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Effect of continuous manurial practices on grain yield and soil chemical properties in a rice based cropping system of Cauvery delta of Tamil Nadu

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Abstract : The effect of continuous application of organic, inorganic and biofertilisers on soil fertility and yield of rice was studied in a permanent manurial experiment at Tamil Nadu Rice Research Institute (TRRI), Aduthurai. The treatment receiving continuous application of NPK at 125:50:50 kg ha^{-1} in *Kuruvai* and 150:60:60 kg ha^{-1} in *Tahaladi* season along with green manure at 6.25 t ha^{-1} in *Kuruvai* and at 12.5t ha^{-1} of FYM in *Thaladi* and gypsum at 500 kg ha^{-1} both in *Kuruvai* and *Thaladi* seasons respectively registered significantly higher grain yield in both seasons consecutively for five years (1992 - 1996). At the end of the 10th rice crop in fifth year, the soil physico chemical properties like pH, EC, organic C, available N, P and K were found not affected. This study also indicated the need for integrated approach on fertilisation for sustaining rice productivity in Cauvery Delta Zone. (***Key Words :*** *Permanent manurial experiment, Cropping system, Soil chemical properties).*

Maintenance of soil health is absolutely essential for sustainable crop productivity. The continuous use of inorganic fertilisers, pesticides, soil chemical amendments, etc., in the soil over the years is believed to cause certain deleterious effects on soil health, if they are not programmed for right time and adequate levels of their applications. Hence, the deleterious effects on soil, if any, have to be monitored on a long-term basis so that precautionary measures could be initiated timely to preserve soil fertility and productivity. Long-term field experiment is an appropriate tool for precise monitoring of changes in soil fertility and productivity. Udayasoorian and Paramasivam (1991), Bharadwaj et. al., (1994), Bharadwaj and Omanwar (1994) and Rajukkannu and Nagarajan (1992) and Anilkumar *et.al.*, (1993) reviewed the efficiency of the continuous manurial practices in building up the soil fertility and yield of rice in rice-based cropping system. The present study at Tamil Nadu Rice Research Institute, Aduthurai was also aimed at monitoring the effect of continuous application of farm chemicals, biofertilisers and organics on soil fertility and yield of rice on a long-term basis in rice-based cropping system of Cauvery Delta Zone.

Materials and Methods

A permanent manurial experiment in rice-based cropping system viz., rice-rice-rice fallow blackgram was started at Tamil Nadu Rice Research Institute, Aduthurai (11°N Adtitude, 79°31 E longitude, 19.4 MSL) during June 1992. The rice crop was taken up in *Kuruvai* (June-September) as well as in Thaladi (October-February) seasons followed by a summer Rice fallow pulse viz., blackgram. Temperature was optimal for rice during *Kuruvai* and cool during *Thaladi*. The crop enjoyed long day length but the day length as reduced during Thaladi season.

The soil of the experimental site was fine, montmorillonitic, isohyperthermic, Udorthentic Chromusterts with clay texture belongs to Kalathur soil series. The initial analytical values of the soil are furnished in Table 1.

The experiment was laid out in a randomized block design with four replications. Thirteen treatments were studied both in the *Kuruvai* and *Thaladi* seasons. The details of the treatments in Table 2. Fertilisers (organic and inorganic), biofertilisers, herbicide and soil amendments were applied as per treatment schedule. The fertilisers used were urea, single superphosphate, muriate of potash and zinc sulphate. In the treatments with green manure (T5, T6, T7), Seabania rostrate/ Sunnhemp was used at 6.25 t ha^{-1} in *Kuruvai* season. Uniform plot size of 22.5 x 3.5 m (78.75 m^2) was adopted for this experiment. Need based plant protection measures were taken up against pests and disease. Popular rice varieties like ADT 36 and ADT 42 in *Kuruvai* and ADT 38 and ADT 39 in *Thaladi* were used as test crops. The field experiment was continued from *Kuruvai* 1992 to *Thaladi* 1996 (10 rice crops).

