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Effect of USG and NPK briquette on the performance of bottle gourd

Shammi Akhtar[1], Md. Shahiduzzaman[1], Nargis Sultana[1], Shamim Ara Begum[1], Monira Yasmin[1] and Md. Khurshed Alam[2]

[1]*On Farm Research Division, Bangladesh Agricultural Research Institute, Gazipur-1701, Bangladesh*
[2]*Bangladesh Agricultural Development Corporation, Mymensingh-2200, Bangladesh*

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Corresponding Author

Shammi Akhtar
E-mail: shammiakhter_bari@yhoo.com
Phone: + 880-1682-277465

ABSTRACT

The effectiveness of USG and NPK briquette for sustainable bottle gourd production was studied in the farmer's field of Phulpur upazila under Mymensingh district of Bangladesh. There were six fertilizer treatments such as i) Prilled urea as recommended dose (RD) + recommended dose of other fertilizers (RD) + 4.0 t cowdung ha^{-1} (T_1), ii) 10% less N than RD as USG + other fertilizers (RD) + 4.0 t cowdung ha^{-1} (T_2), iii) 10% less NPK briquette than RD + other fertilizers (RD) + 4.0 t cowdung ha^{-1} (T_3), vi) Farmers' practice (T_4), v) Native fertility (T_5) and vi) T_3 without cowdung (T_6). A randomized complete block design was followed with three replications in this experiment. The bottle gourd variety BARI Lau 3 was used as test crop in the experiment. The fertilizer application as 10% less NPK briquette than RD with recommended dose of other fertilizer and 4.0 t ha^{-1} cowdung gave the highest bottle gourd yield (26.2 tha^{-1}) that was identical with T_6 (25.3 tha^{-1}) fertilization where no cowdung was applied. It was also found that USG and NPK briquette produced 9.78 and 23.7% higher yield over prilled urea (T_1). The highest gross margin (Tk. 2,78,548 ha^{-1}) and gross return (Tk. 3,93,015 ha^{-1}) were also recorded from T_3 treatment. Therefore, 10% less NPK briquette than recommended dose with integrated nutrient management practice and recommended dose of other fertilizer was found suitable for achieving highest yield and economic return of bottle gourd.

Introduction

Bottle gourd (*Lagenaria siceraria* L.) is one of the most important Cucurbitaceous vegetable crops, grown intensively in Bangladesh for its widespread consumption. Due to its crispy and soft taste it is equally liked by rich and poor people (Ram et al., 2006). For bottle gourd production, a wide range of fertile soils are needed. But most of the farmers of Bangladesh do not use judicious nutrient management strategies for maximized bottle gourd production. As a result, farmers do not get maximum benefits of fertilizer use and thereby the yield decreased drastically. Although several factors related to low yield of bottle gourd are involved, nitrogen deficiency is probably the most common nutritional problem affecting plant growth and development for achieving higher yield and better quality.

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). The prilled urea gave N use efficiency up to 36% where USG gave N use efficiency up to 63%. Urea was much quickly hydrolysis by urease to ammonia and carbon dioxide ($NH_2CONH_2 + H_2O \rightarrow 2NH_3 + CO_2$) in the soil solution, ammonium ions in the soil solution exist in equilibrium with ammonia ($NH_4^+ + OH^- \rightarrow NH_2 + H_2O$). More than 40% of N lost through ammonia gas when urea was applied on soil surface (Catchpoole et al., 1983). As a consequence, more N becomes available to the crop plant by reducing losses through atmosphere, groundwater and waterways. Application of urea and NPK briquette proved to be profitable in different upland crops other than those of rice. Rice yields increased almost 30% more with the application of fertilizer in deep placement as a form of urea super granules (USG) in the root zone at 8-10 cm (IFDC, 2015; Savant et al., 1991; Ahmed et al., 2000) compared to broadcasting. Apart from this, NPK briquette gave higher yield and N use efficiency on T. aman rice in tidal ecosystem (Debnath et al., 2013). Crasswell and De Datta (1980) pointed out that broadcasting urea on surface soil causes loss up to 50% while negligible loss may occur at 10 cm depth of USG placement. More than 40% N cause loss through ammonia gas when urea was applied on soil surface (Catchpoole et al., 1983). Deep placement of all essential nutrients may be more efficient and farmers could get more benefits from this practice compared to broadcast method. The use of NPK briquette, a mixture of urea, triple super phosphate (TSP), and muriate of potash (MoP) may help to reduce the loss of nutrients from crop fields. Deep placement of fertilizer briquettes also environmentally and economically benefitted (IFPRI, 2004). Khalil et al. (2009) reported that the volatilization loss of prilled urea is very high and farmers lost a huge amount of money for N fertilizer and he also proposed to control this loss by deep placement of fertilizer and that might be a good option to minimize production cost as well as to increase yield.

