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REQUIREMENT OF DIFFERENT NUTRIENTS FOR YIELD MAXIMIZATION OF BT BRINJAL

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Abstract

The experiment was conducted at Agronomy field of Bangladesh Agricultural Research Institute, Gazipur during 2016-2017 and 2017-2018 to determine the nutrient requirement for yield maximization of Bt brinjal (var. BARI Bt Begun-2). The treatments were T_1= STB (soil test base) recommendation (120-36-90-15-2-1 kg/ha N-P-K-S-Zn-B+ 3 t/ha poultry manure), T_2 = T_1 + 25% of N-P-K-S-Zn-B (150-45-112-18-2.5-1.25 kg/ha N-P-K-S-Zn-B +3 t/ha poultry manure), T_3= T_1 + 50% of N-P-K-S-Zn-B (180-54-135-22-3-1.50 kg/ha N-P-K-S-Zn-B +3 t/ha poultry manure), T_4= T_1 + 25% of N-P-K-S-Zn-B + 3 t/ha poultry manure (150-45-112-18-2.5-1.25 kg/ha N-P-K-S-Zn-B+6 t/ha poultry manure), T_5= T_1 + 3 t/ha poultry manure (120-36-90-15-2-1 kg/ha N-P-K-S-Zn-B + 6 t/ha poultry manure). Nutrient uptake, yield components and yield of Bt brinjal varied significantly due to variation of nutrients in the tested years. The highest plant height (98-116 cm), canopy coverage (1.21-1.26 m^2/plant), number of fruits/plant (57.69-59.23) and individual fruit weight (83-86 g) were obtained from 180-54-135-22-3-1.50 kg/ha N-P-K-S-Zn-B +3 t/ha poultry manure ($T_{3)}$ treatment where days to flowering showed the lowest values (109-110 days). The highest pooled yield (58.46 t/ha) of Bt brinjal was observed from the treatment 180-54-135-22-3-1.50 kg/ha N-P-K-S-Zn-B +3 t/ha poultry manure(T_3) and the lowest (23.39 t/ha) from 120-36-90-15-2-1 kg/ha N-P-K-S-Zn-B+ 3 t/ha poultry manure) (T_1). The highest nutrient uptake (214-43-208-60-0.38-0.213-49 kg/ha N-P-K-S-B-Ca) was also observed from the same treatment (T_3). Fruit yield showed a strong (r=0.97) linear relationship with applied nutrients. Effect of nutrient application on fruit yield of Bt brinjal was estimated about 86%. The highest gross return (Tk. 587900/ha), gross margin (Tk. 417660/ha) and benefit cost ratio (3.45) were obtained by applying 180-54-135-22-3-1.50 kg/ha N-P-K-S-Zn-B+3 t/ha poultry manure. Results revealed that application of 180-54-135-22-3-1.50 kg/ha N-P-K-S-Zn-B along with 3 t/ha poultry manure would be economically optimum for achieving higher yield of Bt brinjal grown under Grey Terrace soil (Aeric Albaquept) of Gazipur.

Keyword: Nutrient requirement, nutrient uptake, yield and Bt brinjal

Introduction

Brinjal (*Solanum melongena*) is the third most important vegetable in terms of both yield and production area in Bangladesh. Recently Bangladesh Agricultural

