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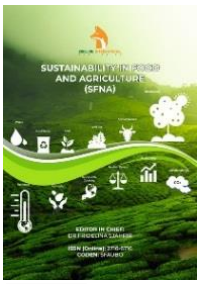

RESEARCH ARTICLE

COMPARATIVE STUDY OF EFFECTIVENESS OF TSP AND DAP FERTILIZER ON BRINJAL

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ABSTRACT

The experiment was conducted at Regional Agricultural Research Station (RARS), Jamalpur, Bangladesh during the period of 2018-19 and 2019-2020 to find out suitable phosphorus fertilizer source and application method for higher brinjal production and to increase phosphorus use efficiency. There were six treatments comprising T_1 = P from TSP (100% basal dose), T_2 = P from DAP (100% basal dose), T_3 = P from DAP (50 % basal + 50% top dress), T_4= P from DAP (25 % basal + 75 % top dress), T_5 = P from DAP (100 % top dress) and T_6 = P-control. NKSZnB were used as a blanket dose in all treatment. Two years results revealed that, DAP fertilizer gave superior performance over TSP fertilizer. The highest average brinjal fruit yield (33.13 t ha^{-1}) was found in T_3 treatment [DAP application (50 % basal + 50% top dress)] compared to TSP treatment (30.05 t ha^{-1}) and the lowest (17.97 t ha^{-1}) came from T_6 (control treatment). The highest phosphorus use efficiency (433.14 Kg yield/Kg P) and highest phosphorus recovery (28.75%) was also obtained from DAP treatment with highest BCR (3.6) compared to TSP treatment. It was conclude that, splitting application of DAP fertilizer led to an increased of P availability at proper time of demand which effects on growth and yield of brinjal.

KEYWORDS

TSP fertilizer, DAP fertilizer, phosphorus use efficiency, phosphorus recovery, brinjal and yield.

1. INTRODUCTION

Phosphorus (P) is an essential nutrient for plant growth and development and its deficiency is considered a major constraint to crop production worldwide. Thus, P needs to be applied to soils as soluble P fertilizers; a small part (1 %) is utilized by plants and the remainder (99 %) is rapidly converted into insoluble complexes (Mehta et al., 2014) due to precipitation reactions with Al^{3+} and Fe^{3+} in acidic and Ca^{2+} in calcareous soils (Khan et al., 2009). These metal ion complexes precipitate about 80% of added P fertilizer. Hence, the recovery efficiency of P is not more than 20% of applied P in the world soils (Qureshi et al., 2012). Considering the low recovery of applied and native P and the high cost of chemical phosphatic fertilizers in addition to an increasing concern about environmental degradation, it is important to find viable solutions to increase P fertilizer use efficiency.

Brinjal (*Solanum melongena*) is one of the most important, popular and nutritious vegetables in Bangladesh which is a cheaper and economically feasible source of vitamin A, B, C and iron. Unfortunately, farmers do not always follow the fertilizer guide or do not make rational use of P fertilizers. Consequently, it sometimes produces a negative effect on the cost benefit ratio. Hence, knowledge of the Fertilizer Use Efficiency (FUE) is a prerequisite to the profitable use of fertilizer. TSP was one of the first high analysis P fertilizer that becomes widely used. It is an excellent P source, but its use has declined as other P fertilizer such as DAP has become more popular and is being extensively used in some areas of the country. DAP is a two-nutrient fertilizer. It contains 18% (N) and 20% (P). Thus an understanding of the efficiency of the fertilizer P would provide a basis for consideration of economic response of crops to different P fertilizers. In highly sandy soils, P may need to be managed like nitrogen, by splitting applications and applying small amounts at sowing and topdressing later in the crop growth cycle. With the above point of view, the present study was carried out to fulfill the following objectives: i. to determine the appropriate source and methods of P fertilizer application to brinjal production and to estimate the phosphorus use efficiency of two phosphorus bearing fertilizers (TSP and DAP).

2. MATERIALS AND METHODS

The experiment was started in 2018-19 period at the soil science field of Regional Agricultural Research Station (RARS) under Jamalpur district in Bangladesh. The site is located at Sonalata series under Agro-Ecological Zone - 8, 24°56´11´´N latitude and 89°55´54´´E longitude and an altitude of 16.46m. The soil of the experimental site was silt clay loam in texture. Before initiation the experiment, the soil samples were collected from a depth of 0-15 cm for each replication and analyzed following standard methods (Table 1). Nutrient status of initial soil prior to fertilization is presented in Table 1.

