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Response of nitrogen levels on the growth and yield of bottle gourd varieties

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Abstract

A field trial was carried out to assess the response of various nitrogen (N) levels on the growth and yield of bottle gourd varieties. Two varieties (Anmol and Long Green) were evaluated for their yield performance on six N levels (0, 50, 75, 100, 125 and 150 kg N ha^{-1}). The experiment was conducted in a three replicated randomized complete block design with two factorial arrangements. The results revealed that all the characters examined in this study were significantly affected by different N levels ($P<0.05$. The highest N level of 150 kg ha^{-1} produced greatest values for all the evaluated traits as compared to control. The results further demonstrated that there was a simultaneous reduction in the values of all the parameters studied under nitrogen levels of 100, 75, 50 kg ha^{-1} and control remained the least. Across N application rates, Bottle gourd varieties significantly varied from each other for their various parameters. As compared to Anmol, long green produced largest values for all the traits investigated. Long green produced 240 cm vine length, 4.08 branches $vine^{-1}$, 7.35 fruits $vine^{-1}$, 484.39 g single fruit weight, 2360 g weight of fruits $vine^{-1}$. In contrast, Anmol showed lowest values and produced 220.44 cm vine length, 3.76 branches $vine^{-1}$, 5.91 fruits $vine^{-1}$, 428.39 g single fruit weight, 2490 g weight of fruits $vine^{-1}$. The current study concluded that the bottle gourd variety long green should be grown with N application at 150 kg ha^{-1}.

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Introduction

Bottle gourd, *Lagenaria siceraria* is one of the most important vegetables grown worldwide. Due to its crisp, soft, and tasty fruits, it is equally liked by rich and poor people (Ram *et al.*, 2006). The composition of immature fruits of bottle gourd per 100 g of fresh edible portion consists of water 93.9 g, energy 88 kJ (21 kcal), protein 0.5 g, fat 0.1 g, carbohydrate 5.2 g, fiber 0.6 g, a 44 mg, P 34 mg, Fe 2.4 mg, β-carotene 25 µg, thiamin 0.03 mg, niacin 1.2 mg, ascorbic acid 10 mg. The leaves per 100 g of fresh edible portion comprises: water 83.7 g, energy 180 kJ (43 kcal), protein 4.4 g, fat 0.3 g, carbohydrate 8.3 g, fiber 1.8 g, a 560 mg, P 88 mg, Fe 7.4 mg.

Bottle gourd needs a well-distributed rainfall of 600-1500 mm and is adopted to semi-arid conditions. The optimum temperature for germination is 20–25°C; however, the germination rate declines below 15°C and above 35°C. It tolerates low temperatures, but if the temperature drops below 10°C, flowering is often reduced, due to its intolerance to frost. Low temperature and drought lead to flower and fruit abortion. Bottle gourd grows in a wide range of soils, but prefers well-aerated, fertile soils with pH 6-7 (Chungheddon *et al.*, 1999).

Soils used for crop production are severely deficient of essential nutrient elements due to continuous cropping and numerous other reasons. Nitrogen deficiency is probably the most common nutritional problem affecting plant growth and development worldwide. Nitrogen strongly stimulates growth, expansion of the crop canopy and interception of solar radiation (Milford *et al.*, 2000). Efficient use of nitrogen plays a major role in successful crop production. Nitrogen is an important determinant in growth and development of plants and has a major role in chlorophyll, protein, nucleic acid, hormones and vitamin synthesis and also helps in cell division, cell elongation (Silberbush, 2002). Nitrogen is also a major element of nucleic acid, co-enzymes and membranes and it is involved in many metabolic processes viz., cell division, photosynthesis, protein synthesis and expansion of shoot and root growth in plants and has an active role during vegetative growth (Tripathy *et al.*, 1993). Patil *et al.* (1996) recommended that nitrogen at the rate of 100 g plant^{-1} may be applied to bottle gourd for better growth and development. Effect of N on the growth and yield of Bottle gourd has been well documented. Patil *et al.*, (1998) applied 150 kg N, 50 kg P and 50 kg K and found a significant effect on the growth and development of fruits. Singh and Chonkar (1996) applied 150 kg N ha^{-1} and recorded the highest vegetative growth of plants, including vine length, number of branches compared to lower doses of 50 and 100 kg ha^{-1}. Umamaheshwarappa *et al.*, (2003) reported that significantly higher fruit yield recorded with the application of 120 kg nitrogen ha^{-1} compared to control Umamaheswarappa *et al.*, (2009) further suggested dose of 120 kg N ha^{-1} for highest yield.

