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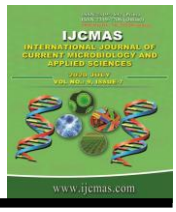

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Maximization of Productivity in Sodic Soil through Bio-Intensive Complementary Cropping System with Organic Amendments

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A B S T R A C T

Field experiment was conducted at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli to enhance productivity of sodic soil thorough bio intensive complementary cropping systems with organic amendments. The soil of the experiential field was alkali with pH: 8.8, EC: 0.96 ds/m and ESP: 17.1. The experiment was laid out in split plot design and replicated thrice. Main plot comprises three complementary cropping system *ie.* M_1: Maize + Cowpea + Daincha, M_2: Sunflower + Greengram + Daincha and M_3: Bhendi + Onion + Daincha and sub plot comprises five treatment combinations like S_1: 100% recommended NPK through fertilizers, S_2: 50% recommended NPK through fertilizers + 50% N through FYM, S_3: 75% recommended NPK through fertilizers + 25% N through FYM, S_4: 50% recommended NPK through fertilizers + 50% N through poultry manure and S_5: 75% recommended NPK through fertilizers + 25% N through poultry manure. Based on the results, it is concluded that complementary cropping of maize + cowpea + daincha with application of 75% recommended NPK through fertilizers + 25% N through poultry manure may be recommended for sodic soils for soil health improvement and obtained maximum economical benefits.

Introduction

In India sodic soils have occupied 37.71lakh ha and these soils are essentially located in the Indo-Gangetic plain, arid and semiarid region in Western and Central India and the peninsular region in the Southern India. In the peninsular region, sodic soils have occupied extensive areas in Tamil Nadu, Andhra Pradesh, Telangana and Karnataka state. In Tamil Nadu sodic soils have occupied 3.55 lakh ha and these are essentially found in the central Tamil Nadu covering Ramanathapuram, Cuddalore, Kanchipuram, Tirunelveli, Thanjavur, Pudukottai, Madurai and Tiruchirappalli districts. The combined application of different organic amendments improves their effectiveness for increasing soil properties. Several studies suggested that the application of organics in saline sodic and sodic soil can ameliorate the physical and chemical soil properties such as bulk density,

hydraulic conductivity, water infiltration, pH, electrical conductivity, exchangeable sodium percent and sodium adsorption. Recently, various organic amendments such as mulch, FYM and compost, have been effectively used to improve salt affected soils. Moreover, organic materials improve the soil physico-chemical properties that accelerate exchange of cations on soil solids and leaching of salts from the root zone (Clark *et al.,* 2007). Use and management of crop residues, FYM and green manures are becoming an increasingly important aspect of environmentally sound sustainable agriculture. Long term addition of organic materials to soil results in increased organic matter, crop productivity and soil biological activity. Adoption of suitable cropping system is essential for ensuring the most rational use of land and increasing productivity per unit area per unit time. It is possible to enhance the production potential and remuneration with adoption of alternate productive and profitable cropping. Diversification of the existing cropping through introduction of alternate bio intensive complementary copping may pave way for increased economic benefits over traditional systems along with soil health improvement. Hence, using organic sources like FYM and composted poultry manure deserves priority for sustained production and better resource utilization in salt affected soils. This method was self-sufficient and self-dependent as it is relying more on organic inputs. With this background this project is to be taken up to find out the effect of different organic amendments on production and productivity of different crops under salt affected soils.

