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Research Article

Response of bitter gourd (*Momordica charantia* L.) to varying nitrogen doses

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Abstract

A field study was carried out during 2011-12 to evaluate the growth and fruit yield contributing parameters ofbitter gourd in response to varying nitrogen doses. Six nitrogen levels including a control were tested (T_1= control, T_2=50 kg ha^{-1}, T_3=75 kg ha^{-1}, T_4=100 kg ha^{-1}, T_5=125 kg ha^{-1} and T_6=150 kg ha^{-1}). A uniform dose of phosphorus (75 kg ha^{-1}) and potash (50 kg/ha^{-1}) was also be added in all the experimental units. The results revealed growth and yield components were significantly ($P<0.05$) influenced by increasing nitrogen doses. The highest nitrogen dose of 150 kg ha^{-1} resulted in 138.68 cm vine length, 14.06 cm fruit length, 59.97 average fruit weight, 15.60 total number of fruits $vine^{-1}$, 1.14 fruit weight $vine^{-1}$, 36.87 kg fruit yield $plot^{-1}$ and 14748 kg fruit yield ha^{-1} which were resulted highest values for all the parameters studied, However, bitter gourds given nitrogen fertilizer dose of 75 kg and 50 kg ha^{-1} resulted in lower values for all the parameters studied, while the control remained the least. The fruit yield ha^{-1} was mainly contributed by improved length of fruits, average fruit weight, number of fruits $vine^{-1}$,and fruit weight $vine^{-1}$, Differences in all the above characters between 150 kg and 125 kg nitrogen dose were non-significant ($P>0.05$) and significant when compared with rest of the treatments and control. It was concluded that 125 kg nitrogen was considered as an appropriate level for achieving economically maximum fruit yield ha^{-1}.

Keyword: Bitter gourd; Nitrogen levels; Yield

Introduction

Bitter gourd (*Momordica charantia)* is a climbing habit plant and belongs to family of Cucurbitaceae, also called bitter melon [1]. Different cultivars are different in the shape and bitterness. It is used in cooking in the green or early yellowing stages. The young shoots and leaves of the bitter gourd may also be eaten as greens. Chinese like Bitter gourd due to its bitter flavor used in cooking as stir-fries, soup and as tea. It is very popular throughout South Asia; it is often prepared with potatoes and served with yogurt on the side to offset the bitterness [2]. In Pakistan and Bangladesh, bitter gourd is generally cooked with onions, red chili powder, turmeric powder, salt, coriander powder, and a pinch of cumin seeds. Another dish in Pakistan calls for whole, unpeeled bitter

gourd to be boiled and then stuffed with cooked ground beef, served with either hot tandoori bread, naan, chappati, or with khichri a mixture of lentils and rice [3].The center of bitter gourd domestication likely lies in eastern Asia, possibly eastern India or southern China [4].Among the different agronomic practices nutrient management is one of the prime considerations for getting higher yield of any crop. Inorganic fertilizers are commonly used by most of the farmers because of quick availability of essentially required nutrient elements to the plants. Application of fertilizer doses depend on soil fertility level, soil type and soil organic matter. Before sowing Farm Yard Manure (FYM) is added to each planting hole at 10 to 12 tons ha-1. The application of 100:50:50 kgha^{-1} N-P_2O_5-K_2O is recommended [5]. In sandy soils recommended doses of fertilizers are 184, 112, and 124 kg of N, P_2O_5, and K_2O a basal dose and four side dressings applied [6]. Potassium is an important element in plant metabolism, promoting carbohydrates synthesis. In many cases such promotion is observed only at selectively low potassium levels. An antagonistic relationship between nitrogen and potassium as related to dry weight of Echinacea was noted [7, 8]. Obtained fruit length of 17.3 cm, fruit number 26.3 and fruit yield ha^{-1} of 17.12 tons with the application of 80:30:0 kg NPK ha^{-1} in bitter gourd. [9] Reported significantly higher fruit weight of 239.7 g, number of fruits 15.8 vine^{-1}, fruit yield of 3.79 kg plant^{-1} and fruit yield ha^{-1} of 33.7 tons with the application of 80 kg nitrogen ha^{-1} in bitter gourd. [10] Reported that maximum number of fruits was obtained with use of the combined application of nitrogen and high potassium at higher doses in bitter gourd. Keeping view the facts stated above, the experiment was conducted to investigate the response of bitter gourd to varying nitrogen levels.

