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Effect of Sugarcane Pressmud Biocompost on Dry Matter Yield and Nutrient Uptake in Maize

Korai, P.K*, Memon, K.S*, Genxing Pan, Rajper, A.A, Jamro, G.M, Korai, S.K and Jarwar, A.D**
* Sindh Agriculture University,Tando Jam.
** Agriculture Research Institute Tando jam Sindh Pakistan.
Contact information: Institute of Recourses, Ecosystem and Environment of Agriculture, Nanjing agriculture university, 1 Weigang, Nanjing, 210095-China.
Author: punhoonkorai@gmail.com

Abstract

An experiment was conducted to determine the nutrient contents and manurial value of biocompost, collected from Matiari Sugar Mill, Matiari and analyzed for macro nutrients N, P and K. The biocompost was evaluated in a pot experiment on maize crop with eight treatments in factorial combinations of two rates of biocompost (0 and 10 tons ha^{-1}) and four fertilizer treatments (0-0-0, 150-0-0, 150-75-0 and 150-75-60 kg ha^{-1} N, P and K) . The treatments were replicated three times in a randomized complete block design and maize was grown for 7 weeks. The soil was a clay loam (31% clay) with EC 0.35 dSm^{-1}, pH 7.87, low in organic matter (0.80%) and Olsen P (7.0 mg kg^{-1}) and high in NH_4OA_C-K (320 mg kg^{-1}). The nutrient contents of biocompost were 1.8% N, 1.83% P and 0.9% K. Results revealed that there were pronounced positive effects of addition of biocompost, as well as N on plant height and dry weights of maize. Plant analysis data showed that the effect biocompost and mineral fertilizers was non-significant with respect to N, P and K contents. Soil analytical data showed that the EC values of post harvest samples increased with the application of biocompost while pH was not affected. Soil organic matter, Olsen P and NH_4OA_C-K increased significantly with the application of biocompost. Fertilizer application also increased Olsen P and NH_4OA_C-K contents in soil. The results of this study showed that biocompost can be used along with mineral fertilizers to increase maize growth and dry matter yield.

Keywords: Maize, Dry matter yield, Pressmud Biocompost;

INTRODUCTION

Generally the soils of Pakistan are deficient in N, whereas 80% soils are deficient in P and 30-40% soils are also deficient in K. Majority of soils contain <1.0% organic matter. Continuous cropping without application of organic materials is leading to depletion of available nutrients and organic matter. The situation calls for integrated use of organic sources of nutrients such as FYM, poultry manure, press mud etc., along with mineral fertilizer sources.

Among the organic sources of nutrition, pressmud occupies unique position as a by-product of sugar industry. Pressmud can serve as a good source of organic matter (Bokhtiar *et al.*, 2001), an alternate source of crop nutrients and soil ameliorant (Razzaq, 2001). It is also known as filter cake or filter mud, and used as fertilizer in soils (Raman *et al.*, 1999; Barry *et al.*, 2001). It contains much of the colloidal organic matter anions that precipitate during clarification, as well as certain non-sugar occluded in these precipitates. It is the residue obtained from sedimentation of the suspended materials such as fiber, sugar, wax, ash, soil and other particles from the cane juice. The organic fraction of pressmud is 15-30% fiber, 5-15% crude protein, 5-15% sugar, 5-15% crude wax and fats and 10-20% ash comprising oxides of Si, Ca, P, Mg and K (Partha and Sivasubramanian, 2006). This organic matter is highly soluble and readily available to the microbial activity and so to the soil (Gaikwad *et al.*, 1996; Rangaraj *et al.*, 2007).

The weight of wet filter mud (80% water) averages about 3.4% cane. There are many physical, chemical and biological advantages of pressmud. It improves structure, texture, aeration, water-holding capacity, and porosity and increases stress tolerance. The yields of various crops including maize and millet showed substantial increases with pressmud (PM) applications (Rangaraj *et al.*, 2007; Elsayed *et al.*, 2008) that were attributed to the improvement in soil physical, chemical and biological conditions (Barry *et al.*, 2001).

