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Effect of Phosphorus and Organic Manure Levels on Quantitative and Qualitative Characteristics of Tuberose (*Polianthes tuberosa*)

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Authors' contributions

This work was carried out in collaboration between the authors. Author SHMND designed the study, collected the data acquisition and did the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and manuscript review. Author RE carried out the plant analyses and manuscript editing and review. Both authors read and approved the final manuscript.

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ABSTRACT

To evaluate the effects of phosphorus and organic matter on quantitative and qualitative characteristics of tuberose cv. Double (*Polianthes tuberosa L.*) an the experiment was conducted at the Agricultural Research Center in Safiabad, in year 2011 and 2012 cropping seasons. It was a factorial laid out in randomized block design with 12 treatment combinations and 3 replications. The first factor was different levels of phosphorus; P_1=0, P_2=75, P_3=150 and P_4= 225 in kg P_2O_5 ha^{-1} from triple super phosphate and the second factor consisted of different levels of organic manure; OM_1=0, OM_2=20 and OM_3=40 ton ha^{-1}. Results showed that phosphorus fertilizer had significant (at the 5% level) effect on leaf phosphorus content and the best treatment was application of 75 kg P_2O_5 ha^{-1} but it had no significant effect on the other parameters. Effect organic manure on stem length was significant at 5% level (the best treatment was application of 20 ton organic manure ha^{-1}) and its effects on leaf phosphorus and bulb weight were significant at 1% level so the best treatments were application of 20 and 40 ton organic manure ha^{-1}, respectively. Interactive effects of phosphorus and organic manure were significant on some parameters. found, P_4OM_2

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treatment (225 kg P_2O_5 ha^{-1} and 20 ton organic matter ha^{-1}) was the appropriate treatment for optimal growth of stem length, number of florets, P_2OM_2 treatment (75 kg P_2O_5 ha^{-1} and 20 ton organic matter ha^{-1}) was the appropriate treatment for optimal growth of spike length and stem diameter. P_3OM_2 treatment (150 kg P_2O_5 ha^{-1} and 20 ton organic matter ha^{-1}) was the appropriate treatment for optimal growth of number and weight of bulbs.

Keywords: Phosphorus; organic manure; quantitative and qualitative characteristics; tuberose.

1. INTRODUCTION

Tuberose (*Polianthes tuberose* L) is a perennial plant that belongs to the category of monocots. Hachinson [1] has placed the genus in the family of Agavaseh and has confirmed cytological examinations of this classification. This plant originates from Mexico and then reached Europe, but it is still unknown how and when it reached India and Sri Lanka and elsewhere in the East [1]. The experiment results of Malakuti & Hoayii [2] indicated that application of organic matter along with chemical fertilizers increased crop yield. Cirrito and Zizzo [3] reported more number of bulbs at low values of nitrogen and phosphorus and high level of potassium in tuberose. Also flowers that were produced from side bulbs was increased by high levels of phosphorous. Nethra et al. [4] reported highest vase- life in gladiola cut flowers is achieved with the application of 15 tons per hectare of vermicompost and 50% NPK while Paryban & Khader [5] reported effect of nitrogen, phosphorus and potassium fertilizers on yield of tuberose and concluded that the fertilizers at a rate of 62.5:75:100 kg per hectare, resulted in the highest number of florets per spike and yield of the flowers. Half of nitrogen fertilizer at planting and the other 45 days later and all the phosphorus and potassium were used at planting. Barreto et al. [6] reported, that maximum yield of gerbera flowers, especially vase- life will be achieved with the application of vermicompost with cocopeat. Asrey et al. [7] reported, using of organic matter in gladiola caused to increases of vase- life cutting flowers, while Vetal et al. [8] found an increase of quantitative and qualitative characteristics in Lilium that obtained agrupit and vermicompost. Singh, during tests conducted in 2006 showed, better growth of florets in tuberose in 10 tons organic matter per hectare, 200 kg ha^{-1} nitrogen, 200 kg ha^{-1} phosphorus and 150 kg ha^{-1} potassium that led to maximum number of florets per spike and yield of the flower [9]. The survey was conducted in 2007 by Ranjan et al. [10] showed, that the maximum number of open florets per spike, the maximum absorption water and vase- life of tuberose in treatments of 5 tons per hectare of manure and 3 tons per hectare vermicompost and 100 g. kg^{-1} of Azotobacter onions. Patil et al. [11] reported that, N: P: K in amount of 200:50:50 kg ha^{-1} and 10-12.5 ton organic matter ha^{-1} led to the maximum absorption of nitrogen, phosphorus and potassium by plants and soil makes maximum P_2O_5 and K_20. In 2011, during tests of Mondal et al. [12] to examine the impact of chemical fertilizers with organic matters on the stem length and growing tuberose onions, they found that, NPK in amount of 400:200:300 kg ha^{-1} and 20 ton organic matter (cow) ha^{-1} is responsible for the greatest growth of the stem and bulbs. The research showed the best growth bulbs and stem length after manure was related to litter. The purpose of this study was to evaluate the effects of phosphorus and organic manure on stem length, spike length, florets number, stem diameter, vase- life, number and weight of bulbs, leaf phosphorus and leaf OC to find the best treatment for this purpose.