Materials and methods

In order to investigate the response of bitter gourd, *Momordicacharantia* L. to varying nitrogen doses, the experiment was conducted at experimental and demonstration orchard of Horticulture department Sindh Agriculture University Tandujam in a 3replications R.C.B. Design, size of plot was 5m x 5m (25m^2). For this experiment, the fallow land was worked by giving one plowing with disc plow, followed by disc harrow. For even distribution of irrigation water the land was ploughed and removed the all weeds. The bunds were prepared to separate the sub-plots and feeding channels were prepared to facilitate the crop irrigation. Finally, ridges were prepared according to the plan of work.

The NPK Fertilizers in the form of urea, SSP and SOP were applied. Nitrogen was applied at different rates, while P and K were applied uniform doses of 75 and 50 ha^{-1}.At the time of sowing, all phosphorus and potash along with 1/3rd of nitrogen was applied, remaining 3 nitrogen doses were applied at 60, 80 and 100 days after sowing. The irrigations were applied at an interval of 8 days regularly. All the cultural practices were operated as per the recommendations in all the plots uniformly. Bitter gourd vines were left to creep on wide ridges to farm fruits on soil surface. All the cultural practices, i.e. weeding, hoeing etc. were carried out. The observations, Vine length (cm), Fruit length (cm), Average fruit weight (g), Number of Fruits Vine^{-1},Weigh of Fruit Vine^{-1} (kg), Fruits yield plot^{-1}(kg) and Fruit yield ha^{-1} were recorded on basis of five selected vines in each plot. The analysis of variance was employed to examine the significance for each character for overall treatments, while the L.S.D. (Least Significant Difference) test was employed to compare the treatment means, following the statistical methods suggested by Gomez and Gomez [11].

Results

Vine length (cm)

The bitter gourd vines were left to creep on wide ridges of the experimental plots to farm fruits on soil surface. The data in regards to vine length of bitter gourd as affected by varying nitrogen doses are given in (Table 1), demonstrated that there was a significant ($P<0.05$) and linear impact of varying nitrogen levels on the bitter gourd vine length. The bitter gourd vines (creeping on soil surface on ridges) supplied with nitrogen dose of 150 kg ha^{-1}demonstrated highest length of 138.68 cm, while the bitter gourd vines receiving nitrogen dose of 125 kg $ha^{-1}$and 100 kg ha^{-1} ranked second and third with average vine length of 131.21 cm and 126.36 cm, respectively. The decreasing dose of nitrogen up to 75 kg ha^{-1} and 50 kg ha^{-1}demonstrated a simultaneous reduction in vine length up to 118.81 cm and 109.79 cm, respectively. However, the plots receiving no nitrogen (control) resulted in a minimum vine length of 71.54 cm. It was noted that the increasing nitrogen contributed a concurrent increase in the vine length of bitter gourd, which indicated that the experimental soil was inadequate for nitrogen and soil became adequate when higher nitrogen levels were applied and in result the vine length increased remarkably. The LSD test suggested that statistically the differences among all the treatments as well as control were significant ($P<0.05$).

