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Role of Different Levels of Nitrogen, Phosphorus and Potassium on Growth, Yield and Quality Attributes of Bitter Gourd (*Momordica charantia* L.)

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Abstract Bitter gourd is an important crop in Pakistan. Bitter gourd has a lot of dietary and medicinal importance. In Pakistan, there is a tremendous potential for using the inorganic fertilizer, but unfortunately adequate amount of fertilizer regarding the bitter gourd crop are lacking. The experiment was studied at the Vegetable Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad during the year 2014-2015, to see the efficacy of inorganic fertilizers on vegetative and reproductive attributes of bitter gourd. Faisalabad Long variety of bitter gourd was used. The experiment was laid out according to Randomized Complete Block Design consisting of six treatments with four replications. The response of vegetative parameters like growth, yield and quality were recorded and analyzed statistically at the 5 % level of significance. Different doses of inorganic fertilizers showed variations among, germination, fruit, fresh weight, fruit diameter and chemical parameter like vitamin C, pH and phenolic compound of fruit. This experiment showed that treatment (T_4) N: P: K (250,100,80 kg/ha) gave more fresh and dry weight of the fruit and Vitamin C. Treatment (T_5) N: P : K (300, 120, 100 kg/ha) showed increased the vegetative growth, vine length, number of leaves but showed least reproductive phase. It is concluded that dose of nitrogen (250kg/ha) and adequate amount of potassium (100kg/ha) along with phosphorus (80kg/ha) fertilizers increase the vegetative growth as well as reproductive growth.

Keywords Bitter Gourd, Fertilizer, Fruit Quality

1. Introduction

Bitter gourd (*Momordica charantia*) is a creeper that mainly cultivated in China, India, Pakistan, Central America, East America and South America (Nadkarni, 2000).

In Pakistan, India, Vietnam, Thailand and Nepal bitter gourd are grown in highest in the world. The largest producer of bitter gourd is India that produces 31% of the total world's production while China produces 22% and Pakistan 9% of the world production of bitter gourd. In 2012-13, the average yield of bitter gourd was 14 tons /hectare in Pakistan. Among all provinces, Punjab has the highest yield (15tonnes/ hectare). In the Punjab total area under cultivation of bitter gourd was 4299 hectares with production of 49781tonnes (GOP, 2013).

Son (2002) concluded in bitter gourd that potassium and nitrogen affect more than that of phosphorus to the number of fruit and also to the fresh and dry weight of fruits and the mixture of high dose of nitrogen along with potassium has less effect on number of fruit but if we add them separately in higher amount then they have a great effect. Akhter et al. (2009) stated that potassium element is very important for the metabolism of plant and also for more production of carbohydrates in bitter gourd. Adequate uses of inorganic and organic fertilizers is very important for getting good yield and quality, enhance of the crop also improve the soil environmental and health conditions (Rani and Mallareddy., 2007). However, there is a basic constraint in handling organic fertilizers due to their balkiness and slowly available nutrient compared to chemical fertilizers (Hailu et al., 2007). Shalaby et al. (1997) reported that nitrogen and potassium have an inverse relationship. If we increase one of them, then other is decreased. If we apply both in high or less amount the resulting decrease the production. Nitrogen ranking as fertilizer in the eyes of scientist is higher than other nutrient in bitter gourd quality enhancement. (Hochmuth et al., 2006; Nikolova et al., 1999) found that due to the instant accessibility of nitrogen to the plants that use of inorganic fertilizer by the farmers is common. But the ecosystem and environment is damaged by using fertilizers continuously. Adequate supply of N to

crops is fundamental to optimize crop yields, but the mismanagement of nitrogen, such as excessive N application can result in contamination of groundwater (Jaynes et al., 2001). Potassium is an important element in plant metabolism, promoting carbohydrate synthesis (Shalaby et al., 1997)