2. MATERIALS AND METHODS

The experiment was carried out at research farm of Safiabad Agricultural Research Center in south – west of IRAN (32°16' N, 48°*26*'E*)* during two years (2011-2012). The design was a factorial arranged in randomized block design with 12 treatments and 3 replications. The first factor included different levels of phosphorus; P_1=0, P_2=75, P_3=150, P_4=225 kg P_2O_5 ha^{-1} from the triple super phosphate and the second factor included different levels of organic manure; OM_1=0, OM_2=20 and OM_3=40 ton ha^{-1} sheep manure.

The interaction effects of phosphorus and organic manure has been shown in Table (1). The experiment plan has been shown in Table (2).

At the beginning of the project a combined soil sample (depth of 0-30 cm) was prepared and sent to the laboratory to determine the physico-chemical properties of soil according to soil and water research institute recommendations [13]. Experimental plots with length and width of 1.5

meter and the distance between the plots was 50 cm. 100 kg Nitrogen ha^{-1} (in three equal installments: Planting, 45 and 60 days after planting) and 100 kg K_2O ha^{-1} were distributed uniformly in all plots. Iron sequestrine one month after planting in the all plots were distributed at a rate of 4 kg per hectare. Tuberose bulbs with density of 36 bulbs per plot (with a distance of 25 cm) were planted. Double dwarf cultivar of tuberose bulbs, which have a relatively uniform size were used in the project. Weeding, hoeing, irrigation and spraying of insecticide were done whenever necessary throughout the course of investigation. Leaf analysis before flowering was performed on P and OC. 4 month after planting (In November and December), the desired traits such as stem length, spike length, number of florets per spike, stem diameter, vase life, number and weight of bulbs per plot were measured. For determination of vase-life, 4 flowers were selected in each treatment which had 2-3 open florets then the flowers placed in pots containing distilled water and in controlled conditions with 25°C temperature, 85-90% relative humidity and 12-hour light cycles where they were kept until florets faded. The stem diameter was measured by Digimatic Cliper 500-11 (average of three points of stem: Near the crown, middle and the lowest floret). The two years data were collected and analyzed by using of SAS statistical software and treatments were compared by Duncan's multiple rang test (P= .05).

