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REQUIREMENT OF N, P, K, AND S FOR YIELD MAXIMIZATION OF BITTER GOURD (*Momordica charantia*)

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Abstract

Experiments were carried out at the research field of Horticulture Research Centre, BARI, Joydebpur during kharif seasons of 2010 and 2011 to find out the requirement of N, P, K, and S application for obtaining higher yield of bitter gourd (var. BARI Karola-1). There were 14 treatment combinations comprising four levels each of N (0, 90, 20,150 kg/ha), P (0, 20, 40, 60 kg/ha), K (0, 40, 80, 120 kg/ha), and S (0, 20, 30, 40 kg/ha). A blanket dose of 2 kg B, 4 kg Zn, and 5 ton cowdung/ha was used. The maximum fruits/plant, fruit size, and single fruit weight and yield of bitter gourd was achieved from the treatment N_{120} P_{40} K_{80} S_{30} kg/ha and the lowest from the control treatment. The yield benefit for the best treatment over the control was 208% in 2010 and 137% in 2011. Response to N and P was more pronounced in comparison to K and S. The yield increased linearly with increasing rates of N up to 120 kg/ha, P up to 40 kg/ha, K up to 80 kg/ha, and S up to 30 kg/ha and thereafter decreased. The highest gross margin (Tk. 486867/ha) and marginal rate of return (8083%) was also obtained from the same treatment. Overall results reveal that application of N_{120} P_{40} K_{80} S_{30} kg/ha along with a blanket dose of 2 kg B, 4 kg Zn and 5 ton cowdung/ha appears to be the best treatment for maximizing the yield of bitter gourd in Grey Terrace Soil (AEZ-28) of Joydebpur.

Keywords: Yield maximization, bitter gourd, requirement of NPK, and S.

Introduction

Bitter gourd (*Momordica charantia*) known as bitter melon, bitter squash or karela, is one of the most popular vegetables in Bangladesh for its nutritive and medicinal values (Nadkarni, 1982). It is rich in vitamin C (88 mg/100g) (Akter *et al.*, 2009). Bitter gourd is widely cultivated in this country during kharif season. The yield of bitter gourd is low which can be attributed to lack of improved varieties, imbalanced use of fertilizers, disease, insect infestation, and inadequate irrigation. Of these factors, proper fertilizer management and use of good varieties can improve the situation greatly (Tindall, 1983). Application of 184 kg N, 112 kg P_2O_5, and 124 kg K_2O/ha gave significant yield of bitter gourd (Palama and Chang, 2003). There is a great possibility to improve its production and quality through proper nutrient management. The present study was, therefore,

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undertaken to find out the proper combination of fertilizer nutrients (NPKS) for higher and sustainable yield of bitter gourd.

Materials and Method

The experiment was carried out at the research field of Horticulture Research Centre, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during kharif seasons of 2010 and 2011. The soil belongs to Chhiata series of Grey Terrace Soil (Aeric Albaquept) under AEZ-28. Characteristically, the soil was silt loam having 6.5 pH, 0.55 % organic matter, 0.028% N, 7.1 mg/kg P, 0.14 me % K, 10 mg/kg S, 0.94 mg/kg Zn, and 0.1 mg/kg B contents.

There were 14 treatment combinations comprising four levels each of N (0, 90,120,150 kg/ha), P (0, 20, 40, 60 kg/ha), K (0, 40, 80, 120 kg/ha), and S (0, 20, 30, 40 kg/ha). A blanket dose of 5 ton cowdung/ha, 2 kg B and 4 kg Zn/ha was used. The treatment combinations are shown in Table 1. The field experiment was laid out in a randomized complete block design with three replications. The unit plot size was 4m x 4m. Variety BARI Karola-1 was used in this trial. Urea, TSP, MoP, gypsum, zinc sulphate, and boric acid were used as sources of N, P, K, S, Zn, and B, respectively. The whole amount of P, S, B, Zn, cowdung, and 50% K were applied and mixed up with the soil during final pit preparation. Twenty five days old seedlings were transplanted on 5 March with 1m x 1m spacing in both the years. Only one plant was planted into a pit. One-third of N was applied around the plants after 15 days of transplanting. Half of K and second installment of 1/3 N was top dressed at flower initiation stage by ring placement method. The remaining 1/3 N was applied to the plants at fruiting stage. Irrigation, insect control, and other intercultural operations were done as and when required. Plants were provided with support by bamboo stick before flowering. Young bitter gourd fruits were harvested time to time starting from the beginning of May until end of June. Data on the yield and yield attributes of bitter gourd were collected. The data were statistically analyzed using MSTAT-C programme and the significance of differences between pair of means was tested by Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984). Partial budget and marginal analysis of undominated fertilizer responses on bitter gourd were done following the method suggested by Elias and Karim (1984).