2. Materials and Mehtods

Present experiment was conducted on the area of =6x16=96 ft^2 at vegetable experimental and research area, institute of Horticultural Sciences, University of Agriculture, Faisalabad, during the year 2014-15. The experiment was laid out according to Randomized Complete Block Design (RCBD). The seeds of bitter gourd were parched from seed market Dajkot road, Faisalabad. Bitter gourd variety Faisalabad long was selected for research. Six treatments of NPK are with different concentration with four replications. One third nitrogen was applied at the time of seedbed preparation, One third after one month and remaining after two months. Whole of the phosphorus was applied at the time of seed bed preparation. Half of the potassium was applied at the time of seed bed preparation and half of the potassium after one month of sowing. Seed was sown on raised beds. Application of 184 kg N, 112 kg P2O5, and 124 kg K2O/ha gave a significant yield of bitter gourd (Palama and Chang, 2003).

The following treatments were studied:

T_0 = Control, T_1 = N: P: K (100 : 40 : 20) kg/ha, T_2 = N : P : K (150 : 60 : 40) kg/ ha, T_3 = N : P: K (200 : 80 : 60) kg/ha, T_4 = N: P: K (250: 100 : 80) kg/ ha, T_5 = N: P: K (300 : 120 : 100) kg/ha

3. Results and Discussion

Present research studies were carried out at Vegetable Research Area, University of Agriculture, Faisalabad, during 2014 to ascertain the role of different levels of NPK fertilizers on growth, yield and quality attributes of bitter gourd. The results of studies pertaining germination %, number of days to first flowering, number of days to first harvesting, fruit diameter, fruit length, fruit weight, Fruit dry weight, number of fruit per vine, yield per plant, yield per ha, number of seed per fruit, seed yield per ha, number of leaves per vine, chlorophyll content and chemical parameters likes vitamin C, phenolic content and ph of fruits are given below

Final Germination Percentage (%)

Bitter gourd (Faisalabad long) was revealed under experiment and germination % was noted. It is clear that different levels of fertilizers showed to significant change in germination percentage (%). Table1 showed the comparison of germination percentage of Faisalabad long by different levels of NPK fertilizers treatments. Maximum germination % was recorder by treatment (N:P:K 250:100:80) with an average of 83.50 , followed by treatment (N:P:K 200:80:60). Minimum germination % was observed in (control) with an average of 63.75.

Premsekhar and Rajashree (2009) worked on tomato and reported that growth parameters of tomato differ significantly with different levels of NPK fertilizers.

Number of Days Taken to First Flowering

Results showed that different levels of fertilizers showed significant difference in number of days taken to first flowering. Table 1 showed the comparison of number of days taken to first flowering of Faisalabad long variety gained by different levels of NPK fertilizers treatments. Maximum number of days taken to first flowering was recorded in (N:P:K 300,120,100) with an average of 50.250 days, followed by (control) with 45.50. Minimum number of days taken to first flowering was recorded as (N:P:K 250:100:80) with 39 days.

The result are correlated with Harris et al. (2007) who reported that potassium causes the earlier flowers in rice and increased the yield. Murunge et al., (2004) reported that reduce the number of days of flowering by using fertilizers and seed priming.

Table 1. Role of different levels of Nitrogen, Phosphorus and Potassium on germination % , Days to flowering, fruit diameter, fruit length and days taken to harvest of bitter gourd (*Momordica charantia* L.).

