Production and Nutrient Uptake of Sweet Corn Treated with Manure 'plus' and Inorganic Fertilizer

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Abstract

Most of the land in Indonesia used for food-crops production belongs to acid soil characterized by low phosphorus (P), and low pH. Rock phosphate (RP) and scallop shell meal as phosphorus source, combined with manure maybe a promising technique to overcome those problems. A field experiment was conducted on an acid soil (low pH and low available Bray II extractable P) to evaluate the effect of manure, manure 'plus' (RP and scallop shell meal, combined with manure), and inorganic fertilizer on corn production and nutrient uptake of stover. A completely randomized block design with 3 replicates was used. The treatments were manure (T1), manure 'plus' (T2), RP+ZA (T3), SP+urea (T4), manure+RP+ZA (T5), manure+SP+urea (T6), manure 'plus'+RP+ZA (T7), manure 'plus'+SP+urea (T8). Dosage of manure was 1 ton/ha. Dosage of N, and P was 200 kg N/ha, and 150 kg P2O5/ha, respectively. All plot received basal fertilization of KCl (150 kg K2O/ha). Zea mays saccharata was cut at ground level on 70 days after planting and analyzed for dry matter yield, nitrogen and phosphorus uptake. Result showed that corn production and nutrient uptake, significantly influenced by the treatment. Manure 'plus' (T2) resulted nutrient uptake of stover significantly higher compared to manure (T1). Manure 'plus' combined with inorganic fertilizers (T7, T8) resulted in significantly higher of corn production and nutrient uptake compared to T1 and T2, and tend to be higher compared to the other treatments. Therefore, manure 'plus' (RP+scallop shell meal+manure) could improve the quality of manure and increased corn production and nutrient uptake in acid soil.

Key words: manure, nitrogen, phosphorus, scallop shell meal, Zea mays saccharata

Introduction

Crop-livestock system (CLS) has been used by farmers in Indonesia. The characteristic of CLS is crops yield for food, stover for ruminant feed and manure can be used as organic fertilizer. Farmyard manure is traditionally widely used for improving soil fertility, but since it is relatively low in phosphorus in relation to nitrogen and potassium, it is often supplemented with a phosphatic fertilizer or with a mixed fertilizer with a high phosphate component (Ann, 1993). Superphosphate fertilizer (SP) has been widely used to improve food crop production on non-productive lands in Indonesia. However, the high cost of SP is now focusing attention on rock phosphate (RP) fertilizer and scallop shell meal as P sources. In addition, Lukiwati (2002) showed that RP and SP fertilizer increased maize grain yield, dry matter (DM) stover yield of maize stover over those of the control that did not receive P fertilizer. Finely ground RP is an apatite mineral not readily soluble in water, and when added to acid condition, the solubilization of RP is increased. Therefore, and expensive P source (SP) can be replaced by RP when the application of the latter is combined with amonium sulphate fertilizer (Lukiwati *et al*., 2001) or decomposition process of organic materials (Sumida and Yamamoto, 1997). Combination of manure 'plus' and inorganic fertilizer as being an alternative strategy for more rational and sustainable agriculture. The objective of the research was to investigate the influence of manure and manure 'plus' combined with inorganic fertilizer (N, P) on sweet corn yield and nutrient uptake of stover in the acid soil.

Materials and Methods

A field experiment of completely randomized block design with three block as replicates was conducted in Semarang-Central Java Indonesia, during 70 days on acid soil with the following pH values 5.15 (block I), 5.30 (block II), and 5.11 (block III). Available P (Bray-I) was 2.17 (block I), 1.48 (block II), and 1.18 ppm (block III). Soil nitrogen content (%N) were 0.132 (block I), 0.164 (block II), and 0.142 (block III). Thus the soil was acid, low in both of P and N content. The experiment was conducted on 350 m^2 divided into 24 plots. Each plot size was 3m x 3m or 9 m^2. The treatments consisted of P fertilizers from two sources; RP-27 and SP-18. Nitrogen fertilizers from two sources; urea and amonium suplphate. Level of both P and N fertilizers was at 66 kg P/ha and 100 kg N/ha, respectively. Level of manure and manure 'plus' at 1 ton/ha. Manure made from cattle dung and urine mixed with waste of forage of straw waste, while it combined with P and scallop shell meal as P source was called manure 'plus'. A basal application fertilizer was KCl at 125 K/ha, was applied to each plot. The treatments of fertilization were T1 (manure), T2 (manure 'plus'), T3 (RP + AS), T4 (SP + urea), T5 (manure + RP + ZA), T6 (manure + SP + urea), T7 (manure 'plus' + AS), T8 (manure 'plus' + urea). Sweet corn seed

was dibbled into small holes, spaced 100 x 50 cm. Each plot contained 30 plants from 15 holes planting. The sweet corn was harvested at 70 days after planting. After harvesting of sweet corn, the stover was cut close to the ground and measured for DM yield, nitrogen and phoshorus uptake. The analyses of variance for sweet corn yield, DM yield, N and P uptake of stover were made using the general linear model procedue of SAS. Significant differences among the treatments were calculated using DMRT.