Maize dry matter yields increased with increasing nitrogen and pressmud rates (Bangar *et al.*, 2000). Memon (2005) reported that the raw pressmud had depressing effect on dry matter yield of maize, and that the benefit of previously applied pressmud was evident in the subsequent wheat crop. Viator *et al. (*2002) reported that filter cake increases cation exchange capacity for thirty months after its application and its residual effect remains after four years.

In addition to pressmud, the sugur mills running distillery unit also produce another by product called "spent wash". These two by products and fly ash are mixed in a certain ratio and composted for 4-6 weeks before it is sold as "biocompost" by sugar mills. While pressmud is the basic material used in preparation of biocompost, spent wash is sprinkled on it during composting process. The resulting "biocompost" is therefore considered to be rich in nutrients and ready to be applied to soils as a soil amendment.

Keeping in view the significance of pressmud in the present scenario of agriculture and availability of nutrients, this study was conducted to determine the value of bio-compost prepared from sugar cane pressmud using maize as a test crop.

MATERIALS AND METHODS

A pot experiment was conduced in the Ware House of the Department of Soil Science. Bulk sample of fertile soil (plough layer) was collected from Latif Experimental Farm of Sindh Agriculture University Tandojam. The soil was air dried and passed through 4 mm garden sieve. Ten kilogram air dried soil was placed in each of the 24 plastic pots. The experiment was laidout with eight treatments with three replications in a randomized complete block design (RCBD). The treatments were factorial combination of four rates of mineral fertilizer and two rates of biocompost. The details of the treatment combinations are as under.

Fertilizer treatments (Four)

Control = No fertilizer applied

N = 150 kg N ha^{-1}

NP = 150 kg N+75 kg P_2O_5 ha^{-1}

NPK = 150 kg N + 75 P_2O_5 + 60 kg K_2O ha^{-1}

Biocompost tretments (Two)

1. -Biocompost = No biocompost applied
2. +Biocompost = Biocompost at 10 t ha^{-1}

Analysis

Soil sampling

The soil samples were analyzed for some physico-chemical properties by internationally recognized methods as follows: Soil texture (particle size) by Bouyoucos Hydrometer method as described by Bouyoucos (1962), EC (dSm^{-1}) and pH of 1:5 soil water extract by digital Conductivity Meter and digital pH Meter respectively, organic matter by Walkley-Black method as described by Jackson (1958), available P by Olsen's (Olsen's *et al.* 1954) $NaHCO_3$ (0.5M, pH 8.5) extraction followed by colour development by ascorbic acid method as given by Murphy and Riley (1964), and extractable K by extraction with 1N ammonium acetate followed by analysis of the extract on flame photometer as described by Jackson (1958).

Biocompost and plant

Biocompost used in this study and the plant samples drawn at harvesting from each treatment were analyzed for total N, P and K. Total N was determined by digestion with concentrated H_2SO_4 along with a mixture of selenium, $CuSO_4$ and K_2SO_4 in 0.1:1:10 ratio using Kjeltech Digestion System 20. The digests were distilled by using Kjeltech Distillation Unit 1002 as described by Winkleman *et al.* (1986).

For P and K, the plant samples were digested in 1:5 $HClO_4$: HNO_3 mixture followed by analysis of the digest by vandomolybdophosphoric acid yellow colour method (Barton, 1954) for P and flame photometer for K (Jackson, 1958).

Data analysis

The data were statistically analysed by using software Statistix 8.1 and the calculations were made using following formulae.

1. Standard Error for Difference between Means (S.E.D) was calculated using the following formula: S.E.D = (√2EMS/n) EMS= Error Mean Square.
2. Least Significant Difference (LS.D) = S.E.D x t value for Error df at 5% probability level.
3. Coefficient of Variance (%) = (√MSE / Grand Mean) x 100.

RESULTS AND DISCUSSIONS

Soil properties

The soil used for the experiment was analyzed for some physico-chemical properties (Table 1). The results revealed that the soil was a clay loam (31% clay) with EC 0.35 dSm^{-1}, and pH 7.87. It was low in organic matter (0.80%), and Olsen P (7.0 mg kg^{-1}), and adequate in NH4OAc – extractable K (320 mg kg^{-1}).