Treatment	Germination%	Days to flowering	Fruit Diameter (cm)	Fruit Length (cm)	Days taken to first harvest
Control	63.750 f	45.50 b	3.59 d	12.903 d	66.75 b
(N:P:K 100:40:20 kg ha^{-1})	67.75 e	45.25 b	3.77 d	13.72 cd	65.75 b
(N:P:K 150:60:40 kg ha^{-1})	72.25 d	42.25 c	4.06 c	14.46 c	66.50 b
(N:P:K 200:80:60 kg ha^{-1})	75.25 c	41.0 c	4.51 b	16.65 b	65.50 b
(N:P:K 250:100:80 kg ha^{-1})	83.50 a	39.0 d	4.87 a	19.37 a	59.50 c
(N:P:K 300:120:100 kg ha^{-1})	78.50 b	50.25 a	4.47 b	16.65 b	72.75 a

Fruit Diameter (cm)

It is clear from the Results that different levels of fertilizers showed significant difference in diameter of the fruits. Maximum diameter of the fruit was recorded in (N:P:K 250:100:80) which is of 4.87 cm , followed by (N:P:K 300:120:100) . Minimum diameter of the fruit was in (control) 3.59.

Our results are matching with Nasreen et al., (2013). Mulani et al., (2007) reported that nitrogen and bio fertilizer increase the diameter of the fruits.

Fruit Length (cm)

Maximum fruit length was recorded in (N:P:K 250:100:80) which is of 19.375 cm , followed by (200,80,60) which is 16.650cm . Minimum fruits length was recorded as (control) which is 12.903cm.

Our results are matching with Gengaihi (2005) who stated that bitter gourd fruit length is increased by potassium and nitrogen.

Fruit Fresh Weight (g)

Table 2 showed the comparison of fruit weight of Faisalabad long variety gained by different levels of NPK fertilizers treatments. Maximum fruit weight were recorded in (N:P:K 250:100:80) which is 95.05 cm , followed by (N:P:K 200:80:60). Minimum fruit weight was recorded in (control) which is 61.15.

Results are in line with the finding of El-Gengaihi et al. (2005) reported that due to nitrogen and potassium fresh fruit weight increasing in bitter gourd. Abd-El-Baky (2010) stated that potassium and nitrogen increased the weight in sweet potato.

Besford et al., (1975) stated that due to potassium tomato fresh weight increases.

Fruit Dry Weight (g)

. Maximum fruit dry weight were recorded in (N:P:K 250:100:80) which is 12.25g , followed by (NPK 200:80:60) . Minimum fruit dry weight was recorded as (control) which is 7.70 g.

Results are in line with the finding of Nasreen et al. (2013). Results are in line with the finding of El-Gengaihi et al., (2005) reported that due to nitrogen and potassium fruit dry weight increasing in bitter gourd.

Number of Fruit per Vine

Maximum number of fruit per vine were recorded in (N:P:K 250:100:80) with an average of 18.25 , followed by (NPK 200,80,60) with 16 number of fruit. Minimum number of fruits per vine was recorded as T_0 (control) which is 9.50.

Result is matching with the Palada et al., (2003) who stated that nitrogen increased the number of fruits.

Fruit Yield per Vine (kg)

Maximum fruit yield per vine were recorded in (N:P:K 250:120:100) with an average of 2.04 kg, followed by (N:P:K 200:80:60) which is 1.58kg. Minimum fruit yield per vine was recorded as (control) which is 0.5765.

Result is matching with the Palada et al. (2003) who stated that nitrogen increased the yield of bitter gourd. Belokar et al. (1992) stated that nitrogen increased the flowering as well fruit yield.

Fruit Yield per Hectare (Tons)

Table 2 showed the comparison of fruit yield per vine of (Faisalabad long) variety gained by different levels of fertilizer treatments. Maximum fruit yield per hectare were recorded in (N:P:K 250:100:80) with an average of 29.27 tons, followed by (N:P:K 200:80:60) which is 22.77 tons. Minimum fruit yield per hectare was recorded as (control) which is 8.28 tons.

Our results are in accordingly to Palada et al. (2003). Bidari et al. (2011) and El- Desuki et al. (2005) stated that potassium and nitrogen increased the yield in raddish.

Table 2. Role of different levels of Nitrogen, Phosphorus and Potassium on fruit fresh and dry weight, number of fruit vine^{-1}, fruit yield vine^{-1}, fruit yield hec^{-1} of bitter gourd (*Momordica charantia* L.).

