J. Appl. Environ. Biol. Sci., 2(9)485-491, 2012

ISSN 2090-4274
Journal of Applied Environmental and Biological Sciences
www.textroad.com

Effects of Nitrogen, Potassium and Phosphorus on Quantitative and Qualitative Characteristics of Tuberose Cv. Double (*Polianthes Tuberosa L*)

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ABSTRACT

In order to study the effects of nitrogen, potassium and phosphorous on quantitative and qualitative characteristics of tuberose cv. Double (*polianthes tuberosa L.*), this experiment was conducted in 2010-12 at Safiabad Agricultural Research Center of Dezful, Iran. The design was a factorial randomized block design with 3 replications. Factors included four levels of nitrogen: 0, 100, 200 and 300 kg N ha^{-1}as Urea, three levels of Potassium: 0, 150 and 300 kg K_2O ha^{-1}as potassium sulfate and a fixed level of phosphorous @100 kg P_2O_5 ha^{-1}as super phosphate. The results showed that potassium had no effect on most of the parameters in the experiment. The effect of nitrogen on stem length, spike length, florets number $spike^{-1}$, leaves nitrogen content, highest quality flowers and LAI were significant at 1% probability level while leaves length and chlorophyll meter readings were significant at 5%. The effect of nitrogen on vase-life, leaves number and leaves potassium was not significant. The effect of potassium on spike length was significant at 1% but it had not a significant effect on other parameters. N×K had only a significant effect on florets number $spike^{-1}$at 1% level of prob. The best nitrogen treatment for most of the parameters was the application of 100 kg ha^{-1} while maximum leaves length and LAI were obtained with the application of 300 kg N ha^{-1}as Urea.

Keywords: tuberose, nitrogen, potassium, quantitative and qualitative characteristics.

INTRODUCTION

Tuberose is an important commercial cut flower crop among the bulbous flowers. It is popular among the farmers due to higher return, sweet fragrance, longer vase life of spikes and wide adaptability to climate and soil. The flowers of tuberose are used for making garlands, bouquets, gajras and extraction of essential oil. The tuberose that is produced in Iran is unique throughout the world because of being aromatic and each year a large quantity of it, is being exported to all over the world, especially Europe. Tuberose (*Polianthes tuberosa L.*) is a perennial herbaceous plant of division *Angiospermae*, the sub-division *Monocotyledoneae* that according to cytogenetic studies belongs to *Agavaceae* family. Although nutritional issues are important in improving qualitative and quantitative properties, marketability and exports of this flower, but they have not been getting much attention in Iran.

Nitrogen fertilizer is one of the important factors in canopy formation that its deficiency leads to a decrease of photosynthesis (Thomas at el, 1975). Nitrogen and phosphorous are essential elements for growth (Banker at el, 1980) but potassium has no effect on it (Kishore at el, 2006). Go pal kerishnan (1995), mentioned N: P: K in amount of 120:60:30 kg ha^{-1} led to maximum growth and yield of the flower.

Partiban at el (1999) noted that, N:P:K in amount of 100:75:62.5 N:P:K kg ha^{-1} led to the highest number of florets $spike^{-1}$, number of flowers and yield. Patil et al (2007) reported that, N: P: K in amount of 200:50:50 kg ha^{-1} and 10-12.5 ton ha^{-1} of organic matter led to the maximum of nitrogen, phosphorous and potassium absorption. There is a significant relation between chlorophyll and nitrogen content of leaves in most of plants and we can measure this nitrogen using by a chlorophyll meter.

Al-Badawy *at el* (1995) reported that, the application of nitrogen led to increase of photosynthetic pigments (chlorophyll a, b) in leaves and carotenoids in flowers and nitrogen percentage in shoot. The observations of Khalaj at el (2007) on tuberose showed that, the application of nitrogen had no significant effect on vase- life. This experiment was

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conducted to evaluate the effects of nitrogen, potassium and phosphorous on quantitative and qualitative characteristics of tuberose cv. Double (*polianthes tuberosa L.*).