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Table 1: Initial soil status of the experimental soils

Location	pH	OM (%)	Ca	Mg	K	Total N%	P	S	B	Cu	Fe	Mn	Zn
			meq 100g^{-1}				μg g^{-1}						
RARS, Jamalpur	6.9	0.89	6.0	1.9	0.094	0.050	8.6	7.5	0.32	2.4	24	4.0	1.22
Critical level	-	-	2.0	0.5	0.12	-	10	10	0.20	0.2	4	1	0.6

The experiment was conducted to determine the effect of phosphorus fertilizer source and application method for quality brinjal production. The experiment was laid out in a Randomized Complete Block Design (RCBD) having 6 replications. The unit plot size was 2.5m x 2.3m and the variety was BARI begun-8. Recommended doses of chemical fertilizer for brinjal ($N_{140}P_{35}K_{85}S_{15}Zn_2B_1$ Kgha^{-1}) were calculated on the basis of soil test values according to fertilizer recommendation guide (BARC, 2018). Phosphorus was added as per treatment from two sources as TSP and DAP. All fertilizers except urea were incorporated to soil during final land preparation. Urea was applied in three equal splits, one-third after 20 DAT, one-third after 40 DAT and the rest one-third after 60 DAT. In plots receiving DAP as a full or partial source of P, the amount of nitrogen from DAP (18 %N) was adjusted with urea-N. The 30 days old brinjal seedlings were transplanted on 1 November 2019 in a spacing of 100 cm x 70cm.TSP and DAP fertilizers were applied in basal and top dress (four splits at one months interval) application method according to the treatment. Other intercultural operations were done as per requirement. Nogos 50 EC was used to control brinjal fruit and shoot borer. The crop harvesting continued during the month of February to May. Data on yield and yield contributing characters were recorded from ten plants selected randomly for each plot and total yield was calculated through average plant yield by multiplying plant population. Plants were selected randomly from the area marked for the purpose of dry matter estimation. Plants were cut at the soil surface and samples were sun-dried and finally oven-dried at 70°C to a constant weight for estimation of dry matter accumulation and ground to 20 mesh and preserved for subsequent chemical analysis.

Treatments were as follows

T_1 = P from TSP (100% basal dose)

T_2 = P from DAP (100% basal dose)

T_3 = P from DAP (50 % basal + 50% top dress)

T_4= P from DAP (25 % basal + 75 % top dress)

T_5 = P from DAP (100 % top dress)

T_6 = P-control

Blanket dose: NKSZnB

Phosphorus Use Efficiency (PUE)

a. Phosphorus Use Efficiency (aPUE) = $(Y_{high} - Y_{low})/\Delta P_{fert}$

Where, Y_{high} = Yield of the fertilized plants

Y_{low} = Yield of the unfertilized plants

ΔP_{fert} = difference of the applied P fertilizer between the two treatments. (Hammond *et al.*, 2009).

b. P recovery (%) = (P uptake from treated plot - P uptake from control plot)/amount of fertilizer P

applied x 100

P uptake was calculated by the following formula:

Uptake of P (kgha^{-1}) = % P × drymatter (kgha^{-1})/100

Data on vegetative and fruit characters were recorded and analyzed statistically using statistical software STAR which was developed by IRRI. Least significant differences (LSD) were used for means separation at 5% probability level.

3. Result and Discussion

3.1 Effect of P fertilizers on plant growth and yield of brinjal

The effect of different phosphorus fertilizer source and application method on the growth and yield of brinjal are presented in Table 2. The plants fertilized with TSP and DAP were significantly taller than that for P-control plants. The highest plant height (109.66 cm) was obtained from DAP treated treatment T_3 (DAP: 50%basal + 50% top dress) where TSP treated treatment T_1 produced plant height of (104.70 cm) and the lowest plant height (79.81cm) was obtained from P- control treatment.The T_3 treatment gave the highest value in case of fruit length (18.37 cm), fruit diameter (3.19 cm),number of fruits plant^{-1} (28.34) and weight of fruits plant^{-1} (147.36 g) and these values were found lowest in P-control treatment.