In Bangladesh, there having inadequate research on vegetable production by using USG and NPK

briquette. Profitability of cauliflower by application of USG and NPK briquette has been observed by (Hussain et al., 2010), while integrated management of NPK briquette reported to increase bitter gourd yield up to 12% over recommended dose of fertilizer (Akter et al., 2015). Therefore, in order to augment and sustain the productivity of vegetable crop production, granular form of fertilizer application deserves special attention. The present study was taken to evaluate the effect of USG and NPK briquette fertilizer on the yield of bottle gourd and to find out a suitable technology for bottle gourd cultivation.

Materials and Methods

Experimental site

The experiment was conducted at the farmers' field of Phulpur upazila under Mymensingh district of Bangladesh during the period from October 2012 to March 2013. The present study was taken to evaluate the response of broadcast incorporation of N, P, and K to the deep placement of urea super granule, NPK briquette and the farmers' practice. The experimental site was located under the Agro-Ecological Zone 9 at about 24° 44′ and 25° 02′ N latitudes and in between 90° 13′ and 90° 33′ E longitudes. The soil was slightly acidic (pH 6.5) and low in organic matter (1.01%), whereas very low in N and Zn content (0.053% and 0.44 μgg^{-1} soil). The soil P (15 μgg^{-1}) and S (13 μgg^{-1}) content were above the critical level while B content was at par with critical level (Critical levels of P, S and B were 15, 13 and 0.2 μgg^{-1}, respectively) and that K was 0.09 meq/100 g soil.

Fertilizer combination

Considering the soil nutritional status, six fertilizer combinations were designed to evaluate the response of to the broadcast incorporation of N, P, and K deep placement of urea super granule, NPK briquette and the farmers' practice (Table 1). The combinations were selected on the basis of fertilizer recommendation guide (FRG 2012). The recommended dose of fertilizer (RD) was 55-17-72-12-2.5-1.5 kg of N-P-K-S-Zn-B ha^{-1}, respectively with 4.0 ton cowdung ha^{-1}.

Planting materials

Bottle gourd (*Lagenaria sicesaria*, var. BARI Lau 3) was used as planting material for this study. Seeds were collected from Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh.

Cultivation procedure

The seeds of bottle gourd were transplanted on 18 October, 2012 maintaining the spacing 2 m × 2 m. In the farmers field the study was designed in a randomized complete block followed by three replications. Full amount of well decomposed cowdung, S, Zn and B fertilizers were broadcasted and mixed thoroughly with soil at the time of final land preparation. The application of P and K were made as basal except for T_3 and T_6. After establishment of seedlings, recommended numbers of USG and NPK briquettes were applied to the pits in ring method. A total of 24 USG briquettes were applied in two installments such as 16 USG briquettes (1.8 g) were applied as 1st installment at 12 days after transplanting and the remaining 8 USG briquettes were applied as 2nd installment at 40 DAT. The USG were applied at 8 cm deep and 12 cm apart from the base of the plant. Subsequently, all the fertilizers were covered by soils perfectly. A total of 33 NPK briquettes (2.4 g) were applied in T_3 and T_6 by splitting 20 briquettes at 12 DAT and the remaining 13 were applied at 40 DAT as 2nd installment. In T_1 and T_4, one third of N as prilled urea were applied at 10 DAT and the remaining two third of N were applied at 25 and 45 DAT (before flowering). 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. Harvesting of fruit was started from 20 December, 2012 and it was continued up to 28 March, 2013.

Table 1. Fertilizer combinations applied for bottle gourd production under Agro-ecological Zone 9 condition.

Fertilizer combination	Description
T_1	Prilled urea as recommended dose (RD) + other fertilizer (RD) (55-17-72-12-2.5-1.5 kg N-P-K-S-Zn-B ha^{-1} with 4.0 t cow dung ha^{-1})
T_2	10% less N than RD as urea super granule (USG) (49.5 kg N ha^{-1}) + other fertilizer (RD) (17-72-12-2.5-1.5 kg N-P-K-S-Zn-B ha^{-1} with 4.0 t CD ha^{-1})
T_3	10% less NPK briquette than RD (49.5-15.3-64.8 kg N-P-K ha^{-1}) + other fertilizer (RD) (12-2.5-1.5 kg S-Zn-B ha^{-1} with 4.0 t CD ha^{-1})
T_4	Farmers practice (12-15-42 kg N-P-K ha^{-1} and 3.0 t CD ha^{-1})
T_5	Native fertility (85-12-60-16-2-1 kg N-P-K-S-Zn-B ha^{-1})
T_6	T_3 without cow dung (CD)

Data collection and statistical analysis

The data were recorded on the parameters such as number of fruits plant^{-1}, single fruit weight (kg), fruit length (cm), diameter of fruit (cm). The recorded data on yield and yield components were analyzed statistically following MASTAT-C and Microsoft Excel 2007 program and means were separated by LSD at 5% level of significance.

