**Influence of Percent Shade and Foliar Application of Humic Acid on Growth and Development of *Gladiolus* *Grandiflorus***

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**Abstract**

Research with the title “Influence of percent shade and foliar application of Humic acid on growth and development of *Gladiolus grandifloras* L.” were performed at the University of Swabi, Khyber Pakhtunkhwa, Pakistan. in the year of 2019/20**.** The research was set up in two factorial Randomized Complete Block Design (RCBD). using a split plot arrangement, and replicated twice. Four levels of Humic acid (0, two hundred, four hundred and six hundred parts per million) and gladiolus was treated with three levels of percent shade (0, 50 and 75%). Shade was applied to main plots while plants in subplots were treated with Humic acid. The result reveals that Humic acid and percent shade levels have significantly affected all the growth parameters of gladiolus, however, for the majority of the parameters their interaction effect was non-significant. The maximum plant height (115.9 cm), flower size (73.9 mm), days to emergence (9.4 days), number of leaves, per plant (16.7), number of flower per plant (9.7), flower diameter (91.8 mm), spike length (58.8 cm), rachis length (24.1 cm), spike diameter (8.3 mm) were noticed in plants treated with 600 ppm Humic acid. Regarding shade levels, the maximum plant height (114.0 cm), flower size (74.9 mm), number of leaves,per plant (15.3), number of flower per plant,(9.8), flower diameter (93.6 mm), spike length (58.5 cm), rachis length (22.8 cm), spike diameter (7.9 mm) were recorded in control (0 % shade) plants. It can be concluded from the current study that gladiolus should be grown with the application of 600 ppm Humic acid in the open field.

**Keywords:** *Gladiolus*, Humic acid, Shade, Height of plant, Flower size.

**Introduction**

Gladiolus (*Gladiolus grandiflorus* L,) belongs to the family Iridaceae. It is the queen of bulbous flowers due to its bright colors, size, heavy shape, fascinating shape and good post-harvest life of flowers florets and spikes. It’s grown for its fascinating spike as a cut flower and as well in flower beds in gardens in the time of winter season. Cut flowers are expensive output of horticulture (El-Kot *et al*., 2020). For having acceptable products for the markets, it is considered important and practical to maintain cut flowers of good grade and extend the shelf life two major factors affect the vase life of cut flowers,. This is ethylene that many flowers senescence is accelerated and microorganisms that cause vascular blockage are accelerated, thereby reducing the vase life of cut flowers, (Van Doorn, 1994; Zencirkiran, 2005; Zencirkitan, 2010).

The gladiolus species consists of approximately 260 species of which 10 are native to Eurasia and 250 belong to Sub-Saharan Africa (Goldblatt and Manning 1998). Pakistan’s floriculture industry is becoming lucrative for small farmers. Pakistan’s cut flower production is estimated between 10 and 12 thousand tons per year and their demand on the market has increased (Rehman, 2004). Pakistan’s floriculture market is dominated by roses because of their use on different occasions and in different places. (Nadeem *et al*., 2011) follow by as cut flower gladiolus (*Gladiolus hybridus* Hort.). It is considered one of the world four well known cut flowers (Bai *et al.,* 2009). One of the main challenges facing florets today is the quality of cut flowers. Because apart from its external quality; one of the most important factors for consumers is the vase life, of cut flowers. Gladiolus cut flowers, are very-short in longevity. The typical vase of individual florets, is only 4 to 6 days and after opening the upper florets, senescent florets remain at the spikes (Yamada *et al*., 2003).

The organic polymer compound occurs naturally in Humic, acid and is a potentially natural resource,it might be utilized to boost the availability, nutrient,production and growth. The soil, humus, peat, oxidized wood ash and sulfur are derivatives of Humic acid from these sources. Humic acid is a company drug. The components in Humic acid promote soil fertility, minimize nutrient deficit and increase accessibility of nutrients and water supply by forming different chelates of essential minerals (Ghoneim *et al*., 2020). The Humic acid substance (Humic and fulvic acid) make up organic matter (65 to 70%) and diverse agriculture fields studied due to multiple roles of these substances, which can benefit plant development. The Humic acid also increased the stress and resistance of plants to the environment (Yamada *et al*., 2003). . Previously it has also been observed that the use of Humic acid is beneficial for the abortion of nutrients by plants, in particular N, P, K, Ca,.Mg, Cu, Fe,and Zn. The Humic acid increased the abortion of nutrients. Humic acid positive effects are directly on plant growth and enhance plant growth of shoots and roots, nitrogen abortion, potassium, calcium, magnesium, and phosphorus. Humic acid is compatible with nature and is not harmful to plants and the environment. The solicitation of Humic acid increases soil aggregation,.Structure, capacity to hold moisture, fertility and activity of micro-organism. The application of Humic acid considerably increased the photosynthetic efficiency and chlorophyll content of ryegrass. It not only encouraged but also vegetative growth increased as well as floral development plants that received three administrations of Humic acid and NPK had the most florets per spike.