In 2019-2020, the highest brinjal yield (30.49 t ha^{-1}) was found in T_3 treatment which was statistically identical to T_4 treatment (29.63 t ha^{-1}), both were DAP treated treatment whereas TSP treatment produced brinjal yield of (27.78 t ha^{-1}). The lowest brinjal yield (16.27 t ha^{-1}) was obviously found in T_6 (control) treatment. From the two years results, it was observed that T_3 (DAP treatment) produced maximum average brinjal yield (33.13 t ha^{-1}) whereas (30.05 t ha^{-1}) brinjal yield was noticed T_1 (TSP treatment) and minimum (17.97 t ha^{-1}) was recorded in T_6 control treatment which indicating that 10.24 % yield increase was possible due to using of DAP fertilizer.

The good performance of DAP treated brinjal can be attributed to the nitrogen available in the fertilizer at a rate of 18 kg ha^{-1} which may have been vital in vegetative growth and grain filling at a later stage of crop growth. Brinjal under TSP may have had poor assimilation of P because of the soil fixation of P from the fertilizer. However, the superiority of DAP over TSP could be attributed to their higher solubility and thus, higher P availability to the plant as they are fast-release fertilizers (Siam, H.S; et al; 2008) .The results were in agreement with the findings of many researchers (Ramirez, R. et al; 2009 and Odongo, N.E; et al; 2007) which indicated that the effectiveness of TSP was less than those of the other kinds of water-soluble P fertilizers.

Table 2: Yield components of brinjal as influenced by different P fertilizer, 2019-2020

Treat.	Plant height	Fruit length	Fruit diameter	Fruit no. plant^{-1}	Av. fruit weight (g plant^{-1})	brinjal yield (t ha^{-1})		Average yield (t ha^{-1})	% increase over TSP
						2018-19	2019-2020		
	(cm)								
T_1	104.70 b	17.45 ab	3.08 a	23.97 b	140.96 b	32.33 b	27.78 b	30.05	-
T_2	93.63 c	15.55 c	2.84 b	18.31 c	125.27 d	24.50 d	21.74 c	23.12	-
T_3	109.66 a	18.37 a	3.19 a	28.34 a	147.36 a	35.77 a	30.49 a	33.13	10.24
T_4	106.04 b	16.18 bc	3.12 a	24.95 b	145.36 a	34.10 a	29.63 a	31.86	6.02
T_5	88.94 d	15.00 c	2.65 c	15.85 d	129.41 c	26.37 c	22.71 c	24.54	-
T_6	79.81 e	12.41 d	2.36 d	13.40 e	91.99 e	19.67 e	16.27 d	17.97	-
CV%	2.13	3.34	2.19	6.49	7.15	4.29	7.54		
LSD (0.05)	1.7	1.49	0.17	1.43	3.77	1.7	1.14		

Means in a column followed by same letter(s) do not differ significantly at 5% level by LSD

Note : T_1 = TSP (100% basal), T_2 = DAP (100% basal), T_3 = DAP (50%basal + 50% top dress), T_4= DAP(25 % basal + 75 % top dress), T_5 = DAP (100 % top dress) and T_6 = P-control

3.2 Phosphorus Use Efficiency (PUE)

3.2.1 Agronomic Phosphorus Use Efficiency (aPUE)

Agronomic Phosphorus Use Efficiency refers to the increase in brinjal yield per kg of phosphorus applied.

Table 3 showed agronomic Phosphorus use efficiency (aPUE) in brinjal crop treated with different P fertilizer. The highest Phosphorus use efficiency (433.14 Kg yield Kg P^{-1}) was found in T_3 treatment i.e.; DAP

treated treatment whereas (345.14 Kg yield Kg P^{-1}) aPUE was noticed in TSP treatment.

Table 3: Agronomic Phosphorus Use Efficiency of different P fertilizer in brinjal, 2019-2020

Treatment	Applied P	Increase P over control	Brinjal yield	Increase yield over control	Agronomic Phosphorus Use Efficiency (aPUE) (Kg yield Kg P^{-1})
	(Kg ha^{-1})				
T_1	35	35	30050	12080	345.14
T_2	35	35	23120	5150	147.14
T_3	35	35	33130	15160	433.14
T_4	35	35	31860	7320	396.85
T_5	35	35	24540	6570	187.71
T_6	0	0	17970	-	-

