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Exploiting Fly Ash as Soil Ameliorant to Improve Productivity of Sabai Grass (*Eulaliopsis binata* (Retz.) C.E. Hubb) under Acid Lateritic Soil of India

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Abstract: Present investigation was carried out for two years in sandy loam acid lateritic soil to study the effect of Fly Ash (FA), organic wastes like Farm Yard Manure (FYM), vermicompost (VC) and green manure (*Sesbania rostrata*) (GM) and chemical fertilizers on growth and yield of sabai grass (*Eulaliopsis binata*). Integrated application of FA, organic wastes and CF resulted in significantly higher tiller number, dry matter accumulation and green leaf yield as compared to sole application of CF in both the years. Application of fly ash in combination with organic wastes and chemical fertilizers recorded maximum yield advantage (up to 22.8 and 27.6% in the wet season of first and second year, respectively), while the yield increase was 3.6 and 9% in the first and second year, respectively when it was used in combination with only chemical fertilizers. As regards organic wastes GM recorded higher yield as compared to FYM or VC during wet season, however, the performance of sabai grass was superior under residual fertility of VC based treatments as compared to FYM or GM during dry season.

Key words: Sabai grass, fly ash, organic wastes, chemical fertilizers

INTRODUCTION

Sabai grass (*Eulaliopsis binata* (Retz.) C. E. Hubb), a perennial plant, is cultivated extensively on marginal and sub-marginal rainfed uplands as a commercial crop. With an estimated average global production of 200 million tones per year (Atchison, 1995), it is mainly distributed in China, India (Gupta, 2006), Pakistan (Sial, 2006), Nepal (Khatri, 2006), Bhutan, Mayanmar, Thailand, Malaysia (Yong, 2006) and Phillipines. In India it is grown in the states of West Bengal, Bihar, Jharkhand, Orissa, Punjab, Haryana, Jammu and Kashmir, Himachal Pradesh, Madhya Pradesh and Uttar Pradesh (Gupta, 2006). Its thin and long leaves with high quality fibre constitute a major raw material for paper industries (Barik, 1998; Gupta, 2006; Khatri, 2006; Sial, 2006), also the flexibility and strength properties of the leaves are utilized for making ropes and other rope based utility items (Basu *et al*., 2006, Gupta, 2006). At present Sabai grass has an important position in tribal economics of some region (Anonymous, 2002) of India. In north eastern India sabai grass is mainly cultivated in acid lateritic upland soils. These soils are characterized by low organic matter content (Mahapatra *et al*., 1985), toxicity of Fe, Mn and Al; deficiencies of N, P, K, Ca and Mg as well as some micronutrients; reduced uptake of nutrients (Beckie and Ukrainetz, 1996) and leaching loss of essential nutrients. Again continuous use of high levels of chemical fertilizers causes nutritional imbalance in soil (Nambiar, 1994). These problems can be solved by raising the soil pH through application of lime and combined use of organic sources and chemical fertilizer. But often farmers can not afford lime because of its cost barrier. Fly ash, a by-product of Thermal Power Plants is alkaline in nature with pH value of more than 9.0 (Cha *et al*., 1999) , can neutralize acidic soils (Molliner and Street, 1982; Rautaray *et al*., 2003) and can increase the availability of Si, Na, K, Ca, Mg, B, S and other trace nutrients (Ko, 2000). Moreover, the fly ash contains all the essential elements present in soil except nitrogen (Jala and Goyal, 2006). Since information regarding nutrient management of sabai grass are scanty (Tripathy, 1998), therefore the present investigation was undertaken to study the effect of fly ash, organic wastes and inorganic fertilizers on yield of sabai grass in acid lateritic soil.

MATERIALS AND METHODS

Treatments: A field experiment was carried out for two years (2002-03 and 2003-04) with sabai grass (*Eulaliopsis binata*) (variety local) at the experimental farm of Indian Institute of Technology, Kharagpur, India.

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The climate of this region is warm humid and the soil is acid lateritic with a sandy loam texture and low in available N, P and K. Coal FA was obtained from Kolaghat Thermal Power Plant, West Bengal, India produced through combustion of pulverized bituminous coal. The physical and chemical properties of the test soil and fly ash are presented in Table 1. Potential organic wastes like Farmyard Manure (FYM), vermicompost (VC) and Green Manure (GM), *Sesbania rostrata* were used as organic nutrient sources. A uniform fertilizer dose of 30:20:20 kg N:P:K ha^{-1} for sabai grass was applied in all the treatments (except control) through chemical fertilizers and organic wastes. Half of the recommended dose of N was supplemented by organic wastes. Rest of the N as well as balance dose of P and K was applied through CF.