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Research Institute has developed four Bt brinjal varieties. It has high potentiality to boost up the yield and brinjal production of the country. Bt brinjal needs additional fertilizer than the recommended dose for proper growth and yield (Mian, 2017). Optimum nutrient dose exerts proper growth and development of crop plant contributing to better yield components and yield (Morgan and Connolly, 2013). Nutrient involves in many important metabolic *processes* in the plant system and influences the growth and development of crop plant. Recommended fertilizer dose for non Bt brinjal is generally used in Bt brinjal because of no fertilizer recommendation for Bt brinjal yet in Bangladesh (FRG, 2018). Bt brinjal produced lower yield when recommended fertilizer dose for non Bt brinjal is used in Bt brinjal (BARI, 2017). Previous field experience and observation indicated that Bt brinjal has profused bearing than non Bt brinjal. Hence, higher fertilizer dose may require for full exploitation of yield potentiality of Bt brinjal. Most of the flowering buds of Bt Brinjal are active for fruiting. Bt gene is resistance to brinjal shoot and fruit borer of Bt brinjal. Probably Bt gene is also tolerance to fungal disease development on flowering buds of Bt brinjal. Consequently, more active flowering buds produce more fruits/plant and higher yield of Bt brinjal. Higher fruit yield of Bt brinjal may require high nutrient dose as compared to recommended nutrient dose for non Bt Brinjal because of high nutrient uptake by Bt Brinjal from the soil. There is a positive relationship between yield and nutrient uptake of a crop (Masni and Wasli, 2019). On the other hand, one of the major causes of low yield of brinjal might be due to low organic matter content as well as low nutrient status of soils those has been declined over time (Mian, 2008). Application of higher dose of nutrients than at present nutrient recommendation for non Bt brinjal may improve the yield of Bt brinjal. Moreover, optimum application of nutrient provides better agronomic and economic benefits to brinjal growers. Very little information is available regarding fertilizer management in Bt brinjal. As such, there is a need to recommend the fertilizer requirement for Bt brinjal. Therefore, the experiment was undertaken to find out economic fertilizer dose for achieving high yield of Bt brinjal.

Materials and Methods

The experiment was conducted at Agronomy field of Bangladesh Agricultural Research Institute, Gazipur during 2016-2017 and 2017-2018. The soil of the experimental field is clay loam under Chhiata series. Soil samples were collected from a depth of 0-20 cm prior to application of fertilizer in both the years. Results of soil analysis are presented in Table 1. Organic matter content and total N were very low. Exchangeable K and available P, S, Zn and B were found to be below the critical level. Five treatments consist of T_1=120-36-90-15-2-1 kg/ha of N-P-K-S-Zn-B+ 3 t/ha poultry manure based on STB (FRG, 2012), T_2 = T_1 + 25% of N-P-K-S-Zn-B (150-45-112-18-2.5-1.25 kg/ha of N-P-K-S-Zn-B +3 t/ha poultry manure), T_3= T_1 + 50% of N-P-K-S-Zn-B (180-54-135-22-3-1.50 kg/ha of N-P-K-S-Zn-B +3 t/ha poultry manure), T_4= T_1 + 25% of N-P-K-S-Zn-B + 3 t/ha poultry manure (150-45-112-18-2.5-1.25 kg/ha of N-P-K-S-Zn-B+6 t/ha

poultry manure), T_5= T_1+ 3 t/ha poultry manure (120-36-90-15-2-1 kg/ha of N-P-K-S-Zn-B + 6 t/ha poultry manure). The experiment was conducted in a randomized complete block (RCB) design with three replications. Unit plot size was 6.4 m ×5.4 m. All of poultry manure, phosphorus, sulphur, zinc and boron fertilizers were applied at the time of final land preparation. Nitrogen and potassium fertilizers were applied in four equal splits at 20, 40, 60 and 80 DAT (days after transplanting) around the plant roots and mixed thoroughly with the soil. The brinjal var. BARI Bt Begun-2 was used as test crop. Thirty days old seedling was transplanted on 11 November 2016 and 16 November 2017 at a spacing of 90 cm ×80 cm. Intercultural operations such as weeding, mulching, irrigation etc. were done as per requirement. The crop was harvested from 8-12 February to 1-5 April in 2017 and 2018. Frequent rainfall (66-107 mm in February to April) at later stage affected the crop (Fig.2) and drastically reduced fruit yield. Nutrient concentration in fruit and plant tissues of Bt brinjal was analyzed following the standard laboratory procedures. Nutrient uptake was computed on the basis of dry matter accumulation of Bt Brinjal and nutrient concentration in the tissues (both fruit and plant). Correlation of yield with nutrient uptake and nutrient uptake with applied nutrients were done. Functional relationship between total applied nutrient and fruit yield of Bt brinjal were established. Nutrient from poultry manure were calculated and considered in total applied nutrient (FRG, 2012). Data on yield and other associated characters were recorded. Canopy coverage was measured by meter-stick method (Armbust, 2009). Vertical projection area of the outer most perimeter of the natural spread of foliage of plants was measured. Soil surface coverage (D=diameter of coverage of the plant) was measured at four positions of spreading margin of the plant canopy (perimeter) perpendicular to the soil surface. Randomly selected 5 plant's canopy coverage (D=diameter) was measured from each plot. Then mean value was calculated using the following formula. This measurement ($A= \pi r^2$ where, D=2r) was done at first harvesting time of fruits. Data on yield and other associated characters were recorded. Collected data was subjected to analysis of variance. Least significant difference (LSD) value was used for mean separation and treatments means were compared by LSD (0.05) (Gomez and Gomez, 1984). Cost benefit analysis was also evaluated.