Gladiolus is an ornamental species manufactured for flower cut and propagated by corms. In addition to the production of commercial coms, early flowering and an increase in the number of flower buds are constant challenges to be addressed in the cultivation improvement. Thanks to growth regulators, the commercial production of ornamentals is accelerated technologically. The auxin stands out among them for their key role in the adventitious rooting and the elongation of the cells. Conversely, the Humic acid substance in the organic matter also has a bio stimulating effect.

**Objective**

* To study the response,of Gladiolus to various levels,of shades.
* To determine the impact of humic acid on Gladiolus growth and development.
* To assess the interactive impact of Humic,acid and shade levels on the growth and development of Gladiolus

**Materials And Methods**

The Research, entitled “Influence of percent shade and foliar application of humic acid on growth and development of gladiolus *grandiflorus* wasconducted, at the Horticultural Research Farm” The University, of Swabi in 2019. The experiment was set up in a Randomized Complete Block Design (RCBD) with 3(three) replications and a two-factor split plot arrangement. Gladiolus corms were planted in soil at depth of 5cm by keeping plant to plant and row to row distance of 1.5 feet and 2 feet on ridges respectively. Four levels of Humic acid (0, 200, 400 and 600 ppm) and three levels of shade (0%, 50% and 75%), Lath cloth was used to get the desired shade (50 and 75% respectively). Percent shade was allotted to main plots while Humic acid was as applied to subplot all other cultural practices like weeding, irrigation etc. was carried out when required. Humic acid was sprayed at 30th days after planting on weekly basis. The tunnel with a total area of 450 m2 was oriented from east to west with 104×33×11 ft dimensions Lux meter was installed inside the tunnel for recording light intensity.

Data was recorded on the following parameters to find, the impact of shade and humic acid on Gladiolus performance.

**Factor, A**: Humic acid levels (HA) **Factor, B: Levels of Shade** (PS)

**H0 =** 0 ppm  **PS1 =** 0%

**H1 =** 200 ppm **PS2 =** 50%

**H2 =** 400 ppm **PS3 =** 75%

**H3 =** 600 ppm

**FIELD LAYOUT**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Replication** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Shade (%)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Humic Acid (ppm)** | 0 | 400 | 600 | 200 | 400 | 0 | 200 | 600 | 400 | 200 | 0 | 600 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Replication** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **Shade (%)** | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| **Humic Acid (ppm)** | 400 | 0 | 200 | 600 | 400 | 600 | 200 | 0 | 600 | 200 | 400 | 0 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Replication** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Shade (%)** | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 |
| **Humic Acid (ppm)** | 600 | 200 | 0 | 400 | 0 | 200 | 600 | 400 | 0 | 200 | 400 | 600 |

**The following parameters were measured and recorded**

Days to emergence data were taken from the sowing date to the emergence of seed was different days The plant height was measured in centimeters from the bottom plant to the top of the leaves with a measuring tape and the average was determined from three plants chosen at random, the total number of plant-1 leaves at physiology maturity was counted, and the average was determined. Data of flower size was noted with the help of Vernier caliper, of randomly selected plants and then average was counted. The number of the flower of the +individual plants in each plant was counted separately and then average was determined. With the aid of a Vernier caliper the flower diameter is determined by taking on each of the two florets and then measuring the average. The length of spike was measured from the bottom of the plant up to the top of the flower with the help of measuring tape. The distance between the points of spike emergence and the first florets of the flower was used to assess the length of the rachis. The spike diameter is determined from the three points of each with the aid of Vernier caliper and then estimated as average.

**Statistical analysis**

Significant differences were used to do statistical analysis of the data using the statistical software Statistical TM 8.1. the LSD test (p 0.05) was used to establish the comparative mean (Jan et al., 2009).

**RESULTS**

Changing climatic scenarios arise the problem of light concentration and uncertainty of rainfall. Nutrient management from organic and inorganic sources is also one of the most important factors to get good size of flower from gladiolus. Gladiolus is an ornamental plant and its flower size, diameter and number of florets is greatly influence by percent shade and Humic acid application.

**Days to emergence**

Data regarding days to the emergence as affected by Humic acid application and percent shade is given in Table 4.1 and its analysis of variance (ANOVA) as shown in Table 4.1a. The analysis of variance shows that there exists (p≤0.05) significant variation in days to emergence in relation to percent shade and interaction of Humic acid and percent shade. However, Humic acid has a non-significant effect on days to emergence of gladiolus.

The means data reveals that a significant variation was observed in days to emergence in relation to the shade levels. Gladiolus plants are grown under 75% shade took more days to emergence (9.4), followed by 8.3 in control, however, the least days to emergence (8.0) were recorded in plants under 50 % shade. Moreover, the latter two were at par with each other.

The interaction of Humic acid and percent shade also significantly affected the days to emergence of gladiolus. The highest days to emergence (11.0) were observed in plants treated with 600 ppm Humic acid and grown under 75 % shade. However, the least days to emergence (7.0) were recorded in plants treated with 200 ppm Humic acid and 0% shade.