All together nine treatments viz., 1. CF; 2. FA+CF; 3. VC+CF; 4. VC+FA+CF; 5. GM+CF; 6. GM+FA+CF; 7. FYM+CF; 8. FYM+FA+CF and 9. Control were arranged in a Complete Randomized Block Design (CRBD). GM was chopped manually to 3-4 cm sizes before application while dust form of VC and FYM were applied. Organic wastes were incorporated manually 15 days before planting of sabai grass slips. Chemical fertilizers like urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O) were used as sources of N, P and K, respectively. As sabai grass is perennial in nature 10-12 slips per hill were planted once in first week of July during first year with the onset of monsoon at a spacing of 100×50 cm between rows and plants, respectively. One hand weeding was done at one month after planting to keep the field weed-free. Remarkable incidence of insects or diseases was not observed. Sabai grass was harvested twice in a year, first cut in first week of November and second cut in first week of March.

For soil chemical analysis, samples were collected before starting of experiments from 20 cm soil depth at random from different locations. The samples were air-dried in shade for 48 h, ground in a pestle and mortar and passed through a 2 mm sieve. Estimation of the pH, organic carbon and available N, P and K contents of the soil were done using a glass electrode, Walkley and Black method, Kjeldahl distillation, NH_4F extraction and NH_4OAc extraction methods, respectively (Jackson, 1973).

Table 1: Physical and chemical properties of experimental soil and fly ash

Particulars	Soil	Fly ash
1. Particle Size Distribution		
Sand (%)	61.25	40.51
Silt (%)	21.35	48.29
Clay (%)	17.40	11.20
Bulk density (Mg/cu. m)	1.65	0.91
Soil reaction (pH)	5.35	8.08
Organic Carbon (g kg^{-1})	2.81	2.80
Total N (%)	0.44	0.05
Total P (%)	0.23	0.27
Total K (%)	0.58	0.46
Available N (g kg^{-1} of soil)	72.62	15.20
Available P (g kg^{-1} of soil)	5.15	43.60
Available K (g kg^{-1} of soil)	42.41	66.40

The recorded data were analyzed with the help of analysis of variance (ANOVA) for Completely Randomized Block Design (CRBD). Least Significant Differences (LSD) were conducted at a 5% level of probability, where significance was indicated by F-test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Direct effect of nutrient sources on growth and yield of sabai grass during wet season: It is apparent from Table 2 and 3 that combined application of CF and organic wastes recorded significantly higher tiller number m^{-2}, dry matter accumulation (g m^{-2}) and green leaf yield (kg ha^{-1}) as compared to control in both the years. Application of FA along with CF and any of organic wastes further improved the growth as well yield of the crop. Application of FA at 10 t ha^{-1} supplied about 270 kg P and 460 kg K ha^{-1} as clear from Table 1. Besides P and K, FA also contains nutrients like Ca, Mg, Fe, Mn, Zn and Cu (Jala and Goyal, 2006). As it is alkaline in nature it also raises the pH of the soil and thereby facilitates the availability of P, K, Ca and Mg (Khan and Khan, 1996; Cha *et al*., 1999). Organic wastes like GM, FYM and VC also contributed other macro and micro nutrients in addition to N, P and K. This was helpful for better growth and yield of sabai grass. Moreover, favorable soil pH and supply of substrates and nutrients through organic sources and CF might have promoted microbial activity (Sarangi *et al*., 1997; Rautaray *et al*., 2003) resulting in higher nutrient release and uptake by sabai grass. The higher nutrient uptake ultimately resulted higher yield of sabai grass. Similar findings have been reported (Basu *et al*., 2006). Increased rice crop yield due to mixed application of fly ash and paper factory sludge and farmyard manure was also reported by Molliner and Street (1982) and Rautaray *et al*. (2003). Among three organic wastes, the GM based treatments involving FA and CF was proved to be superior to the rests followed by FYM based treatments. VC-based treatments resulted in lower leaf yield as compared to GM or FYM based treatments in both the years. Green manure with very low C:N ratio of 17:1 is as efficient as chemical fertilizer on equal N basis (Meelu and Morris, 1988). So after the addition to soil, this nitrogen-rich organic substrate encouraged higher microbial activity in soil (Mukherjee *et al*., 1990), thereby promoted decomposition of readily decomposable carbonaceous materials at the