Table 1. Chemical properties of the experimental soil (average of two years)

Properties	pH	OM(%)	Total N (%)	Exchangeable K (meq/100g soil)	P (ppm)	S (ppm)	Zn (ppm)	B (ppm)
Nutrient Status	6.25	1.73	0.079	0.16	8.09	9.88	0.47	0.18
Critical limit	-	C:N=10:1	0.12	0.12	10	10	0.60	0.20
Interpretation	Acidic	VL	VL	L	L	L	L	L

VL=Very low, L=Low

Table 2. Total nutrient uptake (kg/ha) by Bt Brinjal fruit and plant as influenced by nutrient level (Average of 2016-2017 and 2017-2018)

Treatment	N	P	K	S	Zn	B	Ca
T_1	85	17	65	25	0.114	0.072	19
T_2	134	28	132	32	0.231	0.132	32
T_3	214	43	208	60	0.380	0.213	49
T_4	162	35	156	41	0.288	0.158	34
T_5	127	30	77	38	0.213	0.116	29
SE(±)	6.91	3.09	7.66	3.63	0.010	0.007	3

Table 3. Yield attributes and yield of Bt brinjal as influenced by nutrient level in 201-2017 and 2017-2018

Treatment	Plant height (cm)		Canopy coverage (m^2)/plant		Days to flowering (day)		Fruits/plant (no.)		Individual fruit weight (g)		Fruits yield (t/ha)		
	2016-2017	2017-2018	2016-2017	2017-2018	2016-2017	2017-2018	2016-2017	2017-2018	2016-2017	2017-2018	2016-2017	2017-2018	Pooled
T_1	52	66	0.89	1.01	114	112	24.45	22.32	72	61	24.45	22.32	23.39
T_2	76	93	1.05	1.06	113	111	46.77	42.03	78	76	46.77	42.03	44.40
T_3	98	116	1.26	1.21	110	109	59.23	57.69	83	86	59.23	57.69	58.46
T_4	84	103	1.17	1.09	113	111	48.28	46.81	79	79	48.28	46.81	47.55
T_5	65	81	0.89	1.03	113	110	34.35	33.37	75	70	34.35	33.37	33.86
LSD $_{(0.05)}$	4.22	8.93	0.32	0.18	NS	NS	4.01	3.68	2.3	2.1	4.01	3.68	3.35
CV (%)	4.92	5.27	7.85	4.58	5.37	4.33	5.07	5.67	3.11	3.02	5.07	5.67	5.37

T_1= 120-36-90-15-2-1 kg/ha N-P-K-S-Zn-B+ 3 t/ha poultry manure
T_2 = 150-45-112-18-2.5-1.25 kg/ha N-P-K-S-Zn-B +3 t/ha poultry manure
T_3= 180-54-135-22-3-1.50 kg/ha N-P-K-S-Zn-B +3 t/ha poultry manure
T_4= 150-45-112-18-2.5-1.25 kg/ha N-P-K-S-Zn-B+6 t/ha poultry manure
T_5= 120-36-90-15-2-1 kg/ha N-P-K-S-Zn-B + 6 t/ha poultry manure

Results and Discussion

Nutrient uptake:

Uptake of N, P, K, S, Zn, B and Ca by whole plant (stem+leaves+fruit) of Bt brinjal differed among the treatments (Table 2). N uptake by both shoot and fruit varied from 85 to 214 kg/ha. The highest N uptake by whole plant occurred in the 180-54-135-22-3-1.5 kg/ha N-P-K-S-Zn-B + 3 t/ha poultry manure (T_3) treatment. Higher nutrient application into soil enhanced crop growth as well as total dry matter resulting the highest nutrient uptake from soil. Similar results were also reported by Ghosh *et al*. (2014). The uptake of N was the lowest in the treatment 120-36-90-15-2-1 kg/ha N-P-K-S-Zn-B+ 3 t/ha poultry manure (T_1) possibly due to lower availability of N coupled with lower dry matter. P, K, S, Zn, B and Ca uptake by whole plant of Bt brinjal also followed a similar pattern to that obtained for N uptake (Table 2).

