Indian Journal of Agronomy **52** (2) : 160–163 (June 2007)

Evaluation of sugarcane (*Saccharum officinarum*)-based industrial waste and litter fall of jatropha (*Jatropha curcas*) for nutrient management in oleiferous rocket salad (*Eruca sativa*)

D.K. SHARMA*, D.S. RANA[1] AND H.C. JOSHI

Division of Environmental Sciences, Indian Agricultural Research Institute, New Delhi 110 012

Received: December 2006

ABSTRACT

A field study conducted for 2 years (2003-05) on sandy-loam soil at New Delhi showed that seed yield (1.80 t/ha) of oleiferous rocket salad (*Eruca sativa* Mill.) obtained with distillery pressmud-distillery effluent compost @ 5 t/ha + half the recommended dose of NPKS (60 kg N, 13.1 kg P, 25.0 kg K and 20 kg S/ha) was on a par with the seed yield (1.69 t/ha) recorded with the recommended dose of NPKS. The seed yield recorded with former treatment was significantly superior to that with flyash-distillery effluent mixture (1:1) @ 5 t/ha + half the recommended dose of NPKS by 30.4% and litter-fall of jatropha (*Jatropha curcas*) @ 5 t/ha + half the recommended dose of NPKS by 24.1%. On an average, pressmud-distillery effluent compost @ 5 t/ha + half the recommended dose of NPKS recorded perceptible increase in the available NPK status of the soil recorded after oleiferous rocket salad harvest compared with the initial fertility status. Available nutrient status of this treatment was also higher when compared with the recommended dose of NPKS and other treatments. Application of pressmud-distillery effluent compost @ 5 t/ha alone recorded significantly higher seed yield and residual fertility after oleiferous rocket salad harvest when compared with flyash effluent mixture and jatropha litter-fall applied at the same rate.

Key words : Flyash-distillery effluent mixture, Jatropha litter-fall, Oleiferous rocket salad, Pressmud-distillery effluent compost, Residual fertility

Rocket salad or *taramira* (*Eruca sativa* Mill.) is an annual oilseed crop. In the European countries it is cultivated mainly for salad purpose, whereas in India it is taken as a contingent crop under limited soil-moisture conditions for oilseed production. It is generally cultivated on conserved moisture and problematic soils of north-west India. It has potential to outyield Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson) and chickpea (*Cicer arietinum* L.) under moisture stress (Singh and Sharma, 1976). Sugarcane (*Saccharum officinarum* L.)-based industries such as distilleries and sugar industries generate a huge quantity of organic wastes. Sugar industry generates 5-6 million tonnes pressmud and 7.5 million tonnes molasses as by-product annually (Sharma *et al.,* 2006). In India molasses based distilleries face severe problem in disposing off their anaerobically digested, foul-smelling, coloured wastewater, which is generated in large quantity, and has very high biological and chemical oxygen demand (5,000-8,000 mg/litre and 25,000-30,000 mg/litre respectively (Joshi *et al.,* 1996). Its in judicious discharge on land surfaces and in water-courses damages the aquatic life and deteriorates the soil and ground-water and micro-plant nutrients. Several workers have suggested its use in agriculture in proper way either as soil amendment without dilution before sowing the crop or in conjunction with irrigation water for application in the standing crop (Pathak *et al.,* 1999). Transportation of large quantity of distillery effluent for ferti-irrigation to agricultural field away from the distilleries is difficult and hence its adsorption to some filler material is required for easy transportation. Pressmud, which is also generated in large quantity by sugar industry, has good manurial potential. Another waste generated from the distillery unit is flyash, which also contains plant nutrients. This also is facing disposal problem in and around the area of distillery unit. Jatropha (*Jatropha curcas*) plantation is being promoted on rainfed agro-ecosystem for bio-diesel production. This plant produces large amount of litter-fall, which can be incorporated in the cropped land as a source of organic carbon and plant nutrients. Hence an attempt was made to find out the effect of these sugarcane-based industrial wastes and litter-fall of jatropha on crop and soil, and their suitable integration with chemical fertilizers.

