TRASH AND GREEN MULCH EFFECTS ON SOIL N AND P AVAILABILITY

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ABSTRACT

Interest in the use of organic materials as mulch has been revived because of their beneficial effects on nutrient availability and role in improving soil productivity. Our objectives were to quantify the comparative effects of *Sesbania aculeata* as 'in situ' green mulch IGM and sugarcane trash mulch SM on soil N and P availability. The study was carried out on a fine loamy soil at research farm of C C S Haryana Agricultural University, Hisar, India ($29^0 05'$N, $75^0 38'$E, 222 m elevation) for two years 1997-98 and 1998-99 at ratoon sugarcane (*Saccharum officinarum* L.) under shallow water table condition (0.75-1.65 m). The IGM (4 Mg ha^{-1}), SM (6Mg ha^{-1}) and unmulched (no mulching material) as main treatments, and different doses of inorganic nitrogen (urea) and phosphorous (single super phosphate) fertilizers as sub treatments were arranged in a split plot experimental design with three replications. The mulches increased the availability of N and P to 11.9 and 16.1% as compared to those of unmulched over the two years. Application of 'in situ' green mulch and sugarcane trash mulch increased the availability of native phosphorous by 19.3 and 4.8%, and of added phosphorous by 23.6 and 11.5% as compared to those of unmulched plots. The higher availability of native and added phosphorous under 'in situ' green mulch was due to its lower pH value. These results suggested that *Sesbania aculeata* and sugarcane trash as mulching material may be used for enhancing the nutrient availability of N and P for sustainable soil productivity.

Key words: Available N and P, Mulch, *Sesbania aculeata,* Sugarcane trash

INTRODUCTION

The non availability of phosphorus and nitrogen applied as fertilizers to plants continue to be a major constraint to soil productivity. Many researchers had reported that incorporation of crop residues increased soil N and P availability (Aggarwal et al.1997), green manure (*Sesbania aculeata*) increased availability of added and native P (Hundal et al. 1988, Yash Pal et al. 1993, Vig

and Chand 1993). The increase in P availability had been described due to mineralization of green manuring material, chelation of Ca in alkaline soil and Al in acid soils (Hundal et al. 1988), and due to accumulation of organic acids produced during decomposition of green manuring materials. The information regarding effect of green manure (*Sesbania aculeata*) as mulching material on availability of native and added P is scanty. Therefore, present study was undertaken to quantify the effects of *Sesbania aculeata* as 'in situ' green mulch and sugarcane trash mulch on soil N and P availability at ratoon sugarcane under shallow water table condition.

MATERIALS AND METHODS

The field experiment was conducted at research farm of CCS HAU, Hisar during 1997-98 and 1998-99 at ratoon sugarcane (Saccharum officinarum L.) crop planed in March 1996. The experimental soil was fine loamy (54% sand, 22% silt, 24 % clay) and classified as Torripsamment according to Soil Survey Staff (1998). The climate of the area was semi arid with an average annual evapotranspiration of 1450 mm and rain fall of 426 mm, 80% of which is concentrated from July to Sept. The site had a shallow water table (0.75-1.65 m). A split plot research design having mulch treatments (i) unmulched (no mulch), (ii) sugarcane trash mulch SM (6 Mg ha^{-1}) and (iii) 'in situ' green mulch IGM (4 Mg ha^{-1}) inorganic fertilizers namely (a) $N_0P_{0,}$ (b) $N_{1/2}P_{0,}$ (c) $N_{1/2}P_{1/2}$ and (d) $N_FP_{1/2}$ as sub treatments was applied in triplicates with observation plot of size 8 m × 4.5 m. In case of fertilizer treatments N_0&P_0 stand for nil addition of nitrogen and phosphorous fertilizer, $N_{1/2}$ &$P_{1/2}$ represent their half dose of recommended and N_F represents its full dose of recommended as per the package and practice of the University. The inorganic phosphorous fertilizer (single super phosphate) was applied in form of single split and inorganic nitrogen fertilizer (urea) in two splits. The recommended dose of nitrogen and phosphorous fertilizers were 150 kg N ha^{-1} and 50 kg P ha^{-1}. After crop harvest, whole sugarcane trash was removed from the experimental field. In case of SM, sugarcane trash (15-20 cm long) at 6 Mg ha^{-1} was spread manually and uniformly on soil surface on 15th May,97 and 1st June,98. In case of ' in situ' green mulch GM, *Sesbania aculeata* was sown on 9th May, 97 and 1st June, 9; then allowed to grow for two months and cut with the sickle near to ground and spread uniformly over the soil surface at 4 Mg ha^{-1} on dry weight basis. The crop was harvested in March in each year and then soil samples (0-15 cm) from each treatments were collected and analysed for pH (1:2 soil water suspension), available N (Subbiah and Asija,

1956) and available P (Olsen et al. 1954). The relevant properties of the materials used in the present study are given in Table 1.

