Original article

The effects of phosphorus and humic acid on some soil properties flowers quality of Gladiolus

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Summary. This study was conducted to determine the effects of various phosphorus and humic acid applications on the development of gladiolus varieties in pot culture. This study was carried out between May 2014 and April 2015. Rose Supreme, Red, and Essential cultivars were grown in soiled pods with 0, 100, 200 mg/kg phosphorus and 0, 1000, 2000 mg/kg humic acid doses. We found that application of humic acid and phosphorus had positively contributed to N and P contents in the soil as well as floret number of gladiolus and flower-stalk length. As a result of the study, optimum doses were determined as 2000 mg/kg humic acid and 200 mg/kg phosphorus with regard to the studied characteristics.

Key words: Gladiolus, humic acid, phosphorus

Introduction

Gladiolus from the Iridaceae family has never lost its place in the world as a well sought after ornamental plant due to its variety of lively colours, longer life expectancy of the flowers after being cut, being cheap and easy to produce, and the longer duration of its flowering season. Many studies were carried out to improve the quality of gladioli and to increase their market share. For example; a study carried out by Shoushan et al (1) showed that many corms and cormels developed when chemical fertilisers were used and when they were planted late, and that the weight and dimensions of the corms increased with chemical fertiliser usage.

With continuous exploitation of the soil, cutting down of forests, destruction of vegetation, and burning of vegetative waste and turds, the organic matter in soil is quickly separated and not replaced, thus decreasing the organic material content of the soil. The absence of sufficient phosphorus and the resulting increase in the usage of phosphorus-containing fertilisers, is an important problem in plant nutrition and fertilization (2).

In majority of soils, phosphorus is an inactive nutrient. By reacting with the calcium, clay, iron, and aluminium hydroxide present in the soil, phosphorus turns into a useless or into a less useable form for plants.

Addition of humic acid results in root development in many plants (3). It also stimulates the shoot to store nutrients in the leaves (4). Many researchers have indicated that humic acid was effective on plant growth and development and that while applications of low concentrations had a positive effect, applications of high concentrations had no effect or a negative effect on plant development. Wallace et al. (5) indicated that they form chelates with metals, decrease the toxicity of heavy metals, affect the colour of the soil, and thus increase plant development and vegetative production.

The objective of this study is to determine the effects of humic acid and phosphorus application in various concentrations on the yield and quality of gladioli.

Materials and Methods

In the study, a total of 162 gladioli were used which consisted of three types: Rose supreme (Pink), Essential (White), and Deepest Red (Red). A solid powder form of humic acid with the commercial name Agrohoum (85% HA) and the phosphorus (46% P_2O_5) containing Di Ammonium Phosphate (DAP) were used as fertilisers. Into 1 kg of plant pot compost DAP (18% N, 46% P_2O_5) and humic acid (commercial name Agrohoum (85% HA) fertilizers were added. 0, 100, 200 P mg/kg and 0, 1000, 2000 HA mg/kg were used respectively, while the sand to soil ratio was prepared to be 2:1 as a growth medium.

Soil constitution was prepared according to Bouyoucus (6), soil reaction according to Chapman and Pratt (7), water soluble salt according to Richards (8), lime content according to Hizalan and Unal (9), organic matter content according to Walkey (10), total nitrogen content (%) according to Kacar (11), and useable phosphorus content according to Olsen et al. (12). Shoot formation period (in days), flower development period (in days), plant size (in cm), head length (in cm), the number of bulbs (in numbers), flower stalk width (in mm), flower stalk length (in mm), and plant weight were determined for the plants. For the data obtained in the study, variance analysis was applied. The approximate factor levels of the characters analysed were compared according to the Duncan (0.1%, 1%, and 5%) Test.

Results

It was observed according to table 2 that there were no significant differences in soil phosphorus content between the different species. The highest phosphorus content was observed in the soil sample of the 1st species (Deepest Red), while the lowest phosphorus content was observed in the soil sample of the 3rd species (Essential), with values of 31.7 ppm and 29.5 ppm respectively. With increasing applications of humic acid, phosphorus content in the soil increased. In the control group the phosphorus content was 25.8 ppm and this amount increased to 32.5 ppm when 1000 mg/kg humic acid was applied and to 33.7 ppm when 2000 mg/kg humic acid was applied. According to the control, this increase was at 25.9% in the first dose, and 30.6% in the second dose. The application of increasing doses of phosphorus and humic acid resulted in a statistically significant increase (5%) in the phosphorus content in the gladioli species.

The soil nitrogen content was found to be effected at a significant percentage of 0.1% due to the species and different phosphorus applications. While species x phosphorus and species x humic acid interactions were found to be significant, phosphorus x humic acid interactions were found to be insignificant.