***Corresponding author** (Email: dks_env@rediffmail.com)

Present address: [1]Division of Agronomy, IARI, New Delhi 110 012

MATERIALS AND METHODS

A fixed-plot field experiment on oleiferous rocket salad was conducted for 2 years (2003-04 and 2004-05) at New Delhi. The alluvial soil of the experimental site was sandy loam, having a bulk density of 1.38 g/cm^3, pH (1:2 soil:water) 8.1, electrical conductivity 0.48 dS/m, cation exchange capacity (CEC) 7.3 cMol (p^+) kg/ha; and available N, P and K 215, 13.2 and 205 kg/ha respectively.

The seven treatment combinations of sugarcane-based industrial wastes, litter-fall of jatropha and NPKS through fertilizers were : the control, recommended dose of NPKS (60 kg N, 13.1 kg P, 25.0 kg K and 20 kg S/ha), flyash-distillery effluent mixture (1:1) @ 5 t/ha, pressmud-distillery effluent compost @ 5 t/ha, jatropha litter-fall @ 5 t/ha, flyash-distillery effluent mixture @ 5 t/ha + half the recommended dose of NPKS (60 kg N/ha, 13.1 kg P/ha, 25.0 kg K and 20 kg S/ha: $N_{60}P_{13}K_{25}S_{20}$), pressmud-distillery effluent compost @ 5 t/ha + half the recommended dose of NPKS and jatropha litter-fall @ 5 tonnes/ ha + half the recommended dose of NPKS. The experiment was conducted in three times replicated randomized block design. The flyash distillery-effluent mixture (1:1) and pressmud-distillery effluent compost were collected from Jubilant Organosys Ltd, Gajraula, Uttar Pradesh. Flyash distillery effluent mixture (1:1) , pressmud-distillery effluent compost and litter-fall of jatropha on an average contained 0.31-0.07-1.57; 0.93-0.50-1.14 and 0.86-0.26-1.06% N, P and K respectively. Nitrogen, phosphorus and potassium contents in seeds and stover of oleiferous rocket salad were estimated by standard methods. Uptake of these nutrients was estimated by multiplying the weight of seeds and stover by their respective percentages. Total uptake of oleiferous rocket salad was calculated by adding the uptake of seed and stover. For residual fertility, soil samples were collected at the end of the experiment from 0-15 cm soil depth and were analysed for the available N, P and K following standard procedures.

Organic materials were added in the soil after initial preparation of land and 4 weeks before sowing oleiferous rocket salad. After addition of organic material, good moisture content was maintained in the soil through moisture conservation and pre-sowing irrigation for rapid decomposition of organic material. Oleiferous rocket salad cv 'RTM 314' was sown in the last week of October at inter-row spacing of 30 cm. The recommended dose of fertilizer for oleiferous rocket salad is 60 kg N, 13.1 kg P, 25.0 kg K and 20 kg S/ha ($N_{60}P_{13}K_{25}S_{20}$). The crop was hand-weeded and thinned 20 days after sowing (DAS). The experimental crops were irrigated with water from a bore-well. The crop received one irrigation in addition to pre-sowing irrigation. Half the N and full doses of P, K and S were applied as per treatment before sowing the crop, whereas the remaining half N was applied at the time of first irrigation. The crop was harvested in the second week of March during both the years.

RESULTS AND DISCUSSION

Growth attributes

The growth components recorded marked variations due to treatments (Table 1). Recommended dose of NPKS and 50% recommended dose of NPKS + pressmud-distillery effluent compost @ 5 t/ha recorded statistically similar values of growth components, viz. plant height and the primary and secondary branches/plant. But values of growth parameters recorded under these two treatments were significantly superior to those of alone application of pressmud-distillery effluent compost, flyash effluent mixture (1:1), jatropha dry leaves each applied @ 5 t/ha as well as their combined application with 50% of the recommended dose of NPKS and the control. Integration of 50% of the recommended dose of NPKS with sugarcane-based industrial wastes caused perceptible change in the plant height and the primary branches and secondary branches/ plant compared with alone application of each organic material. These changes in the growth components of plants due to treatments may be ascribed to variations in the amount of nutrients added through each material, extent of availability of the added nutrients and changes expected in the physico-chemical properties due to sugarcane-based industrial organic wastes.

