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Feasibility of Replacing Chemical Fertilizer by Organic Fertilizer in Maize (*Zea mays* L.) Production in Dhaka, Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Present research work conducted at the experimental field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from November 2011 to April 2012 to study the feasibility of replacing chemical fertilizer by organic fertilizer in maize production. The experiment comprised of 10 treatments with organic manure and inorganic fertilizer viz., T_0: Control (without any fertilizer), T_1: All chemical fertilizers (recommended dose), T_2: Cowdung (Recommended dose), T_3: Compost (recommended dose), T_4: ½ Compost + 1/2 Cowdung, T_5: Full cow dung + Full compost, T_6: Full cow dung + 1/2 Chemical fertilizer, T_7: Full compost + ½ Chemical fertilizer, T_8: Full cow dung + Full compost + 1/2 Chemical fertilizer, T_9: 1/2 Cowdung + 1/2 Compost + 1/2 Chemical fertilizer. Maize variety of BARI hybrid bhutta 9 was the test crop. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Results indicated that the highest cobs plant^{-1} (1.67), cob length (22.27 cm), cob diameter (14.12 cm),

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grains cob^{-1} (531.90), weight of 1000 grain (305.30 g), grain yield (11.75 t ha^{-1}) and stover yield (13.97 t ha^{-1}) was obtained from T_1. Treatments T_7, T_8 and T_9 gave statistically similar values in respect of yield and yield contributing characters. Treatment T_9 (1/2 Cowdung + 1/2 Compost + 1/2 Chemical fertilizers) could be ideal fertilizer management for maize cultivation keeping chemical pollution minimum with improved soil condition and increased grain yield.

Keywords: Organic fertilizer; compost; grain yield; chemical fertilizer; maize; Bangladesh.

1. INTRODUCTION

Maize (*Zea maize*) is the third most important cereal crop in the world after wheat and rice [1]. Maize crop has been included as a major enterprise in the crop diversification and intensive cropping programs [2]. The demand for maize has been increasing day by day due to its potential use in poultry, fish and livestock feed production although it is an exhaustive crop and uptakes more nutrients from the soil. Chemical fertilizers used extensively due to their convenience, ease application and high yield potentials. However, chemical fertilizer is costly and creates pollution to the ecosystem when is used injudiciously at farmers' level due to its different ways of loss. In long term use of chemical fertilizer may emerge as toxic to the soil system. In this context, organic manure has been proved as a good nutrient supplement having different beneficial factors of it comparing to the chemical fertilizers [3]. Maia and Cantaruti [4] reported that the continuous use of organic fertilizers increased maize productivity whereas chemical fertilizer application showed less expressive effects. They also observed that the continuous use of the organic fertilizers increases in total N-reserve and availability of N, while the chemical fertilizer application had little influence on these characteristics. Compared with the chemical fertilizer treatments, equal amounts of substitutions with cow manure or chicken manure increased production, and a 25% nutrient substitution resulted in the best yield increase [5]. Application of inorganic fertilizers along with organic fertilizer can increase the activities of soil micro-organisms and enzymes and soil available nutrient contents [6]. Furthermore, this type of application can prove to be an excellent procedure in maintaining and improving soil fertility and increasing fertilizer use efficiency. Management methods that decrease requirements for agricultural chemicals are needed to avoid adverse environmental impacts [7]. Moreover, emerging evidence indicates that integrated soil fertility management involving the judicious use of combinations of organic and inorganic resources is a feasible approach to overcome soil fertility constraints [8, 9]. Very few research works have been conducted in Bangladesh regarding the use of inorganic and organic fertilizers on the growth and yield if maize. In view of this fact, the study was conducted to evaluate the effect of the chemical and organic fertilizer as alone and in combination with the maize production.