MATERIALS AND METHODS

The experiment was conducted at Research Farm of Safiabad Agricultural Research Center in south-west of IRAN (32º16´N, 48º26´E), during 2010-2012. Nitrogen and potassium were the main factors of experiment, which applied at 0, 100, 200 and 300 kg ha^{-1} and 0, 75 and 150 kg ha^{-1} respectively. One third of the nitrogen was applied as basal dressing, 1/3 was applied 45 days after planting of the bulbs and remaining 1/3 was applied as top dressing after 60 days after planting of the bulbs. All potassium rate and 100 kg ha^{-1} phosphorous (P_2O_5) was applied at the time of planting in all treatments. The source of nitrogen (N), potassium (K) and phosphorous were urea, potassium sulfate and super phosphate respectively. The experiment plan has shown in figure (3). The experiment was conducted as factorial randomized block design with 3 replications. A combined soil sample was used to determine the physico-chemical properties of soil according to soil and water research institute recommendations (Ehiaie and Behbahanizadeh, 1993). The soil was silty loam in texture and had a pH of 7.06, EC_e of 3.3 dS m^{-1} , O.C of 0.75 % and 11.8 mg kg^{-1} P, 168 mg kg^{-1} K, 1.66 mg kg^{-1} Cu, 2.96 mg kg^{-1} Fe, 0.7 mg kg^{-1} Zn, 3.1 mg kg^{-1} Mn in first year and silty loam in texture and had a pH of 7.72, EC_e of 1.8 dS m^{-1}, O.C of 0.92 % and 13 mg kg^{-1} P, 159 mg kg^{-1} K, 1.6 mg kg^{-1} Cu, 7.6 mg kg^{-1} Fe, 2.6 mg kg^{-1} Zn, 6.36 mg kg^{-1} Mn in second year. Each data was an average of 3 replications (depth of 0-30 cm). Also the parameters such as length of stem, length of spike, number of florets $spike^{-1}$, leaves nitrogen, leaves potassium and highest quality flowers were measured in both years of the experiment while the measuring of length of leaves, number of leaves, vase- life, chlorophyll meter readings and leaf area index (LAI) were only occurred during the second year of the experiment. Weeding, hoeing, irrigation and spraying of insecticide and fungicide were done whenever necessary throughout the course of investigation. For determination of vase-life, 4 flowers were selected in each treatment which had 2-3 open florets, the flowers then 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 leaf area index (LAI) was measured by leaf area meter model: AM 300-002- ADC Bio Scientific Ltd. Chlorophyll meter readings was made by chlorophyll-meter (Minolta-502). The bulbs of tuberose cv. double which had an approximately equal weight were planted at a spacing of 25cm×25 cm in August, for both years. The two years data were collected and analyzed by using of SAS statistical software and treatments were compared by Duncan's multiple rang test.

RESULTS AND DISCUSION

Plant quantitative characters are influenced by plant genetic (variety), environmental factors and nutritional conditions of the plant. In present study, variety (genetic information) was same but the nutritional (fertilizer) supplies and environment factors were different. The variation in plant quantitative characters was due to the various levels of fertilizers use. The significance of year's effect on studied parameters in the experiment showed that environmental effects in each year were different. The difference in climate conditions and soil analysis which is unavoidable, led to the significance of year's effect.

Both nitrogen and year had a significant effect on stem length in 1% level of probe (Table-1).Length of stem was increased by applying nitrogen up to 200 kg ha^{-1}, while applying more nitrogen decreased it. The best nitrogen treatment to obtain the maximum Length of stem (35.11cm) is 100 kg ha^{-1} that is 5.3% more than control treatment. N× K effect was not significant but the best treatment for length of stem were N_3K_3 (39.17cm) and N_3K_2 (38.4cm) which ranked in a statistical level (Table-2,3).The above findings are in conformity with the observations made by Yadav (2003), Khalaj *et al* (2007) and sharma (2007), in *polianthes tuberose L*. Sultan *et al* (2006) reported that all the parameters except plant height were the highest with 200 kg ha^{-1} but plant height was the highest with 300 kg ha^{-1}. Amarget *et al* (1995) showed that increasing of N, P and K increases the plant height significantly.