Table 1. Physico-chemical properties of the soil used for pot experiment on maize.

Soil property		Values
Texture	Sand (%)	26.5
	Silt (%)	42.5
	Clay (%)	31.0
	Textural Class	Clay loam
EC (1: 5 soil – water extract) (dS m^{-1})		0.35
pH (1:5 soil – water extract)		7.87
Organic matter (%)		0.80
Olsen P (mg kg^{-1})		7.0
NH_4OAc- extractable K (mg kg^{-1})		320

Uptake of N in maize

The data presented on Table 2 showed that there was pronounced positive effect of addition of biocompost as well as mineral fertilizer treatments on N uptake in maize. Overall, the N uptake ranged from 9.03% to 15.41%. On an average, the N uptake increased by 28.2% from 10.39 to 13.20% with addition of biocompost. When biocompost was applied alone to unamended soil, the N uptake increased from 9.03% to 12.21%. Similarly the applications of N fertilizer also increased it significantly to 11.38% and to 15.41% when biocompost was also added. It was noted that there was no effect of P fertilization (NP treatment) on N uptake, and that the addition of K fertilizer (NPK treatment) showed decline in N uptake. The effect of fertilizer and biocompost treatments was similar in all combinations, thus the interaction between fertilizer and biocompost treatments was observed non significant.

Table 2. Effect of biocompost and mineral fertilizer treatments on N uptake in maize.

Fertilizer treatment	- Biocompost	+ Biocomost *	Fertilizer Mean
Control	9.03	12.21	**10.26b**
N	11.38	15.41	**13.39a**
NP	11.63	13.54	**12.59a**
NPK	9.53	11.65	**10.59b**
Biocompost Mean	**10.39b**	**13.20a**	**10.59**

*Biocompost is prepared from sugarcane filtercake and other waste materials of sugarmill, as detailed in methodology section.

C V%	13.03
S.E	1.53
L.S.D @ 5%	
Fertilizer	1.90
Biocompost	1.34
Fertilizer x Biocompost	NS

DISCUSSIONS

Recycling of organic wastes of animal and plant origin is being advocated, along with chemical fertilizers, as a part of integrated plant nutrition management system. Sugarcane filter cake or pressmud is valued as a soil amendment and an important source of crop nutrients. It is discarded as a solid waste from sugarmills or used as manure. It is a source of replenishing nutrients in the soil either alone or in combination with fertilizer to subsidize the input costs (Khattak and Bhatti, 1986, Hussain and Anjum, 1999). Some sugar mills enrich pressmud and convert it into a product called as “Biocompost”. This is done by composting of pressmud after adding distillery spent wash and fly ash in a certain ratio and allowing it to compost for 4-6 weeks before the product is sold as “Biocompost”. This study was undertaken to investigate the comparative value of biocompost and mineral fertilizer in dry matter yield and nutrition of maize.

Nutrient composition on pressmud

Pressmud sample from Matiari Sugar Mills of Sindh revealed that it contained sufficient amount of nutrients for application as soil amendment. Average values of total N, P and K contents were 1.8% N, 1.83% P and 0.9% K. Many workers have reported the nutrient composition of pressmud. Ibrahim *et al.* (1999) collected pressmud samples from five sugarmills of Punjab province of Pakistan and observed variable proportion of plant nutrients from one mill to another. The values ranged from 1.7-2.3, 1.0-1.3 and 0.6-0.8 % N, P and K respectively. Besides this, pressmud also contained sufficient amount of micronutrients, which ranged from 58-71, 4750-5904, 249-330, and 143-220 mg kg-^{1} Cu, Fe, Mn and Zn respectively.

In one study, Memon (2005) collected sample of pressmud from twenty-one sugarmills of Sindh and analyzed for macro and micronutrient contents. The analytical data showed that the values ranged from 1.38-2.29%, 1.29-1.90%, and 0.62-1.98% for total N, P and K respectively and reported that the nutrient contents of pressmud were not only variable from one mill to the other, but also when the samples were taken at different times from the same mill. The value for N, P and K contents of the biocompost obtained in this study fall within the range of the values.