At harvest, the yield of grain and straw was recorded from a harvest area of 5 m2 in each plot and the data on grain yield were adjusted to 14 per cent moisture in both the seasons. Plant samples (grain and straw) or the 10th rice crop (1996) were analysed for N, P and K contents by using

standard procedures. The dry weight of above biomass was also estimated for calculating nutrient uptake by the crop. At the end of the fifth year (Thaladi 1996), post harvest soil samples (0-5 cm depth) were collected and analysed for organic carbon, pH, EC and available N, P and K adopting standard laboratory procedures.

Results and Discussion

The grain yields of rice obtained for five years from 1992 to 1996 are presented in Table 3. The results revealed that the effects of various treatments on the grain yield were statistically significant in different seasons. During *Kuruvai*, the treatment T_7 receiving continuous application of NPK fertilisers at 125:50:50 kg ha^{-1} along with green manure (6.25 t ha^{-1}) and gypsum (500 kg ha^{-1}) recorded significantly higher grain yield in all the five years (1992-96). The yield increase in T_7 was from 17 to 24 per cent over the application of NPK alone (T_3). On perusal of yield data in *Thaladi* seasons, the treatment T_7 viz., the continuous application of 150:60:60 kg NPK/ha along with FYM (12.5 t ha^{-1}) and gypsum (500 kg ha^{-1}) recorded significantly higher grain yield in all the five years (1992-96). The yield increase of 14 to 23 per cent over the application of NPK alone (T_3). The yield data emphasised the need for integrated use of organic manure (6.25 t ha^{-1} green manure in *Kuruvai* and 12.5 t ha^{-1} FYM in *Thaladi*) with inorganic NPK fertilizers (125:50:50 kg ha^{-1} in *Thaladi*) besides soil amendment (500 kg ha^{-1} gypsum in both seasons) for sustainable rice productivity in Cauvery Delta. The complementary effect of organic and inorganic fertilizers on rice grain yield was also reported by Tiwari *et.al.*, (1980). The results in Table 3 showed further that irrespective of treatments, grain yields varied to a greater extent between years, which might be attributed to the influence of variations in weather and varieties used.

The data on certain soil physico-chemical properties assessed after the 10th rice crop in the fifth year are presented in Table 4. The results revealed that pH, EC and organic carbon were not affected by any of the treatments imposed. The soil available N and K were higher in the treatment T_7, while the available P did not change much due to various treatments. When the values of initial soil analyses done in 1992 were compared, the pH and EC had not changed much. The organic carbon content was even increased at the end of the fifth year which indicated the maintenance of stability in the organic matter status of soil. The beneficial effect of chemical fertilisers and organic manures on the soil organic carbon content might be mainly due to better root growth and more crop residue in the treatment plots. These results suggested that there was no deleterious effect on soil fertility due to different chemicals and organics as was reported by Rajukkannu and Nagarajan (1992).

The data on the NPK uptake by rice crop at the end of the fifth year (1996) revealed that the treatment with the highest grain yield (T_7) recorded significantly highest N, P and K uptake in both grain and straw (Table 5). Deka Medhi et.al., (1996) also found a significant increase in N uptake due to the effect of organic and inorganic source of N addition. The total uptake of N, P and K was the lowest in the plots receiving no fertiliser or manure treatment (T_{13}). This clearly indicated that continuous cropping without fertilisation resulted in the lowest uptake of nutrients by the crop as compared to fertilised plots.

The results of the present study emphasised the need for combined application of organic manures, gypsum and inorganic NPK fertilisers for soil health care and sustainable rice productivity in Cauvery Delta. It was also established that continuous rice cultivation over five years did not produce deleterious effect on soil properties.