Materials and Methods

Field experiment was conducted at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli during *rabi* season of 2016 -2017 to enhance productivity of sodic soil thorough bio intensive complementary cropping systems with organic amendments. The farm is situated in the Cauvery Delta Agro-climatic Zone of Tamil Nadu at 10° 45'N latitude and 78° 36'E longitude with an altitude of 85 m above MSL. The mean maximum and minimum temperatures were 32.7°C and 22.3°C respectively. The mean relative humidity was 85 per cent in the FN and 58.2 percent in the an and the mean sunshine hours were 5.8. Soil of the experimental field was sandy clay loam and taxonomically the soil belongs to the family *Vertic Ustropept* having pH: 8.8, EC: 0.96 ds/m and ESP: 17.1. The experiment was laid out in split plot design and replicated thrice. Main plot comprises three complementary cropping system ie. M_1: Maize + Cowpea + Daincha, M_2: Sunflower + Greengram + Daincha and M_3: Bhendi + Onion + Daincha and sub plot comprises five treatment combinations like S_1: 100% recommended NPK through fertilizers, S_2: 50% recommended NPK through fertilizers + 50% N through FYM, S_3: 75% recommended NPK through fertilizers + 25% N through FYM, S_4: 50% recommended NPK through fertilizers + 50% N through poultry manure and S_5: 75% recommended NPK through fertilizers + 25% N through poultry manure.

The land configuration for the study was FIRB (Furrow irrigated raised bed). For yield and economic analysis, various crops yield were converted into maize equivalent yield based on the value of the concerned crop produces. The plot size was 5m x 4m. In the main plot daincha was sown in the furrow and incorporated 40 days after sowing. Economic analysis was done by computing the cost of cultivation, gross return and net return for each treatment considering the prevailing market rate of inputs, produce and the wages paid to the labourers. The data from the experiments were analysed statistically wherever treatment differences were found significance, the critical differences were worked out at 5% probability level (P = 0.05).

Results and Discussion

Maize equivalent yield

Complementary cropping and graded dose of fertilizers with organic amendments significantly influenced maize equivalent yield and given in Table **1**. Higher maize equivalent yield was recorded by maize + cowpea +daincha (6931 kg/ha) cropping followed by sunflower + greengram + daincha (4396kg/ha) cropping. Regarding fertilizer dose and organic amendments, application of 75% recommended NPK through fertilizers + 25% N through poultry manure recorded higher maize equivalent yield (5865kg/ha) and was followed application of 75% recommended NPK through fertilizers + 25% N through FYM. Interaction was significant. Higher miaze equivalent yield was recorded by maize + cowpea +daincha with 75% recommended NPK through fertilizers + 25% N through poultry manure (7668kg/ha) and was followed by maize + cowpea +daincha with 50% recommended NPK through fertilizers + 50% N through poultry manure (7149kg/ha). The later was comparable with maize + cowpea +daincha with 75% recommended NPK through fertilizers + 25% N through FYM (6928kg/ha). Because of enhanced growth characters with improved yield components, which led to higher grain yield. Moreover, higher concentration of macro and micronutrients in the poultry manure and higher and steady nutrient release compared to other organic amendments such FYM could make it to perform well (Ananda *et al.*, 2006). The findings are in complete agreement with the findings of Sisodia and Kewat (2009). The supply of the required nutrients through organic and inorganic sources facilitated balanced nutrition of the crop, which might have resulted in enhanced grain yield. These findings are in agreement with those of Mukeshkumar et al (2012). Lowest maize equivalent yield was recorded by sunflower + greengram + daincha with application of 100% recommended NPK through fertilizers.

Water productivity

Water productivity was significantly influenced by complementary cropping and graded dose of fertilizers with organic amendments and given in Table 1. Significantly higher water productivity was recorded by maize + cowpea + daincha (15.3 kg/ha mm) cropping and lower water productivity was recorded by bhendi + onion + daincha (7.9kg/ha mm) cropping. Regarding fertilizer dose and organic amendments, application of 75% recommended NPK through fertilizers + 25% N through poultry manure recorded higher water productivity (12.3 kg/ha mm) and was comparable to application of 75% recommended NPK through fertilizers + 25% N through FYM and 50% recommended NPK through fertilizers + 50% N through poultry manure.

