12), maximum plant emergence of (91.34%), days to spike emergence (65.40), number of daughter corms mother $corm^{-1}$ (2.90), number of cormlet mother $corm^{-1}$ (25.55), corm weight (41.77 g), corm diameter (4.66 cm), number of roots (27.58), root weight (3.66 g) and survival of (86.06%) were obtained in gladiolus plants fertilized with NPK @150 kg ha^{-1}. In case of spike removal, the maximum number of corms mother $corm^{-1}$ (2.67), corms weight (39.83 g), corm diameter (4.21 cm), number of cormlets mother $corm^{-1}$ (24.79), number of roots (24.96) and root weight (3.45 g) were observed in the plants whose spikes were removed at the spike emergence stage. The gladiolus plants in which spikes were removed at the spike emergence stage and fertilized with NPK @ 150 kg ha^{-1} gave maximum number of corms (3.60), corm weight (47.66 g), corm diameter (5.43 cm), number of roots (32.00) and root weight (4.43 g). The plants applied with NPK @100 kg ha^{-1} with spike removed at the flower opening stage showed maximum survival percentage (90.00%). From the current study, it can be concluded that the gladiolus plants applied with NPK (mix fertilizer) @150 kg ha^{-1} and spike removal at the spike emergence stage performed best in terms of growth and yield of gladiolus.

Keywords: Gladiolus; NPK level; Spike Removal; Corm Growth

Introduction

Gladiolus is herbaceous perennial bulbous flowering plant commonly known as Glade and botanically known as *Gladiolus grandiflorus*. Gladiolus is also known as Sward lily based on the Greek word Xiphos meaning sword [1] and is usually called as queen of bulbous flowering plants [2], belong to the family irradiance. Gladiolus origin is South Africa and it is grown throughout the world. The genus Gladiolus has 270 species having 10,000 cultivars. More than 120 cultivars of gladiolus are cultivated for cut flower purposes. Many others are also use as seasonal flowering plants in gardens and exhibition [3]. It is popular commercial bulbous flowering plants, widely cultivated in most countries of the world [4]. Popularity of this plant as cut flowers is increasing day by day in developing countries including Pakistan, due to best quality and wide range of colors of its flowers spike. USA, Holland, Italy are the major countries producing gladiolus as a cut flowers.

Gladiolus flowers has taken a great position in the hearts of flower loving people as well as in the cut flower industry [3]. The cut flower industry is a fast growing industry worldwide, which is becoming popular in Pakistan day by day. It is an important cut flower in both domestic and international market [4]. Netherlands, Germany and France are presently focusing over the traditional production of the cut flower to those countries where the climates are better and production costs are low [5]. Commercial cultivation of gladiolus is possible through corms and cormels [6]. One mother corm generally produces two to three daughter corms of standard size with few cormels. The cormels are auxiliary buds on the corm, which is a compressed thickened stem and as resting perpuating organ [7].

Gladiolus requires well-drained soil with pH between 6.0-7.0 for its better growth and development. They also need open position for getting more sunlight, ample water with heavy soaking weekly. Gladiolus corms are harvested six to eight weeks after flowering, and then dried it under shade, treated with fungicides and kept in ventilated area [7]. Corms of gladiolus are mostly planted on ridges or beds, it is recommended to plant the corms on ridges in case of clay soil while planting on beds is recommended for sandy soil [8]. Suitable plant spacing is the key

factor to provide less competition among plants for moisture, light and nutrients to ensure maximum crop production. Commercial quality of gladiolus can be obtained at a planting density of 25 cm. Plant spacing affects yield and high quality of spikes and corms [9].

Zubair and Khan (2005) reported that spike removal affect yield and quality of cormels of gladiolus cultivars in Peshawar. Misra [10] reported that plants divert their energies (dry matter) toward the corms and cormels in the absence of spike. Robert and Milbrath [11] also stated that the removal of spike enhances the numbers, diameter and weight of corms and cormels. Fertilzer application at appropriate time, in appropriate amount and at proper method is the prerequisite for gladiolus cultivation (Islam, 2003). Gladiolus responds greatly to major elements like N, P and K in respect to its growth and yield.