2. MATERIALS AND METHODS

The research work carried out at the experimental field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from November 2011 to April 2012 to come across the optimum combination of chemical fertilizer, cow dung and compost aiming reduction of usage of chemical fertilizer in Maize cultivation. The experimental field is situated at 23°74$^{/}$ North latitude and 90°35$^{/}$ East longitude [10]. The soil of the experimental was characterized by shallow red-brown terrace soil and it was 8.6 m above the sea level. The experiment comprised of ten treatments viz.- T_0: Control (without fertilizer), T_1: All chemical fertilizer (recommended dose), T_2: Cowdung (Recommended dose), T_3: Compost (Recommended dose), T_4: ½ Compost + ½ Cowdung, T_5: Full Cowdung + Full Compost, T_6: Full Cowdung + ½ Chemical fertilizer, T_7: Full Compost + ½ Chemical fertilizer, T_8: Full Cowdung + Full Compost + ½ Chemical fertilizer and T_9: ½ Cowdung + ½ Compost + ½ Chemical fertilizer. Maize variety BARI hybrid maize 9 was used as a test crop. Well, rotten cowdung and compost were applied 6.0 t ha^{-1} before final land preparation according to treatment variables. The recommended dose chemical fertilizer (RDCF) used for hybrid variety was 500-250-200-250-10-5 kg ha^{-1} of Urea, TSP, MP, Gypsum, $ZnSO_4$, Boric acid, respectively [11]. One-third of urea and all other chemical fertilizers at full dose were applied as per treatment variables during final land preparation on 21 November, 2011 as a basal dose. The rest amount of urea as per treatment was applied in two equal instalments on 25 December, 2011 (30 DAS) and 21 January, 2012, (60 DAS), respectively as side dressing. The experiment was laid out in a Randomized Complete Block Design and replicated thrice. The size of a unit plot was 4m × 2.5m. Seeds were sown in lines maintaining a line to line distance of 75 cm and plant to plant distance of 25 cm having 2 seeds hole^{-1} on 21 November, 2011. Different intercultural operations like weeding, thinning, earthing up, irrigation and other plant protection measures were taken as per requirements. The crops were harvested at their full maturity on 25 April, 2012. The cobs of five randomly selected plants of each plot were separately harvested for recording yield attributes and other data. The inner two lines were harvested for recording grain yield and stover yield. The collected data were statistically analyzed with the computer-based software MSTAT-C and the significance of the difference among treatment means were estimated by the Least Significant Difference (LSD) test at 5% level of probability.

3. RESULTS AND DISCUSSIONS

3.1 Plant Characters

Plant characters showed significant variations with chemical and organic fertilizers alone or in combinations (Table 1). The tallest plant (240.50 cm), was measured from T_1 which was statistically at per with T_8 (240.30 cm), T_9 (239.20 cm), T_7 (238.30 cm) and T_6 (236.00 cm) and treatment T_0 had the lowest value (188.90 cm) and this result was supported by Mohsin *et al.* [12] who observed the variation of plant height with different source of fertilizer use in maize plant. Maximum days to 50% tasseling (99.00), 50% silking (106.70) and tassel length (41.87 cm) were observed in T_1 treatment which was statistically similar with T_8 T_7, T_9, T_6, T_5, T_4 and T_3 in case of days to 50% tasseling + 50% silking; but T_8 T_7, T_9, T_6 and T_5 in case of tassel length (Table 1). Fertilized plots showed statistically similar values of the cobs to tassel height except control (T_0) where maximum 72.13 cm and minimum 62.20 cm values were recorded in T_5 and T_0, respectively.

Fig.1 showed that T1 treatment produced the longest cob (22.27 cm) which was followed by T8 and T9 (22.16 cm and 22.14 cm, respectively) and the shortest was recorded from T0 (17.39 cm). Like cob length, a similar trend was observed for cob diameter (Fig. 2). The highest cob diameter (14.12 cm) was obtained with T1 treatment, which was statistically at per with T8 and T9 (13.79 cm and 13.60 cm, respectively). The shortest cob diameter (12.14 cm) was found in the T0 treatment.