Yield components

The yield components such as siliquae/plant, test weight and oil content recorded significant variations due to treatments (Table 1). The recommended dose of NPKS and pressmud-distillery effluent compost @ 5 t/ha + 50% of the recommended dose of NPKS recorded statistically similar values of yield components except test weight, where the latter treatment proved superior to the former treatment. Both these treatments recorded marked increase in the yield components compared with the other treatments under test. Among sugarcane-based industrial wastes, alone application of distillery effluent-based pressmud compost was significantly superior to alone application of flyash effluent mixture (1:1), jatropha dry leaves and the control. Organic sources of nutrients became more effective in improving the test weight and oil content when these were integrated with 50% NPKS compared with their alone application. This is due to the beneficial effect of organic material alone and in combination with fertilizer nutrient in improving the growth attributes, which further contributed to change in the yield attributes.

Table 1. Growth and yield attributes, seed yield and harvest index of oleiferous rocket salad (*Eruca sativa*) as influenced by integrated nutrient management (data pooled over 2 years)

Treatment	Oleiferous rocket salad							
	Growth attributes			Yield attributes			Seed yield (t/ha)	Harvest index (%)
	Plant height (cm)	Primary branches/ plant	Secondary branches/ plant	Siliquae/ plant	Test weight (g)	Oil content (%)		
Control	85	4.6	4.5	76	3.15	31.3	0.83	19
Recommended dose of NPKS	115	6.7	8.5	155	3.57	34.7	1.69	24
Flyash distillery effluent mixture (1:1) @ 5 t/ha	90	5.0	5.3	92	3.25	31.4	1.00	20
Pressmud-distillery effluent compost @ 5 t/ha	102	5.3	6.3	133	3.56	33.3	1.37	21
Litter-fall of jatropha @ 5 t/ha	95	4.7	5.2	107	3.33	31.6	1.10	21
Flyash-effluent mixture (1:1) @ 5 t/ha + 50% recommended dose of NPKS	109	5.6	5.9	121	3.40	32.2	1.38	23
Pressmud-distillery effluent compost @ 5 t/ha + 50% recommended dose of NPKS	122	5.9	8.7	162	3.73	35.2	1.80	25
Litter-fall of jatropha @ 5 t/ha + 50% recommended dose of NPKS	113	5.6	6.0	138	3.48	33.2	1.45	23
SEm±	3.8	0.3	0.4	5.1	0.03	0.4	0.07	0.9
CD (P=0.05)	12	0.8	1.2	16	0.08	1.2	0.20	3

Seed yield and harvest index

The recommended dose of NPKS and pressmud distillery effluent compost @ 5 t/ha + 50% of the recommended dose of NPKS being statistically at par resulted in significantly higher seed yield/ha and harvest index compared with pressmud-distillery effluent compost alone @ 5 tonnes/ha, flyash effluent mixture (1:1) @ 5 t/ha alone and with 50% of the recommended NPKS, jatropha dry leaves @ 5 t/ha alone and with 50% of the recommended dose of NPKS and the control. Pressmud-distillery effluent compost + 50% of the recommended dose of NPKS increased the seed yield of oleiferous rocket salad by 116.8, 80.0, 30.4, 63.6 and 24.1% over the control, flyash effluent mixture (1:1) @ 5 t/ha alone and with 50% of the recommended NPKS, jatropha dry leaves alone and with 50% of recommended NPKS. Among alone application of sugarcane-based industrial organic wastes, pressmud-distillery effluent compost recorded marked increase in seed yield compared with flyash effluent mixture (1:1) and jatropha dry leaves, showing increase in seed yield by 37 and 27% respectively (Table 1).

The different beneficial effects of organic materials alone and in combination with NPKS on growth and yield attributes and thereby on seed yield could be attributed to the expected different decomposition, mineralization and solubilization effects on fixed form of soil nutrients and thereby different supply of the available nutrients to the crop (Singh *et al.*, 1981). Among the organic materials, pressmud-distillery effluent compost showed better results because of higher amount of nutrients added in the soil.

Residual fertility after oleiferous rocket salad

Changes were recorded in the soil-available NPK content due to treatments given to oleiferous rocket salad compared with its initial soil fertility (Table 2). The highest content of available NPK was observed under pressmud-distillery effluent compost @ 5 t/ha + 50% of the recommended NPKS, and it was markedly higher than initial fertility status. Alone application of pressmud-distillery effluent compost also recorded positive balance of NPK. The recommended dose of NPKS recorded perceptible decrease in the available N and K compared with the initial status of N and K, whereas in case of P the balance was positive. There was improvement in the available NPK content due to different organic materials; even there was more depletion than addition. This could be ascribed to the residual effect of sugarcane-based industial organic wastes and their role in improving the availability of nutrients in the soil, as reported by Nanjappa *et al.* (2001).