Results and Discussion

Effect USG and NKP briquette on yield contributing characters of bottle gourd

The yield contributing parameters of bottle gourd varied significantly due to the application of different levels of fertilizers and NPK briquette as well as USG (Table 2). The highest total length of bottle gourd (37.3 cm) was found in T_3 treatment (10% less NPK briquette RD + other fertilizer RD) which was identical to T_1, T_2, T_4 and T_6 but different from the rest of the fertilizer combinations. The lowest total length (31.0 cm) was recorded from T_5 treatment in where no fertilizer was applied from outside. T_3 gave maximum fruit diameter (20.1 cm) and it was followed by T_6 (19.2 cm), T_2 (18.9 cm), and T_1 (18.3 cm) whilst minimum one was accounted from T_4 (16.9 cm) treatment farmers practice. The highest number of fruits per plant (8.50) was found in T_3 which was at par with T_6. The highest single fruit weight (1.87 kg) was demonstrated in T_6 which was identical to T_3 (1.85 kg).

Effect of USG and NPK briquette on yield of bottle gourd

The fresh weight of bottle gourd was significantly influenced by the application of conventional method of urea, USG and NPK briquette (Fig. 1). The fertilizer combination T_3 where 10% less NPK briquette with recommended dose of other fertilizer were applied gave highest yield (26.2 tha^{-1}), the lowest one (15.1 tha^{-1}) was obtained from T_5 receiving no fertilizer (i.e., Native fertility). Fruit yields from T_3 (26.2 tha^{-1}) and T_6 (25.3 tha^{-1}) were statistically at par which indicated that 4.0 t cowdung per hectare did not produce significant effect on yield but it increased 4.2% higher than that of T_6. Organic matter might have created favorable environment for maximum utilization of NPK briquette as thus higher yield was obtained. Akter et al. (2015) reported that the application of cowdung with NPK briquette produced the highest yield of bitter gourd, which supports the findings of the present study. Again it was found that the USG and NPK briquette gave 9.78 and 23.7% higher yield over pilled urea, respectively. The fertilizer treatments having USG and NPK briquette with other recommended dose of fertilizer produced higher yield over pilled urea might be due to slow release with maximum use efficiency of N fertilizer along with root zone application.

Among the fertilizer comparisons USG, NPK briquette and prilled urea the greater achievement for bottle gourd production was attributed from deep placement of NPK briquette and USG than other fertilizer taken in this study. The NPK briquette is a combinations of three fertilizers in a deep placement provides N, P, and K fertilizers needs for the crop production. It greatly reduce environmental loses of fertilizers practically. These findings are corroborated with the yield increases reported in tomato (Kadam & Sahane, 2001), cucumber and yard long bean (Bhattarai et al., 2011) with fertilizer briquette in deep placement compared to conventional practice. The positive effect of cowdung is clear for the higher yield when compare to the NPK briquette with cow dung (T_3) and NPK briquette without cow dung (T_6). This indicates that integrated nutrient management of NPK briquette with manure plays an important role in increasing productivity in upland crops.

Cost and return analysis of bottle gourd production

The cost benefit calculation of different fertilizer combination in bottle gourd production was varied greatly (Table 3). It indicated that the highest gross return (Tk. 3,93,015 ha^{-1}) and gross margin (Tk. 2,78,548 ha^{-1}) were observed in T_3 where 10% less NPK briquette with other recommended dose of fertilizer with 4.0 t cowdung per hectare were treated. Even in the T_6 where NPK briquette with recommended dose of fertilizer without cowdung gave higher gross return (Tk. 3,79,950 ha^{-1}) as well gross margin (Tk. 2,69,483 ha^{-1}) over farmers dose.

Table 2. Yield and yield contributing characters of bottle gourd as affected by NPK briquette and conventional method of different level of fertilizers.