Nitrogen is an important plant nutrient influence vegetative growth and flowers yield of gladiolus. It was concluded from the analysis of leaf that a single leaf must contain dry weight about 2.5-3.0 % nitrogen for optimum yield [12]. Nitrogen is an important nutrient, play a vital role in synthesis of proteins and amino acids, which helps in cell division and boost up meristematic activities when applied in optimum quantity [13]. Nitrogen application in optimum quantity enhances the yield and quality of cut flowers and corm [14]. However higher doses may delay maturity and increase lodging [15]. Phosphorus as plant nutrient influences many plant functions like flowering, root development, disease resistance and maturation. Phosphorus is flower and roots stimulator for newly transplanted plants (seedling) [16]. Mukkherjee et al. [13] stated that phosphorus application enhances number of corms, cormels, number of spikes and spikelet's of gladiolus.

Phosphorus application at proper time and proper amount enhances number of corms and cormels, maximum height of plant, number of leaves, corms weight (g) and cormels weight (gm) and corm diameter (cm) of gladiolus. Potassium is very important plant nutrient for plant growth and development [14-16]. It is responsible for many biochemical processes. Potassium plays an important role in regulation of stomata during transpiration and photosynthesis, enzymes activation and maintenance of turgor pressure [17]. The plant cell swells when potassium ions move toward the guard cell, as a result the stomata opens and exchange of gases takes place. The potassium ion is pushed out of the guard cell when there is water stress situation to avoid loss of water. This mechanism prevents the loss of water by closing the stomata pores. Potassium plays very important role in transpiration. In the process of photosynthesis, Adenosine increases with the increasing of potassium application. Triphosphate (ATP) is formed; this ATP is high-energy product. At the site of ATP, synthesis potassium ions control the electrical charge balance. Photosynthesis is reduced when potassium level in the plant is lower than the required, as a result less ATP is synthesized which ultimately decrease the speed of all other reactions of plant, which is dependent on ATP formation. Potassium deficiency leads to delay flowering, less number of buds, short stem of flowers, weakening of stalks, susceptibility of roots to rotting organisms, the yellowing of older leaves and lodging of plants due to wind and rain [18].

Objectives

a. To explore the best NPK levels for gladiolus corm production.

b. To investigate the impact of spike removal on the gladiolus corm production.

c. To find out best interaction between spike removal and NPK levels.

Materials and Methods

An experiment to observe the influence of spike removal and NPK levels on subsequent corms growth and development of Gladiolus under climatic conditions of Peshawar was conducted at Horticulture Research Farm, the Department of Horticulture, The University of Agriculture, Peshawar-Pakistan during the year 2013-14.

Experimental Design

The experiment was laid out in Randomized complete block (RCB) Design with split plot arrangement having main plot factor NPK (mix fertilizer) levels and sub plot factor i.e. spike removal. NPK (mix fertilizer) @ 0, 50, 100 and 150 kg ha^{-1} were applied before corms sowing.

Results and Discussions

Findings of the observed attributes are presented and discussed in the following paragraphs:

Number of Daughter Corm Mother $Corm^{-1}$

The data noted for number of corms $plant^{-1}$ is given in Table 1. NPK levels, spike removal and their interaction had a significant effect on number of corms mother $corm^{-1}$. Mean values of different NPK levels showed that plots fertilized with NPK @ 150 kg ha^{-1} had maximum number of corm of (2.90), followed by (2.14) and (1.86) in plots fertilized with NPK @ 100 kg ha^{-1} and NPK @ 50 kg ha^{-1} respectively. Minimum number of corms (1.36) was recorded in control treatment. Mean value of spike removal at three different stages showed that spike removal at spike emergence stage resulted maximum number of corms (2.67), followed by (1.97) in spike removal at flower opening stage. Minimum (1.55) number of corms was recorded in control treatment. NPK levels and spike removal stages recorded a significant interaction for number of corms. Data showed that interaction of NPK @ 150 kg ha^{-1} and spike removal at a spike emergence stage resulted maximum number of corms (3.60), whereas minimum number of corms (1.06) was recorded in control treatment. NPK @ 150 kg ha^{-1} recorded maximum number of corm (2.90). This might be due to nitrogen application in optimum quantity, which increases number of corms and cormels in gladiolus. Application of nitrogen with phosphorus can also enhance number of corms, cormlets, floret and spike length [19]. Milbrath (1943) also concluded by

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his experiment that the removal of spike enhances the numbers, diameter and weight of corms.

Table 1: Number of Daughter Corms Mother Corm^{-1}, Number of Cormels Mother corm^{-1} and Corm weight (g) as affected by various spike removal stages and NPK levels.