Nutrient uptake by oleiferous rocket salad

The total uptake of N, P, K and S in seed + straw of oleiferous rocket salad was significantly highest with 50 per cent of the recommended dose of NPKS + pressmud-distillery effluent compost, followed by the recommended dose of NPKS (Table 2). The increase in total uptake of

Table 2. Nutrient uptake by oleiferous rocket salad and soil fertility after its harvest as influenced by organic and inorganic sources of nutrients (pooed data of 2 years)

Treatment	Nutrient uptake by seed and stover of oleiferous rocket salad (kg/ha)				Available nutrients after oleiferous rocket salad harvest (kg/ha)		
	N	P	K	S	N	P	K
Control	37.6	7.6	64.9	12.5	190	11.5	195
Recommended dose of NPKS	81.9	16.7	120.6	25.0	210	13.6	198
Flyash distillery effluent mixture (1:1) @ 5 t/ha	48.1	10.8	80.7	14.1	195	11.6	215
Pressmud-distillery effluent compost @ 5 t/ha	65.1	14.1	103.4	22.4	222	15.8	222
Litter-fall of jatropha @ 5 t/ha	50.6	10.8	89.1	16.2	210	13.3	218
Flyash distillery effluent mixture (1:1) @ 5 t/ha + 50% recommended dose of NPKS	67.0	13.8	110.6	20.1	210	13.9	218
Pressmud-distillery effluent compost @ 5 t/ha + 50% recommended dose of NPKS	88.8	17.3	132.1	26.5	235	17.6	226
Litter-fall of jatropha @ 5 t/ha + 50% recommended dose of NPKS	70.5	14.6	114.8	21.2	218	14.6	223
SEm±	1.9	0.6	2.2	0.9			
CD (P=0.05)	6.1	2.1	7.5	3.2			
Initial nutrient status					215	13.2	205

NPKS due to the former treatment was 8.4, 3.5, 9.5 and 6.0% compared with the recommended dose of NPKS and 136.1, 127.6, 103.5 and 52.8% compared with the control. In the remaining treatments the recommended dose of NPKS recorded significantly highest NPKS uptake compared with the rest of the treatments, except jatropha dry leaves + 50% of the recommended dose of NPKS, where both the treatments were on a par in the uptake of P and K. Among alone application of organic sources of nutrients, pressmud-distillery effluent compost recorded significantly highest uptake of NPKS compared with flyash effluent mixture and dry leaves of jatropha. The variation in nutrient uptake under different treatments is the combined effect of the variations in the quantum of nutrients added, changes in physico-chemical properties of the soil, seed and straw yields and the nutrient content in seed and straw.

It was concluded that pressmud-distillery effluent compost @ 5 t/ha can be used to replace 50% of the recommended dose of NPKS with 0.11 t/ha bonus seed yield of rocket salad compared with the recommended dose of inorganic fertilizers, besides having marked favourable effect on residual soil fertility.

REFERENCES

Joshi, H.C., Pathak, H., Choudhary, A. and Kalra, N. 1996. Distillery effluent as a source of plant nutrient: problems and prospects. *Fertilizer News* **41:** 41-47.

Nanjappa, H.V., Ramachandrappa, B.K. and Mallikarjuna, B.O. 2001. Effect of integrated nutrient management on yield and nutrient balance in maize. *Indian Journal of Agronomy* **46**(4): 698-701.

Pathak, H., Joshi, H.C., Choudhary, A., Chaudhary, R., Kalra, N. and Dwivedi, M.K. 1999. Soil amendment with distillery effluent for wheat and rice cultivation. *Water, Air and Soil Pollution* **113:** 133-140.

Sharma, D.K., Kaushik, R.S., Tripathi, S. and Joshi, H.C. 2006. 'Distillery effluent based pressmud compost for nitrogen and phosphorus nutrition in rice-wheat cropping system'. Paper presented at 2nd Intenational Rice Conference held during 9-13 October 2006 at New Delhi, 341 pp.

Singh, B.P. and Sharma, H.C. 1976. In poor soil, grow oleiferous rocket salad for better returns. *Haryana Farming* **5:** 5.