EFFECT OF POULTRY MANURE IN COMBINATION WITH CHEMICAL FERTILIZERS ON THE YIELD AND NUTRIENT UPTAKE BY CHILLI IN THE HILLY REGION

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ABSTRACT

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Field experiment was conducted to determine poultry manure in combination with chemical fertilizers on the yield and nutrient uptake by chilli in the hill valley. There were six treatments T_1- 100% STB (Soil Test Base) chemical fertilizer dose N_{100} P_{65} K_{100} S_{20} Zn_4 kg N-P-K-S-Zn ha^{-1}, T_2 - 100% STB + 2.5 ton PM ha^{-1}, T_3 - 75% STB + 2.5 ton PM ha^{-1}, T_4- 75% STB + 5 ton PM ha^{-1}, T_5 – Farmers' Practice, T_6- Native fertility. The experiment was laid out in a randomize complete block design replicated 3 times. Average results revealed that the T_4 (75% STB+ 5 t PM/ha) produced the highest fruit yield 6.25 t ha^{-1} and lowest 3.67 t ha^{-1} in control treatment. An inclusion of 10 t PM/ha can reduce 25% of chemical fertilizer. Integrated use of PM at the rate of 5 t ha^{-1} with 75% STB dose were found to be the best combinations in respect of dry chilli yield and fertility management by enriching the soil with organic matter.

Keywords: nutrient uptake, poultry manure, chemical fertilizers, yield of chilli

INTRODUCTION

Chilli (*Capsicum frutescens* L.) belong to the nightshade family, *Solanaceae* and originates from South America; the name comes from Nahuat via the Spanish word chilli (Wikipedia, 2006) is an important spice crop grown all over Bangladesh. Chillies are very rich in vitamin C and pro-vitamin A, particularly the red chilies. Yellow and especially green chillies (which are essentially unripe fruit) contain a considerably lower amount of both substances. In addition, peppers are a good source of most B vitamins, and vitamin B6 in particular. They are very high in potassium and high in magnesium and iron. Their high vitamin C content can also substantially increase the uptake of non-heme iron from other ingredients in a meal, such as beans and grains (Sparkyby, 2006). The yield of chillies obtained in Bangladesh is far less than the potential exists. The causes of low yield may be due to improper cultural operations, inputs etc. Chilli occupies nearly 1.04 thousand ha with annual production 1.14 lac. Mt. (Anonymous 2004). The average yield of chilli is 0.08 t ha^{-1} (Anonymous 2004) which is comparatively low in respect to other countries. Of the inputs, N. P. K. fertilizers play a significant role in successful chillies production (Jack *et al.*, 2006). The reasons for this low yield are multifarious. The most important reasons are inadequate and irrational use of fertilizers by the farmers and the depletion of native soil fertility and soil productivity due to intensive cropping.

The variety, local is widely adapted in the hilly regions of Bangladesh. The yield of chilli is greatly influenced by organic and inorganic fertilizers. Improved soil fertility is a pre-requisite for increasing crop productivity. The practice of chemical fertilizer with Poultry Manure is important for sustainability of soil fertility of Bangladesh. Organic manure not only supply nutrients into the soil but also enriches the physical properties of soil. On the other hand, chemical fertilizers only supply nutrients into the soil. There are several factors, which are responsible for low yield i.e. unavailability of approved varieties, lack of modern technology and technical guidance. Among the various factors affecting the yield, the most important one is to supply an adequate amount of organic and chemical fertilizers. Sethupathi (1978) obtained the highest yield (1.6 t dry pod ha^{-1}) by applying 50 kg N, 25 kg P and 25 kg K ha^{-1} in India. Sharma *et al.* (1996) investigated the effects of N (0, 60, 90 or 120 kg/ha) and P (0, 30 or 60 kg/ha) on the growth of chilli (cv. Jawahar Mirch 218) at Jabalpur, India, during 1991-92. K (40 kg K_2O ha^{-1}) was applied to all plots. Singh *et al.* (1997) evaluated the performance of Capsicum cv. Scotch Bonnet in response to farmyard manure, NPK (150:75:75 kg/ha) or vermincompost at Saklespur, Karnataka, India. No significant differences in yields were observed due to the different fertilizer treatments. The proper combination of organic and chemical fertilizers enhances the growth and development of the crop.