It can be observed from table 3 that with increasing applications of humic acid doses the nitrogen content in the soil also increased. While the nitrogen content in the control group was 0.142 ppm, this value increased to 0.154 ppm when 1000 mg/kg humic acid

Table 1. The amounts of humic acid and phosphorus applied to the trial pots

Essential (White)			Rose Supreme (Pink)			Deppest Red (Red)		
Phosphorus (mg /kg)	Humic acid (mg/kg)	Replication	Phosphorus (mg /kg)	Humic acid (mg/kg)	Replication	Phosphorus (mg /kg)	Humic acid (mg/kg)	Replication
0	0	6	0	0	6	0	0	6
100	0	6	100	0	6	100	0	6
200	0	6	200	0	6	200	0	6
0	1000	6	0	1000	6	0	1000	6
100	1000	6	100	1000	6	100	1000	6
200	1000	6	200	1000	6	200	1000	6
0	2000	6	0	2000	6	0	2000	6
100	2000	6	100	2000	6	100	2000	6
200	2000	6	200	2000	6	200	2000	6

was applied, and to 0.165 ppm when 2000 mg/kg humic acid was applied. When compared to the control, this increase was 0.8% for the first dose and 0.16% for the second dose. While the lime content in the soil of the different species was insignificant, applying phosphorus effected lime content significantly by 0.1%, but there was no difference observed between the lime content in the soil of different species.

It was observed that increasing humic acid applications decreased soil pH. Application of 2000 mg/kg humic acid decreased soil pH from 8.13 to 8.03 compared to the soil without humic acid application (Table 4).

It can be observed from table 5 that organic matter content in the soil was lower in the 2000 mg/kg humic acid group than the control and in the 1000 mg/kg hu-

Table 2. The effect of different doses of phosphorus and humic acid applications on soil phosphorus

Cultivar	Phosphous (mg/kg)	Humic acid dose (mg/kg)			mean
		0	1000	2000	
Rose	0	13,3	23,7	23,3	
Supreme	100	25,0	33,3	35,0	31,7
	200	36,0	45,7	50,3	
Deppest	0	14,6	16,0	18,3	
Red	100	27,0	32,3	34,0	30,8
	200	39,3	47,3	48,7	
Essential	0	15,7	14,7	17,3	
	100	23,7	28,0	27,7	29,5
	200	38,0	52,0	48,3	
Humic acid mean		25,8 C	32,5 B	33,7 A	

Table 3. The effect of different phosphorus and humic acid applications on soil nitrogen

Varieties	Phosphorus (mg/kg)	Soil nitrogen (%)			Variety mean
		HA1	HA2	HA3	
Rose	1 dose	0,127	0,159	0,168	
Supreme	2 dose	0,134	0,135	0,145	0.146 C
	3 dose	0,144	0,152	0,153	
Deppest	1 dose	0,156	0,161	0,168	
Red	2 dose	0,151	0,157	0,171	0.155 B
	3 dose	0,136	0,145	0,153	
Essential	1 dose	0,149	0,155	0,178	
	2 dose	0,139	0,160	0,170	0.159 A
	3 dose	0,138	0,158	0,184	
Humic acid mean.		0.142 C	0.154 B	0.165 A	

Table 4. The averages and Duncan groups of the effect on soil pH upon different phosphorus and humic acid applications

Cultivar	Phosphorus (mg/kg)	pH			Cultivar mean
		HA1	HA2	HA3	
Rose	1 dose	8,01	8,15	7,88	
Supreme	2 dose	8,21	8,44	7,94	8,04 A
	3 dose	8,02	7,60	8,11	
Deppest	1 dose	8,24	7,92	8,04	
Red	2 dose	8,18	7,57	8,14	8,07 A
	3 dose	8,17	8,18	8,16	
Essential	1 dose	8,05	8,01	7,72	
	2 dose	8,13	8,23	8,02	8,09 A
	3 dose	8,16	8,24	8,21	
Humic acid mean.		8,13 A	8,04 B	8,03 B	

Table 5. Averages and Duncan groups of the effect of applying different phosphorus and humic acid doses on soil organic matter content

Cultivar	Phosphorus (mg/kg)	Organic matter (%)			Cultivar mean
		HA1	HA2	HA3	
Rose	1 dose	2,24	2,64	2,79	
Supreme	2 dose	2,86	2,25	2,40	2,55 A
	3 dose	2,40	2,52	2,55	
Essential	1 dose	2,60	2,70	2,79	
	2 dose	2,51	2,61	2,86	2,58 A
	3 dose	2,26	2,40	2,55	
Deppest Red	1 dose	2,48	2,60	2,96	
	2 dose	2,33	2,63	2,84	2,65 A
	3 dose	2,30	2,64	3,06	
Humic acid mean		2,44 B	2,55 B	2,76 A	

mic acid groups. With increasing humic acid applications soil nitrogen content increased, but it was observed that there was no significant effect on plant height.

The effect of phosphorus and humic acid on plant weight was found to be insignificant. However, in the Essential species, a significant increase (5%) in plant weight was observed (Table 6).

