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Effect of Nutrient Recycling in Seri-based Integrated Farming System on Soil Fertility, Productivity and Profitability in Maize – Sunflower Cropping System

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ABSTRACT

Field experiments were conducted at Thalingipalayam block (Avinashi, Tiruppur district of Tamil Nadu) India.during 2011-2012 to study the effect of organic manure (seriwaste compost + goat manure + poultry manure + farm waste) obtained from Integrated Farming Systemon maize-sunflower sequential cropping system for enhancing productivity and economics. The experiments were laid out in randomized block design with three replications. The organic manures of various regimes (25%, 50%, 75% and 100%)were applied along with Nitrogen (N), Phosphorus (P), Potassium (K) levels (150:75:75 kg ha{ ¹) at different levels (25%, 50%, 75 % and 100%).The results revealed that plant growth, Dry matter production, yield, soil fertility and economics were found to be higher with integrated nutrient supply through 100% of RDF+75% of organic manure from Integrated Farming System components with increased net returns and B:C ratiowhich was *on par* with 50% RDF +50% organic manure in maize-sunflower sequential cropping system.

Key words *Maize, Sunflower, IFS, Seri-waste, soil fertility,profitability.*

Maize (*Zea mays* L.) is one of the most important cereal crop grown all over the globe as poor man's food besides, as cattle and poultry feed. With the intention of achieving evergreen revolution, intensive research in maize has been started anticipating its importance for enhancing food and feed production. Maize, not only provides nutrients for human beings and animal but also serves as a basic raw material as an ingredient to more than 3000 industrial products *viz.,* for the production of starch, oil, protein, alcoholic beverages, food sweetners and more recently as fuel.

In India, maize is grown in an area of 8.26 million hectares with a production and productivity of 20.03 million tonnes and 2.3 t ha^{-1} respectively (Crop Report, 2010). By 2020, the requirement of maize for various sectors will be around 100 million tonnes of which the poultry sector demand alone will be around 31 million tonnes.

Sunflower is an important oil yielding crop endowed with short growth period, wider adaptability, photo insensitive nature, tolerant to drought with high quality oil and high degree of fatty acid content (Tandon, 1990).

In recent years, recycling of crop residues has received considerable interest. In sericulture farms, the left over mulberry leaves from rearing bed and field and other waste including silkworm litter are not properly utilized in preparing compost of highly organic and nutritive value. Hence, it is essential to convert the sericulture farm waste in to valuable compost by adopting suitable technology. Sericulture waste serves as good source of organic nutrients for the crops. Seriwaste contains more amounts of plant nutrients like macro and micro nutrients which contribute to increased production.Nutrients contained in organic manures are released more slowly and stored for a long time in the soil, ensuring a long residual effect (Sharma and Mittra, 2007).

Thus, it has been realized that application of chemical fertilizers in conjunction with organic manures will sustain with environmental protection and maintain the productivity of soil. Therefore, this study was undertaken to explore the possibilities of linkages of various components in the integrated farming systems in terms of optimization and resources utilization with various organics as well as chemical fertilizers in order to find out the most effective integrated nutrient supply system in maize-sunflower sequential cropping system.

MATERIALS AND METHODS

Seriwaste compost (organic manures) was prepared in the farmer field in Avinashi, Tiruppur District as per the standard recommended procedure. Rearing waste and mulberry farm residues and weeds (removed before flowering) are collected in a pit of convenient size with 1 m depth. The left over stems/shoots should be crushed before putting them in pit, which makes their decomposition faster. A thin layer of cattle dung and poultry waste with water are spread into the pit regularly after every collection of one foot thick compacted layer of the wastes. When the pit is filled, it is plastered with a layer of mud and cattle dung. The pit should be left undisturbed and opened only after 5 months.

The Experimental field was prepared with primary and secondary tillage operations to bring the soil to required level of tilth and levelled uniformly with convenient plot size. The layout so formed was kept undisturbed throughout

the period of investigation.