Post harvest soil fertility status

Soil available N

Post harvest soil available N was not significantly influenced by complementary cropping systems but was significantly influenced by application of graded dose of fertilizers with organic amendments and given in Table 2. Higher post harvest soil available N (261.3 kg/ha) was recorded in application of 50% recommended NPK through fertilizers + 50% N through poultry manure which was statistically on par with application of 75% recommended NPK through fertilizers + 25% N through poultry manure (259 kg/ha). Due to increase in microbial activity in the presence of organic matter, it released the available form of native and unavailable form of nutrients. Consequently, available nutrients status was enhanced (Singh *et al.*, 2006) and when organic manure was added to the soil complex, nitrogenous compounds braked

down slowly and made steady N supply throughout the growth period of the crop.

Higher post harvest soil available N was recorded in maize + cowpea +daincha with 50% recommended NPK through fertilizers + 50% N through poultry manure (271 kg/ha). Lowest post harvest soil available N was recorded by sunflower + greengram + daincha with application of 100% recommended NPK through fertilizers.

Soil available P

Complementary cropping systems does not significantly influence post harvest soil available P but post harvest soil available P was significantly influenced by application of graded dose of fertilizers with organic amendments (Table 2). Higher post harvest soil available P (18.9 kg/ha) was recorded in application of 50% recommended NPK through fertilizers + 50% N through poultry manure which was comparable with 50% recommended NPK through fertilizers + 50% N through FYM (17.6 kg/ha). Higher soil available P might be due to release of CO_2 and organic acids during decomposition. This helps in solubilizing the native soil P.

Table.1 Effect of complementary cropping and graded dose of fertilizers with organic amendments on maize equivalent yield, water productivity, post harvest pH and EC

Treatments	Maize equivalent yield (kg/ha)	Water productivity (kg/ha mm)	pH	EC
Main plot: Complementary cropping				
M_1: Maize + Cowpea + Daincha	6931	15.3	8.56	0.53
M_2: Sunflower + Greengram + Daincha	4396	9.7	8.58	0.54
M_3: Bhendi + Onion + Daincha	4369	7.9	8.56	0.53
SEd	119	0.34	0.20	0.01
CD (p=0.05)	332	0.81	NS	NS
Subplot: Graded dose of fertilizers with organic amendments				
S_1: 100% recommended NPK through fertilizers	4553	9.5	8.96	0.60
S_2: 50% recommended NPK through fertilizers + 50% N through FYM	4943	10.4	8.45	0.48
S_3: 75% recommended NPK through fertilizers + 25% N through FYM	5403	11.3	8.54	0.49
S_4: 50% recommended NPK through fertilizers + 50% N through poultry manure	5395	11.3	8.39	0.54
S_5: 75% recommended NPK through fertilizers + 25% N through poultry manure	5865	12.3	8.49	0.56
SEd	80	0.79	0.30	0.01
CD (p=0.05)	165	1.67	NS	0.03

Table.2 Effect of complementary cropping and graded dose of fertilizers with organic amendments on post harvest soil fertility status

Treatments	Post harvest soil fertility status (kg/ha)		
	Available N	Available P	Available K
Main plot: Complementary cropping			
M_1: Maize + Cowpea + Daincha	244.4	17.9	181.0
M_2: Sunflower + Greengram + Daincha	244.2	16.6	173.0
M_3: Bhendi + Onion + Daincha	241.4	16.2	172.4
SEd	2.7	0.67	2.0
CD (p=0.05)	NS	NS	5.4
Subplot: Graded dose of fertilizers with organic amendments			
S_1: 100% recommended NPK through fertilizers	214.7	14.3	153.3
S_2: 50% recommended NPK through fertilizers + 50% N through FYM	249.0	17.6	172.0
S_3: 75% recommended NPK through fertilizers + 25% N through FYM	232.7	16.6	162.0
S_4: 50% recommended NPK through fertilizers + 50% N through poultry manure	261.3	18.9	199.7
S_5: 75% recommended NPK through fertilizers + 25% N through poultry manure	259.0	17.2	190.3
SEd	5.3	0.68	4.5
CD (p=0.05)	11.0	1.41	9.4

Table.3 Effect of complementary cropping and graded dose of fertilizers with organic amendments on economics