**Plant height (cm)**

The means data in Table 4.2 shows that there was a significant variation in plant height was observed in the plant height of gladiolus in relation to Humic acid, percent shade and HA × PS. The analysis of variance (ANOVA) is given in Table 4.1a.

The plant height improved significantly with increasing level of Humic acid. Maximum plant height (115.9 cm) was recorded with Humic acid @ 600 ppm followed by 400 ppm of Humic acid treatment. However, the minimum plant height (105.2 cm) was observed in control. The statistically analyzed data regarding the application of Humic acid at different percent shade of gladiolus plants disclosed that there was a significant difference between the plant height as affected by the Humic acid application at different percent shade during growth and development. The maximum plant height (114.0 cm) was noted when Humic acid was applied at the open field (0 % shade). While there was the non-significant differences in between 50% and 75% shade.1

The interaction of Humic acid and percent shade revealed a significant difference among the treatments. The highest value (118.3 cm) for plant height was noted when the plants were treated with 400 ppm of Humic acid at the open field (0 % shade) followed by 600 ppm of Humic acid at 0 % shade whereas minimum plant height (104.4 cm) was recorded in untreated plants. While there were no effects of percent shade in control Humic acid of the gladiolus plant.

**Leaves plant-1**

Plant-1 is influenced by humic acid, according to the data and percent shade is furnished in Table 4.3 and analysis of variance is given in table 4.3a. The statistical analysis showed a significant influence of Humic acid, while percent shade had no significant influence on leaves plant-1, similarly, its interaction was also found significant.

The findings obtained by statistical analysis for the number of leaves varied significantly for gladiolus crops shown in (Table 4.3). Significantly better number of leaves (16.7) of gladiolus plant was recorded in treatment where 600 ppm of Humic acid were applied followed by 400 ppm of Humic acid treatment while the minimum number of leaves were seen in controlled plant (12.5). The mean data for number of leaves indicated that there was a significant difference among percent shade.

Maximum number of leaves plant-1 (15.3) was recorded when plants were treated with 600 ppm at control shade while the other percent shade treatments showed non-significant differences among them. The interaction of Humic acid and percent shade showed a significant difference among the treatment. The highest value (18.3) for number-of leaves was noted when plants were treated with 600 ppm of Humic acid at 0% shade followed by 400 ppm of Humic acid at 75% shade. While the minimum number (10.0) of leaves of gladiolus plant was recorded in 0 ppm of Humic acid at 75% shade.

**Flower size (mm)**

The data regarding flower size of gladiolus Table 4.4 shows the plants, as well as the results of the analysis of variance (ANOVA) documented in table 4.4a that show that levels of Humic acid and percent shade showed significant values however, its interaction effect was non-significant on flower size of gladiolus.

The mean table values showed flower size was affected on Humic acid at concentration of 600 ppm which showed value (73.9 mm), and the flower size which was not affected which showed at control Humic acid (66.3 mm) at different percent shade showed maximum flower size on 0 % shade (74.9 mm), while minimum flower size showed at 75 percent shade (64.0 mm). The percent shades also significantly affected the flower size of gladiolus. The maximum flower size (74.9 mm) was observed in control whereas the least flower size (64.0 mm) was recorded in plants grown under 75 % shade.

**Number of flowers**

Data on number of flower of gladiolus plant is presented in Table 4.5 and analysis of variance (ANOVA) showed in Table 4.5a The statistical analysis showed significant (p≤0.05) variation was recorded in number of flowers of gladiolus influence of Humic acid while percent shade had non-significant influence flower number, similarly, its interaction was also found non-significant effect on number of flower of gladiolus that flowers number were significantly improved when 600 ppm Humic acid were applied in control field (0 % shade).

The maximum number of flowers (9.7) noted when the plants were treated with 600 ppm of Humic acid whereas the minimum number of flowers (7.3) was recorded at control treatment. The mean data regarding number of flowers indicated that there is significant differences among different percent shade. Maximum number of flowers (9.8) were recorded when plants were grown in the open field (0 % shade) while remaining percent shade showed a non-significant difference. Interaction between Humic acid concentration and different percent shade showed that maximum number (12.0) of flower per plant of gladiolus appeared on 600 ppm of Humic acid with the open field ( 0% shade), while minimum number of flower per plant of gladiolus (6.7) appeared where the plant were treated with 0 ppm of Humic acid at 50% shade.

**Flower diameter (mm)**

The data regarding flower diameter as influenced by Humic acid and percent shade is presented in table 4.6 and analysis of variance is given in table 4.6a. It is clear the means data that significant (p≤0.05) variation was recorded in flower diameter of gladiolus regarding percent shade and Humic acid however, the blossom diameter of gladiolus was unaffected by their interaction.

