Effect of Organic and Inorganic Fertilizer Combinations on Yield, Dry Matter Production, and Crude Protein Content in Stover and Cornhusk

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ABSTRACT. Crop-livestock system is a common practice in most farmers in Indonesia. The characteristic of crop-livestock system is crops yield for food, stover for ruminant feed and manure can be used as organic fertilizer which is important to maintain the fertility of cultivated soils. Indonesian farmers feeding the stover of sweet corn (*Zea mays saccharata*) to their livestock. Manure has been widely used for improving soil fertility, but it is often combined with inorganic fertilizer. The high cost of super phosphate (SP) has caused farmers to alter the use of other sources, are now focusing attention on rock phosphate (RP). Amonium sulphate (AS) lead in some circumtances to acidification of the soil. Therefore, SP can be replaced by RP when the application of the latter is combined with AS. The objective of the research was to investigate the influence of organic fertilizer combined with inorganic from different sources on sweet corn and dry matter (DM) production and crude protein concentration of stover and cornhusk. A field experiment of completely randomized block design with three block as replicates was conducted on acid latosolic soil. Level of both P (SP, RP) and N (urea, AS) fertilizers was 66 kg P/ha, and 200 kg N/ha, respectively. Organic fertilizers were manure and super petro organic (SPO) each at 5 ton/ha. Application of KCl fertilizer (50% K_2O) was at 125 kg K/ha according to the assigned treatment. The treatments were T0 (control), T1 (manure), T2 (SPO), T3 (BP + AS + KCl), T4 (SP + urea + KCl), T5 (manure + BP + AS + KCl), T6 (manure + SP + urea + KCl), T7 (SPO + BP + AS + KCl), and T8 (SPO + SP + urea + KCl). The sweet corn was harvested at 70 days after planting, and the stover was cut close to the ground and measured for DM yield and crude protein content of both stover and cornhusk. The analyses of variance for sweet corn and DM production, crude protein of stover and cornhusk were made using the general linear model procedure of SAS. Significant differences among the treatments were calculated using Duncan's Multiple Range Test (DMRT). The result showed that the combination of organic and inorganic fertilizers from different sources (T5, T6, T7, T8) produced highers yield sweet corn, DM production, crude protein content of stover and cornhusk compared to those of the application of organic or inorganic fertilizer, separatedly (T1, T2, T3, T4) and was significantly higher to control (T0). Application of RP+AS compared to SP+urea with or without manure resulted in similar of maize and DM production and crude protein content of stover and cornhusk.

Keywords: manure, nitrogen, phosphorus, super petro organic, sweet corn.

Introduction

Crop-livestock system is a common practice in the farmers in Indonesia. The characteristic of crop-livestock system is that crops yield is used for food, stover for ruminant feed and manure be used as organic fertilizer which is important to maintain the fertility of cultivated soils. Javanese farmers feed the stover of sweet corn and cornhusk to livestock. Manure has traditionally been 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. However, the high cost of super phosphate (SP) has caused farmers to focus their attention on rock phosphate (RP). Finely ground RP is an apatite mineral not readily soluble in water, and when added to acid soils, the solubility of RP is increased.

The availability of inorganic P is enhanced under acidic conditions in the soil (Nassir 2001). Amonium sulphate (ZA) can lead in some circumtances to acidification of the soil. Therefore, an expensive P source (SP) can be replaced by RP when the application of the latter is combined with ZA fertilizer (Lukiwati *et al*. 2001). Combination of organic fertilizer and inorganic fertilizer is considered an alternative strategy for more rational and sustainable agriculture. Most of the soils in Indonesia that are cultivated for crops production, such as latosolic soils, are deficient in P, N, and low in soil pH. The objective of the research was to investigate the influence of organic fertilizer combined with inorganic fertilizer on sweet corn and dry matter production, and crude protein content of both stover and cornhusk in the latosolic soil.

Materials and Method

A field experiment was conducted in a completely randomized block design with three replications in Semarang, Central Java, Indonesia, on the latosolic soil with low pH and low in both of P and N content. The experiment was conducted on 250 m^2 divided into 27 plots, and each plot size was 7.5 m^2. The treatments consisted of P fertilizers from two sources; RP and SP containing 27% and 18% P_2O_5, respectively. Nitrogen fertilizers from two sources; urea (45% N), and ZA (21% N, 24% S). Level of both P and N fertilizers was 66 kg P/ha, and 200 kg N/ha, respectively.

Organic fertilizers were poultry manure and super petro organic (SPO). Level of organic fertilizer (poultry manure and SPO) at 5 ton/ha, each. Application KCl fertilizer rate of 125 kg K/ha according to the assigned treatment. The treatments were T_0 (control), T_1 (manure), T_2 (SPO), T_3 (BP + ZA + KCl), T_4 (SP + urea + KCl), T_5 (manure + BP + ZA + KCl), T_6 (manure + SP + urea + KCl), T_7 (SPO + BP + ZA + KCl), and T_8 (SPO + SP + urea + KCl).