Treatments	Cost of cultivation (Rs ha^{-1})	Gross income (Rs ha^{-1})	Net income (Rs ha^{-1})	Benefit Cost ratio
M1S1	48661	123167	74506	2.53
M1S2	51248	135020	83772	2.63
M1S3	49954	138573	88619	2.77
M1S4	49671	142987	93316	2.88
M1S5	49166	153353	104187	3.12
M2S1	45370	73230	27860	1.61
M2S2	46368	78527	32159	1.69
M2S3	44559	93977	49418	2.11
M2S4	45667	92330	46663	2.02
M2S5	44209	101530	57321	2.30
M3S1	45486	76793	31307	1.69
M3S2	45531	83047	37516	1.82
M3S3	44016	91610	47594	2.08
M3S4	46137	88425	42288	1.92
M3S5	44318	97035	52717	2.19

The organic matter may also reduce the fixation of phosphate by providing protective cover on sesqueoxides and chelating catons like Ca^{2+} and Mg^{2+} (when applied along with inorganic fertilizer) which in turn enhanced the availability of P (Singh *et al.,* 2010) and build up of available phosphorus in soil was released from organic acids during the microbial decomposition of organic manures which help to improve native phosphorous content of soil. Higher post harvest soil available P was recorded in maize + cowpea +daincha with 50% recommended NPK through fertilizers + 50% N through poultry manure (19.2 kg/ha), Lowest post harvest soil available P was recorded by sunflower + greengram + daincha with application of 100% recommended NPK through fertilizers.

Soil available K

Complementary cropping systems and application of graded dose of fertilizers with organic amendments significantly influenced post harvest soil available K (Table 2). Higher post harvest soil available K was recorded by maize + cowpea +daincha (181 kg/ha) cropping which was followed by sunflower+ greengram+ daincha (173kg/ha) cropping. Regarding graded dose of fertilizers with organic amendments, higher post harvest soil available K (199.7 kg/ha) was recorded in application of 50% recommended NPK through fertilizers + 50% N through poultry manure which was statistically on par with application of 75% recommended NPK through fertilizers + 25% N through poultry manure (190.3 kg/ha). The available nutrients in soil increased due to treatments incorporating either total or part of nutrients through organic sources as compared to inorganic sources. This may be due to the release of aliphatic and aromatic hydroxy acids, humates and lignins from organic manures which would release the nutrients into the soil (Aruna *et al.,* 2012).

Post harvest soil pH and EC

Complementary cropping systems does not significantly influenced post harvest soil pH and EC. Post harvest soil EC was significantly influenced by application of graded dose of fertilizers with organic amendments and given in Table 1. Higher post harvest soil EC was recorded with application of 100% recommended NPK through fertilizers. This was followed 75% recommended NPK through fertilizers + 25% N through poultry manure. Lower EC was recorded by 50% recommended NPK through fertilizers + 50% N through FYM.

Economics

The economic analysis (Table 3) indicated that higher gross return, net return and B: C ratio was realized with maize + cowpea +daincha with 75% recommended NPK through fertilizers + 25% N through poultry manure and was followed by maize + cowpea +daincha with 50% recommended NPK through fertilizers + 50% N through poultry manure. Higher crop productivity with lesser cost of cultivation could result in better economic parameters like higher net returns and B:C ratio. Similar view was expressed by Meena et al (2010). Lowest gross income, net income and B: C ratio was recorded by sunflower + greengram + daincha with application of 100% recommended NPK through fertilizers. The highest cost of cultivation was realized in maize + cowpea + daincha with 50% recommended NPK through fertilizers + 50% N through FYM plots.

In sodic soil, higher maize equivalent yield, water productivity, net income and B:C ratio was recorded by maize + cowpea + daincha with application of 75% recommended NPK through fertilizers + 25% N through poultry manure and was comparable with maize +

cowpea + daincha with 25% N supplied through FYM for yield and water productivity. FYM application resulted in increased cost of cultivation due to the low nutrient content compared to poultry manure. A complementary cropping of maize + cowpea + daincha with application of 75% recommended NPK through fertilizers + 25% N through poultry manure may be recommended for sodic soils.

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