The mean table 4.6 reveals that greater diameter of flower (91.4 mm) was recorded in gladiolus plant which was grown in the open field( 0 % shade) with the treatment of 600 ppm Humic acid, followed by 400 ppm of Humic acid with 50% shade while the smallest flower diameter (78.6 mm) was recorded in control plot (no Humic acid).

In case of percent shade, the greatest flower diameter (93.6 mm) was observed in plant in the open field (0 % shade) as compared to other shade ratios which is non-significant (76.9 mm) at 75 % shade and (85.3 mm) at 50% shade flower diameters were recorded.

The interaction of Humic acid and percent shade showed non-significant differences among the flower diameter of gladiolus plant. The maximum flower diameter (104.8 mm) were obtained with the application of 600 ppm Humic acid in the open field (0 % shade) followed by 400 ppm while the minimum flower diameter (73.5 mm) was noted when we applied 200 ppm Humic acid with 75% shade.

**Rachis length (cm)**

Table 4.7 shows the gladiolus plant's rachis length as influenced by Humic acid, as well as % shade, and table 4.7a shows the analysis of variance. The statistical analysis showed a significant variation (p≤0.05) in rachis length by Humic acid, percent shade and its interaction.

The table of rachis length shows that the maximum rachis length (24.1 cm) was produced in gladiolus plants when plants were treated with 600 ppm of Humic acid, followed by (19.2 cm) with 400 ppm of Humic acid, while the control (no Humic acid) produced minimum Rachis length (15.8 cm) however the latter two were at par with each other. In case of percent shades 0% (open field) produced grater Rachis Length (22.8 cm) as compared to other shade ratios which is (16.0 cm) in 75 % shade and (17.5 cm) at 50% shade.

Interaction between different concentration of Humic acid and different percent of shade shows that highest rachis length (30.0 cm) of the gladiolus plant produced in open the field (0 % shade) with 600 ppm of Humic acid while minimum rachis length recorded (12.0 cm) with the treatment of 200 ppm of Humic acid at 75 % shade.

**Spike length (cm)**

Data concerning spike length as strengthened by Humic acid and percent shade is documented in Table 4.8. and analysis of variance (ANOVA) shows in table 4.8a the statistical analysis showed significant (p≤0.05) influence of Humic acid and percent shade on spike length, while its interaction was also found non-significant.

The mean table shows that maximum spike length (58.8 cm) was produced by 600 ppm Humic acid levels, which is followed by 400 ppm, while the control (no Humic acid) produces minimum spike length (54.6 cm). In case of percent shade 0 % of shade produce lengthy spike (58.5 cm) as compared to other shade ratios which was 54.7 and 56.0 cm at 75 % and 50 % shades respectively however these were at par with each other.

Interaction between levels of Humic acid and different percent shade the maximum spike length (60.7cm) was recorded in the application of 600 ppm of Humic acid under control condition while the minimum spike length (52.2 cm) observed in covered shade of 75% with the treatment of Humic acid at the level of 0 ppm.

**Spike diameter (mm)**

The spike diameter data of gladiolus plant as influenced by Humic acid application and different percent shade is furnished in Table 4.9 and the analysis of variance is shown in table 4.9a. The statistical analysis showed substantial influence (p≤0.05) of Humic acid and percent shade on spike diameter of gladiolus, while its interaction was found non-significant.

Mean table figured that the maximum Spike diameter (8.3 mm) was produced when plants were treated with 600 ppm of Humic acid, which is followed by 400 ppm of Humic acid, while the control (no Humic acid) produces minimum spike diameter (5.8 mm) of gladiolus plant. In case of percent shades, the maximum spike diameter (7.9 mm) was observed in control, followed by 6.8 mm with 50 % shade, however, the minimum spike diameter (6.2 mm) was recorded in plants grown under 75 % shade, however, the latter two were at par with each other.

The interaction between different percent of shade and different concentration of Humic acid the highest spike diameter (8.8 mm) was recorded when plants were treated with 600 ppm of Humic acid with covered of 0 % shade, while the minimum spike diameter (4.6 mm) observed under 75% shade with the treatment of Humic acid at 0 ppm.

**DISCUSSION**

This might because light play substantial role in enzyme activation during emergence of seed and plant growth, therefore the least number of days to emergence was taken by plant, grown in the open field. Days to emergence were increased due to the application of Humic acid with different percent of shade in the growth and development as it played a sustainable role in germination or sprouting as an earlier simulation because of Humic molecules (Atiyeh *et al.,* 2002). Our findings are also in line with Eyheraguibel *et al.* (2008). Similar results were also observed by Ahmad *et al.* (2013) in gladiolus.