Keeping in view the significant importance of nitrogen on the plant growth and productivity, the present study was conducted to evaluate the response of nitrogen levels on the growth and yield of bottle gourd varieties under agro- climatic conditions of TandoJam.

Materials and methods

Experimental Layout

The study was conducted out to evaluate the response of N levels on the growth and yield of bottle gourd varieties in the experimental area of Department of Horticulture, Sindh Agriculture University Tandojam. The experiment was laid out in a three replicated randomized complete block design keeping net plot size of 5 m x 5 m (25 m^2).

Seed bed preparation and sowing of seeds

The soil was initially plowed with disc plow to remove the hard pan and then disc harrow was operated. When the land was ploughed up, the clods were crushed, and leveling was done to make the soil surface leveled for uniform distribution of irrigation water. After preparation of a land, seed beds were prepared at the distance of 200 cm and seeds were sown at a distance of 100 cm. Seeds were sown on 27th February, 2013, using 3-4 seeds in each hole and thinning was done after the establishment of the

seedlings and one seedling was maintained in each hole.

N levels and assessment of traits

The treatments included two varieties (Long green and Anmol) and six N levels viz 0-50-75-100-125-150 N kg ha^{-1}. Nitrogen was applied in the form of urea at different levels. A constant dose of phosphorus (P) 100 kg ha^{-1} in the form of Di-ammonium phosphate and Potassium (K) 75 kg ha^{-1} in the form of sulphate of potash (SOP) were also applied. Full dose of P and K along with 1/3rd of N was applied at the time of sowing. The remaining N was applied in two equal split doses and was added to the soil three weeks after sowing and a month later. Each application of fertilizer was immediately followed by irrigation. The experimental fields were kept clean, and a periodical weeds removal practice was carried out to avoid any possible constraint during the experimental process. Thus, all the cultural practices were performed uniformly in all the plots, according to the crop requirement. The data were recorded on the following parameters; Vine length (cm), Number of branches vine^{-1}, Number of fruits vine^{-1}, Single fruit weight (g), Weight of fruits vine^{-1} (g).

Statistical analysis

The data so collected were tabulated replication-wise on the basis of five randomly selected plants and then averages were worked out. Statistical analysis of the data was done to discriminate the superiority of treatment means, using L.S.D (Least Significant Differences) test, as per the statistical methods developed by Gomez and Gomez (1984). All the statistical tests were performed by using MSTAT-C Computer Software.

Results

Vine length (cm)

The analysis of variance demonstrated that increasing N levels and varieties had significant (P<0.05) effect on vine length. The results revealed that vine length was significantly (P<0.05) highest 261.50 cm when N was applied at the rate of 150 kg ha^{-1} followed by 125 and 100 kg N ha^{-1} with an average vine length of 248.00 and 239.33 cm, respectively (Table 1). However, the minimum vine length of 182.17 cm was found in control. In varieties, the vines of the variety Long Green were longer (240.00 cm) than Anmol (220.44 cm). The interactive effect of 150 kg ha^{-1} N × variety "Long Green" resulted in a maximum vine length (272.67 cm) and interaction of Control N × variety Anmol resulted in a minimum vine length (174.33 cm). It was observed that each increased N level showed a linear and significant effect on vine length.

Table 1. Vine length (cm) of bottle gourd varieties influenced by different N levels.

Nitrogen levels	Varieties		Mean
	Anmol	Long green	
T_1 = Control	174.33	190.00	182.17 F
T_2 = 50 kg ha^{-1}	214.67	234.00	224.33 E
T_3 = 75 kg ha^{-1}	217.00	236.33	226.67 D
T_4 = 100 kg ha^{-1}	229.00	249.67	239.33 C
T_5 = 125 kg ha^{-1}	237.33	258.67	248.00 B
T_6 = 150 kg ha^{-1}	250.33	272.67	261.50 A
Mean	220.44 B	240.00 A	-

Values followed by same letters do not differ significantly at 0.05 probability level.

	N levels (F)	Varieties (V)	F x V
S.E.±	2.2332	1.2894	3.1583
LSD 0.05	4.6315	2.6740	-
LSD 0.01	6.2950	3.6344	-
CV%	1.68		

Number of Branches vine^{-1}

The number of branches vine^{-1} were significantly affected by various N levels and varieties, while the effect of interaction between nitrogen levels × varieties on this trait was non-significant (P>0.05). Maximum branches (4.49) were obtained from plots given N at the rate of 150 kg ha^{-1}, followed by 125 and 100 kg N ha^{-1} with 4.21 and 4.06 branches vine^{-1}, respectively (Table 2). However, the lowest number of branches vine^{-1} (3.10) was noted in the control where N was not applied. In case of varieties, Long green produced more branches vine^{-1} (4.08) compared to Anmol which produced (3.76). The study further showed that the interactive effect of 150 kg ha^{-1} N × variety Long green resulted in maximum branches vine^{-1} (4.64) and interaction of Control N × variety Anmol produced minimum branches vine^{-1} (2.96). It was further noted that with increasing N levels, the

number of branches vine^{-1} was simultaneously improved in a linear and significant ($P<0.05$) manner.