The sweet corn was harvested at 70 days after planting, and the cornhusk were removed. After harvesting, the stover was cut close to the ground and measured for DM production, and crude protein content of both stover and cornhusk. DM production was measured by DM content in % x fresh stover cornhusk yield. The harvested stover and cornhusk were chopped, sub-sampled, and oven-dried to constant weight at 70^0C for 48 h and weighed. These samples were finally ground and analyzed for N content (Islam *et al*. 1992). Crude protein content was measured by N concentration in % x 6.25.

Table 1. Sweet corn yield and dry matter yield of sweet corn grown in the field with different combinations of organic and inorganic fertilizers.

Treatment (fertilizer combination)	Corn ears (t/ha)	Dry matter production	
		Stover (t/ha)	Cornhusk (t/ha)
T_0 (control)	12.56 c	4.21 b	1.09 b*
T_1 (manure)	15.67 bc	5.61 ab	1.72 ab
T_2 (SPO)	14.20 c	4.79 ab	1.17 b
T_3 (RP + ZA + KCl)	16.81 abc	4.68 b	1.43 ab
T_4 (SP + urea + KCl)	15.85 bc	4.63 b	1.41 ab
T_5 (manure + RP + ZA + KCl)	19.95 ab	5.53 ab	1.85 ab
T_6 (manure + SP + urea + KCl)	20.83 a	5.89 ab	2.14 a
T_7 (SPO + RP + ZA + KCl)	20.26 ab	6.60 a	1.84 ab
T_8 (SPO + SP + urea + KCl)	19.41 ab	5.36 ab	2.01 a

Numbers in each column followed by the a common letter are not significantly different by the Duncan's Multiple Range Test at 5% of significance.

The analyses of variance for sweet corn yield without cornhusk, dry matter production of stover and cornhusk, and crude protein of both stover and cornhusk were made using the general linear model procedure of SAS. Significant differences among the treatments were calculated using Duncan's Multiple Range Test (DMRT) at 5% level of significance.

Results and Discussion

Applications of different combinations of organic and inorganic fertilizers from different sources (T5, T6, T7, and T8) on sweet corn resulted in higher yields of husked sweet corn and DM production (Table 1), crude protein of stover and cornhusk (Table 2) compared to the application of organic or inorganic fertilizer, separatedly (T1,T2, T3, and T4). Soil fertility is more limited if inorganic or organic was used only (Min *et al*. 2002). The agronomic effectiveness of RP can be enhanced through acid condition (Bationo and Kumar 2002). Sumida and Yamamoto (1997) showed that organic material in the soil could increase the availability of plant nutrients because of high solubility under acid condition.

Lukiwati *et al*. (2010) reported, combination between manure with N and P fertilizers increased the availability of soil nutrient, i.e. N and P for sweet corn plant. Combination between organic with inorganic fertilizers made nutrient balance for sweet corn plant. Application of RP+ZA or SP+urea combined with organic (T5, T6, T7, and T8) or without organic fertilizer (T3 and T4) resulted in similar of sweet corn yield, DM and crude protein content of stover and cornhusk.

Table 2. Crude protein content in stover and cornhusk of sweet corn grown in the field with different combinations of organic and inorganic fertilizers.

Treatment (fertilizer combination)	Stover (%)	Cornhusk (%)
T_0 (Control)	8.48 b	3.08 cd
T_1 (Manure)	9.79 ab	2.64 d
T_2 (SPO)	8.79 b	3.56 c
T_3 (RP + ZA + KCl)	9.56 ab	5.10 a
T_4 (SP + urea + KCl)	12.06 a	4.19 b
T_5 (manure + RP + ZA + KCl)	9.77 ab	4.65 ab
T_6 (manure + SP + urea + KCl)	10.64 ab	4.70 ab
T_7 (SPO + RP + ZA + KCl)	10.38 ab	4.54 ab
T_8 (SPO + SP + urea + KCl)	11.91 a	4.75 ab

Numbers in each column followed by the a common letter are not significantly different by the Duncan's Multiple Range Test at 5% of significance.

Combination of N and P fertilizers from different sources resulted in similar sweet corn yield, DM and crude protein. Sweet corn yield, DM and crude protein responded samilarly to various of N-P fertilizers. The same result was reported by Toth *et al*. (2006), N and P derived from manure applications did not differ in supplying nutrients for crop growth. In addition Lukiwati *et al*. (2001) reported that P fertilizers (SP, RP) in combination with N fertilizers (ZA, urea) resulted similiar DM yield and crude protein content of *Setaria splendida*. According to Nassir (2001), reactive RP when directly applied at initial rates of 80 to 360 kg P_2O_5/ha, increased yield of corn, result obtained from the application of SP and it also increased soil pH. Phosphorus fertilizers could increase plant growth, especially if the P nutrient is a major limiting factor to the plant production (Lukiwati 2002). Combination between organic and inorganic fertilizer may improve nutrient balance for sweet corn plant in the acid soil.

Conclusions

Combination of organic and inorganic fertilizer applications on sweet corn resulted in higher ear yields, dry matter, and crude protein contents in stover and cornhusk, compared to the application of organic or inorganic fertilizers alone. Application of RP + ZA and SP + urea with or without organic fertilizers on sweet corn produced similar ear yield, dry matter production as well as crude protein contents in stover and cornhusk.

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