Hilman and Galston (1961) reported that the reason of growth increase was the role of nitrogen in forming important molecules of phospholipids, nucleotides, nucleic acid and certain co-enzymes which play an important role in plant metabolism and shortage of N results in the reduction of auxin and thus growth which was also confirmed by Wandliegh (1957), Kadu *et al* (2009).

The data showed that with nitrogen increase up to 100 kg ha^{-1}, spike length (46.62 cm) and the number of florets (34.15 $spike^{-1}$) were increased and applying more nitrogen reduced the amount of these parameters. With nitrogen increase up to 200 kg ha^{-1}, nitrogen content of leaf before flowering was increased and applying more nitrogen reduced the amount of this parameter. Treatments 100, 200 and 300 kg ha^{-1} nitrogen had no significant difference (Table-2). Partiban (1999) showed that, the maximum number of florets $spike^{-1}$produced with the application of 100 kg ha^{-1} nitrogen. Kadu *et al* (2009) reported the

maximum spike length (106.32cm), maximum length of rachis (33.82cm) and the most number of florets spike^{-1}(41.58) were obtained with the application of 300 kg ha^{-1}nitrogen. Parmer (2007) 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.

According to table (1-2), nitrogen, year and Y× N× K affected the percentage of high quality flowers. Application of nitrogen increased the high quality flowers. The highest quality flowers produced by the application of 300 kg ha^{-1} which more 45.5% than control (Table-2). Similar results reported by Kadu *et al* (2009) and Khalaj *et al* (2007).The effect of nitrogen on potassium content of leaves were not significant. The application of potassium had no significant effect on all studied characteristics except spike length (Table-1). The highest (45.25 cm) and lowest (42.37) spike length produced by the application of 150 and 75 kg ha^{-1} respectively. Banker and Mukhopadhyay (1980) reported that nitrogen, phosphorus are essential for initiating growth of tuberose.

Data showed (Table- 2) that increasing of nitrogen more than 100 kg ha^{-1} reduced spike length and florets number spike^{-1}. Increasing of nitrogen more than 200 kg ha^{-1} had a negative effect on stem length. These results might be due to the interaction of nitrogen at high levels with number of nutrition elements (Loue, 1979).

A number of characteristics such as leaves length leaves number, vase-life, chlorophyll meter readings and LAI measured only in the second year of experiment (2011-2012).The results of this year indicated that increasing of nitrogen increased the length of leaves significantly and has no significant effect on the number of leaves (Table-4). The highest length produced by 300 kg ha^{-1} nitrogen which was 12.35% more than control (Table-5).

Potassium had no significant effect on the number and length of leaves during the period of experimentation. The above findings are in conformity with observations of Jana *et al* (1974), Kishore *et al* (2006), Kadu *et al* (2009). Mohana Sundaram *et al* (2003) reported the increase of number and length of leaves in tuberose with increasing of nitrogen. Jana *et al* (1974) and Kishore *et al* (2006) mentioned that, the application of potassium had no significant effect on the number of leaves. Hagiya (1960) showed that phosphorus and potassium had no significant effect on the width of leaf on tulip.

The favorable effect of nitrogen in promoting number and length of leaves might be due to the fact that nitrogen is a constituent part of protein and component of protoplasm which increases the chlorophyll contents in leaves. All this factors led to cell multiplication, cell enlargement and cell differentiation which have resulted in increasing of number and length of leaves (parmar, 2007).

Figure (1) shows that, the mean of weekly leaf number increase pattern in control treatment. We conclude the number of leaves in successive weeks increased because growth of side bulbs leads to leaf production. Mean of weekly leaf length increase pattern in control treatment (Figure-2) showed liner increasing from beginning of the growing season until the fifth week, and remained almost constant after that because of plant entering to flowering phase and decreasing of vegetative growth.