Table 2. Number of branches vine^{-1} of bottle gourd varieties influenced by different N levels.

Nitrogen levels	Varieties		Mean
	Anmol	Long green	
T_1 = Control	2.96	3.24	3.10 F
T_2 = 50 kg ha^{-1}	3.64	3.97	3.81 E
T_3 = 75 kg ha^{-1}	3.69	4.02	3.85 D
T_4 = 100 kg ha^{-1}	3.89	4.24	4.06 C
T_5 = 125 kg ha^{-1}	4.03	4.39	4.21 B
T_6 = 150 kg ha^{-1}	4.34	4.64	4.49 A
Mean	3.76 B	4.08 A	-

Values followed by same letters do not differ significantly at 0.05 probability level.

	N levels (F)	Varieties (V)	F x V
S.E.±	0.6599	0.0346	0.0847
LSD 0.05	0.1241	0.0717	-
LSD 0.01	0.1687	0.0974	-
CV%	1.68		

Number of Fruits vine^{-1}

The analysis of variance illustrated significant effect of various N levels and varieties on the number of fruit vine^{-1}, while the interactive action of N levels × varieties did not affect this trait significantly ($P>0.05$). The fruits vine^{-1} were significantly higher (7.75) when N was applied at the rate of 150 kg ha^{-1}, followed by 125 and 100 kg N ha^{-1} with 7.41 and 7.03 fruits vine^{-1}, respectively (Table 3). However, the lowest number of fruits vine^{-1} of (4.47) was obtained in control where N was not applied. In varieties, Long Green produced more fruits vine^{-1} (7.35) than Anmol (5.91). The interactive effect of 150 kg ha^{-1} N × variety Long green produced maximum fruits vine^{-1} (8.35) and interaction of Control N × variety Anmol produced minimum fruits vine^{-1} (3.11).

Table 3. Number of Fruits vine^{-1} of bottle gourd varieties influenced by different N levels.

Nitrogen levels	Varieties		Mean
	Anmol	Long green	
T_1 = Control	3.11	5.83	4.47 D
T_2 = 50 kg ha^{-1}	5.71	7.15	6.43 C
T_3 = 75 kg ha^{-1}	6.16	7.23	6.69 B
T_4 = 100 kg ha^{-1}	6.43	7.63	7.03 B
T_5 = 125 kg ha^{-1}	6.91	7.91	7.41 A
T_6 = 150 kg ha^{-1}	7.15	8.35	7.75 A
Mean	5.91 B	7.35 A	-

Values followed by same letters do not differ significantly at 0.05 probability level.

	N levels (F)	Varieties (V)	F x V
S.E.±	0.3212	0.1854	0.4542
LSD 0.05	0.6661	0.3846	-
LSD 0.01	0.9054	0.5227	-
CV%	8.39		

Single fruit weight (g)

The single fruit weight showed significant difference for different N levels and varieties. However, the effect of interaction between N levels × varieties showed non- significant difference for this trait. The maximum single fruit weight (729.17 g) was obtained, when N was applied at the rate of 150 kg ha^{-1}, followed by 588.00 and 477.33 g single fruit weight, respectively under the N level of 125 and 100 kg N ha^{-1} (Table 4). On the contrary, control plot showed the lowest values (158.33 g) for this trait. In case of varieties, Long green produced higher single fruit weight (484.39 g) on average than Anmol (428.39 g). The interactive effect of 150 kg ha^{-1} N × variety showed that Long green produced maximum single fruit weight (783.33 g) while Anmol produced minimum single fruit weight (150.33 g) at control.

Table 4. Single fruit weight (g) of bottle gourd varieties influenced by different N levels.

Nitrogen levels	Varieties		Mean
	Anmol	Long green	
T_1 = Control	150.33	168.33	158.33 F
T_2 = 50 kg ha^{-1}	344.00	385.33	364.67 E
T_3 = 75 kg ha^{-1}	396.00	443.678	419.83 D
T_4 = 100 kg ha^{-1}	450.33	504.33	477.33 C
T_5 = 125 kg ha^{-1}	554.67	621.33	588.00 B
T_6 = 150 kg ha^{-1}	675.00	783.33	729.17 A
Mean	428.39 B	484.39 A	-

Values followed by same letters do not differ significantly at 0.05 probability level.