Spike Removal	Number of Daughter Corms Mother corm^{-1}	Number of Cormels Mother Corm^{-1}	Corm Weight (g)
Control (No Removal)	1.55 c	21.34 b	37.00 c
At spike emergence stage	2.67 a	24.79 a	39.83 a
At flowers opening stage	1.97 b	22.10 b	38.00 b
NPK Level (kg ha^{-1})			
0	1.36 d	19.14 d	35.44 d
50	1.86 c	21.49 c	37.11 c
100	2.14 b	24.79 b	38.66 b
150	2.90 a	25.55 a	41.77 a

Number of Cormels Mother Corm^{-1}

The data observed for number of cormels mother corm^{-1} is given in Table 1. NPK levels and spike removal had a significant effect on number of corms mother corm^{-1}, whereas their interaction showed non-significant effect. Mean values of various NPK levels showed that plots fertilized with NPK @ 150 kg ha^{-1} produced maximum number of cormels (25.55) followed by (24.79) and (21.49) number of cormels in plots fertilized with NPK @ 100 kg ha^{-1} and NPK @ 50 kg ha^{-1} respectively, whereas minimum number of cormels (19.14) obtained in control treatment. Number of cormels was significantly affected by spike removal stages. Data showed that maximum numbers of cormels (24.79) were produced in plots in which spikes were removed at spike emergence stage, whereas minimum numbers of cormels (21.34) were produced in plots with control treatment. It is obvious from the mean table that NPK levels significantly increased the yield of cormels by applying NPK @ 150 kg ha^{-1} and 100 kg ha^{-1} which produced 25.55 and 24.79 cormels mother corm^{-1}, statistically similar to each other. This might be due to nitrogen that influences vegetative growth and flowers yield of gladiolus. Nitrogen application in optimum quantity enhances the yield and quality of cormels. From the above results we concluded that spike removal had significant effect on cormels production of gladiolus, this might be due to the store food of corm utilizes for spike production divert towards corm and cormels of gladiolus plants. Singh confirm these results. He stated that Spike removal at spike emergence stage gave efficiently better results regarding number of daughter corm mother corm^{-1}, number of cormels mother corm^{-1}, corm weight (g), corm diameter (cm) and survival percentage of gladiolus plants [20-23].

Corm Weight (g)

The data recorded for corm weight is presented in Table 1. NPK levels, spike removal and their interaction showed significant effect on corm weight. Mean values of different NPK levels showed that plots fertilized with NPK @ 150 kg ha^{-1} produced maximum corms weight (41.77 g), followed by (38.66 g) and (37.11 g) in plots fertilized with NPK @ 100 kg ha^{-1} and NPK @ 50 kg ha^{-1} respectively. Whereas minimum corms weight (35.44 g) was recorded in control treatment. Weight of corms is significantly affected by spike removal stages. It is obvious from mean table that maximum corm weight (39.83 g) was noted when spikes were removed at spike emergence stage. While minimum weight (37.00 g) was recorded in control treatment. There was a significant interaction between NPK levels and spike removal, data reveals that combination of NPK levels @150 kg ha^{-1} and spike removal at spike emergence stage gave maximum corm weight (47.66 g). Whereas minimum corm weight (33.00 g) was recorded in control treatments.

Data showed that application of NPK 150 kg ha^{-1} recorded maximum (41.77 g) corm.weight/which/might/be due/to/ nitrogen, Phosphorus/and/Potassium/as/these/are the most important plant macronutrients that enhances corm production of gladiolus plants. Phosphorus is one of the most important essential macro elements for the normal growth and development of the plants. These results are in accordance with the finding of Singh and Arora (1980). He stated that phosphorus application improves the growth and development of gladiolus plant. Maximum corm weight (39.83 g) was recorded in spike removal at spike emergence stage. Similar observation was studied by Das (2003) who studied the effect of spike removal on gladiolus flowers. It was found that yield of corms growth in sense of corms diameter (cm), corms weight (g) and number of corms are doubled in spike removal at emergence stage as compare to control.

Corm Diameter (cm)

The data recorded for corm diameter is given in Table 2. It is obvious from the ANOVA that NPK levels, spike removal and their interaction had significant effect on corm diameter. Mean values of different NPK levels showed that plots fertilized with NPK @ 150 kg ha^{-1} recorded maximum diameter of corms (4.66 cm), followed by (4.14 cm) and (3.78 cm) corms diameter (cm) in plots fertilized with NPK @ 100 kg ha^{-1} and NPK @ 50 kg ha^{-1} respectively. The minimum corms diameter (3.07 cm) was recorded in control treatment. Diameter of corms is significantly affected by spike removal stages, it is obvious from mean table that maximum corm diameter (4.21 cm) was recorded in plants, where spike was removed at spike emergence stage. Minimum corm diameter (3.62 cm) was recorded in control treatment. There is a significant interaction between NPK levels and spike removal, data reveals that combination of NPK 150 kg ha^{-1} and spike removal at spike emergence stage recorded maximum corms diameter (4.40 cm), whereas minimum corm diameter (2.23 cm) was noted in control treatment. Maximum corm diameter (4.66 cm) was noted in