The experiment was laid out in a randomized block design with three replications. Treatment details:

T1 – 100% Recommended dose (RDF) of NPK (150:75:75 kg NPK/ha)

T2 – 75% RDF + 25% *organic manure

T3 – 50% RDF + 50% *organic manure

T4 – 25% RDF + 75% *organic manure

T5 – 100% RDF + 75% *organic manure

T6 – 100% *organic manure alone (5 tons/ha)

T7 – Absolute Control * Organic manure (Silkworm rearing waste + Animal waste + Poultry waste + Farm waste)

Seeds of maize hybrid CoH(M)5 were sown on sides of the ridges. Seeds were dibbled at the rate of one seed hill^{-1} with a spacing of 60 x 30 cm and seed rate of 15 kg/ ha as per the recommendation. The inorganic fertilizers *viz.*, Urea, Single Super phosphate and Muriate of potash @ 150:75:75 kg NPK ha^{-1} were applied as per the treatment schedule.

Sunflower hybrid CoSF(H) seeds were sown in the maize plots as succeeding crop after the harvest of maize to study the residual effect of manures and fertilizers applied to maize with a plant spacing is 30 x 15 cm.

Biometric,yield parameters and yield. Economics was also worked out for the cropping system as a whole.

RESULTS AND DISCUSSION

Effect of treatments on Maize:

Growth parameters:

Plant height was significantly influenced by the application of organic manures and inorganic fertilizers at 90 days after sowing (DAS). Among the treatment combinations, application of 100% RDF + 75% organic manure (T_5) recorded taller plants (320cm) followed by 50% RDF + 50% organic manure (T_3) which was *on par* with 75% RDF + 25% of organic manure (T_2). The plant height was lowest with absolute control (215 cm).

Application of 100% RDF + 75% organic manure (T_5) recorded highest dry matter production (16188 kg ha^{-1}) and this was followed by application of 50% RDF + 50% organic manure at the time of harvest. This might be due to better nutrient release from the organic manures and better crop growth and biomass production (Chandrasekara, *et al.,* 2000).

Yield parameters:

Significant variation was observed on number of grains per row cob length, cob weight and test grain weight due to the application of organic manures and inorganic fertilizers. Application of 100% RDF + 75% of organic manure (T_5) and 50% RDF + 50% organic manure (Tf) recorded the more number of grains per row (32.01) and (30.29) respectively.

Application of 100% RDF + 75% of organic manure (T_5) recorded higher values (20.64 cm) of cob length and cob weight (222gm) this was followed by 50% RDF + 50% organic manure (Tf) which recorded lengthier cob (19.23cm) and cob weight of (204 gm). The cob length and weight was lowest in the absolute control(13.24 cm and 133 gm) (Table 1). The positive influence of the higher doses of applied NPK could be attributed to their favourable effect on yield attributes of plants. The results are in conformity with the findings of Pattanashetti, *et al.,* 2002 and reported that maize being a quick and heavy feeder it responded conspicuously to application of chemical fertilizers as earlier observed by Gill, *et al*., 1994 and Sahoo and Panda, 2000. Similar results were also reported in maize-wheat cropping system by Gill, *et al.,* 1994.

Table 1. Effect of organic manure* and inorganic fertilizers on growth and yield of maize

Treatment	Plant height (cm)	DMP (kg ha^{-1})	No. of grains / row	Cob length (cm)	Cob weight (g)	Test weight (g)	Yield kg ha^{-1}	
							Grain	Stover
T1	249	14329	28.32	18.61	184	22.93	5652	10044
T2	264	15502	29.63	19.01	191	24.92	6098	10597
T3	282	15652	30.29	19.23	204	25.39	6243	10831
T4	243	12525	26.62	18.28	178	23.31	5414	9295
T5	320	16188	32.01	20.64	222	31.43	6828	11647
T6	238	12474	22.46	17.38	171	22.19	4718	9130
T7	215	11774	18.68	13.24	133	20.24	3651	6914
SEd	11.20	83.240	0.400	0.156	5.070	0.654	77.31	114.24
$CD_{(0.05)}$	24.40	181.38	0.873	0.341	11.04	1.427	168.45	248.91

* Organic manure (Silkworm rearing waste + Animals waste + Poultry birds waste + Crop waste)

Table 2. Effect of organic manure* and inorganic fertilizers on growth and yield of Sunflower.