This might be due to the reason that high percent shade damages the apical cell of plant, so that why the gladiolus has maximum growth in open field. Our results are in line with Qayyum *et al.* (2020) who recorded maximum plant height in open field as compare to poly tunnel condition. The present study is also in line with Celik *et al.* (2008) and Taha *et al.* (2006) who observed similar results when Humic acid specifically applied during the leaves stage with different percent of shade in the green house to gladiolus plant.The improvement of vegetative growth parameter like height of plant, diameter of stem and leaves number with increase in Humic acid organic fertilizer rate can be attributed to increased uptake of nitrogen and its play a critical role in chlorophyll synthesis and therefore, the process of photosynthesis and carbon dioxide (CO2) assimilation leading to improve growth characteristic. The same results were obtained by Niyokuri *et al.* (2013). Moreover, increase in height of plant can be attributed to better uptake of nutrition by plants that activate enzymes, involved in protein and carbohydrate metabolism. Thus, added Humic acid might have improved the photosynthesis activity and played an important role in the translocation of photosynthesis (Singh *et al.,* 2008). Fan *et al.* (2015) observed that different levels of Humic acid with different percent shade increase photosynthetic activity, nutrient absorption, shelf life and also plant height.

This could be due to the reason that Humic acid is a naturally occurring polymeric organic compound, is a potential natural resource that can be utilized to increase growth, nutrient availability and yield Sharif *et al.,* (2002). Our results are also in agreement with Ahmad *at al.* (2013) recorded maximum leaves plant-1 with Humic acid application as compare to no Humic acid.

The primary nutrients stimulate the enzymes involve in the digestion of protein and carbohydrates and play a significant role in the translocation of photosynthesis. Increased synthesis and translocation of photosynthates induced by added Humic acid, which was further used to creating cells and tissues, leading to more leaves plant-1 (Kumar *et al.,* 2015). These results were observed that Humic acid substances increased micro and macronutrients uptake from the soil and reduce evaporation of water from the soil in result they observed greater number of leaves per plant due to the different concentration of Humic acid with different percent of shade (Baldotto & Baldotto, 2013).

This could be explained because gladiolus grows well in the open field as compared to shade conditions, so that’s why the flower size of the open field plants was greater as compared to plants grown in shade conditions. Application of Humic acid significantly improved the flower size and increased nutrients uptake by the plant supplied with Humic acid three treatments as compared to untreated controls (Baldotto and Baldotto, 2013).

Application of Humic acid during flower stage improve overall reproductive parameters in respond as observed by Ahmad *et al.* (2005). Humic acid significantly affected the flower of gladiolus in result shown that gladiolus emerged or sprouted a greater number of flowers per plant as compared to control when plants were treated with 600 ppm of Humic acid, this all result because of Humic substances which involve to uptake more nutrients from the soil (Bashir *et al.,* 2016). Our results are also in line with Ristow *et al.* (2008) who observed that overall production of plants has been improved including metabolic process and thus plant reproductive as well as vegetative growth has also increased. This could be due to the reason that Humic acid is a naturally occurring compound and it has the potential to increase growth, nutrient availability and number of flower Sharif *et al.,* 2002.

This might be because Humic acid is a naturally occurring polymeric organic compound, is a potential natural resource that can be utilized to increase growth, nutrient availability and yield Sharif *et al.,* (2002). Application of Humic acid during the flowering stage improved overall reproductive parameters in rapeseed, as observed by Ahmad *et al*. (2005). Over result also in line with Baldotto (2013), who noted that flower diameter is increased by Humic acid and different levels shade with the uptake of nutrients from earth as compared to control treatment of Humic acid and different percent shade.

This might because Humic acid application and increasing Percent shade increase photosynthesis rate which influences the final rachis size. This result matched with the published papers of Canellas *et al.* (2006) and Baldotto *et al.* (2012). Humic acid has stimulating effects on shoots, such as increased rachis length, plant height and leaf nutrient accumulation and chlorophyll synthesis (Chen *et al.,* 2004; Baldotto *et al.,* 2009).

Our results are in line with a published paper from Qayyum *et al.* (2020) observed that gladiolus grows well in full sunlight as compare to shade conditions. In case of Humic acid the application lengthy spikes were observed in the plot applied 600 ppm. Similarly, Bashir *et al.* (2016) recorded maximum spike length with 600 ppm of Humic acid application as compare to other levels. Our results are also similar to Bashir (2016) who observed that Spike length of gladiolus was highest with the treatment of Humic acid with 600ppm along with 0% shade. Our results are also in line with Arancon *et al.* (2003).

This could be due to the greater spike diameter in the open field plants as compare to plants grow in shade condition. Our results are in line with a published paper from Qayyum *et al*. (2020) who observed that gladiolus grow well in the open field as compared to shade. The use of Humic acid has greater impact on growth and spike diameter of gladiolus plant which was significantly enhanced with the application of Humic acid and shade it showed significant improvement in spike diameter of gladiolus plant which treated with Humic acid of 600 ppm with 0 % shades as compared to untreated plants (Bashir, 2016).

**Table 4.1 Days to emergence of gladiolus as influence by different regimes of Humic acid and percent shade.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Humic Acid (ppm)** | **Percent shade %** | | | **Mean** |
| **Control** | **50** | **75** |
| **0** | 8.7bcd | 7.7cd | 8.7bcd | **8.3ab** |
| **200** | 7.0d | 8.7bcd | 8.3bcd | **8.0c** |
| **400** | 9.3abc | 8.0bcd | 9.7ab | **9.0a** |
| **600** | 8.3bcd | 7.7cd | 11.0a | **9.0a** |
| **Mean** | **8.3b** | **8.0b** | **9.4a** |  |

Mean value in a single column or row followed by different letters are significantly different at 0.05 LSD.