Table 1. Effect of different Nitrogen levels on Vine length (cm), Fruit length (cm), Average fruit weight (g), Number of fruits $vine^{-1}$, Weight of fruits $vine^{-1}$ (kg), Fruits yield $plot^{-1}$ (kg) and Fruit yield ha^{-1} (kg) of bitter gourd

Treatments N-P-K kg ha^{-1}	Vine length (cm)	Fruit length (cm)	Average fruit weight (g)	Number of fruits $vine^{-1}$	Weight of fruits $vine^{-1}$ (kg)	Fruit yield $plot^{-1}$ (kg)	Fruit yield ha^{-1} (kg)
Control 0	71.54 f	8.71 d	35.91 d	4.82 e	0.53 e	7.78 e	3113 e
50-75-50	109.79 e	11.17 c	47.71 c	9.88 d	0.78 d	19.07 d	7627 d
75-75-50	118.81 d	12.61 b	52.95 b	12.10 c	0.91 c	23.80 c	9518 c
100-75-50	126.36 c	13.10 b	57.14 a	13.54 b	0.99 b	30.36 b	12143b
125-75-50	131.21 b	13.85 a	59.48 a	15.22 a	1.15 a	36.16 a	14464 a
150-75-50	138.68 a	14.06 a	59.97 a	15.60 a	1.14 a	36.87 a	14748 a
S.E.±	2.3212	0.1813	1.4157	0.3222	0.0352	0.9851	394.01
LSD 0.05	5.1719	0.4040	3.1543	0.7179	0.0784	2.1950	877.90
LSD 0.01	7.3564	0.5747	4.4867	1.0212	0.1116	3.1221	1248.7
CV%	2.45	1.81	3.32	3.37	4.76	4.74	4.74

The values followed by same alphabetic letters describe that these means are not significantly different from one another

Fruit length (cm)

Fruit length is most important yield component and this character vitally contributes to final fruit yield ha^{-1}. The result relating to fruit length of bitter gourd effect by varying nitrogen doses are given in (Table 1). The analysis of variance illustrated that the fruit length of bitter gourd was significantly influenced ($P<0.05$) due to application of nitrogen at varying levels. The plants fertilized with highest nitrogen dose of 150 kg ha^{-1} resulted in highest fruit length of 11.06 cm, while the vines receiving nitrogen dose of 125 kg ha^{-1} and100 kg ha^{-1}occupied second and third positions with average fruit length of 10.85 cm and 10.10 cm, respectively. The crop under reduced nitrogen doses up to 75 kg ha^{-1} and 50 kg ha^{-1} followed an adverse impact for fruit length with 9.61 cm and 9.17 cm, length of fruits, respectively. However, the bitter gourd plantation left untreated for nitrogen (control)

produced minimum fruit length of 6.71 cm. This greater fruit length on average under higher nitrogen doses was mainly associated with improvement in the growth and vigor of bitter gourd vines and with each increasing nitrogen dose resulted in a considerable improvement in the fruit length. This suggested higher nitrogen doses fulfilled the bitter gourd growth and fruiting requirement for nitrogen and in result the fruit length was improved markedly. However, this increase in fruit length was non-significant (P>0.05) when the nitrogen was applied at the dose higher than 125 kg ha^{-1}, because statistically the differences between fruit length of bitter gourd under 150 kg and 125 kg ha^{-1} nitrogen doses were non-significant as suggested by the LSD test.

Average fruit weight (g)

Average fruit weight is a character having direct effect on fruit yield ha^{-1}. The data in relation to fruit weight of bitter gourd as influenced by varying nitrogen doses are given in (Table 1). The analysis of variance indicated that the application of nitrogen at varying levels had significant (P<0.05) effect on average fruit weight of bitter gourd. The average fruit weight was significantly highest (59.97 g) in plots fertilized with highest nitrogen rate of 150 kg ha^{-1}, followed by average fruit weight of 59.48 and 57.14 g, recorded in plots fertilized with nitrogen at the dose of 125 kg ha^{-1} and 100 kg ha^{-1}, respectively. The bitter gourd given nitrogen doses at the rates of 75 kg ha^{-1} and 50 kg ha^{-1} resulted in lower average fruit weight of 52.95 g and 47.71 g, respectively. However, the lowest average fruit weight (35.91 g) was obtained in control plots, where nitrogen was not applied. The higher average fruit weight under higher nitrogen doses was linearly contributed by increased fruit length, and these parameters are directly and positively influenced by the soil applied nitrogen at higher doses; because in control plots, the average fruit weight was significantly lowest. The data also indicated the average fruit weight was increased significantly when nitrogen was applied upto 100 kg ha^{-1}, and further increase in nitrogen upto 125 kg or 150 kg ha^{-1} did not improve the average fruit weight significantly. Hence, the optimum nitrogen dose for average fruit weight was 100 kg ha^{-1}. LSD test suggested non-significant (P>0.06) difference between nitrogen doses of 100 kg, 125 kg and 150 kg ha^{-1}.