Table 1. Relevant properties of materials * used in this study

Soil/Organic materials	Organic matter (%)	Total N (%)	pH
Hisar fine loamy	0.7	0.06	8.1
Sesbania aculeata	81.5	1.10	6.6
Sugarcane trash	80.0	0.52	6.8

* These values are oven dry (60^0C) weight basis.

Irrigation was scheduled at I/CPE ratio of 0.8, where I is irrigation depth in mm and CPE is cumulative pan evaporation in mm between two irrigation. Experimental data were analyzed as analysis of variance of spit plot design.

RESULTS AND DISCUSSION

The application of sugarcane trash mulch SM and 'in situ' green mulch IGM significantly increased soil available P (0-15 cm) by 8.3 and 23.8 % as compared to unmulched during the 1997-98 and 1998-99 (Table 2). It may be due to low pH of *Sesbania aculeata* itself and that of soil where IGM was applied (Dahiya 2001) at 4 Mg ha^{-1} in addition to P mineralization of mulching material due to release of organic acid during decomposition. Bahl et al. (1988) had reported the decrease in rate and extent of P adsorption with application of *Sesbania aculeata*. The application of inorganic N and P fertilizers increased significantly soil P availability where as the interactive effects of mulch and fertilizer treatments remained non-significant during the study period. On an average, the mulch treatments increased available P by 16.1% as compared to that unmulched. Yadav et al. (1994) had also observed increase in soil P availability with the sugarcane trash mulch. The SM and IGM increased the availability of native phosphorus by 19.3 and 4.8% and of added phosphorus by 23.6 and 11.5% (Table 3). The organic acids produced during the decomposition of mulching materials complexed metal cations Ca, Al and Fe, hereby helping in solubilization of native P and reduction in P sorption.

The SM and IGM significantly increased soil available N (0-15 cm) by 7.2 and 16.5 % as compared to unmulched during the 1997-98 and 1998-99 (Table 4). The results indicated that on an

Table 2. Effect of sugarcane trash SM, 'in situ' green mulch IGM and fertilizer treatments on soil available P (0-15 cm) during 1997-98 and 1998-99.

Treatments	Unmulched	SM	IGM	Mean
	Available P (kg ha^{-1})			
N_0 P_0*	14.5	15.2	17.3	15.7
$N_{1/2}$ P_0	15.8	16.3	19.9	17.3
$N_{1/2}$ $P_{1/2}$	18.0	18.7	21.6	19.4
N_F $P_{1/2}$	19.2	22.8	24.4	22.1
Mean	16.8	18.2	20.8	
CD at P=0.05	Mulch M = 1.2 Fertilizer F = 1.3 M × F = NS			

* subscript 0,1/2 and F in case of fertilizer treatments denote nil, half and full recommended dose of respective fertilizer.

Table 3. Effect of sugarcane trash SM, 'in situ' green IGM mulch on availability of native and added P (0-15 cm) during 1997-98 and 1998-99.

Treatment	Native P (kg ha^{-1})	Added P(kg ha^{-1})
Unmulched	14.50	18.60
SM	15.20	20.75
IGM	17.30	23.00

average the mulch treatments increased the available N by 11.9 % as compared to unmulched during the study period. Weerararna and Asghar (1992) had reported similar effects of mulches on soil N availability.

The application of inorganic N and P fertilizers significantly increased the soil N availability. The interactive effects between fertilizer treatments and mulches remained non-significant during both the years. The increase in N availability with crop residue as mulching material may encourage the farmers for using crop residue as mulch instead of removal of residue.

Table 4. Effect of sugarcane trash SM, 'in situ' green mulch IGM and fertilizer treatments on soil available N (0-15 cm) during 1997-98 and 1998-99.

Treatments	Unmulched	SM	IGM	Mean
	Available N (kg ha^{-1})			
N_0 P_0*	88.7	92.5	96.8	92.7
$N_{1/2}$ P_0	91.3	95.5	107.4	98.1
$N_{1/2}$ $P_{1/2}$	95.4	103.2	114.2	104.3
N_F $P_{1/2}$	99.5	110.9	118.5	109.6
Mean	93.7	100.5	109.2	
CD at P=0.05	Mulch M = 6.2 Fertilizer F = 4.2 M × F = NS			

* subscript 0,1/2 and F in case of fertilizer treatments denote nil, half and full recommended dose of respective fertilizer.

The results of the present study implied that *Sesbania aculeata* as mulching material has potential to enhance soil N and P availability. Sugarcane trash might be used as mulch to restore nutrient availability instead of its removal.

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