LSD value at 5% for Humic Acid (HA) = NS

LSD value at 5% for Percent shade (PS) = 0.24

LSD value at 5 % for PS×HA = 1.00

**Table 4.1a Analysis of variance for days to emergence of Gladiolus as affected by percent shade and Humic acid**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SOV** | **D.F** | **SS** | **M.S** | **F-value** | **P** |
| **Rep** | 2 | 5.16 | 2.58 | 2.48 | 0.10 |
| **HA** | 3 | 6.75 | 2.25 | 2.16 | 0.12 |
| **PS** | 2 | 13.16 | 6.58 | 6.34 | 0.00 |
| **HA×PS** | 6 | 16.83 | 2.80 | 2.70 | 0.04 |
| **Error** | 22 | 22.83 | 1.03 |  |  |
| **Total** | **35** | **64.75** |  |  |  |

Coefficient of Variance (%) = 11.87

**Table 4.2 Plant height (cm) of gladiolus as influence by different regimes of Humic acid and percent shade**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Humic Acid (ppm)** | **Percent shade (%)** | | | **Mean** |
| **Control** | **50** | **75** |
| **0** | 105.8d | 105.4d | 104.4d | **105.2c** |
| **200** | 114.5c | 111.4c | 112.7bc | **112.9b** |
| **400** | 118.3 | 112.8bc | 112.1c | **114.4a** |
| **600** | 117.2a | 115.8bc | 114.7bc | **115.9a** |
| **Mean** | **114.a** | **111.4b** | **111.0b** |  |

Mean value in a single column or row followed by different letters are significantly different at 0.05 LSD.

LSD value at 5% for Humic Acid (HA) = 0.54

LSD value at 5% for Percent shade (PS) = 0.40

LSD value at 5 % for PS×HA = 1.63

**Table.4.2a Analysis of variance for plant height of gladiolus as affected by percent**

**shade and Humic acid**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SOV** | **D.F** | **SS** | **M.S** | **F. value** | **P** |
| **Rep** | 2 | 6.83 | 3.41 | 0.91 | 0.41 |
| **HA** | 3 | 611.35 | 203.78 | 54.31 | 0.00 |
| **PS** | 2 | 63.76 | 31.88 | 8.49 | 0.00 |
| **HA×PS** | 6 | 32.70 | 5.45 | 1.45 | 0.24 |
| **Error** | 22 | 82.54 | 3.75 |  |  |
| **Total** | **35** | **797.1875** |  |  |  |

Coefficient of Variance % =1.728

**Table 4.3 Leaves plant-1 of gladiolus as influence by different levels of Humic acid and percent shade**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Humic Acid**  **(ppm)** |  | **Percent Shade (%)** |  | **Mean** |
| **Control** | **50** | **75** |
| **0** | 12.3b | 14.0c | 10.0bc | **12.3 c** |
| **200** | 14.0bc | 12.7b | 12.7bc | **13.1 bc** |
| **400** | 16.3a | 14.3bc | 12.0bc | **14.2 b** |
| **600** | 18.3a | 15.3a | 16.3a | **16.7 a** |
| **Mean** | **15.3** | **14.1** | **12.9** |  |

Mean value in a single column or row followed by different letters are significantly different at

0.05 LSD

LSD value at 5% for Humic Acid (HA) = 0.45

LSD value at 5% for Percent shade (PS) = NS

LSD value at 5 % for PS×HA = 1.34

**Table 4.3a Analysis of variance for number of leaves per plant of gladiolus as affected by percent shade and Humic acid**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SOV** | **D.F** | **SS** | **M.S** | **F-value** | **P** |
| **Rep** | 2 | 0.5 | 0.25 | 0.11 | 0.89 |
| **HA** | 3 | 96.31 | 32.10 | 14.26 | 0.00 |
| **PS** | 2 | 32.66 | 16.33 | 7.25 | 0.00 |
| **HA×PS** | 6 | 29.77 | 4.96 | 2.20 | 0.08 |
| **Error** | 22 | 49.50 | 2.25 |  |  |
| **Total** | **35** | **208.75** |  |  |  |

Coefficient of Variance % = 10.65

**Table 4.4 Flower size (mm) of gladiolus as influence by different regimes of Humic acid and percent shade**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Humic Acid (ppm)** |  | **Percent Shade (%)** |  | **Mean** |
| **Control** | **50** | **75** |
| **0** | 69.6 | 69.2 | 60.0 | **66.3c** |
| **200** | 76.8 | 65.2 | 60.4 | **67.4bc** |
| **400** | 75.7 | 63.9 | 64.0 | **67.9ab** |
| **600** | 77.7 | 72.3 | 77.7 | **73.9a** |
| **Mean** | **74.9a** | **67.7b** | **64.0b** |  |