Treatment	Fruit weight(g)	Fruit dry weight (g)	Number of fruit vine^{-1}	Fruit yield fruit yield vine^{-1} (kg) per hectare
(control)	61.15 d	7.70 d	9.50 e	0.576 e 8.28 e
(N:P:K 100:40:20 kg ha^{-1})	77.40 c	9.45 c	12.00 d	0.930 d 13.34 d
(N:P:K 150:60:40 kg ha^{-1})	78.05 c	10.13 bc	13.75 c	1.073 c 15.39 cd
(N:P:K 200:80:60 kg ha^{-1})	87.12 b	11.86 a	18.10 b	1.587 b 22.77 b
(N:P:K 250:100:80 kg ha^{-1})	95.05 a	12.35 a	22.25 a	2.041 a 29.27 a
(N:P:K 300:120:100 kg ha^{-1})	86.30 b	11.09 ab	16.00 b	1.204 c 17.10 c

Number of Leaves per Vine

Maximum number of leaves per vine were recorded in (N:P:K 300:120:100) with an average of 124, followed by (N:P:K 250:100:80) which is 103.50 . Minimum number of leave per vine was recorded as (control) which is 78.75.

Our results are matching with Nasreen et al., (2013). She stated that due to high amount of nitrogen the number of leaves increased. Aghassbasi (2012) stated that due to organic and inorganic chemicals the number of leaves increased in bitter gourd.

Final Vine Length (cm)

Maximum final vine length was recorded in (N:P:K 300:120:100) with an average 316.50 cm, followed by (N:P:K 250:100:80) with 295.95 cm. Minimum final vine length was recorded as (Control) which is 243.13cm.

Our results are matching with palada et al. (2003). Aghassbasi (2012) stated that due to organic and inorganic chemicals the vine length increased in bitter gourd.

Number of Seed per Fruit

Maximum number of seed per fruit were recorded in (N:P:K 250:100:80) with an average of 24.20, followed by T_3 (N:P:K 200:80:60) which is 23.50. Minimum diameter 3.4 cm of fruits was recorded as T_0 (control) which is 16.875.

Results are similar to Aruna et al., (2012). Ahmad et al., (2011) stated that due to nitrogen the seed yield increased in canola. Hossain et al. (2009) stated that due to nitrogen the seed yield increased in carrot.

Seed Yield per Hectare (kg)

Maximum seed yield per hectare were recorded in (N:P:K 250:100:80) with an average of 522.27 kg, followed by (N:P:K 200:80:60) which is 456.27 kg . Minimum seed yield per hectare T_0 (control) was recorded as T0 270.46 kg.

Results are similar to Aruna et al. (2012). Ahmad et al. (2011) stated that due to nitrogen the seed yield increased in canola. Hossain et al., (2009) stated that due to nitrogen the seed yield increased in carrot.

1000 Seed Weight (g)

Table 3 showed the comparison of average 1000 seed weight of Faisalabad long variety gained by different levels of fertilizers treatments. Maximum1000 seed was recorded in (N:P:K 250:100: 80) with an average of 142.5, followed by (N:P:K 200:80:60) 142.15. Minimum seed yield per hectare T_0 (control) was recorded in which is 134.88 g.

Results are similar to Aruna et al. (2012) who stated that nitrogen increased the 1000 seed weight in bitter gourd.

Chlorophyll Content

Table 4 showed the comparison of average chlorophyll content of Faisalabad long variety gained by different levels of fertilizers treatments. Maximum chlorophyll content were recorded in (N:P:K 300:120:100) with an average of 21.94, followed by (N:P:K 250:100:80) 20.1. Minimum chlorophyll content was recorded as (control) 13.5.

These results are in the agreement with the findings of Sonu and Singh (2005) who reported that maximum chlorophyll content when 100 kg potassium was applied.