The use of inorganic chemical fertilizers is expensive and also hazardous to the soil environment. Chemical fertilizer causes problems not only to the soil health but also to the human health and physical environment.

Considering the above facts, the present study was undertaken to determine the effect of poultry manure in combination with chemical fertilizers on the yield and nutrient uptake by chilli in the hilly region.

MATERIALS AND METHODS

The study was conducted at hill valley of HARS, Khagrachari using the chilli variety local, was initiated from *rabi* seasons of 2007-2009. The initial soil samples of the experimental field were collected and analyzed following standard methods. The analytical report has been presented in Table 1.

Table 1a. Analytical data of the experimental soils

Location	pH	OM (%)	Ca	Mg	K	Total N (%)	P	S	Zn
			meq/100g				µg g^{-1}		
HARS, Khagrachari	5.4	0.60	2.3	2.6	0.16	0.078	6.5	12	1.8
Critical level	-	-	2.0	0.8	0.20	-	14	14	2.0

Table 1b. Nutrient status of poultry manure and cowdung used in the experimental field

Name of the manure	pH	OM (%)	Ca	Mg	K	Total N (%)	P	S	B	Zn	Pb	Cd	As
			meq/100g				µg g^{-1}			µg g^{-1}			
Poultry manure	7.3	16.3	11.0	2.4	1.02	1.08	1.4	0.5	0.09	0.10	10.0	Tr.	2.90

The experiment consisted of six treatments, viz., T_1- 100% STB (soil Test base) chemical fertilizer dose for high yield goal N_{100} P_{65} K_{100} S_{20} Zn_4 kg/ha, T_2- 100% STB + 2.5 ton PM ha^{-1}, T_3 - 75% STB + 2.5 ton PM ha^{-1}, T_4- 75% STB + 5 ton PM ha^{-1}, T_5 – Farmer's Practice, T_6- Native fertility. The experiment was laid out in RCB design with three replications. The unit plot size was 5m x 3 m with spacing of 40cm x 30cm. Thirty days old chilli seedlings were transplanted. All the intercultural operations were done as and when necessary. The crop was harvested eight times after the fruit maturity. The field data on important parameters were recorded from 10 randomly selected plants for analysis. The data were collected on plant height, fruit length, fruit diameter, weight of fruit, fruit weight per plant and yield (t ha^{-1}). Data on different yield contributing parameters and yield were recorded and analyzed statistically and adjusted with least significant difference (LSD) at 5% level of significance.

Methods of chemical analysis

Soil pH was measured by a combined glass calomel electrode (Jakson, 1958). Organic carbon determination by wet oxidation method (Walkley and Black). Total N was determined by modified Kjeldahl method. Ca and Mg were by KCl extractable method. K, Cu, Fe, Mn and Zn were determined by $NaHCO_3$ extraction followed by AAS reading. Boron was determined by $CaCl_2$ extraction method. Phosphorus was determined by Bray and Kurtz method. S was determined by turbidity method with $BaCl_2$.

RESULTS AND DISCUSSION

Plant height

The effect of applied fertilizer on plant height of chilli was non-significant. (Table 2). However, plant height at maturity varied from 75.27 to 89.13cm (2009), 70.50 to 87.9 cm (2008) and 73.26 to 87.80 cm (2007) where the highest result was observed in 100% STB with 2.5 ton PM ha^{-1} followed by 75% STB + 5 ton PM ha^{-1} and lowest in control but this variation was statistically non-significant.

Weight of fruit (gm)

There was no significant effect of added fertilizer on the fruit weight of chilli (Table 2). However, the fruit weight varied from 1.43 to 1.89 cm, where the highest result was observed with 100% STB with 2.5 ton PM ha^{-1} and the lowest in control but the variation was statistically non-significant. The second highest was recorded under T_4 treatment. The above results showed that fertilizer virtually had no effect on the fruit weight of chilli plant.