3. RESULTS AND DISCUSSION

Results showed that different levels of phosphorus and organic manure had a significant effect on some quantitative and qualitative characteristics of tuberose (Table 3). Differences in soil analysis, climate conditions and nutrient- containing bulbs be purchased in two years led to a significant effect of year on some parameters in this experiment (Table 3). Results in the Tables (3 to 6) show that different levels of phosphorus was not significant on stem length however, the maximum stem length is application of 225 kg P_2O5 ha^{-1}. Levels of organic manure were significant on the mentioned parameter at the 5% level and the best treatment is application of 20 tons organic manure ha^{-1}. Interaction of phosphorus and organic manure (P×OM) were not significant on stem length, but the best treatment was P_4OM_2 that its effect by 16.7% more than control treatment. As shown at Table (3), the effect of phosphorus, organic manure and interaction of phosphorus and organic manure (P×OM) were not significant on spike length. According to Table (6) it is considered the best treatment for spike length was P_2OM_2 (31.78 cm), which is 5.6% more than control treatment. Table (3) shows the effect of phosphorus, organic manure, P×OM are not significant on number of florets, however the maximum number of florets treated with 225 kg P_2O_5 ha^{-1} (Table 4). Table (6) shows that, the best treatment for number of florets was P_4OM_2. According to Table (3) it could be found that effect of phosphorus, organic manure and P×OM were not significant on stem diameter. The highest stem diameter belonged to treatments P_3OM_3, P_2OM_2 and P_4OM_2 (Table 6). Table (3) shows that the effect of phosphorus, organic matter and P×OM was not significant on vase- life. Table (6) shows that, the highest vase-life is related to treatments of P_1OM_2 and P_4OM_3, that due to the principle of the fertilizer efficiency can be treated P_1OM_2 (8.43 days) as the best treatment, that increased 9% compared to control. Table (3 to 5) shows, the effect of phosphorus, organic manure and P×OM were not significant on the number of bulbs in plot However, the highest number of bulbs is related to the treatment of 150 kg P_2O_5 ha^{-1} and 20 tons organic manure ha^{-1}. According to Table (6) it could be found that the best treatment of bulbs in plot is P_3OM_2, that increased 19.7% more than control treatment. Findings in Tables (3 and 5) shows different levels of organic manure on the weight of bulbs in plot were significant at the 1% level and the best treatment organic manure is 20 tons per hectare, while the effect of phosphorus and P×OM were not significant on mentioned parameter. According to Table (6), it could be found that the best treatment is P_3OM_2 that increased 29.7% more than control treatment. Results showed that treatments of phosphorus and organic manure had significant effect on leaf phosphorus but their interaction was not significant (Table 3). Table (4) shows an increase in application of phosphorus led to increase leaf phosphorus but, since levels of 75, 150 and 225 kg P_2O_5 ha^{-1} are statistically on one level, can be introduced the treatment of 75 kg P_2O_5 ha^{-1} as the best treatment to achieve maximum leaf phosphorus. Table (5) shows, the highest leaf phosphorus can be obtained by application of 40 ton organic manure ha^{-1}. According to Table (6) can receive the best treatment was P_1OM_3 that is on the same statistical level with P_2OM_3, P_3OM_2, P_4OM_2 and P_4OM_3.

Table 1. The characteristics of experimental treatments (interaction effects of phosphorus and organic manure)

P_1OM_1	0 kg P_2O_5 ha^{-1} and 0 ton organic manure ha^{-1}
P_1OM_2	0 kg P_2O_5 ha^{-1} and 20 ton organic manure ha^{-1}
P_1OM_3	0 kg P_2O_5 ha^{-1} and 40 ton organic manure ha^{-1}
P_2OM_1	75 kg P_2O_5 ha^{-1} and 0 ton organic manure ha^{-1}
P_2OM_2	75 kg P_2O_5 ha^{-1} and 20 ton organic manure ha^{-1}
P_2OM_3	75 kg P_2O_5 ha^{-1} and 40 ton organic manure ha^{-1}
P_3OM_1	150 kg P_2O_5 ha^{-1} and 0 ton organic manure ha^{-1}
P_3OM_2	150 kg P_2O_5 ha^{-1} and 20 ton organic manure ha^{-1}
P_3OM_3	150 kg P_2O_5 ha^{-1} and 40 ton organic manure ha^{-1}
P_4OM_1	225 kg P_2O_5 ha^{-1} and 0 ton organic manure ha^{-1}
P_4OM_2	225 kg P_2O_5 ha^{-1} and 20 ton organic manure ha^{-1}
P_4OM_3	225 kg P_2O_5 ha^{-1} and 40 ton organic manure ha^{-1}