Table 2: Effect of different nutrient sources on growth parameters at harvest and green leaf yield (kg ha^{-1}) of sabai grass during wet and dry season of 2002-'03

	No. of tillers m^{-2}		Dry matter (g m^{-2})		Leaf yield (kg ha^{-1})	
Nutrient sources	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season
CF	81.0	65.0	117.4	53.0	1746.0	742.5
FA+CF	82.6	74.8	120.9	68.0	1809.5	1006.8
VC+CF	83.6	74.8	124.8	72.8	1862.9	1026.5
FA+VC+CF	89.1	81.9	135.0	79.5	1971.2	1153.5
FYM+CF	88.3	69.6	129.6	63.2	1949.4	914.3
FA+FYM+CF	92.3	76.7	142.1	75.0	2144.3	1093.8
GM+CF	85.6	72.8	126.4	67.6	1918.8	945.9
FA+GM+CF	90.7	79.3	139.7	77.4	2045.4	1118.7
Control	68.9	61.8	72.8	48.8	1082.4	707.4
LSD (p = 0.05)	2.1	3.9	3.0	5.9	75.6	91.9

CF = Chemical Fertilizer; FA = Fly Ash; VC = Vermicompost; FYM = Farm Yard Manure; GM = Green Manure (*Sesbania rostrata*); LSD = Least Significant Difference

Table 3: Effect of different nutrient sources on growth parameters at harvest and green leaf yield (kg ha^{-1}) of sabai grass during wet and dry season of 2003-'04

	No. of tillers m^{-2}		Dry matter (g m^{-2})		Leaf yield (kg ha^{-1})	
Nutrient sources	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season
CF	142.6	125.0	243.2	112.8	3648.0	1437.0
FA+CF	159.7	145.0	289.5	155.9	3976.5	1998.0
VC+CF	154.8	143.6	276.4	151.4	3987.2	2136.4
FA+VC+CF	164.0	157.5	293.8	168.0	4341.1	2412.6
FYM+CF	164.0	135.0	294.8	138.6	4257.6	1887.3
FA+FYM+CF	175.4	148.8	317.3	161.8	4654.4	2253.5
GM+CF	158.3	136.2	281.6	141.6	4075.2	1920.2
FA+GM+CF	168.3	151.3	299.0	162.6	4452.6	2306.5
Control	122.6	117.5	140.6	108.9	2079.4	1311.3
LSD (p = 0.05)	4.1	5.3	11.4	7.0	175.6	245.9

CF = Chemical Fertilizer; FA = Fly Ash; VC = Vermicompost; FYM = Farm Yard Manure; GM = Green Manure (*Sesbania rostrata*); LSD = Least Significant Difference

initial stage and as a consequence, provided greater availability of nutrients to the crop. However, VC having comparatively higher C: N ratio (45:1) might have caused microbial immobilization resulted in an limited supply of N in initial stage. As a result VC based treatments recorded lower yield as compared to FYM and GM.

Residual effect of nutrient sources on growth and yield sabai grass during dry season: The effect of different nutrient sources applied to the sabai grass during rainy season under residual fertility was studied on the growth and yield of sabai grass during dry season (Table 2 and 3). In general irrespective of treatments the tiller number m^{-2}, dry matter accumulation (g m^{-2}) and green leaf yield (kg ha^{-1}) of dry season sabai grass was lower as compared to wet season. The residual effect of all the fertilization treatments recorded higher tiller number, dry matter and leaf yield of sabai grass as compared to CF alone or control in both the years. The residual fertility of FA based treatments involving organic wastes and CF recorded higher yield as compared to similar combinations but without FA. As regards residual effect of organic wastes VC recorded higher yield as compared to FYM and GM. However, no significant differences were found under residual effect of FA+FYM+CF and FYM+GM+CF when compared with the grass yield under residual fertility of FA+VC+CF. Addition of nutrients through FA and slow mineralization of the organic wastes supplied essential nutrients to the crop under residual fertility in the dry season also (Rautaray *et al*., 2003). Thus integrated application of FA, organic wastes and CF resulted higher availability of nutrients in soil over CF only under the residual effect, thereby, helped in higher uptake of nutrients and finally led to higher leaf yield of sabai grass.

CONCLUSIONS

It could reasonably be said that integrated use of fly ash, organic wastes and chemical fertilizers provided higher benefits towards crop yield as compared to continuous use of only chemical fertilizers in acid lateritic sandy loam soils. The beneficial role of fly ash was more apparent when it was used in combination with organic wastes and chemical fertilizers than in combination with only chemical fertilizers.

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