Fruit length (cm)

Added fertilizer provided significant effect on the fruit length of chilli (Table 2). However, the length of the chilli varied from 5.42 to 7.21 cm, where the highest result was observed with 100% STB + 2.5 ton PM ha^{-1} and the lowest in control but the variation was statistically non-significant. The second tallest fruit was recorded 75% STB + 5 ton PM ha^{-1} treatment. The above results showed that fertilizer virtually had no effect on the fruit length of chilli plant.

Fruit diameter (mm)

There was no significant effect of added fertilizer on the fruit diameter of chilli (Table 2). However, the fruit diameter varied from 6.00 to 8.15 mm (2009), 6.30 to 7.41 mm (2008) and 6.10 to 7.75 mm (2007) where the highest result was observed with 100% STB with 2.5 ton PM ha^{-1} and the lowest in control but the variation was statistically non-significant. The second highest was recorded under T_4 treatment. The above results showed that fertilizer virtually had no effect on the fruit weight of chilli plant.

Fresh fruit weight/plant

The fresh fruit weight was remarkably maximum (460 g $plant^{-1}$) in plots fertilized with 100% STB with 2.5 ton PM ha^{-1} application followed by average fresh fruit weight of 430 and 398 g $plant^{-1}$ achieved from the treatments under application of 75% STB + 5 ton PM ha^{-1} and 100% STB dose fertilizer, respectively (Table 3). However, the minimum fresh fruit weight of 283 g $plant^{-1}$ was obtained in control plots. These results are in line with those of Patil and Biradar (2001) who applied foliar fertilizer "Polyfeed" and found significant effect on fruit weight of chillies.

Table 2. Yield components of chilli as influenced by organic and inorganic fertilizer at Khagrachori during 2007-2009

Treatment	Plant height (cm)			Weight of fruit (gm)			Fruit length (cm)			Fruit diameter (mm)		
	2009	2008	2007	2009	2008	2007	2009	2008	2007	2009	2008	2007
T_1	87.80	83.73	77.70	1.73	1.8	1.69	6.58ab	6.2ab	6.16ab	6.98bc	6.96	7.05ab
T_2	89.13	87.90	87.80	1.78	1.89	1.78	7.21a	6.82a	7.07a	8.15a	7.41	7.75a
T_3	82.13	82.13	81.13	1.57	1.81	1.65	6.21bc	6.56ab	6.33abc	6.92bc	6.93	6.95ab
T_4	87.30	85.16	86.30	1.74	1.85	1.74	6.69ab	6.39ab	6.73ab	7.73ab	7.03	7.17ab
T_5	84.30	81.33	75.63	1.68	1.69	1.64	5.32c	5.88bc	6.06bc	6.11c	6.38	6.30b
T_6	75.27	70.50	73.26	1.43	1.57	1.51	5.59c	5.42c	5.67c	6.00c	6.3	6.10b
F-test	NS	NS	NS	NS	NS	NS	**	**	**	**	NS	**
CV%	8.28	8.78	7.42	8.63	7.02	6.92	7.54	6.48	7.36	7.87	6.18	7.96

Fresh fruit yield (t ha^{-1})

Data regarding the effect of organic fertilizer showed signification variation on the yield of chilli (Table 3). On an average the highest yield (6.25 t ha^{-1}) was found in T_2 (100% STB + 2.5 t PM ha^{-1}) treatment and the lowest in control (T_6). However, at first, second and third year the highest yield 6.37 t ha^{-1}, 6.15 t ha^{-1} and 6.22 t ha^{-1} of chilli were obtained from the use of 100% STB with 2.5 ton PM ha^{-1} and the statistically identical result was found in T_4 (75% STB + 5 t PM ha^{-1}) and T_1 (100% STB + 2.5 ton PM ha^{-1}) treatments. Application of 5 t PM ha^{-1} might increase the physical properties of soil which was again enhanced by the use of 75% STB. As a result growth and yield of chilli was increased in the stated treatment. It is also revealed from the experiment that combined application of chemical and organic fertilizer is effective for the production of chilli. However, the average lowest yield (3.67 t ha^{-1}) was obtained from control treatment.