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plots fertilized with NPK levels @ 150 kg ha^{-1}. This might be due to nitrogen and potassium application, because both these are plant macronutrients enhances many biological and physiological functions of plants. Maximum corm diameter (4.21cm) was recorded by spike removal at spike emergence stage. A balance fertilizer (NPK) and irrigation is necessary for best growth and biological function (Woltz, 1976) of plants. It was stated that spike removal had significant effect on corm diameter in gladiolus plants. Misa (1997) reported that plants divert their energies (dry matter) toward the corms and cormels in the absence of spike. Robert and Milbrath (1943) stated that spike removal maximizes the weight (g) and size of corm.

Root Weight (g)

The data noted for root weight is given in Table 2. Analysis revealed that NPK levels, spike removal and their interaction had efficient effect on root weight of gladiolus. Mean values of various NPK levels showed that plots fertilized with NPK @ 150 kg ha^{-1} recorded maximum root weight (3.66 g), followed by (3.14 g) and (2.78 g) root weight in plots fertilized with NPK @ 100 kg ha^{-1} and NPK @ 50 kg ha^{-1} respectively. The minimum root weight (2.06 g) was recorded in control treatment. Root weight is also significantly affected by spike removal stages, it is obvious from mean table that maximum weight of roots were recorded in spike emergence stage i.e. (3.45 g). whereas minimum (2.43 g) root weight were recorded in control treatment.

A significant interaction between NPK and spike removals, Data showed that combination of NPK @ 150 kg ha^{-1} and spike removal at spike emergence stage recorded maximum root weight (4.43 g). On the other hand minimum root weight (1.23 g) was recorded in control treatments. Maximum root weight (3.45 g) was recorded in plot fertilized with NPK @150 kg ha^{-1}, This might be due to nitrogen which enhances vegetative growth of the plants, and also excellent environment which encourage root system to develop. From the results it is concluded that nitrogen application enable the plants to gain maximum roots weight (Khan 1985 and Ahmad 2000). Maximum root weight (3.45 g) was recorded by spike removal at spike emergence stage, this might be due to spike removal. The findings of current study are in close agreement with the findings of Gimassy and Sirry (1967) who observed that spike removal had an effect on root number, root length, number of corms and cormels by diverting more energy for their development.

Plant Survival Percentage

The data recorded for the plant survival percentage (%) is presented in Table 2. Analysis of the data showed that NPK levels, spike removal and their interaction had a significant effect on plant survival percentage. Mean values of NPK levels shows that plots fertilized with NPK @ 150 kg ha^{-1} recorded maximum survival of (86.06%) which is statistically similar (85%) in plots fertilized with NPK @ 100 kg ha^{-1}. The minimum plant survival of (78.00 %) was recorded in control. Mean values of spike removal stages shows that spike removal at spike emergence stage recorded maximum survival of (84.13%) which is statistically similar to spike removal at flowers opening stag. A significant interaction between NPK and spike removal stages was also observed. It is clear from the table that combination of NPK @ 100 kg ha^{-1} and spike removal at flower opening stage recorded maximum plant survival of (90.00 %), because due to spike removal the reserved food does not utilized in seed setting and development, so the survival percentage increases. While minimum plant survival of (75.33 %) was recorded in control treatments. The highest survival of (86.06 %) seems due to nitrogen and potassium application, because all these nutrients play their own roles. Nitrogen application encouraged plant growth and the reserved food remain stored for further growth and development (Wilfret, 1980). Plant survival percentage is also significantly affected by spike removal. Mean value in Table 2 show that maximum plant survival of (84.13 %) was recorded in spike removal at spike emergence stage as well as spike removal at flower opening stage having 83.50 respectively. Whereas minimum plants survival % age was indicated in control treatment i.e. 81.75%. This might be due to the fact that more reserved food in plants with spike removal at spike emergence stage survives better (Misra, 1994).

Table 2: Corm Diameter (cm), Root weight (g) and Plant survival Percentage as affected by various spike removal stages and NPK levels.