Results and Discussion

Significant variation in fruits/plant, fruit size, single fruit weight, and yield/ha were observed due to execution of different treatments (Table 1). Plants grown with no application of fertilizer and manure (control) produced significantly lower number of fruits/plant compared to others. The maximum number of fruits/plant was found in treatment $N_{120}P_{40}K_{80}S_{30}$ and it was

Table 1.Yield and yield contributing characters of bitter gourd as affected by different levels of N, P, K, and S application in two years.

Treatment (kg/ha)	Fruits/plant (no.)		Fruit size (cm)				Single fruit wt (g)		Yield (t/ha)	
			Length		Diameter					
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
N_0 P_{40} $K_{80}S_{20}$	18de	19g	12.3f	14.3g	4.0c	4.6f	74.30h	116.01g	10.00f	11.58h
N_{90} P_{40} K_{80} S_{20}	20d	22f	12.9e	15.5f	4.0c	4.9e	80.25g	126.86ef	13.69d	13.68fg
N_{120} P_{40} K_{80} S_{20}	28ab	29b	16.6a	17.6a	5.2a	5.5a	128.32b	143.11b	18.56b	17.85b
N_{150} P_{40} K_{80} S_{20}	26bc	26d	13.3d	15.4f	4.7b	5.2d	94.93e	136.78bcd	16.08c	15.85cd
$N1_{20}$ P_0 K_{80} S_{20}	20d	23ef	12.9e	16.2e	4.2bc	5.2d	73.58h	120.82eg	12.21e	12.54gh
N_{120} P_{20} K_{80} S_{20}	23 c	27cd	13.4d	16.8c	4.5b	5.3c	85.04f	133.56cde	14.21d	14.95de
N_{120} P_{60} K_{80} S_{20}	26bc	29b	13.8c	17.3b	5.3a	5.4b	108.48c	141.28bc	17.92b	16.66c
N_{120} P_{40} K_0 S_{20}	25c	24e	14.0c	16.0e	4.6b	5.2d	80.43g	130.27de	14.07d	13.65fg
N_{120} P_{40} K_{40} S_{20}	28ab	26d	15.5b	16.6cd	5.2a	5.2d	104.68d	137.68bcd	15.80c	15.68cd
N_{120} P_{40} K_{120} S_{20}	20d	26d	12.0f	17.2b	4.1c	5.3c	80.57g	141.65bc	16.43c	16.84c
N_{120} P_{40} K_{80} S_0	24c	28bc	11.0f	16.5d	4.0c	5.3c	75.0h	137.26bcd	14.07d	14.27ef
N_{120} P_{40} K_{80} S_{30}	30a	33a	16.8a	17.6a	5.5a	5.5a	132.20a	156.41a	19.90a	20.15a
N_{120} P_{40} K_{80} S_{40}	26bc	27cd	15.6b	17.1b	5.0b	5.2d	130.0a	151.82a	16.52c	16.68c
Native nutrient (Control)	16e	11h	10.9g	17.7h	3.5d	4.3g	62.24i	72.62 h	6.47g	8.50i
CV (%)	7.0	4.9	4.5	4.8	3.9	3.3	6.2	4.0	9.2	6.2

Means having same letter(s) do not differ significantly at 5% level of probability.

statistically different from all other treatments. Fruit size significantly differed among the treatments. The longest fruit was observed in treatment $N_{120}\,P_{40}\,K_{80}\,S_{30}$ followed by that from $N_{120}\ P_{40}\ K_{80}\ S_{20}$ in both the years and these were significantly different from all other treatments. The shortest fruit was obtained in control plot. The maximum diameter was found in the treatment $N_{120}\ P_{40}\ K_{80}\ S_{30}$ and it was statistically similar with the treatments $N_{120}\,P_{40}\,K_{80}\,S_{20}$, $N_{120}\ P_{60}\,K_{80}\ S_{20}$ and $N_{120}\ P_{40}\ K_{40}\ S_{20}$ in 2010. During 2011, treatments $N_{120}P_{40}K_{80}S_{30}$ and $N_{120}\ P_{40}\ K_{80}\ S_{20}$ gave statistically similar fruit diameter, which was significantly different from rest of the treatments. The minimum diameter of bitter gourd was recorded in control treatment. Application of chemical fertilizer also increased the single fruit weight, which was the highest with $N_{120}\,P_{40}\,K_{80}\,S_{30}$ treatment and it was statistically identical with treatment $N_{120}\,P_{40}\,K_{80}\,S_{40.}$ These two treatments were significantly different from all other treatments in both the years. The lowest fruit weight was noted in control plot.