Table 3. Yield of chilli as influenced by organic and inorganic fertilizer at Khagrachori during 2007-2009

Treatment	Fresh fruit weight $plant^{-1}$ (gm)			Yield (t ha^{-1})				% yield increase over control
	2009	2008	2007	2009	2008	2007	Mean	
T_1	398ab	375.6b	397a	5.85ab	5.52ab	5.72ab	5.70	55.19
T_2	460a	482.3a	440a	6.37a	6.15a	6.22a	6.25	70.18
T_3	385bc	375.0b	382a	5.51b	5.31b	5.48b	5.43	48.08
T_4	430ab	448.4a	428a	5.92ab	5.58ab	5.89ab	5.80	57.95
T_5	326cd	286.1c	325b	4.55c	3.85c	4.87c	4.43	20.65
T_6	283d	240.7c	295b	3.62d	3.55c	3.84d	3.67	
F-test	**	**	**	**	**	**	-	-
CV%	8.56	7.15	8.29	7.36	7.56	6.16		-

Apparent Nutrient Balance

Apparent Nutrient balance of a particular element was estimated on the basis of nutrient added to the soil and the amount of nutrient uptake by the plant. The difference between the nutrient input (addition) and output (uptake) can be regarded as apparent nutrient balance. Positive balance indicates nutrient accumulation and negative balance shows nutrient depletion. To achieve sustainability, the quantity of nutrient input and output could be equal. Nutrient mining may eventually cause soil degradation and affect crop production. On the other hand, excess nutrient accumulation may lead to soil and water pollution. However, the balance sheets of

different nutrients are presented in Figure 1 with subsequent discussion as below. In all cases, N balance is negative. In T_6 treatment, all the nutrient balance is negative as because no additional nutrient is add to the soil in spite of nutrient uptake.

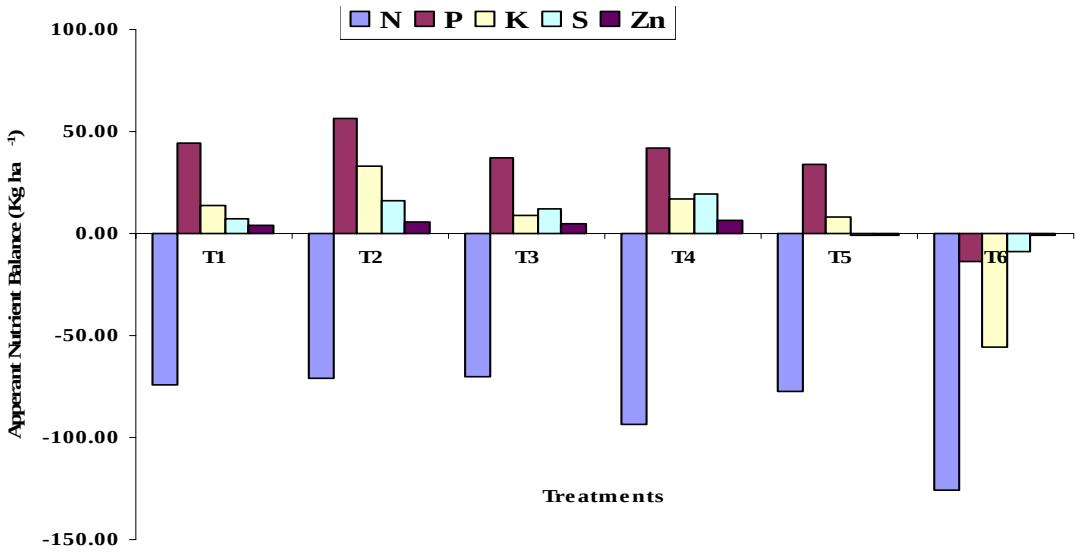

Figure1 Apparent nutrient Balance as affected by different nutrient packages

CONCLUSION

Based on a three year s trial it can be concluded that 100%STB based fertilizer with 2.5 t ha^{-1} poultry manure gave highest yield. But poultry manure 5.0 t ha^{-1} along with 75% recommended dose of chemical fertilizer (N_{75} P_{50} K_{75} S_{15} Zn_3 kg/ha) may be recommended for chilli cultivation in the hilly region.

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