	N levels (F)	Varieties (V)	F x V
S.E.±	14.502	8.3727	20.509
LSD 0.05	30.075	17.364	-
LSD 0.01	40.878	23.601	-
CV%	8.39		

Weight of fruits vine^{-1} (g)

The data shown in (Table 5) indicated that both the factors viz. N levels and varieties had highly significant effect on fruit weight, while the interactive effect of N levels × varieties showed non-significant

difference (P>0.05) for this trait. The highest weight of fruits vine^{-1} (3630 g) was achieved from the plots fertilized with N at the rate of 150 kg ha^{-1}. However, the lowest weight of fruit vine^{-1} of 1.08 kg was obtained from control where no fertilizer was applied. In varieties, "Long green" produced maximum weight of fruits compared to Anmol. The interactive effect of N levels × variety showed that the maximum weight of fruit vine^{-1} (3710 g) was obtained from Long green at the level of 150 kg ha^{-1}. It was further observed that there was a consecutive increase in weight of fruits vine^{-1} with each increment in the N levels.

Table 5. Weight of fruits vine^{-1} (g) of bottle gourd varieties influenced by different N levels.

Nitrogen levels	Varieties		Mean
	Anmol	Long green	
T_1 = Control	1050	1120	1080 F
T_2 = 50 kg ha^{-1}	1980	2100	2040 E
T_3 = 75 kg ha^{-1}	2430	2570	2500 D
T_4 = 100 kg ha^{-1}	2750	2920	2830 C
T_5 = 125 kg ha^{-1}	3190	3390	3290 B
T_6 = 150 kg ha^{-1}	3550	3710	3630 A
Mean	2490 B	2630 A	-

Values followed by same letters do not differ significantly at 0.05 probability level.

	N levels (F)	Varieties (V)	F x V
S.E.±	94.000	54.20	132.90
LSD 0.05	194.80	112.50	-
LSD 0.01	264.80	152.90	-
CV%	6.34		

Discussion

N is the key element for plant growth and development (Wakene Negassa, 2001). In the past, N fertilization has significantly increased the yield of crops, however excessive use of the N in crop cultivation caused severe environmental pollution due to nitrate leaching and nitrous oxide emission to the atmosphere. (Ron and Johnson, 1999), therefore, its optimum use needs to be analyzed critically. Thus, present study was carried out to assess the response of various N levels on the growth and yield of bottle gourd varieties. Available evidences indicate that N is necessary for photosynthesis and affects vegetative and reproductive growth of the plants (Fageria and Baligar, 2005). In line to above pronounced effect of N in plant nutrition, the current study witnessed enhanced growth and development of both vegetative and yield attributed traits, including vine length, number of branches vine^{-1}, number of fruits vine^{-1}, weight of single fruit, weight of fruits vine^{-1} under ample N nutrition. Similar results have been found by Umamaheshwarappa *et al.*, (2003) who reported significantly higher fruit yield with the application of increasing N levels compared to control. Similarly, Baloch (2012) reported that higher N levels improved the bottle vine growth and fruit yield remarkably. Number of branches vine^{-1} is a main and key trait that affects the number of fruits. In the present study, maximum number of branches have been recorded under higher N levels. More branches under higher N levels were mainly associated with a total vine length that ultimately affects the branches in a vine. The finding is agreement to that of Chonkar (1996) who reported that increasing N level produced a greater vine length and number of branches compared to lower doses. Number of fruits, weight of single fruit and fruit vine-^{1} are the main traits that determine the final yield. In the present study, there was a significant increase in the values of these parameters at higher N level. The greater values of these traits under higher N levels might be due to increased vine length, more branches vine^{-1} that eventually influence these parameters significantly. The results of the present study are further supported by Patil *et al.*, 1996, Umamaheswarappa *et al.,* (2008), Bairwa and Khandelwal (2010). These authors reported that higher level of N significantly increased the number of fruits, fruit weight and fruit yield vine^{-1}. In the current study, Long green comparatively produced higher values for all the traits investigated as compared to Anmol. This reflects that naturally Long green had got potential for better uptake and utilization of N that ultimately influence the final yield.

Conclusion

It is concluded that bottle gourd vines fertilized with N at the rate of 150 kg ha^{-1} resulted in superior performance for all the traits examined as compared to other N levels. In varieties Long green showed better performance as compared to Anmol. Hence, bottle gourd variety long green should be grown with N application at 150 kg ha^{-1}.

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