The fruit yield/ha of bitter gourd was significantly influenced by different treatment combinations (Table 1). Fertilizer application in general increased fruit yield from 6.47 to 19.90 t/ha in 2010 and 8.50 to 20.15 t/ha in 2011. The highest yield (19.90 t/ha in 2010 and 20.15 t/ha in 2011) was obtained from $N_{120}\,P_{40}\,K_{80}\ S_{30}$ treatment and it was significantly different from all other treatments. Sanap *et al.* (2010) reported that application of 250 kg N, 50 kg P_2O_5 and 100 kg K_2O/ha significantly increased the yield of bitter gourd in India. Islam and Irabangon (1994) also observed that application of 240-120-60-kg NPK/ha markedly improved the number of fruiting and yield of bitter gourd. Rajan and Markose (2005) reported that the maximum fruit set and yield were obtained with 90: 25:50 kg NPK/ha. The maximum yield/ha produced by $N_{120}\,P_{40}\,K_{80}\,S_{30}$ treatment was mainly due to cumulative effects of number of fruits/plant, fruit size, and fruit weight. The experimental soil was highly deficient in different nutrients. So, the application of different nutrients to the soil resulted in the highest uptake by plants which ultimately helped increase production of assimilates that causes higher fruit size and yield. Plants grown without added fertilizer (native nutrient) produced the lowest yield (6.47 t/ha in 2010 and 8.50 t/ha in 2011).

The yield increase over control due to single effect of NPK and S are shown in Table 2. Nitrogen application up to 120 kg/ha increased yield significantly and thereafter decreased. Application of 120 kg N/ha increased yield of bitter gourd by 86% in 2010 and 54% in 2011 over the control. Yield of bitter gourd also increased significantly due to application of P up to 40 kg/ha and further increase in P decreased the yield. Fertilization with K also followed the same response on yield (Table 2). The yield varied from 14.07 to 18.56 t/ha in 2010 and 13.65 to 17.85 t/ha in 2011 due to different levels of K application. Yield of bitter gourd also increased with the increase rate of S up

to 30 kg/ha and then decreased. The result indicates that the yield increased with the increase of N, P, K, and S application up to certain limit. Effect of N and P was distinct in comparison to K and S.

Table 2. Single effect of N, P, K, and S application on the yield of bitter gourd in two years.

Nutrients levels (kg/ha)	Yield (t/ha)		% yield increase over control	
N levels	**2010**	**2011**	**2010**	**2011**
0	10.00	11.58	-	-
90	13.69	13.68	37	18
120	18.56	17.85	86	54
150	16.08	15.85	61	37
P levels				
0	12.21	12.54	-	-
20	14.21	14.95	16	19
40	18.56	17.85	52	42
60	17.92	16.66	47	33
K levels				
0	14.07	13.65	-	-
40	15.80	15.68	12	15
80	18.56	17.85	32	31
120	16.43	16.48	17	21
S levels				
0	14.07	14.27	-	-
20	18.56	17.85	32	25
30	19.90	20.15	41	41
40	16.52	16.68	17	17

Economic evaluation

Gross return was calculated from the price of bitter gourd. Costs that vary were calculated from the cost involved for fertilizer used for the experimental treatments. The partial budget analysis of fertilizer revealed that the maximum gross margin/ha was achieved with the treatment combination N_{120} P_{40} $K_{80}S_{30}$ (Table 3). Dominance analysis shows that treatments N_0 P_{40} K_{80} S_{20}, N_{90} P_{40} K_{80} S_{20}, N_{150} P_{40} K_{80} S_{20}, N_{120} P_{60} K_{80} S_{20}, N_{120} P_{40} K_{120} S_{20}, N_{120} P_{40} K_{80} S_0 and N_{120} P_{40} K_{80} S_{40} were cost dominated. Marginal analysis shows that the highest marginal rate of return of 8083 (%) was obtained when the crop was fertilized with N_{120} P_{40} K_{80} S_{30} treatment (Table 4). Hence, application of fertilizer at the rate of N_{120}

P_{40} K_{80} S_{30} kg/ha would be economical for bitter gourd production in Grey Terrace Soil (Aeric Albaquept) of Joydebpur, Gazipur.

Table 3. Partial budget and dominance analysis for different fertilizer response data of bitter gourd (pooled data of 2010 and 2011).