Plant height and yield attributes:

Plant height and canopy coverage/plant showed significant variation among the nutrient level in both the years (Table 3). Plant height was found maximum in T_3 treatment followed by T_4 treatment and the lowest from T_1. Similar trend was also observed in the case of canopy coverage/plant. Higher nutrient level increased plant height and canopy coverage indicated better crop growth. Similar results were reported by Khanum *et.al.* (2017) in Bt Brinjal. Days to flowering did not differ significantly among the treatments in both the years. Days to flowering ranged from 109-114 days being the lowest value from T_3 treatment (Table 3). The results indicated that higher nutrient level enhanced early flowering (Ahmad *et al*., 2011; Sajid and Amin, 2014). The highest number of fruits/plant was found in T_3 treatment and it was significantly different from all other treatments. The lowest number of fruits/plant was obtained from T_1 treatment. The result indicated that higher nutrient level enhanced crop growth resulting higher fruits/plant. Similar results were reported by Sharma and Guru (2016) in brinjal. Individual fruit weight varied considerably and increased significantly in different treatments as compared to T_1. The highest fruit weight was recorded in T_3 treatment and it was significantly superior to all other treatments in both the years. Treatment T_1 produced the lowest individual fruit weight.

Fruit yield:

Application of different nutrients (higher nutrients) increased fruit yield from 24.45 to 59.23 t/ha in 2016-2017 and 22.32 to 57.69 t/ha in 2017-2018 (Table 3). The highest fruit yields (59.23 t/ha in 2016-2017 and 57.69 t/ha in 2017-2018) were obtained from T_3 treatment and it was significantly different from all other treatments. The result indicates that Bt brinjal produced higher fruit yield at higher nutrient level as it was required for exploitation of it's high yield

potentiality. The results are in agreement with the findings of Anonymous (2017) and Mian (2017). The yield advantage was achieved through greater nutrient uptake by Bt brinjal resulting increased fruits/plant and individual fruit weight which eventually increased fruit yield of Bt brinjal. Recommended nutrient level for brinjal produced lower yield of Bt brinjal in both the years. Fruit yield was significantly correlated with applied nutrients (r=0.97). Correlation of yield with nutrient uptake and nutrient uptake with applied nutrients were positive and significant (Table 4). Functional relationship between applied nutrient and fruit yield of Bt brinjal suggests that variation in yield can be attributed to the differences in applied nutrients. The result shows that higher nutrients gave higher fruit yield of Bt brinjal (Fig.1). Cost and return analysis of different treatments are presented in Table 5. Gross return (Tk. 587900/ha), gross margin (Tk. 417660/ha) and BCR (3.45) were found the highest in T_3 treatment followed by T_4 treatment and T_2 treatment. The results indicated that higher nutrient dose gave higher economic advantage.

Table 4. Correlation of yield with nutrient uptake and nutrient uptake with applied nutrients (average of 2016-2017 and 2017-2018)

Nutrient	Correlation of yield with nutrient uptake (r)	Correlation of nutrient uptake with applied nutrient (r)
N	0.98**	0.86**
P	0.95**	0.73**
K	0.98**	0.79**
S	0.89**	0.85**
Zn	0.99**	0.91**
B	0.99**	0.93**
Ca	0.97**	0.86**

** Significant at 1% level of probability

Table 5. Cost and return analysis of Bt brinjal as influenced by nutrient level (average of 2016-2017and 2017-2018)

Treatment	Gross return (Tk./ha)	Cost of cultivation (Tk./ha)	Gross margin (Tk./ha)	BCR
T_1	223200	121600	101600	1.84
T_2	420300	145920	274380	2.88
T_3	587900	170240	417660	3.45
T_4	468100	152000	316100	3.08
T_5	333700	127680	206020	2.61

Price (Tk./kg)

Urea:16.00, TSP:22.00, MOP:15.00, Gypsum:10.00, Zinc sulphate :170.00, Boric acid:200.00