Table (3) shows that the effect of phosphorus, organic manure and P×OM were not significant on leaf OC. According to Table (6) it could be observed that, the highest percentage of leaf OC appointed to the treatments P_3OM_3, P_4OM_2 and P_2OM_3. Increased organic manure could also increase leaf phosphorus by increasing the phosphorus solubility in soil (Table 5). Sharif et al (1974) the main role of animal manure as increases the solubility of phosphorus in the soil [14]. Malakuti and Homayii [2] showed, effect of organic manure on phosphorus uptake is due to production of CO_2 from the decomposition of this material, organic phosphorus compounds, reducing contact with the surface of iron oxides and aluminum phosphate, clay and calcium carbonate. Mohammadzadeh and Mivechi [15] reported with conducting a greenhouse experiment and to compare different methods of phosphorus fertilizer application that the combined use of animal manure and fertilizer phosphorus may lead to maximum increase of phosphorous availability in soil. As can be seen in Table (6), maximum stem length and floret number per spike belonged to treatment of P_4OM_2 that it can be said percentage of leaf phosphorous and leaf OC before flowering was higher (Table 4 and 5), and probably is better balance of nutrients elements and plant nutrition in this treatment that makes the most of the parameters. The same table shows, the maximum stem diameter can be found in the treatment P_3OM_3 had maximum percentage of OC in leaf before flowering, there are in the same treatments, a symbol is of relationship between stem diameter with leaf OC percentage and percentage of leaf nitrogen, likely. According to Table (6) it can be seen that the maximum number and weight of bulb in plot is placed in a treatment that is also the percentage of leaf phosphorus in level A. Finally, from these results it can be found that in treatments which had the maximum percentage of phosphorus and OC in leaf, they had relative maximum of the most parameters of measuring that regarding the effect of the phosphorus in the process of transfer of hydrocarbons in the cell, making ATP and chlorophyll in plants is not unexpected. Parmer [16] reported that, the increase of number of florets $spike^{-1}$ was due to synthesis of amino acid and chlorophyll formation and better carbohydrates transformation which resulted into better growth and better length of rachis which had ultimately produced more number of florets per spike. Data showed (Table 4), the increasing use of large amount of phosphorus led to decrease in some parameters such as number and weight of bulbs in plot. Loue [17] reported, these results might be due to the interaction of phosphorus at high levels with number of nutrition elements. Banker [18] reported that nitrogen and phosphorus are essential for growth in tuberose. Mondal et al. [12] reported that, phosphorus (200 kg ha^{-1}) and organic manure (cow= 20 tons ha^{-1}) increased stem length and grow bulbs. Effect of organic manure to improve the physical, chemical and biological characteristics have been identified as the main cause in soil fertility. Singh, during tests conducted in 2006 showed better growth in tuberose florets in 10 tons organic manure ha^{-1}, and maximum number of florets $spike^{-1}$ and yield obtained when 200 kg nitrogen, 200 kg phosphorus and 150 kg potash per hectare, was used [9]. Kishore and Singh in 2006 on the impact of NPK treatments on yield and tuberose growth observed with 150 kg P_2O_5 ha^{-1} obtained the highest yield of the flower and plant growth [19]. All in all, this project is conformity with the results of recent research scientists.

Table 2. Experiment plan

Third replication	(P2O5)150 (OM)0	(P2O5)0 (OM)40	(P2O5)0 (OM)0	(P2O5)150 (OM)20	(P2O5)75 (OM)0	(P2O5)225 (OM)0	(P2O5)150 (OM)40	(P2O5)225 (OM)20	(P2O5)0 (OM)20	(P2O5)75 (OM)20	(P2O5)75 (OM)40	(P2O5)225 (OM)40
Second replication	(P2O5)225 (OM)40	(P2O5)75 (OM)40	(P2O5)75 (OM)20	(P2O5)0 (OM)20	(P2O5)225 (OM)20	(P2O5)150 (OM)40	(P2O5)225 (OM)0	(P2O5)75 (OM)0	(P2O5)150 (OM)20	(P2O5)0 (OM)0	(P2O5)0 (OM)40	(P2O5)150 (OM)0
First replication	(P2O5)225 (OM)0	(P2O5)75 (OM)0	(P2O5)150 (OM)20	(P2O5)0 (OM)40	(P2O5)150 (OM)0	(P2O5)0 (OM)0	(P2O5)225 (OM)20	(P2O5)150 (OM)40	(P2O5)75 (OM)20	(P2O5)0 (OM)20	(P2O5)225 (OM)40	(P2O5)75 (OM)40

OM: organic manure (ton ha^{-1}), P2O5: kg ha^{-1}

Table 3. Mean square of variance on quantitative and qualitative characteristics of tuberose cv. Double