Results and Discussion

Result showed that sweet corn yield, DM yield, N and P uptake of sweet corn stover (Table 1) were significantly ($P<0.05$) influenced by the treatments. Table 1 showed that manure 'plus' (T2) resulted sweet corn yield and DM yield non-significantly different compared to manure (T1). The application of manure 'plus'combined with inorganic fertilizer (T7 and T8) resulted in significantly different of sweet corn yield and DM yield of stover compared to manure and manure 'plus' only (T1 and T2). Inorganic fertilizer (T3 and T4) resulted in non-significant difference on sweet corn yield compared to T1 and T2. Dry matter production with SP+urea (T4) showed significantly higher compared to T1 and T2. Dry matter production of T3 showed a significant difference compared to T1 and tend to higher compared to T2. Manure + SP + urea (T6) resulted in significantly higher of corn production compared to T1 and T2, while T5 significantly different compared to T1 and tend to higher compared to T2. However, the application of manure combined with inorganic fertilizer (T5 and T6) resulted in significant different of DM yield of stover compared with T1, T2, T3 and T4. Application of both manure and manure 'plus' resulted in similar sweet corn yield, and DM yield of stover compared in the same combinations of inorganic fertilizers, i.e. T5 vs T7, and T6 vs T8. Combination of N and P fertilizers from difference sources resulted in similar sweet corn yield, and DM yield of stover, i.e. T3 vs T4.

Application of manure and manure 'plus' combined with inorganic fertilizers T5, T6 and T7, T8 resulted in N and P uptake of sweet corn stover non-significantly different. Application of T5, T6 and T7, T8 resulted N and P uptake tend to be higher compared with inorganic fertilizer only (T3, T4). Combination between organic and inorganic fertilizer resulted nutrient uptake tended to be higher compared to inorganic only. The application of manure and manure 'plus' combined with inorganic fertilizers (T7 and T8) resulted in significantly different of phosphorus and nitrogen uptake of sweet corn stover compared to manure and manure 'plus' only (T1 and T2). Inorganic fertilizer (T3 and T4) resulted in significantly different on N and P uptake of sweet corn stover compared to T1 and non-significantly different compared to T2.

Table 1. Production of sweet corn and dry matter, nitrogen and phosphorus uptake of stover with manure 'plus' and inorganic fertilizer

Treatments	Sweet corn (kg/m^2)	Dry matter	N uptake (g/m^2)	P uptake
Manure (T1)	0.63^{c}	139.90^{e}	2.01^{d}	0.72^{c}
Manure 'plus' (T2)	0.81^{bc}	161.43^{de}	3.07^{c}	1.01^{b}
RP + AS (T3)	1.02^{abc}	170.49^{cd}	3.17^{c}	0.88^{b}
SP + urea (T4)	1.05^{abc}	199.96^{bc}	3.36^{bc}	0.91^{b}
M + RP + AS (T5)	1.15^{ab}	222.74^{ab}	3.84^{ab}	1.14^{ab}
M+SP+urea (T6)	1.31^{a}	248.79^{ab}	4.11^{ab}	1.42^{a}
M'plus'+ AS (T7)	1.36^{a}	269.87^{ab}	4.82^{ab}	1.39^{a}
M'plus'+ urea (T8)	1.51^{a}	279.49^{a}	5.38^{a}	1.21^{ab}

Different superscript in the same column means significantly different ($P<0.05$).

Inorganic fertilizers (T3 and T4) resulted in higher on sweet corn yield, DM production, N and P uptake of stover compared to organic fertilizers (T1 and T2). Soil fertility is more limited without inorganic fertilizers (ntrogen and phosphorus), and only using manure or manure 'plus' (Min *et al*., 2002). Nutrient content (P, N) of manure 'plus' (T2) was increased, because made from manure with RP and scallop shell meal added. The agronomic effectiveness of RP can be enhanced through acid condition (Bationo and Kumar, 2002; Lukiwati, 2002). Sumida and Yamamoto (1997) showed that decomposition process of organic materials could released organic acids, and decreased pH and redox potential might have increased the availability of plant nutrients which high solubility in acid condition. Therefore, manure 'plus' (T2) resulted in higher of sweet corn yield, DM production, and nutrient uptake compared to manure (T1) only. Combination between manure and manure 'plus' with N and P fertilizers increased the availbility of soil nutrient i.e N and P for sweet corn plant (Lukiwati *et al*., 2010). Combination between manure or manure 'plus' with inorganic fertilizers (N and P) could improve nutrient balance for sweet corn plant. Application of both manure or manure 'plus' resulted in similar sweet corn yield, DM yield and nutrient uptake of stover compared in the same combination of inorganic fertilizers. The dosage of both organic and inorganic fertilizers were not different, respectively. Combination of N and P fertilizers from different sources resulted in similar of sweet corn yield, and DM yield of stover. The dosage of those fertilizers were not different, respectively. Therefore, sweet corn yield, DM and nutrient uptake response to those fertilization were not different as well. The same result reported by Toth *et al*. (2006). N and P – based manure applications did not differ in ability to supply nutrients for crop growth. Lukiwati *et al*. (2001) reported that P fertilizers (SP, RP) in combination with N fertilizers (AS,

urea) resulted in similar DM yield and crude protein content of *Setaria splendida.* According to Nassir (2001), reactive RP when it was directly applied at initial rates of between 80-360 kg P_2O_5/ ha, not only increased yields of corn, but resulted in similar yields than SP and also increased soil pH. Phosphorus fertilizers could increase the plant growth, especially if the P nutrient is a major limiting factor to the plant production (Lukiwati, 2002). Combination between manure or manure 'plus' with inorganic fertilizer could improve nutrient balance for sweet corn plant.

Conclusions

Manure 'plus' resulted in higher of sweet corn yield, dry matter yield and nutrient uptake of stover compared to manure only. Organic fertilzers (manure and manure 'plus') combined with inorganic fertilizes resulted in higher of sweet corn yield, DM yield and nutrient uptake of stover compared to application both of organic' or inorganic fertilizers separatedly. Therefore, organic fertilzer could increase sweet corn yield, DM yield, and nutrient uptake in acid soil, if it is combined with inorganic fertilizer.

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