Spike Removal	Corm Diameter (cm)	Root Weight (g)	Plant Survival Percentage
Control (No Removal)	3.62 c	2.43 c	81.75 b
At spike emergence stage	4.21 a	3.45 a	84.13 a
At flowers opening stage	3.91 b	2.85 b	83.50 a
NPK Level (kg ha^{-1})			
0	3.07 c	2.06 d	78.00 c
50	3.78 b	2.78 c	82.11 b
100	4.14 ab	3.14 b	85.00 a
150	4.66 a	3.66 a	86.06 a

Summary

To study the influence of spike removal and NPK (mix fertilizer) levels on corm growth and development of gladiolus, an experiment was conducted at Horticultural Research Farm, the Department of Horticulture, the University of Agriculture Peshawar, Pakistan during 2013-14. The experiment was laid-out in Randomized complete block Design in split plot arrangement with two factors i.e. NPK (mix fertilizer) levels at the rate of 0, 50, 100 and 150 kg ha^{-1} (main plots) and spike removal (sub-plots) that is control (no removal), spike removal at spike emergence and spike removal at blooming (flower opening). Different growth and yield attributes such as days to plants emergence, plants emergence % age, days to spike emergence, number of daughter corms mother corm-1, corms weight(g), corms size (cm), number

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of cormlet mother corm^{-1}, number of roots, root weight(g) and plants survival % age, were recorded.

Analysis of the data indicated that NPK application, spike removal and their interaction had significant effect on almost all the studied parameters. NPK @ 150 kg ha^{-1} significantly affected plant emergence of (91.34%), days to spike emergence (65.40), number of corms (2.90), number of cormlet mother corm^{-1} (25.55), corm weight (41.77 g), corm size (4.66 cm), number of roots (27.58) root weight (3.66 g) and survival of (86.6%). However, it also gave minimum days to plant emergence (19.12). On the other hand, the plants in control treatment showed maximum days to plant emergence (31.20), minimum plant emergence 0f (82.56%), days to spike emergence (63.88), number of daughter corms mother corm^{-1} (1.36), number of cormlet mother corm^{-1} (19.14), corm weight (35.44 g), corm size (3.07 cm), number of roots (18.88) and root weight (2.06 g). The mean values regarding the spike removal showed that the maximum number of corms (2.67), number of cormlets (24.79), corm weight (39.83 g), corm size (4.21 cm), number of roots (24.96) root weight (3.45 g) and maximum plants survival of (84.13%) were observed in plants of which spike was removed at spike emergence stage. However, the gladiolus plants with control treatment (no spike removal) showed minimum number of daughter corms mother corm^{-1} (1.55), number of cormlet mother corm^{-1} (21.34), corm weight (37.00 g), corm diameter (3.62 cm), number of roots (21.49), root weight (2.43 g) and minimum survival 0f (81.75%). The interaction of NPK fertilizer and spike removal stages revealed that the gladiolus plants which were applied with 150 kg ha^{-1} and subjected to spike removal at spike emergence stage showed maximum number of daughter corms mother corm^{-1} (3.60), maximum corm weight (47.66 g), maximum corm size (5.43 cm), maximum number of roots (32.00) and maximum root weight (4.43 g). The maximum survival of (90.00%) was recorded in plants fertilized with NPK @ 100 kg ha^{-1} and spike removal at the flower opening stage. On the other hand, the gladiolus plants with control treatment gave minimum number of daughter corms (1.06), minimum corm weight (33.00 g), minimum corm diameter (2.23 cm), minimum number of roots (17.00), minimum root weight (1.23 g) and minimum survival 0f (76.66%).

Conclusion

From the observed results and their analysis, it can be concluded that Gladiolus plants received NPK (mix fertilizer) levels @ 150 kg ha^{-1} significantly affected days to plants emergence, plants emergence % age, days to spike emergence, number of daughter corm mother corm^{-1}, number of cormels mother corm^{-1}, corm weight (g), corm size (cm), number of roots, root weight (g) and survival % age of gladiolus plants, which is statistically similar to the result of NPK (mix fertilizer) levels @ 100 kg ha^{-1}.

Spike removal at spike emergence stage gave efficiently better results regarding number of daughter corm mother corm^{-1}, number of cormels mother corm^{-1}, corm weight (g), corm diameter (cm), number of roots, root weight (g) and survival percentage of gladiolus plants.

Recommendations

Based on the above conclusions it is recommended that:

a) Gladiolus plants should be fertilized with NPK (mix fertilizer) levels @ 100 kg ha^{-1} for optimum growth and yield of gladiolus corms.

b) Spikes should be removed as soon as it emerges from plant.

c) Future work is needed to find out the interaction of spike removal and fertilizers like N, P and K alone on gladiolus and other bulbous flowering plants in order to minimize the cost of fertilize.

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