Treatment (kg/ha)	Gross return (Tk/ha)	Costs that vary* (Tk/ha)	Gross margin (Tk/ha)	Remarks
N_0 P_{40} $K_{80}S_{20}$	269750	10071	259675	Cost dominated
N_{90} P_{40} K_{80} S_{20}	342125	124191	217934	Cost dominated
N_{120} P_{40} K_{80} S_{20}	455125	13202	441923	Cost undominated
N_{150} P_{40} K_{80} S_{20}	399125	13984	385141	Cost dominated
N_{120} P_0 K_{80} S_{20}	309375	8402	300973	Cost undominated
N_{120} P_{20} K_{80} S_{20}	364500	10802	353698	Cost undominated
N_{120} P_{60} K_{80} S_{20}	432250	15602	416648	Cost dominated
N_{120} P_{40} K_0 S_{20}	346500	9042	337458	Cost undominated
N_{120} P_{40} K_{40} S_{20}	393500	11522	381978	Cost undominated
N_{120} P_{40} K_{120} S_{20}	415875	15282	400593	Cost dominated
N_{120} P_{40} K_{80} S_0	354250	12091	342159	Cost dominated
N_{120} P_{40} K_{80} S_{30}	500625	13758	486867	Cost undominated
N_{120} P_{40} K_{80} S_{40}	415000	14313	400687	Cost dominated
Native nutrient (Control)	187125	0	187125	Cost undominated

* Only fertilizer cost considered

Table 4. Marginal analysis of undominated fertilizer response data of bitter gourd (pooled data of 2010 and 2011).

Treatment (kg/ha)	Gross return (Tk/ha)	Costs that vary (Tk/ha)	Marginal increase in gross margin (Tk/ha)	Marginal increase in costs that vary (Tk/ha)	Marginal rate of return (%)
N_{120} P_{40} K_{80} S_{30}	486867	13758	44944	556	8083
N_{120} P_{40} K_{80} S_{20}	441923	13202	59945	1680	3568
N_{120} P_{40} K_{40} S_{20}	381978	11522	28280	720	3928
N_{120} P_{20} K_{80} S_{20}	353698	10802	16240	1760	923
N_{120} P_{40} K_0 S_{20}	337458	9042	36485	640	5701
N_{120} P_0 K_{80} S_{20}	300973	8402	113848	8402	1355
Native nutrient (Control)	187125	0	-	-	-

Conclusion

Two years' results indicate that balanced fertilizer can play a key role in harnessing the production of bitter gourd. Application of N_{120} P_{40} K_{80} S_{30} kg/ha along with a blanket dose of 2 kg B, 4 kg Zn, and 5 ton cowdung/ha appeared as the best combination and economically optimum for maximizing the yield of bitter gourd in Grey Terrace Soil (Aeric Albaquept) under AEZ-28.

References

Akter, L., M. S. Islam, M. N. Uddin and S. Ahmed. 2009. Evaluation of New Bitter Gourd Germplasum. Research Report, 2008-2009. Horticulture Research Centre, BARI, Gazipur.p.16

Elias, S.M. and R. Karim. 1984. Application of partial budget technique in cropping system research at Chittagong. AEER No. 10 April, Econ. Div., BARI, Gazipur, Bangladesh. Pp. 75-81.

Gomez, K. A. and A. A. Gomez. 1984. Statistical Procedure for Agricultural Research. Second edition, John Willey & Sons, Inc. Singapore. P. 680.

Islam, M. S. and J. A. Irabangon. 1994. Influence of different levels of NPK on the growth, fruit and seed yield and quality of bitter gourd *(Momordica charantia). CLSU Sci. J.* **15**(1): 37-42.

Nadkarni, A. K. 1982. Indian Meteria Medica. Publ. Popular Prakashan PVT. Ltd., Bombay. **1:** 805-7.

Palama, M. C. and L. C. Chang. 2003. International Cooperators Guide: Suggested Cultural Practices for Bitter Gourd. AVRDC Pub. No. 03-547.

Rajan, S. and B. L. Markose. 2005. Text Book of Vegetables, Tuber Crops and Spices: Cucurbitaceous vegetable. Directorate of Information and Publications of Agriculture, ICAR, New Delhi, India. P. 284.

Sanap, K. S., S.D. Warade, P. B. Sanap, S. R. Barkule and G.R. Pandhre. 2010. Effect of N, P, and K on growth and yield of bitter gourd *(Momordica charantia). J. Life Sci.* **7**(2): 184-185.

Tindall, H. D. 1983. Vegetables in the Tropics. McMillan Press, United Kingdom. P. 533.