3.2 Yield Attributes and Yields

Yield attributes and yields data varied significantly due to the application of chemical and organic fertilizers (Table 2). The highest cobs plant^{-1} was found in T_1 (1.67), which was statistically similar with T_8, T_9, T_7 and T_6 (1.63, 1.61, 1.53, and 1.43, respectively), while the minimum number (1.00) from T_0. Application of NPK either any form increased cobs plant^{-1} which was supported by Shah [13]. The highest grain rows cob^{-1} and grains cob^{-1} were recorded

Table 1. Effect of chemical and organic fertilizers on plant characters of maize

Treatment	Plant height (cm)	Days to 50% tasseling(days)	Days to 50% silking(days)	Tassel length (cm)	Cob to tassel height (cm)
T0	188.9 c	88.67 c	93.00 c	34.470 d	62.200 b
T1	240.5 a	99.00 a	106.70 a	41.870 a	69.400 ab
T2	200.5bc	91.00 bc	95.00 bc	35.270 d	70.130 ab
T3	205.4bc	93.33 a-c	98.33 a-c	36.470 cd	67.770 ab
T4	208.6bc	95.33 ab	98.67 a-c	36.800 b-d	70.070 ab
T5	214.5 b	93.67 a-c	98.67 a-c	38.320 a-d	72.130 a
T6	236.0 a	94.33 a-c	101.00 a-c	39.000 a-d	68.330 ab
T7	238.3 a	96.33 ab	102.00 a-c	40.790 ac	71.170 a
T8	240.3 a	97.67 a	104.70 a-c	41.540 ab	71.600 a
T9	239.2 a	95.00 ab	101.00 a-c	41.470 ab	68.370 ab
LSD (.05)	**20.92**	**5.28**	**9.76**	**4.256**	**7.649**
CV (%)	**5.51**	**6.26**	**5.69**	**6.43**	**7.91**

T_0: Control (without manure and fertilizer), T_1: All chemical fertilizer as recommended dose, T_2: Cowdung as recommended dose, T_3: Compost as recommended dose, T_4: ½ Cowdung + ½ Compost, T_5: Full Cowdung + Full Compost, T_6: Full Cowdung + ½ Chemical fertilizer, T_7: Full Compost + ½ Chemical fertilizer, T_8: Full Cowdung + Full Compost + ½ Chemical fertilizer, and T_9: ½ Cowdung + ½ Compost + ½ Chemical fertilizer

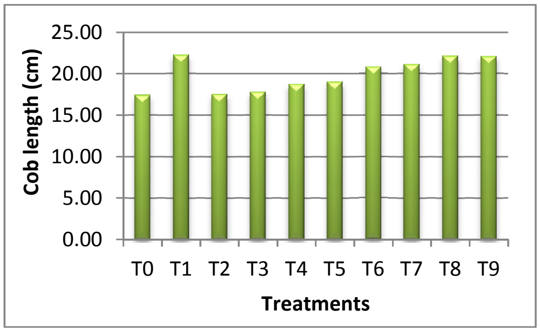

Fig 1. Effect of chemical and organic fertilizers on cob length of maize (LSD $_{(0.05)}$ = 2.17)

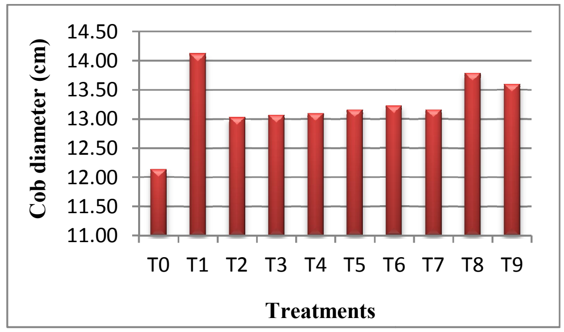

Fig 2. Effect of chemical and organic fertilizers on cob diameter of maize (LSD $_{(0.05)}$ = 1.11)