The data (Table- 4, 5) shows that nitrogen effect on chlorophyll meter readings and LAI before flowering is significant at 5 and 1% level of probe, respectively. K and N× K effects on above parameters are not significant. An increase in nitrogen level, increased chlorophyll meter reading and LAI. The data (Table- 5) shows that with use of more than 100 kg ha^{-1} nitrogen, chlorophyll meter readings before flowering have not a significant difference and the best nitrogen treatment is 100 kg ha^{-1}, so we can choose 42.7 reading of chlorophyll meter as a sufficient level of nitrogen in soil. The use of 300 kg ha^{-1} nitrogen produces the highest LAI. Al-Badawy *at el* (1995) reported that, the application of nitrogen led to increase of photosynthetic pigments (chlorophyll a, b) in leaves and carotenoids in flowers and nitrogen percentage in shoot as Latiri-Souki (1998) suggested that, the usefulness due to the effects of nitrogen on increasing of LAI was in relation to its effect on radiation absorption.According to table (4) with nitrogen increase, vase life decreases and with potassium increase vase life increases but nitrogen, potassium and N× K have not a significant effect on vase life. The above findings are in conformity with observations of Khalaj *at el* (2007) on tuberose. The best nitrogen treatment for vase life is N_0K_{150} (6.96 days) which is 16 % longer than control.

ACKNOWLEDGEMENT

Authors would like to thank all the staff of Safiabad Agricultural Research Center of Dezful, Soil and water research department.

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Table 1. Mean square of variance on quantitative and qualitative characteristics of tuberose cv. Double

Source	df	Stem Length	Spike Length	Florets number spike^{-1}	Leaves nitrogen	Leaves potassium	High quality flowers
Year	1	7253.4 **	4399.2 **	53.13**	13.72 **	28.61 **	879.9 *
Replication× Year	4	1.87 ns	7.94 ns	13.76 **	0.035 ns	0.39 ns	464.1 ns
Nitrogen	3	70.37 **	73.78 **	30.07 **	0.98 **	0.069 ns	1594.2 **
Year× Nitrogen	3	15.09 ns	24.46 ns	7.36 ns	0.08 ns	0.076 ns	174.2 ns
Potassium	2	11.38 ns	63.3 **	0.16 ns	0.01 ns	0.134 ns	232.2 ns
Year× Potassium	2	0.535 ns	7.55 ns	3.75 ns	0.04 ns	0.045 ns	542.9 ns
Nitrogen× Potassium	6	4.093 ns	10.42 ns	14.43 **	0.08 ns	0.253 ns	309.4 ns
Year× Nitrogen× Potassium	6	4.17 ns	18.81 ns	2.87 ns	0.02 ns	0.211 ns	528.3 *
Error	44	6.36	10.34	3.3	4.04	0.177	195.6
Cv (%)	-	7.08	7.27	5.57	7.74	9.75	23.66

*P<0.05, **P<0.01; ns: Non-significant

Table 2. Effect of nitrogen on stem length, spike length, florets number, leaves nitrogen, leaves potassium and high quality flowers.

nitrogen kg ha^{-1}	Stem length (cm)	Spike length (cm)	Florets number spike^{-1}	Leaves nitrogen (%)	Leaves potassium (%)	High quality flowers (%)
0	33.33 B	41.98 B	3.31 B	2.4 B	4.26	45.2 B
100	35.11 AB	46.62 A	34.15 A	2.73 A	4.32	61.8 AB
200	38.07 A	45.07 AB	33.24 AB	2.91 A	4.28	63.5 AB
300	36.07 AB	43.32 AB	31.78 AB	2.89 A	4.4	65.8 A
In each column, means with similar letters have no significant differences						

Table 3. Interaction effects of nitrogen and potassium on length of stem, length of spike, number of florets, leaves nitrogen, leaves potassium and high quality flowers.

Nitrogen kg ha^{-1}	Length of stem (cm)	Length of spike (cm)	Number of florets spike^{-1}	Leaves nitrogen (%)	Leaves potassium (%)	High quality flowers (%)
N1K1	33.27	41.91	29.67 C	2.46	4.25	48.38
N1K2	33.26	41.16	31.88 BC	2.34	4.00	48.3
N1K3	33.45	42.87	32.57 BC	2.41	4.53	38.95
N2K1	33.46	46.9	36.44 A	2.64	4.18	60.11
N2K2	33.98	45.53	33.8 AB	2.72	4.59	55.46
N2K3	35.89	47.44	32.23 BC	2.83	4.18	69.85
N3K1	36.63	46.81	32.83 BC	2.92	4.3	75.36
N3K2	38.41	41.16	33.67 ABC	3.04	4.25	59.46
N3K3	39.17	47.23	33.23 ABC	2.77	4.3	55.9
N4K1	36.04	44.85	31.93 BC	3.00	4.24	66.95
N4K2	36.51	41.65	31.23 BC	2.75	4.4	66.7
N4K3	35.66	43.48	32.18 BC	2.93	4.55	63.86

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

Table 4. Mean square of variance on quantitative and qualitative characteristics of tuberose cv. Double.