Fertilizer combinations	Fruit length (cm)	Fruit diameter (cm)	Fruits plant^{-1}	Single fruit wt. (kg)	Increased yield over conventional method (%)
T_1	34.6	18.3	7.23	1.70	-
T_2	36.6	18.9	8.33	1.62	+ 9.78
T_3	37.3	20.1	8.50	1.85	+ 27.9
T_4	33.3	16.9	7.24	1.65	- 2.8
T_5	31.0	17.6	6.26	1.45	- 26.2
T_6	36.3	19.2	8.13	1.87	+ 23.7
CV(%)	5.53	7.08	16.2	5.52	-
LSD (0.05)	3.32	2.25	2.12	0.16	-

T_1 = Prilled urea as recommended dose (RD) + other fertilizer (RD), T_2 = 10% less N than RD as urea super granule (USG) + other fertilizer (RD), T_3 = 10% less NPK briquette than RD + other fertilizer (RD), T_4 = Farmers' dose, T_5 = Native fertility, T_6 = T_3 without cow dung (CD).

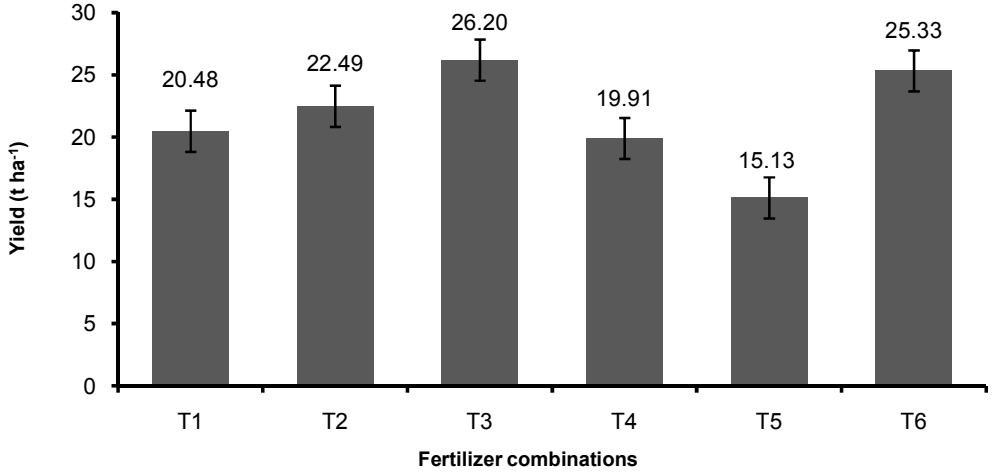

Fig. 1. Bottle gourd yield as influenced by NPK briquette and conventional method of different levels of fertilizers.

T1= Prilled urea as recommended dose (RD) + other fertilizer (RD), T2= 10% less N (RD) as urea super granule (USG) + other fertilizer (RD), T3= 10% less NPK briquette (RD) + other fertilizer (RD), T4= Farmers' dose, T5= Native fertility, T6= As T3 without cow dung (CD). LSD (0.05) = 2.39, CV (%) = 6.45.

Table 3. Cost and return analysis of bottle gourd as influenced by NPK briquette and conventional method of different levels of fertilizers.

Fertilizer combinations	Gross return (Tk. ha^{-1})	Variable cost (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})
T_1	3,07,275	1,15,112	1,92,163
T_2	3,37,350	1,14,870	2,22,480
T_3	3,93,015	1,14,467	2,78,548
T_4	2,98,650	1,06,728	1,91,922
T_5	2,26,920	1,00000	1,26,920
T_6	3,79,950	1,10,467	2,69,483

T_1= Prilled urea as recommended dose (RD) + other fertilizer (RD), T_2= 10% less N than RD as urea super granule (USG) + other fertilizer (RD), T_3= 10% less NPK briquette than RD + other fertilizer (RD), T_4= Farmers' dose, T_5= Native fertility, T_6= As T_3 without cow dung (CD).

Price of input and output: Urea Tk. 20 kg^{-1}, TSP Tk. 22 kg^{-1}, MoP Tk. 15 kg^{-1}, Gypsum Tk. 10 kg^{-1}, Zinc sulphate Tk. 130 kg^{-1}, boric acid Tk. 130 kg^{-1}, Cowdung Tk. 1 kg^{-1}, Bottle Gourd Tk. 15 kg^{-1}

Conclusion

Application of USG and NPK briquette in combination with other recommended fertilizers had significant effect on yield of bottle gourd. The maximum bottle gourd yield and economic benefits were boost up with the combination of 10% less NPK briquette with recommended dose of other fertilizers, which was identical to this fertilizer combination even where no cow dung was used. Therefore, the use of NPK briquette with cow dung could be recommended for bottle gourd production in Bangladesh.

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