T_0: Control (without manure and fertilizer), T_1: All chemical fertilizer as recommended dose, T_2: Cowdung as recommended dose, T_3: Compost as recommended dose, T_4: ½ Cowdung + ½ Compost, T_5: Full Cowdung + Full Compost, T_6: Full Cowdung + ½ Chemical fertilizer, T_7: Full Compost + ½ Chemical fertilizer, T_8: Full Cowdung + Full Compost + ½ Chemical fertilizer, and T_9: ½ Cowdung + ½ Compost + ½ Chemical fertilizer

Table 2. Effect of chemical and organic fertilizers on yield contributing characters and yields of maize

Treatment	Cobs plant^{-1} (no.)	Grain rows cob^{-1}(no.)	Grains cob^{-1}(no.)	Weight of 1000 seed (g)	Grain yield(t ha^{-1})	Stover yield(t ha^{-1})
T0	1.00 b	14.25 c	435.60 b	234.50 c	4.16 c	4.94 c
T1	1.67 a	15.62 a	531.90 a	305.30 a	11.75 a	13.97 a
T2	1.03 b	14.43 bc	440.80 b	248.30 bc	5.10 c	6.50 bc
T3	1.07 b	14.82a-c	436.50 b	250.80 bc	5.24 c	6.79 b
T4	1.07 b	15.06 ab	491.40ab	251.50 bc	6.76 b	8.16 b
T5	1.10 b	15.13 ab	491.10ab	270.20a-c	6.97 b	8.22 b
T6	1.43 a	15.21 a	519.80ab	287.50ab	10.81 a	12.33 a
T7	1.53 a	15.50 a	522.50ab	290.60 ab	10.90 a	12.55 a
T8	1.63 a	15.57 a	521.90ab	303.10 a	11.67 a	13.53 a
T9	1.61 a	15.35 a	521.60ab	304.90 a	11.56 a	13.38 a
LSD(.05)	**0.282**	**0.703**	**79.690**	**45.000**	**1.162**	**1.606**
CV (%)	**12.44**	**7.69**	**9.46**	**9.55**	**7.97**	**9.33**

T_0: Control (without manure and fertilizer), T_1: All chemical fertilizer as recommended dose, T_2: Cowdung as recommended dose, T_3: Compost as recommended dose, T_4: ½ Cowdung + ½ Compost, T_5: Full Cowdung + Full Compost, T_6: Full Cowdung + ½ Chemical fertilizer, T_7: Full Compost + ½ Chemical fertilizer, T_8: Full Cowdung + Full Compost + ½ Chemical fertilizer, and T_9: ½ Cowdung + ½ Compost + ½ Chemical fertilizer

from T_1 (15.62, 531.90, respectively) followed by T_8, T_7, T_9 and T_6, while the lowest (14.25 and 435.60, respectively) were found in T_0 which agrees with the findings of Hassan [14] that application of fertilizer increases the number of grains cob^{-1}. T_1 treatment gave the highest 1000 seeds weight (305.30 g) followed by T_9, T_8, T_7, T_6 and T_5 treatments (304.90 g 303.10 g, 290.60 g, 287.50 g and 270.20g, respectively) and that of lowest 234.50 g recorded from T_0 treatment (Table 2). Maximum grain yield (11.75 t ha^{-1}) was recorded from T_1, which was statistically similar to T_8, T_9, T_7 and T_6 (respectively for 11.67 t ha^{-1}, 11.56 t ha^{-1}, 10.90 t ha^{-1} and 10.81 t ha^{-1}). The lowest yield (4.16 t ha^{-1}) was found in T_0. Stover yield production pattern was found similar to grain yield that was highest in T_1 (13.97 t ha^{-1}), which was statistically at per with T_9, T_8, T_7 and T_6 (13.53, 13.38, 12.55, and 12.33 t ha^{-1}, respectively). The lowest stover was recorded from T_0 (4.94 t ha^{-1}). These results of grain and stover yields corroborate with the findings of Khan *et al.* [15].

4. CONCLUSION

Considering the result discussed above, the number of chemical fertilizers may be reduced as half of the recommended dose when cow dung and compost are used halves of their recommended dose as have been appeared in T_9 (½ Cowdung + ½ Compost + ½ Chemical fertilizer) treatment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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