Source	df	Leaves length	Leaves number	Vase-life	Chlorophyll meter readings	LAI
Replication	2	3.8 ns	19.02 ns	0.57ns	58.33 ns	0.236 ns
Nitrogen	3	32.44 *	12.02 ns	0.2 ns	220.68 *	1.49 **
Potassium	2	1.38 ns	9.63 ns	0.061ns	63.93 ns	0.083 ns
Nitrogen× Potassium	6	16.65 ns	8.99 ns	0.461ns	22.67 ns	0.113 ns
Error	22	6.56	16.82	0.341	33.50	0101
Cv(%)	-	7.16	7.8	9.21	13.66	15.72

*P<0.05, **P<0.01; ns: Non-significant

Table 5. Effect of nitrogen on leaves length, leaves number, vase-life and chlorophyll meter readings and LAI.

Nitrogen kg ha^{-1}	Leaves length (cm)	Leaves number Plant^{-1}	Vase-life (day)	Chlorophyll meter readings (spad)	LAI
0	34.24 B	51.68	6.5	35.29 B	1.497 C
100	34.68 B	52.15	6.27	42.74 AB	2.040 B
200	35.76 AB	52.3	6.26	45.00 A	2.044 B
300	38.47 A	54.3	6.24	46.43 A	2.493 A

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

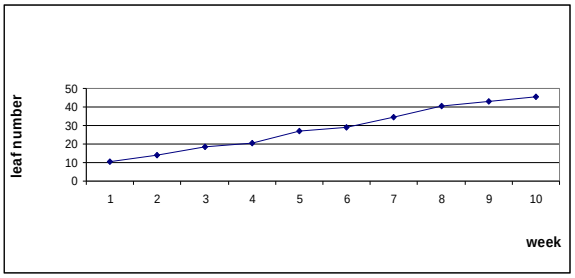

Figure 1.Mean of weekly leaf number increase pattern in control treatment

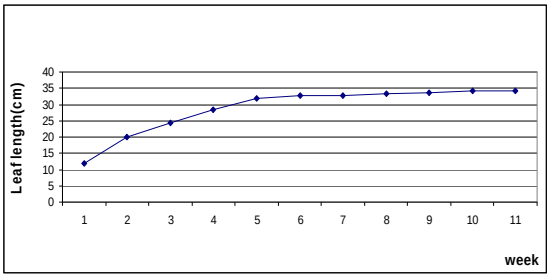

Figure 2 .Mean of weekly leaf length increase pattern in control treatment

Third replication	**N100 (K2O)0**	**N200 (K2O)150**	**N300 (K2O)300**	**N200 (K2O)300**	**N0 (K2O)150**	**N0 (K2O)300**	**N200 (K2O)0**	**N100 (K2O)300**	**N100 (K2O)150**	**N300 (K2O)150**	**N0 (K2O)0**	**N300 (K2O)0**
Second replication	**N200 (K2O)300**	**N0 (K2O)150**	**N0 (K2O)0**	**N100 (K2O)300**	**N300 (K2O)0**	**N300 (K2O)300**	**N200 (K2O)150**	**N100 (K2O)0**	**N0 (K2O)300**	**N100 (K2O)150**	**N300 (K2O)150**	**N200 (K2O)0**
First replication	**N200 (K2O)150**	**N0 (K2O)300**	**N0 (K2O)0**	**N300 (K2O)0**	**N200 (K2O)0**	**N300 (K2O)300**	**N100 (K2O)0**	**N100 (K2O)300**	**N100 (K2O)150**	**N200 (K2O)300**	**N0 (K2O)150**	**N300 (K2O)150**

Figure 3. Experiment plan