Number of fruits $vine^{-1}$

Number of Fruit $Vine^{-1}$ is a character of vital importance in bitter gourd, because this component influences the yield ha^{-1} simultaneously. The result relating to number of fruits $vine^{-1}$ of bitter gourd as influenced by varying nitrogen doses are given in (Table 1). The analysis of variance illustrated that different doses of nitrogen fertilizer had significant (P<0.05) affected on the number of fruits $vine^{-1}$of bitter gourd. The number of fruits $vine^{-1}$ was significantly highest (15.60) in plots fertilized with highest nitrogen dose of 150 kg followed by 15.22 and 13.54 fruits $vine^{-1}$ recorded in plots fertilized with nitrogen doses of 125 kg and 100 kg ha^{-1}, respectively. Number of fruits in bitter gourd fertilized with nitrogen doses of 75 kg ha^{-1} and 50 kg ha^{-1} followed a declining trend with 12.10 and 9.88 Fruits $Vine^{-}1$, respectively. The minimum Number of fruits (4.82) $Vine^{-1}$was observed in plots left untreated for nitrogen (control). This higher number of fruits $vine^{-1}$ under higher nitrogen doses was mainly associated with length of vine because as the vine length increased, the number of fruits was also increased. The increase in the number of fruits $vine^{-1}$ was significant (P<0.05) when nitrogen was applied upto 125 kg ha^{-1}, and further increase in nitrogen upto 150 kg ha^{-1}didn't show positive effect on this trait, due to the different Number of Fruits $Vine^{-1}$between nitrogen doses of 125 kg and 150 kg ha^{-1}were

non-significant (P>0.05) as suggested by LSD test.

Weight of fruit vine^{-1}

Weight of Fruit Vine^{-1} is directly proportional to fruit yield ha^{-1}. The data in record to weight of fruits vine^{-1} of bitter gourd as affected by varying doses of nitrogen fertilizer are shown in (Table 1). The analysis of variance indicated that different doses of nitrogen fertilizer had significant (P<0.05) influence on the weight of fruits vine^{-1}. The maximum weight of fruits (1.15 kg) vine^{-1} was achieved from the bitter gourd fields given nitrogen dose of 125 kg ha^{-1}, followed by 1.14 and 0.99 kg average weight of fruits vine^{-1} obtained from the plots fertilized with nitrogen doses of 150 kg and 100 kg ha^{-1}, respectively. The weight of fruits in bitter gourd fertilized with nitrogen doses of 75 kg ha^{-1} and 50 kg ha^{-1} pursued a diminishing trend with 0.91 and 0.78 kg average weight of fruits vine^{-1}, respectively. The minimum weight of fruits (0.53 kg) vine^{-1} was observed in plots kept without nitrogen (control). The higher weight of fruits vine^{-1} under higher nitrogen doses was mainly relative to average length of fruits, average weight of fruit and average number of fruits and these components are directly proportional to weight of fruits plant^{-1}. It was further noted that with each increased level of nitrogen, the weight of fruits vine^{-1} was increased significantly. However, increasing nitrogen beyond 125 kg ha^{-1} did not increase the weight of fruit vine^{-1} as suggested by the LSD test. Hence, 125 kg ha^{-1} nitrogen was considered to be an optimum dose for achieving economically maximum weight of fruits vine^{-1}.