As the humic acid doses increase, the number of florets also increase. The highest number of florets were observed to be 9 when 200 mg phosphorus and 2000 mg humic acid were applied.

Although flower stem length increased with increasing humic acid doses when compared to the control, this increase was not found to be statistically significant. The longest flower stem was 41.33 cm when 200 mg/kg phosphorus was applied.

Table 6. The averages and Duncan groups of different phosphorus and humic acid applications on plant weight.

Cultivar	Phosphorus (mg)	Plant weight (g)			Cultivar mean
		HA_0	**HA_{100}**	**HA_{2000}**	
Rose	P_0	12,987	15,923	7,960	
Supreme	P_{100}	16,267	21,147	11,697	13,661 A
	P_{200}	10,847	18,920	7,200	
Deppest	P_0	11,437	13,317	12,520	
Red	P_{100}	18,510	14,333	11,350	11,722 A
	P_{200}	5,000	4,700	14,333	
Essential	P_0	17,427	30,239	18,148	20,312 C
	P_{100}	18,483	14,523	18,433	
	P_{200}	29,727	15,550	20,277	
Humic acid mean		15,632 B	16,517 B	13,546 A	

Table 7. The averages and Duncan groups of the effect of different phosphorus and humic acid applications on floret number

Cultivar	Phosphorus (mg)	Floret (no)		
		HA_0	**HA_{1000}**	**HA_{2000}**
Essential	P_0	6,667	6,667	7,000
	P_{100}	5,000	5,000	7,333
	P_{200}	8,667	7,667	9,000
Humic acid mean		6,778 AB	6,445 A	7,778 B

Discussion

It was observed that increasing doses of humic acid applications on tomatoes had a positive effect on phosphorus content and this is in accordance with our study (13). Erdal et al (14) investigated the effects of applying different doses of phosphorus P (0, 20, 40, 80 mg/kg) and humic acid (0,250, 500 mg/kg) on the soil and their effects on the development of corn. They determined that application of humic acid increased the plant P concentration, the amount of P taken up by the plant, and the P left over in the soil. Additionally, they confirmed that applying humic acid with P was more effective than when it was applied by itself. In our study, the highest values were generally obtained when 200 mg/kg phosphorus and 2000 mg/kg humic acid were applied.

Yalcin and Gunaydin (15) determined that humic acid applications increased nitrogen content when compared to the control, and that the highest nitrogen amount was 3.81% for the 250 ppm humic acid application, while it was 3.74% for the 150 ppm humic acid application, 3.35% for the 100 ppm humic acid application, and decreased to 2.99% in the control group. Cimrin and Yilmaz (16) determined that phosphorus application on lettuce increased nitrogen content significantly, but humic acid application did not have a significant effect.

It was observed that as the amount of humic acid increased, the number of florets also increased. This is similar to the observations of Iftikar et al. (17). According to Iftikar et al. (17) the gladioli that had humic acid applied had 11.9 number of florets , while this number was 10.7 in the control group. Vasenthakumar et al. (18) determined that the gladioli grown in pot

Table 8. The averages and Duncan groups of the effect of different phosphorus and humic acid applications on stem length.

Variety	Phosphorus (mg)	Flower stem lenght (cm)		
		HA_0	HA_{1000}	HA_{2000}
Essential	P_0	28,000	35,000	36,333
	P_{100}	32,667	22,333	33,000
	P_{200}	41,333	37,667	40,667
Humic acid mean		34,000 A	31,667AB	36,667 B

cultures had heights of 56.57 cm for the Summer Rose species, 52.28 cm for the Friendship species, and that flower length increased with increasing temperature.

Organic matter has important effects on the physical, chemical, and biological properties of the soil and thus have significant effect on plant development. The fact that the amount of organic matter in the agricultural land in our country is below 1%, shows how much the soil is in need of organic matter. To increase agricultural production humic acid is used in increased amounts nowadays. Humic acid is especially used to decrease the negative effects of chemical fertilizers and some chemicals on soil structure. The effect of humic acid in plant development is known for a long time.

In this study, by applying 0, 1000, and 2000 mg/kg humic acid and 0, 100, and 200 kg/kg phosphorus on the soil, the effect on gladioli cut flower properties and some chemical properties were explored.

Our results show that different humic acid and phosphorus applications increased soil phosphorus and nitrogen content, decreased pH, and increased soil salt and organic matter content. We also found that increasing humic acid and phosphorus applications did not have any effect on the height of gladioli species, but that the number of bulbs increased. By applying humic acid and phosphorus, the number of bulbs increased from 6.67 to 9. One of the most important factors determining cut flower quality is stem length which showed an increase of up to 6 cm. This increase is of significant importance for cut flower cultivation and in particular, for the ornamental plant market.

Our study indicates that applying 2000 mg/kg humic acid and 200 mg/kg phosphorus on gladioli plants had positive effects on plant development and cut flower quality.

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