Source	df	Stem length	Spike length	Florets number spike^{-1}	Stem diameter	Vase- life	Bulbs number	Bulbs weight	Leaf phosphorus	Leaf OC
Year	1	3456.9**	1.9^{ns}	213.9**	19.7**	48.59**	824114**	110.3**	0.001^{ns}	4066.2**
Replication× Year	4	385.7**	14.7**	157.07**	2.7**	5.00*	37.5^{ns}	0.36^{ns}	0.03**	9.54^{ns}
Phosphorus	3	24.7^{ns}	1.74^{ns}	50.9^{ns}	0.06^{ns}	1.37^{ns}	2914^{ns}	0.01^{ns}	0.009*	0.90^{ns}
Year× Phosphorus	3	53.1*	3.2^{ns}	35.49^{ns}	1.04**	3.75^{ns}	947.05^{ns}	0.05^{ns}	0.003^{ns}	5.8^{ns}
OM(organic manure)	2	67.9*	3.9^{ns}	17.7^{ns}	0.19^{ns}	1.08^{ns}	4149^{ns}	1.35**	0.01**	10.90^{ns}
Year× OM(organic manure)	2	61.4*	0.68^{ns}	6.9^{ns}	0.08^{ns}	0.72^{ns}	5423^{ns}	1.12*	0.000^{ns}	12.34^{ns}
Phosphorus × OM(organic manure)	6	23.6^{ns}	3.41^{ns}	14.3^{ns}	0.16^{ns}	0.18^{ns}	1642^{ns}	0.11^{ns}	0.003^{ns}	7.71^{ns}
Year× Phosphorus × OM(organic manure)	6	21.3^{ns}	0.56^{ns}	14.7^{ns}	0.08^{ns}	0.99^{ns}	2368^{ns}	0.14^{ns}	0.004^{ns}	5.86^{ns}
Error	44	16.09	3.63	19.6	0.17	1.79	2247	0.24	0.002	9.78
Cv (%)	-	*7.3*	6.35	12.2	5.33	16.66	14.32	21.28	17.42	6.51

**P = .05, **P = .01; ns: Non-significant.*

Table 4. Effect of phosphorus on stem length, spike length, florets number, stem diameter, vase- life, number and weight of bulbs, leaf phosphorus, leaf OC

Phosphorus kg ha^{-1}	Stem length (cm)	Spike length (cm)	Florets number spike^{-1}	Stem diameter (mm)	Vase- life (day)	Bulbs number	Bulbs weight (Kg)	Leaf phosphorus (%)	Leaf OC (%)
0	53.92^{a}	30.33^{a}	31.52^{b}	7.86^{a}	8.06^{a}	329.6^{a}	2.28^{a}	0.226^{b}	47.71^{a}
75	53.90^{a}	30.32^{a}	32.86^{ab}	7.99^{a}	7.63^{a}	329.7^{a}	2.33^{a}	0.266^{a}	48.21^{a}
150	54.73^{a}	29.85^{a}	34.09^{ab}	7.96^{a}	8.25^{a}	347.8^{a}	2.32^{a}	0.267^{a}	48.14^{a}

In each column, means with same letters have no significant differences

Table 5. Effect of organic manure on stem length, spike length, florets number, stem diameter, vase- life, number and weight of bulbs, leaf phosphorus, leaf OC

Organic manure (Ton ha^{-1})	Stem length (cm)	Spike length (cm)	Florets number spike^{-1}	Stem diameter (mm)	Vase- life (day)	Bulbs number	Bulbs weight (Kg)	Leaf phosphorus (%)	Leaf OC (%)
0	52.87 ^{b}	29.73 ^{a}	33.16 ^{a}	7.85 ^{a}	7.79 ^{a}	324.0 ^{a}	2.07 ^{b}	0.232 ^{b}	47.34 ^{a}
20	56.14 ^{a}	30.52 ^{a}	34.45 ^{a}	8.03 ^{a}	8.19 ^{a}	346.2 ^{a}	2.55 ^{a}	0.263^{ab}	48.11 ^{a}
40	55.20^{ab}	29.93 ^{a}	32.82 ^{a}	7.95 ^{a}	8.11 ^{a}	322.8 ^{a}	2.29^{ab}	0.279 ^{a}	48.68 ^{a}

In each column, means with same letters have no significant differences

Table 6. Interaction effects of phosphorus and organic manure on stem length, spike length, florets number, stem diameter, vase- life, number and weight of bulbs, leaf phosphorus, leaf OC