Note : T_1 = TSP (100% basal), T_2 = DAP (100% basal), T_3 = DAP (50%basal + 50% top dress), T_4= DAP(25 % basal + 75 % top dress), T_5 = DAP (100 % top dress) and T_6 = P-control

3.2.2 Phosphorus recovery (%)

Phosphorus recovery (%) refers to the increase in phosphorus uptake by brinjal per kg of phosphorus applied. Table 4 showed Phosphorus concentration varied between 0.09 to 0.21 percent in different treatment and Phosphorus uptake varied between 2.96 to 13.02 Kg ha^{-1}. Phosphorus applied through DAP fertilizer increased P uptake relative to TSP fertilizer. At the same quantity of P applied, total P uptake was 16.77 % greater in the DAP treatment (13.02 Kg) as compared with TSP treatment (11.15 Kg). Total P uptake was highly correlated with yield of brinjal. Higher brinjal yield and higher P uptake in DAP treatment is possible by the increased P availability at proper time of demand of the crop and by splitting application the lesser contact of P fertilizer with soil which are partially responsible for precipitation and fixation of P fertilizer (Iqbal *et al*., 2013). Similarly, Phosphorus recovery (28.75 %) was higher under T_3 treatment i.e.; DAP treatment compared to TSP treatment (23.40 %).

Table 4: Phosphorus recovery (%) of different P fertilizer in brinjal, 2019-2020

Treatments	P concentration (%)	Dry matter production (DMP)	P uptake	Increase P uptake over control	Applied P	P recovery (%)
		(Kg ha^{-1})				
T_1	0.21	5310	11.15	8.19	35	23.40
T_2	0.17	4620	7.85	4.89	35	13.98
T_3	0.22	5920	13.02	10.06	35	28.75
T_4	0.22	5675	12.48	9.52	35	27.21
T_5	0.18	4280	7.70	4.74	35	13.55
T_6	0.09	3294	2.96	-	-	-

Note : T_1 = TSP (100% basal), T_2 = DAP (100% basal), T_3 = DAP (50%basal + 50% top dress), T_4= DAP(25 % basal + 75 % top dress), T_5 = DAP (100 % top dress) and T_6 = P-control

3.3 Economic analysis

Table 5 showed the economic performance of brinjal as influenced by different P fertilizer. The highest gross return (TK 496950 ha^{-1}), gross margin (TK 359050 ha^{-1}) and BCR (3.6) were recorded from T_3 (DAP: 50%basal + 50% top dress) treatment.T_4 treatment (DAP: 25 % basal + 75 % top dress) gave the second highest values for the said parameters. TSP treatment demonstrated poor performance mainly due to low yield and high market price of TSP fertilizer than DAP.Among the treatment, the lowest gross return (TK 269550 ha^{-1}), gross margin (TK 132500 ha^{-1}) and BCR (2.0) were recorded from P-control treatment.From economic point of view, DAP treatment would be the best for their high yield and economic return.

Table 5: Cost and return analysis of brinjal as influenced by different P fertilizer, 2019-2020

Treatments	Average yield of brinjal (t ha^{-1})	Gross return	Total variable cost	Gross margin	BCR
		(TK ha^{-1})			
T_1 = TSP (100% basal)	30.05	450750	145500	305250	3.0
T_2 = DAP (100% basal)	23.12	346800	137900	208900	2.5
T_3 = DAP (50 % basal + 50 % top dress)	33.13	496950	137900	359050	3.6
T_4 = DAP (25 % basal + 75 % top dress)	31.86	477900	137900	332800	3.4
T_5 = DAP (100 % top dress)	24.54	368100	137900	230200	2.6
T_6 = P-control	17.97	269550	132500	137050	2.0

Input: Unit price (Tk.Kg^{-1}): Urea = 16, TSP = 22, DAP = 16, MoP = 15, Gypsum = 6,

Zinc sulphate = 120 and Boric acid = 150

Output: Price range of brinjal 10.00 to 25.00 Tk Kg^{-1}, average price 15.00 Tk Kg^{-1}

4. Conclusion

From two years experimental results, it can be concluded that phosphorus applied through DAP fertilizer gave higher brinjal yield, Phosphorus use efficiency and Phosphorus recovery (%) compared to TSP fertilizer. Among the treatments, T_3 treatment i.e. application of DAP (50%basal + 50% top dress) was found to be the most effective. So, DAP could be used instead of TSP fertilizer for brinjal production.

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