Fruit yield plot^{-1}

Fruit yield plot^{-1} is a principal character to influence fruit yield ha^{-1}. The results in relation to fruit yield plot^{-1} of bitter gourd as influenced by varying doses of nitrogen fertilizer are shown in (Table 1). The analysis of variance demonstrated significant (P<0.05) effect of varying nitrogen levels on the fruit yield plot^{-1}. It is apparent from the results that the maximum fruit yield plot^{-1}(36.87 kg) was obtained from the bitter gourd plantation receiving highest nitrogen dose of 150 kg ha^{-1}, followed by average fruit yield of 36.16 kg and 30.36 kg plot^{-1} realized from the plots fertilized with nitrogen doses of 125 kg and 100 kg ha^{-1}, respectively. The fruit yield in plots fertilized with nitrogen doses of 75 kg ha^{-1} and 50 kg ha^{-1} chased a declining trend with average fruit yield of 23.80 kg and 19.07 kg plot^{-1}, respectively. The lowest fruit yield (7.78 kg) plot^{-1} was recorded in control plots where nitrogen was not applied. The results suggested that the higher fruit yield plot^{-1} under higher nitrogen doses was largely associated with vine length, length of fruits, weight of fruit vine^{-1}, Number of fruits vine^{-1}and average fruit weight vine^{-1}. These traits have linear contribution to the fruit yield plot^{-1} in bitter gourds. The LSD test showed that the differences in fruit yield plot^{-1} in treatments given nitrogen doses of 150 kg and 125 kg ha^{-1} were statistically non-significant (P>0.05) and significant when compared with rest of the treatments. Hence, 125 kg nitrogen was considered as an optimum level for achieving economically maximum fruit yield plot^{-1} in bitter gourd.

Fruit yield (kg ha^{-1})

Fruit yield ha^{-1} was calculated on basis of average fruit yield plot^{-1}.The data relating to fruit yield ha^{-1} of bitter gourd as affected by different doses of nitrogen fertilizer are given in(Table 1). The analysis of variance illustrated that the fruit yield ha^{-1} was significantly (P<0.05) influenced by varying nitrogen levels. The highest fruit yield of 14748 kg ha^{-1}was received from the plot applied with nitrogen at the maximum dose of 150 kg ha^{-1}, closely followed by fruit yield of 14464 kg ha^{-1} realized from the plots fertilized with nitrogen level of 125 kg ha^{-1} and crop receiving 100 kg ha^{-1} nitrogen

resulted average fruit yield of 12143 kg ha^{-1}. The fruit yield in plots fertilized with nitrogen doses of 75 kg ha^{-1} and 50 kg ha^{-1} trailed a negative trend with average fruit yield of 9518 kg and 7627 kg ha^{-1}, respectively. The minimum fruit yield of 3113 kg ha^{-1} was realized in control plots where nitrogen application was terminated. It is evident from the results that higher fruit yield ha^{-1} was mainly contributed by improved vine length, length of fruits, weight of fruit vine^{-1}, number of fruit vine-^{1}and average fruit weight vine^{-1}. The LSD test suggested that the differences in fruit yield ha^{-1} in treatments given nitrogen doses of 150 kg and 125 kg ha^{-1}were statistically non-significant (P>0.05) and significant with rest of the treatments when compared. Hence, 125 kg nitrogen was considered as an optimum level for achieving economically maximum fruit yield ha^{-1}.