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Table 1. Initial soil properties of experimental plots of permanent manurial experiment

Properties	Value
pH (1:2)	6.9
EC (dS m^{-1})	0.49
Coarse sand (%)	4.88
Fine sand (%)	24.99
Silt (%)	23.26
Clay (%)	46.53
Water holding capacity (%)	38.9
Bulk density (g cm^{-3})	1.5
Organic C (%)	0.57
Free CaCO3 (%)	0.55
CEC (e mol kg^{-1})	40.5
Available N (kg ha^{-1})	231
Available P (kg ha^{-1})	30
Available K (kg ha^{-1})	228
Available Zn (ppm)	1.2

Table 2. Permanent Manurial Experiment - Treatment details

S.No.	*Kuruvai*			*Thaladi*		
	N	P_2O_5 (kg/ha)	K_2O	N	P_2O_5 (kg/ha)	K_2O
1	125	50	0	150	60	0
2	125	0	50	150	0	60
3	125	50	50	150	60	60
4	125	50	50	150	0	60
5	125	50	50 +GM	150	0	60 +FYM
6	125	50	50 +GM+Azos	150	60	60 +FYM+BGA
7	125	50	50 +GM+GYP	150	60	60 +FYM+GYP
8	125	50	50 +$ZnSO_4$	150	60	60 +$ZnSO_4$
9	125	50	50 +WC	150	60	60 +WC
10	125	50	50 +GYP	150	60	60 +GYP
11	125	50	50	112.5	45	45
12	125	50	50 +CPC	150	60	60 +CPC
13	Absolute control			Control		

FYM	Farm yard manure - 12.5 t/ha	For *Kuruvai* N splits
GM	Green manure - 6.25 t/ha	4 splits - Basal, 15 DAT, 30 DAT, 45 DAT
GYP	Gypsum - 500 kg/ha	25% each
WC	Herbicide - (Butachlor - 2.5 lit/ha)	For *Thaladi* N splits
CPC	: Coirpith compost - 12 kg/ha	4 splits - Basal, 20 DAT, 40 DAT, 65 DAT
Azos	Azospirillum - 2 kg/ha	25% each
BGA	Blue Green Algae - 10 kg/ha	

Table 3. Rice grain yield (kg ha^{-1}) in *Kuruvai* and *Thaladi* Seasons

Treatment No.	1992		1993		1994		1995		1992		1996		increase over control (%)	
	Kuruvai	*Thaladi*	*Kuruvai*	*Thaladi*	*Kuruvai*	*Thaladi*	*Kuruvai*	*Thaladi*	*Kuruvai*	*Thaladi*	*Kuruvai*	*Thaladi*	*Kuruvai*	*Thaladi*
T1	5012	3276	3900	2886	4580	4410	5915	4138	5920	4170	5065	3776	43	29
T2	5067	3198	3850	3131	3180	4804	5850	4451	5880	4400	5165	3997	45	37
T3	5473	3720	4200	3423	5255	4500	5235	4190	5240	5030	5081	4173	43	43
T4	5590	3512	4075	3298	5065	4958	5100	4654	5100	4550	4986	4194	40	46
T5	5822	3892	4950	4010	5285	4995	5800	4675	5820	4975	5535	4509	56	54
T6	6276	4282	5025	4051	5460	4819	5490	4560	5490	4605	5548	4463	56	53
T7	6390	4335	5225	4226	6288	5335	6160	4971	6160	5746	6045	4923	70	69
T8	5930	4210	5050	3867	5445	4808	6080	4509	6080	4480	5717	4375	61	50
T9	5714	4000	4425	3668	5020	3878	5755	3668	5760	4540	5335	3951	50	35
T10	5612	4150	4800	3734	5298	5138	5980	4808	5980	5020	5534	4570	56	56
T11	5327	3450	4279	3524	4995	4478	5240	4198	5240	4030	5016	3936	41	35
T12	5495	3880	4625	3629	5370	4148	5665	3899	5500	5025	5331	4116	50	41
T13	3496	3205	3200	2327	3275	2711	3975	3248	3810	3115	3551	2921	--	--
CD (p=0.05)	258	158	190	191	516	472	163	710	876	958				