Nitrogen is the involved in the synthesis of bio molecules in plant such as amino acid and nucleic acid and pigments. Chlorophyll content was reported that it is correlated with the amount of nitrogen .moreover nitrogen application to nitrogen deficient soils transcripts levels of nicotianamine synthesis gene which is directly related to chlorophyll synthesis pich et al., (2001). Chlorophyll content is more when the amount of nitrogen is more .these are not correlated with the amount of potassium and phosphorus.

Table 3. Role of different levels of Nitrogen, Phosphorus and Potassium on no. of leaves per vine, length of vine, no. of seed per fruit, seed yield hec^{-1}, 1000 seed weight of bitter gourd (*Momordica charantia* L.)

Treatment	number of leaves per vine	Final vine length	number of seed per fruit	Seed yield per hectare	1000 seed weight
(control)	78.75 e	243.13 f	16.87 d	270.46 f	134.88 b
(N:P:K 100:40:20 kg ha^{-1})	86.50 d	260.60 e	18.50 cd	334.67 e	140.38 a
(N:P:K 150:60:40 kg ha^{-1})	91.00 cd	274.85 d	20.00 bc	377.00 d	141.25 a
(N:P:K 200:80:60 kg ha^{-1})	95.75 c	283.12 c	23.50 a	456.27 b	142.15 a
(N:P:K 250:100:80 kg ha^{-1})	103.50 b	295.95 b	24.25 a	522.27 a	142.25 a
(N:P:K 300:120:100 kg ha^{-1})	124.00 a	316.50 a	21.50 b	401.75 c	142.00 a

Table 4. Role of different levels of Nitrogen, Phosphorus and Potassium on chemical parameter of bitter gourd (*Momordica charantia* L.)

Treatment	chlorophyll content	vitamin C mg/100g	pH	Phenolic compound CAE/ mg
(control)	14.07 f	82.62 d	5.25 f	5.07 a
(N:P:K 100:40:20 kg ha^{-1})	19.65 e	84.60 c	5.27 e	5.05 a
(N:P:K 150:60:40 kg ha^{-1})	22.65 d	85.15 bc	5.45 d	5.28 a
(N:P:K 200:80:60 kg ha^{-1})	125.05 c	86.72 b	5.62 c	4.26 a
(N:P:K 250:100:80 kg ha^{-1})	27.32 b	89.40 a	5.82 b	4.52 a
(N:P:K 300:120:100 kg ha^{-1})	29.32 a	85.05 bc	5.95 a	4.57 a

Vitamin C mg /100g

Maximum vitamin C were recorded in (N:P:K 250:100:80) with an average of 89.40mg/100g , followed by (N:P:K 200:80:60) which is 86.72mg/100g. Minimum vitamin C was recorded as (control) which is 82.625 mg/100g

Results are in agreement with the finding of (Akhter et al., 2009). The results showed that by applying the adequate amount of fertilizers the highest amount of vitamin C obtained. Results are also in line with Nasreen et al. (2013).

pH of Fruit

Maximum ph of the fruit were recorded in (N:P:K 300:120:100) with an average of 5.95, followed by (N:P:K 250:100:80) which is 5.82 . Minimum ph of fruit was recorded as (control) which is 5.2.

These results showed that highest levels of nitrogen 300kg/ha along with 120 kg/ha potassium gave maximum results.

Phenolic Compound CAE/ mg

Maximum phenolic compound was recorded in (N:P:K 150:60:40) with an average of 5.2875 GAE/mg , followed by (control) which is 5.0750 GAE/mg. Minimum phenolic compound was recorded as (N:P:K 200:8:60) which is 4.2625 GAE/mg .

Kim et al. (2003) and Lee et al. (2003) reported that phenolic compound is different within the same variety it is not depend upon fertilizers. The variation among same or different varieties is due to some environmental factors such as heat availability of water. Phenolic compound highly depend on water (Lee et al., 2003).

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