Discussion

A field study was carried out during 2011-12 to evaluate the growth and fruit yield contributing parameters of bitter gourd in response to varying nitrogen doses. The present study showed that all the growth and yield components of bitter gourd were significantly (P<0.05) influenced by increasing nitrogen doses. The highest nitrogen dose of 150 kg ha^{-1} resulted in 138.68 cm vine length, 11.06 cm fruit length, 59.97 average fruit weight, 15.60 total number of fruits vine^{-1}, 1.14 fruit weight vine^{-1}, 36.87 kg fruit yield plot^{-1} and 14748 kg fruit yield ha^{-1}; while the crop receiving nitrogen dose of 125 kg ha^{-1} resulted in 131.21 cm vine length, 10.85 cm fruit length, 59.48 average fruit weight, 15.22 total number of fruits vine^{-1}, 1.15 fruit weight vine^{-1}, 36.16 kg fruit yield plot^{-1} and 14464 kg fruit yield ha^{-1}. Similarly, The crop fertilized with nitrogen rate of 100 kg ha^{-1} resulted in 126.36 cm vine length, 10.10 cm fruit length, 57.14 average fruit weight, 13.54 total number of fruits vine^{-1}, 0.99 fruit weight vine^{-1}, 30.36 kg fruit yield plot^{-1} and 12143 kg fruit yield ha^{-1}. However, bitter gourds given nitrogen fertilizer doses of 75 kg and 50 kg ha^{-1} resulted in lower values for all the parameters studied, while the control remained the least. The fruit yield ha^{-1} was mainly contributed by improved length of fruits, average fruit weight, number of fruits vine^{-1} and fruit weight vine^{-1}; and differences in all the above characters between 150 kg and 125 kg nitrogen dose were non-significant (P>0.05) and significant when compared with rest of the treatments and control. It was concluded that 125 kg nitrogen was considered as an optimum level for achieving economically maximum fruit yield ha^{-1}. Dealing with the occurrence and accumulation of polypeptide and cucurbitacins content as well as the relation between them and fertilization nothing was reported in previous work concerning bitter gourd or other plants bearing cucurbitacins. This study first reported concerning matter. [12] Reported that nitrogen fertilization slightly decreased the crude protein concentration in the forage dry matter from 120 kg ha^{-1} N and crop performance adversely affected with increasing nitrogen rates. The present results are in accordance with the findings of [13] in bitter gourd. In view of the above findings, it is suggested that nitrogen application the dose 125 kg ha^{-1} through inorganic sources may be applied for highest fruit yield of bitter gourd. Similarly, [8] Obtained fruit length of 17.3 cm, fruit number 26.3 and fruit yield ha^{-1} of 17.12 tons with application of 80:30:0 NPK ha^{-1}in bitter gourd. [9] Reported significantly higher fruit weight of 239.7 g, number of fruits 15.8 vine^{-1}, fruit yield of 3.79 kg plant^{-1} and fruit yield ha^{-1}of 33.7 tons with the application of 80 kg nitrogenha^{-1}in bitter gourd. [14] Reported fruit weight of 23.24 g, number of fruits 15.3, fruit yield plant^{-1} of 3.42 kg and ha^{-1} of 30.8 tons with the

application of 30 kg phosphorus along with 30 kg P and 30 kg K ha^{-1}. [10] Reported that maximum number of fruits was obtained with combination application of nitrogen potassium at higher doses in bitter gourd. [15] Investigated the effect of different N, P and K levels on the growth and yield of bitter gourd and the results showed that the number of branches, diameter of fruit, yield per vine and yield per hectare were highest when 250 kg N, 50kg P_2O_5 and 100kg K_2O per hectare was applied. [16] Also found the results of similar trend as concluded in the present investigation. In another recent study, [17] Used nitrogen up to 300 kg ha^{-1}, and higher levels of N nutrition reduced the ascorbic acid content in fruits. More frequent split application of nutrient N or greater proportion of organic source enhanced the shelf life of fruits. The comparative analysis of the results of the present study with those of reported from different parts of the world indicated that higher rates of nitrogen have become necessary for achieving desired yield results in bitter gourd. However, the variation in the crop yields and application rate of nitrogen are associated with the regional and environmental variation particularly associated with the soil fertility status.

Conclusions

It was observed that that fruit yield ha^{-1} was mainly contributed by improved length of fruits, average fruit weight, number of fruits $vine^{-1}$ and fruit weight $vine^{-1}$and differences in all the above characters between 150 kg and 125 kg nitrogen dose were non-significant ($P>0.05$) and significant when compared with rest of the treatments and control. It was concluded that 125 kg nitrogen was considered as an optimum level for achieving economically maximum fruit yield ha^{-1}.

Authors' contributions

Conceived and designed the experiments: M Jan & FM Bangulzai, Performed the experiments: M Jan & FM Bangulzai, Analyzed the data: N Ahmed, Contributed reagents/ materials/ analysis tools: M Yaqoob, N Sadiq, S Ullah & A Qadir, Wrote the paper: FM Bangulzai & M Jan.

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