Pot experiment on maize

The results of pot study on maize showed that there was pronounced positive effect of addition of biocompost on plant height and dry weights. Similarly, addition of fertilizer, particularly N, increased plant height and dry weights. However, similar study conducted by Memon (2005) revealed that their were pronounced positive effects of addition of fertilizers, particularly nitrogen on plant height and dry weights, and depressing effect of pressmud (5 t ha^{-1}) on maize growth and dry matter. However increase from 5 to 15 tons ha^{-1} slightly improved the growth and yield performance of maize. Drastic decline in maize dry matter yield was observed when the rate of pressmud was increased from 15 to 25 tons ha^{-1}. Plant analysis data revealed significant increase in N contents with the application of N fertilizer but P and K fertilization and pressmud did not significantly influence the N contents. It was hypothesized that the initial depressing effect of pressmud was related to presence of unrecompensed organic matter and the high rates of pressmud. Thus the benefit of pressmud was observed in a follow up experiment on wheat involving same soil and previously applied pressmud. These data therefore show that pressmud could be used in the fields for increasing crop production.

However, it was observed that the pressmud also contains large proportion of organic matter, which upon incorporation in soil undergoes the process of decomposition coupled with enhanced microbial activity. Being exothermic in nature, and having grown maize in plastic pots exposed to solar radiation, it resulted in negative effects on plant growth. These finding are also correlated with the finding by Hamdard *et al.* (2004) who conducted series of field experiments for evaluating the filtercake, a sugar industry waste, as a plant nutrition source alone was well as in various combinations with chemical fertilizers in maize-wheat cropping system. Pooled analysis of three years data showed that maximum wheat grain yield 4.65 tons ha^{-1} was obtained where all NP was applied in the form of chemical fertilizers and closely followed by where 25 and 50% NP was applied in the form of filtercake giving grain yield 4.40 and 4.33 tons ha^{-1}, respectively. The use of filtercake increased NP contents in wheat grain but were statistically at par with chemical fertilizers. In case of maize, filtercake improved NPK contents in maize fodder over control but these were relatively lower than chemical fertilizer. Pooled soil analysis data revealed that combined use of filtercake and chemical fertilizers also increased NPK contents and improved organic matter status of the soil. Thus for the judicious use of filtercake it can be applied up to 50% on nutrient basis, preferably 25% with chemical fertilizers for sustainable agriculture.

Results also revealed that addition of biocompost contributed to improvement in soil properties including organic matter, and available P and K contents. Such beneficial effect of pressmud, and thus biocompost, has been reported in many studies. Juwarkar *et al*. (1993) conducted studies to optimise application of pressmud along with fertilizer on clay soil for maximizing the production of jowar, wheat, moong and sugarcane crops and evaluating residual effect of pressmud on crop growth. Application of 20 t/ha pressmud and addition of NPK equivalent to 75% of recommended dose to each crop through fertilizers were found to be beneficial and gave 21-43% higher crop yield. Residual effect of pressmud continued upto 3 years and 15-31% higher crop yield was obtained even in third year with the addition of only 75% of recommended nutrients through fertilizers. Pressmud application to soil helped to improve the infiltration rate from 4.7 to 5.6 cm per day. There was no appreciable change in soil pH but organic matter, available P and K increased significantly over control. In one study Aziz *et al.* (2010) evaluated the beneficial effects of different sources of organic manures on soil physico-chemical properties and growth of maize. Organic manures viz. farm yard manure, poultry manure and pressmud were added in soil filled earthen pots at 10 t ha^{-1}. Results revealed that organic matter content, phosphorus and potassium bioavailability in soil and their uptake by plants were increased by organic manure application irrespective of the source. Likewise organic manure substantially improved the plant height, leaf area and shoots and root fresh and dry weights. Similarly shoot phosphorus and potassium contents were also improved by the application of organic manures. This improved growth was mainly due to increased soil nutrient availability and uptake by plants. Comparing different sources, phosphorus and potassium concentration in plants were maximum in poultry manure treatment and farm yard manure, respectively.

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