	Stem length (cm)	Spike length (cm)	Florets number spike^{-1}	Stem diameter (mm)	Vase- life (day)	Bulbs number	Bulbs weight (Kg)	Leaf Phosphorus (%)	Leaf OC (%)
P_1OM_1	50.08^{c}	30.08^{ab}	32.45^{abc}	7.85^{a}	7.73 ^{a}	319.0^{ab}	2.09^{ab}	0.187 ^{c}	48.57 ^{a}
P_1OM_2	56.85^{ab}	30.38^{ab}	32.31^{abc}	7.98^{a}	8.43 ^{a}	337.0^{ab}	2.52^{ab}	0.212^{bc}	46.51 ^{a}
P_1OM_3	54.83^{abc}	30.55^{ab}	29.80 ^{c}	7.75^{a}	8.02 ^{a}	333.0^{ab}	2.22^{ab}	0.278 ^{a}	48.06 ^{a}
P_2OM_1	52.30^{bc}	30.08^{ab}	33.35^{abc}	7.85^{a}	7.38 ^{a}	325.5^{ab}	2.27^{ab}	0.237^{abc}	47.81 ^{a}
P_2OM_2	56.01^{ab}	31.78^{a}	34.30^{abc}	8.13^{a}	7.85 ^{a}	331.1^{ab}	2.41^{ab}	0.263^{ab}	48.05 ^{a}
P_2OM_3	53.38^{abc}	29.10^{b}	30.95^{bc}	8.00^{a}	7.68 ^{a}	332.6^{ab}	2.32^{ab}	0.297 ^{a}	48.76 ^{a}
P_3OM_1	55.36^{abc}	29.61^{ab}	33.78^{abc}	7.71^{a}	8.20 ^{a}	327.0^{ab}	1.99 ^{b}	0.242^{abc}	46.52 ^{a}
P_3OM_2	53.26^{abc}	29.63^{ab}	33.88^{abc}	7.93^{a}	8.23 ^{a}	381.8 ^{a}	2.71 ^{a}	0.290 ^{a}	48.60 ^{a}
P_3OM_3	55.58^{ab}	30.31^{ab}	34.61^{abc}	8.23^{a}	8.31 ^{a}	334.6^{ab}	2.27^{ab}	0.270^{ab}	49.30 ^{a}
P_4OM_1	53.75^{abc}	29.16^{ab}	33.08^{abc}	8.00^{a}	7.86 ^{a}	324.8^{ab}	1.93^{b}	0.262^{ab}	46.45 ^{a}
P_4OM_2	58.43 ^{a}	30.28^{ab}	37.33 ^{a}	8.08^{a}	8.26 ^{a}	334.8^{ab}	2.55^{ab}	0.287 ^{a}	49.28 ^{a}
P_4OM_3	57.01^{ab}	29.76^{ab}	35.95^{ab}	7.85^{a}	8.45 ^{a}	291.0 ^{b}	2.34^{ab}	0.272 ^{a}	48.60 ^{a}

In each column, means with same letters have no significant differences

4. CONCLUSION

Based on the results experiment, it can be found that phosphorus was significant (at the 5% level) on leaf phosphorus content and the best treatment is application of 75 kg P_2O_5 ha^{-1}. Effect organic manure on stem length was significant at 5% level (the best treatment is application of 20 ton organic manure ha^{-1}) and on leaf phosphorus and bulb weight was significant at 1% level so the best treatments are application of 20 and 40 ton organic manure ha^{-1}, respectively. According to the main factors (phosphorus and organic manure) and the interaction of phosphorus and organic manure, the results show: P_4OM_2 treatment (225 kg P_2O_5 ha^{-1} and 20 ton organic manure ha^{-1}) was the appropriate treatment for optimal growth of stem length, number of florets, P_2OM_2 treatment (75 kg P_2O_5 ha^{-1} and 20 ton organic manure ha^{-1}) was the appropriate treatment for optimal growth of spike length and stem diameter, P_3OM_2 treatment (150 kg P_2O_5 ha^{-1} and 20 ton organic manure ha^{-1}) was the appropriate treatment for optimal growth of number and weight of bulbs. They are beneficial for florists because can increase the quality and quantity of your products also reduce use of fertilizers (which unfortunately is very common in agriculture) and environmental pollution.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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