Bt brinjal fruit: 9.50-10.00, Labour wage: Tk.400.00/day

T_1= 120-36-90-15-2-1 kg/ha N-P-K-S-Zn-B+ 3 t/ha poultry manure

T_2 = 150-45-112-18-2.5-1.25 kg/ha N-P-K-S-Zn-B +3 t/ha poultry manure

T_3= 180-54-135-22-3-1.50 kg/ha N-P-K-S-Zn-B +3 t/ha poultry manure

T_4= 150-45-112-18-2.5-1.25 kg/ha N-P-K-S-Zn-B+6 t/ha poultry manure

T_5= 120-36-90-15-2-1 kg/ha N-P-K-S-Zn-B + 6 t/ha poultry manure

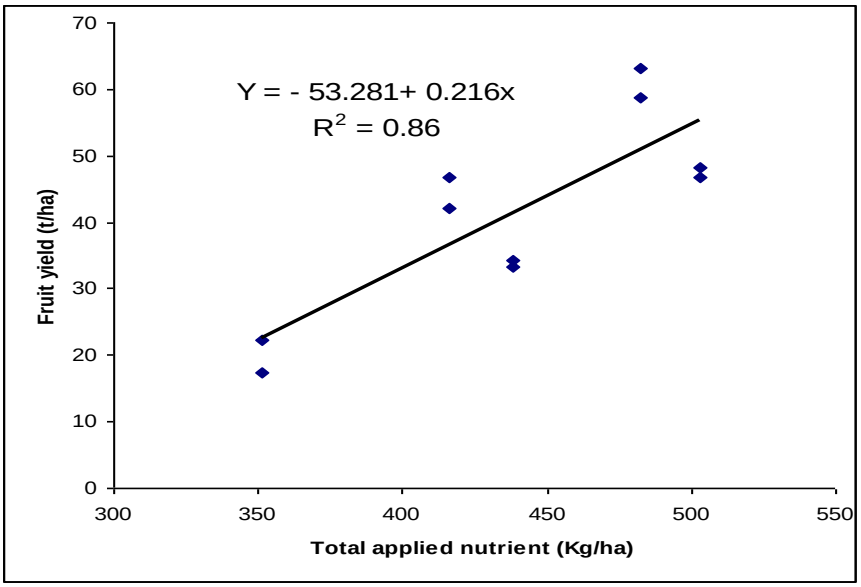

Fig. 1. Functional relationship between applied nutrient and fruit yield of Bt Brinjal (average of 2016- 2017 and 2017-2018).

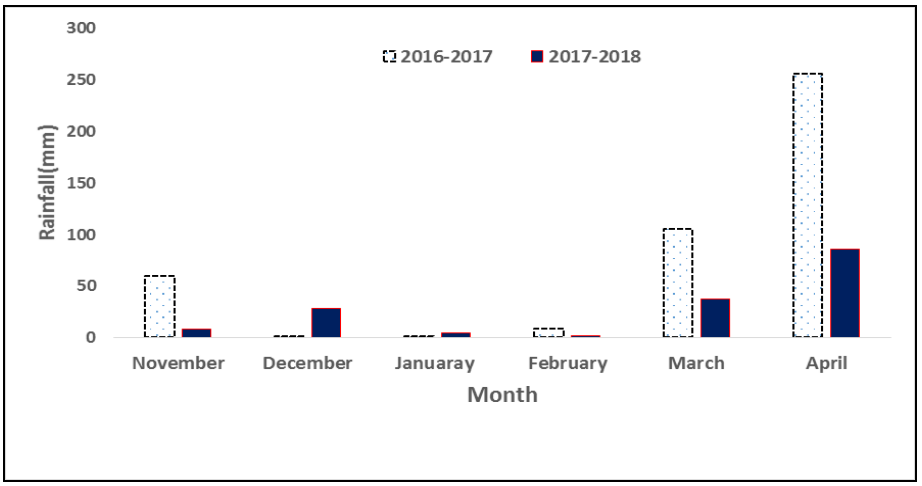

Fig.2. Rainfall distribution during growing period of Bt brinjal (2016-2017 and 2017-2018)

Conclusion

The results of two years' study revealed that application of 180-54-135-22-3-1.50 kg/ha N-P-K-S-Zn-B along with 3 t/ha poultry manure was the suitable combination of nutrients for raising maximum fruit yield and also economically profitable for brinjal production in Chhiata series of the Grey Terrace soil of Gazipur.

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