Table 4. Soil Physico-chemical properties after 10th rice crop

Treatment No.	pH	EC (dSm^{-1})	Organic Carbon (%)	Available N	Available P (kg/ha)	Available K
Initial	6.9	0.49	0.57	231	30	228
T1	6.9	0.52	0.92	233	50	278
T2	7.0	0.53	0.90	222	46	246
T3	7.1	0.52	0.82	227	50	283
T4	6.9	0.54	0.85	246	48	294
T5	7.1	0.53	0.89	217	48	287
T6	7.0	0.52	0.91	240	46	276
T7	6.9	0.53	0.90	260	47	298
T8	7.0	0.55	0.91	238	46	288
T9	7.1	0.49	0.81	231	47	264
T10	7.0	0.53	0.87	252	49	280
T11	6.9	0.52	0.83	246	49	281
T12	7.0	0.52	0.85	241	47	293
T13	6.9	0.52	0.84	225	47	273
CD (p=0.05)	NS	NS	NS	20	NS	24

Table 4. Uptake of N, P and K (kg/ha) by grain and straw at harvest of 10th rice crop

Treatment No.	Grain N	Grain P	Grain K	Straw N	Straw P	Straw K	Total (Grain + Straw) N	Total (Grain + Straw) P	Total (Grain + Straw) K
T1	41.3	8.8	13.3	41.9	6.5	58.6	83.2	15.3	71.9
T2	43.1	7.9	18.0	43.6	5.0	109.9	86.7	12.9	127.9
T3	50.8	11.1	20.1	54.9	8.5	141.8	105.7	19.6	161.9
T4	44.6	7.7	18.2	50.0	5.6	119.9	94.6	13.3	138.1
T5	49.3	8.9	22.4	56.6	8.1	135.6	105.9	17.0	158.0
T6	49.7	10.1	21.6	45.1	6.2	108.6	94.8	16.3	130.2
T7	60.3	12.6	27.0	70.0	8.7	141.3	130.3	21.3	168.3
T8	46.9	9.4	20.6	43.1	6.2	102.1	90.0	15.6	122.7
T9	45.9	9.1	20.0	44.7	6.1	113.7	90.6	15.2	133.9
T10	48.2	10.5	21.6	53.7	7.3	131.7	101.9	17.8	153.3
T11	39.5	8.5	16.9	40.4	6.0	100.6	79.9	14.5	117.5
T12	51.8	11.1	22.1	52.1	8.6	133.6	103.9	19.7	155.7
T13	24.9	5.3	9.3	14.2	3.5	38.0	39.1	8.8	47.3
CD (p=0.05)	11.8	3.2	6.3	9.2	1.2	18.9	10.8	2.4	14.1

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Cost of commercial seed production in hybrid sesame

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Abstract : The floral biology of sesame, despite its autogamous nature, is favourably suited for developing hybrids. To produce hybrid seeds in sesame, different techniques are tried. In the present study, attempt were made to produce large quantities of hybrid seed by hand emasculation and pollination method. It was found that 98.64 per cent of the total cost of hybrid seed production was spent towards emasculation and crossing. On an average, one labour could attend 450 and 275 flower buds respectively for emasculation and pollination in an hour. Only 57 per cent capsule set was recorded and the number of seeds formed in the crossed capsule was also less. The production cost of hybrid seeds was worked out to be Rs. 534.00 per kg. *(**Key Words** : Sesame, Hybrid seed production, Hand emasculation and Pollination).*

Sesame (*Sesamum indicum L.*) is an important and ancient oil yielding crop originated probably in Africa (Osman, 1985) and cultivated extensively in India, China, Japan, Africa, and Mediterranean regions. Sesame, though a self pollinated crop, the study of insect aided natural out crossing (Brar and Ahuja, 1977) and the release of two hybrids from China (Sharma, 1994) have opened up the possibility of commercial exploitation of heterosis. The success of commercial exploitation of hybrids depends on the economics of hybrid seed production. Prasad (1994) is of opinion that since the seed requirement of sesame is very low, exploitation of hand emasculation and pollination technique is possible for commercial seed production. The present study was undertaken to estimate the cost of hybrid seed production by adopting hand emasculation and pollination method.

Materials and Methods

The study was carried out in Cotton and Oilseeds Farm, Tamil Nadu Agricultural University, Coimbatore during kharif-1996. The ovule (VRI.1) and pollen (Si.3214) parents obtained from