Mean value in a single column or row followed by different letters are significantly different at 0.05 LSD

LSD value at 5% for Humic Acid (HA) = 1.9

LSD value at 5% for Percent shade (PS) = 1.42

LSD value at 5 % for PS×HA = NS

**Table 4.4a Analysis of variance for flower size of gladiolus as affected by percent**

**shade and Humic acid**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SOV** | **D.F** | **SS** | **M.S** | **F-value** | **P** |
| **Rep** | 2 | 299.21 | 149.60 | 4.53 | 0.02 |
| **HA** | 3 | 313.01 | 104.33 | 3.16 | 0.04 |
| **PS** | 2 | 738.53 | 369.26 | 11.19 | 0.00 |
| **HA×PS** | 6 | 201.77 | 33.62 | 1.01 | 0.43 |
| **Error** | 22 | 725.96 | 32.99 |  |  |
| **Total** | **35** | **2278.49** |  |  |  |

Coefficient of Variance % = 8.34

**Table 4.5 Number of flowers of gladiolus as influence by different regimes of Humic acid and percent shade**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Humic Acid (ppm)** |  | **Percent Shade (%)** |  | **Mean** |
| **Control** | **50** | **75** |
| **0** | 8.0 | 6.7 | 7.3 | **7.3d** |
| **200** | 8.0 | 7.7 | 7.3 | **7.7bc** |
| **400** | 11.3 | 7.7 | 8.0 | **8.9ab** |
| **600** | 12.0 | 9.3 | 7.7 | **9.7a** |
| **Mean** | **9.8** | **7.8** | **7.6** |  |

Mean value in a single column or row followed by different letters are significantly different at 0.05 LSD.

LSD value at 5% for Humic Acid (HA) = 0.56

LSD value at 5% for Percent shade (PS) = NS

LSD value at 5 % for PS×HA = NS

**Table 4.5a Analysis of variance for number of flowers of gladiolus as affected by percent shade and Humic acid**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SOV** | **D.F** | **SS** | **M.S** | **F-value** | **P** |
| **Rep** | 2 | 57.55 | 28.77 | 9.16 | 0.00 |
| **HA** | 3 | 31.67 | 10.55 | 3.36 | 0.03 |
| **PS** | 2 | 33.72 | 16.86 | 5.36 | 0.01 |
| **HA×PS** | 6 | 18.5 | 3.08 | 0.98 | 0.46 |
| **Error** | 22 | 69.11 | 3.14 |  |  |
| **Total** | **35** | **210.55** |  |  |  |

Coefficient of Variance %= 21.12

**Table 4.6 Flower diameter (mm) of gladiolus as influence by different regimes of Humic acid and percent shade**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Humic Acid (ppm)** |  | **Percent Shade (%)** |  | **Mean** |
| **Control** | **50** | **75** |
| **0** | 83.6 | 76.6 | 75.5 | **78.6 d** |
| **200** | 86.0 | 83.3 | 73.5 | **80.9 c** |
| **400** | 99.9 | 89.0 | 80.3 | **89.7 b** |
| **600** | 104.8 | 92.5 | 78.3 | **91.8 a** |
| **Mean** | **93.6 a** | **85.3b** | **76.9c** |  |

Mean value in a single column or row followed by different letters are significantly different at 0.05 LSD.

LSD value at 5% for Humic Acid (HA) = 2.12

LSD value at 5% for Percent shade (PS) = 1.59

LSD value at 5 % for PS × HA = NS

**Table 4.6a Analysis of variance for flower diameter of Gladiolus as affected by percent**

**Shade and Humic acid**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SOV** | **D.F** | **SS** | **M.S** | **F-value** | **P** |
| **Rep** | 2 | 35.37 | 17.68 | 0.46 | 0.63 |
| **HA** | 3 | 1128.10 | 376.03 | 9.87 | 0.00 |
| **PS** | 2 | 1657.24 | 828.62 | 21.75 | 0.00 |
| **HA×PS** | 6 | 346.26 | 57.71 | 1.51 | 0.21 |
| **Error** | 22 | 838.07 | 38.09 |  |  |
| **Total** | **35** | **4005.04** |  |  |  |

Coefficient of Variance (%) = 7.23

**Table 4.7 Rachis length (cm) of gladiolus as influence by different regimes of Humic acid and percent shade**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Humic Acid (ppm)** | **Percent Shade (%)** | | | **Mean** |
| **Control** | **50** | **75** |
| **0** | 18.7bcd | 15.0cd | 13.7cd | **15.8b** |
| **200** | 21.3bc | 14.7cd | 12.0d | **16.0b** |
| **400** | 21.3bcd | 16.3cd | 20.0ab | **19.2b** |
| **600** | 30.0a | 24.0ab | 18.2a | **24.1a** |
| **Mean** | **22.8a** | **17.5b** | **16.0ab** |  |

Mean value in a single column or row followed by different letters are significantly different at 0.05 LSD.

LSD value at 5% for Humic Acid (HA) = 2.06

LSD value at 5% for Percent shade (PS) = 1.55

LSD value at 5 % for PS × HA = 2.7

**Table 4.7a Analysis of variance for rachis length of gladiolus as affected by percent shade and Humic acid**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SOV** | **D.F** | **SS** | **M.S** | **F-value** | **P** |
| **Rep** | 2 | 23.51 | 11.75 | 1.49 | 0.24 |
| **HA** | 3 | 402.91 | 134.30 | 17.11 | 0.00 |
| **PS** | 2 | 312.34 | 156.17 | 19.90 | 0.00 |
| **HA×PS** | 6 | 116.81 | 19.46 | 2.48 | 0.05 |
| **Error** | 22 | 172.65 | 7.84 |  |  |
| **Total** | **35** | **1028.24** |  |  |  |

Coefficient of Variance (%) = 14.92

**Table 4.8 Spike length (cm) of gladiolus as influence by different regimes of Humic acid and percent shade**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Humic Acid (ppm)** |  | **Percent Shade (%)** |  | **Mean** |
| **Control** | **50** | **75** |
| **0** | 57.7 | 53.8 | 52.2 | **54.6 b** |
| **200** | 55.7 | 55.7 | 54.0 | **55.1 b** |
| **400** | 59.8 | 56.3 | 55.0 | **57.1 b** |
| **600** | 60.7 | 58.1 | 57.7 | **58.8 a** |
| **Mean** | **58.5 a** | **56.0 b** | **54.7 ab** |  |

Mean values in a single column or row followed by different letters are significantly different at 0.05 LSD.

LSD value at 5% for Humic Acid (HA) = 0.87

LSD value at 5% for Percent shade (PS) = 0.65

LSD value at 5 % for PS×HA = NS

**Table 4.8a Analysis of variance for spike length of gladiolus as affected by percent shade and Humic acid**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SOV** | **D.F** | **SS** | **M.S** | **F-value** | **P** |
| **Rep** | 2 | 1634.45 | 817.22 | 112.64 | 0.00 |
| **HA** | 3 | 99.78 | 33.25 | 4.58 | 0.01 |
| **PS** | 2 | 88.16 | 44.08 | 6.07 | 0.00 |
| **HA×PS** | 6 | 19.75 | 3.29 | 0.45 | 0.83 |
| **Error** | 22 | 159.60 | 7.25 |  |  |
| **Total** | **35** | **2001.75** |  |  |  |

Coefficient of Variance (%) = 4.77

**Table 4.9 Spike diameter (mm) of gladiolus as influence by different regimes of Humic acid and percent shade**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Humic Acid**  **(ppm)** |  | **Percent Shade (%)** |  | **Mean** |
| **Control** | **50** | **75** |
| **0** | 7.2 | 5.5 | 4.6 | **5.8b** |
| **200** | 7.0 | 5.4 | 5.8 | **6.1b** |
| **400** | 8.3 | 7.6 | 7.3 | **7.8a** |
| **600** | 8.8 | 8.8 | 7.2 | **8.3a** |
| **Mean** | **7.9a** | **6.8b** | **6.2b** |  |

Mean value in a single column or row followed by different letters are significantly different at 0.05 LSD.

LSD value at 5% for Humic Acid (HA) = 0.33

LSD value at 5% for Percent shade (PS) = 0.24

LSD value at 5 % for PS×HA = NS

**Table 4.9a Analysis of variance for spike diameter of gladiolus as affected by percent shade and Humic acid**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SOV** | **D.F** | **SS** | **M.S** | **F-value** | **P** |
| **Rep** | 2 | 1.86 | 0.93 | 0.91 | 0.41 |
| **HA** | 3 | 41.37 | 13.78 | 13.579 | 0.00 |
| **PS** | 2 | 15.87 | 7.93 | 7.81 | 0.00 |
| **HA×PS** | 6 | 5.86 | 0.97 | 0.96 | 0.47 |
| **Error** | 22 | 22.34 | 1.01 |  |  |
| **Total** | **35** | **87.30** |  |  |  |

Coefficient of Variance (%) = 14.44

**Conclusions**

Based on the results, the following conclusion can be drawn: Maximum growth, plant height, flower size, spike diameter, rachis length, flower diameter, spike length, flower numbers per plant, leaves plant-1 and flower diameter were recorded in Gladiolus, grown in open field. Humic acid application at the rate of 600 ppm produced maximum plant height, flower size, flower diameter, leaves plant-1, flower numbers plant-1, spike diameter, rachis length and spike length of gladiolus. Based on of the above conclusion it can be recommended that; In order to get the quality flower of gladiolus Humic acid @ 600ppm should be applied on gladiolus plants grown with no shade. Further research is recommended to explore the effect of percent shade (PS) and Humic acid (HA) levels on gladiolus as well as on other crops.

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