Treatment	Plant height (cm)	DMP (kg ha^{-1})	No. of grains / Head	No. of filled grains / Head	Test weight (g)	Yield kg ha^{-1}	
						Grain	Stalk
T1	232	5491	1042	921	7.07	1512	4730
T2	245	5945	1171	989	7.18	1558	5010
T3	248	6226	1209	1008	7.28	1589	5093
T4	227	5287	968	852	6.68	1463	4698
T5	263	6665	1398	1302	7.65	1691	5285
T6	218	5011	904	801	6.58	1404	4265
T7	201	4798	800	689	5.18	1266	4017
Sed	3.55	55.82	4.563	6.470	0.064	1.543	62.81
CD $_{(0.05)}$	7.74	121.6	9.942	14.09	0.140	3.361	136.8

* Organic manure (Silkworm rearing waste + Animals waste + Poultry birds waste + Crop waste)

Hundred grain weight also showed significant variation due to the application of organic manures and inorganic fertilizers. Application of 50% RDF + 50% organic manure (T*f*) recorded the highest test weight (31.43 g) next followed by100% RDF + 75% of organic manure. (Table 1). In maize, increased growth parameters made the yield attributes *viz.,* length of cob, width of cob, number of rows cob^{-1}, number of grains row{ ^{1}, test weight etc, more and accelerated in the translocation of photosynthates which be the reason for might increased yield attributes. Findings of Gill, *et al.,* 1994 and Sahoo and Panda, 2000 were in line with the results of increased growth and yield attributes .

Yield:

Grain and stover yields significantly influenced by the application of organic manures and inorganic fertilizers were higher grain yield (6828 kg ha{ ^{1}) and stover yield (11648 kg/ha) obtained with the application of 100% RDF + 75% of organic manure (T_5). This was followed by 50% RDF + 50% organic manure (T*f*) and was *on par* with the application of 75% RDF + 25% organic manure (T_2). The grain and stover yields were lowest (3651 and 6914 kg ha^{-1}) with the absolute control (T_7) (Table 1). The combined application of organic and inorganic fertilizer led to a significant increase in yield of sorghum and it has been indicated earlier by Gangwar and Niranjan, 1991.

The positive influence of the higher doses of applied NPK could be attributed to their favourable effect on yield attributes of maize plants. The results are in conformity with that report of Pattanashetti, *et al.,* 2002 as reported that maize being a quick and heavy feeder it responded conspicuously to application of chemical fertilizers as earlier observed by Gill, *et al*., 1994 and Sahoo and Panda, 2000.

Effect of treatments on succeeding Sunflower:

Growth parameters:

Plant height of sunflower was significantly influenced by the application of organic manures and inorganic fertilizers. Among the treatment combinations, application of 100% RDF + 75% organic manure (T_5) recorded taller plants (263cm) with higher dry matter production (DMP) (6665 kg/ha) followed by 50% RDF + 50% organic manure (T_3) which was *on par* with 75% RDF + 25% of organic manure (T_2). The plant height and DMP were the lowest with absolute control (201 cm and 4798 kg/ha). This might be due to better nutrient release from the organic manures which favoursbetter vegetative growth and development (Chandrasekara, *et al.,* 2000).

Yield parameters:

Total number of grains per head, number of filled grains per head and hundred grain weight were significantly varied by the application of organic manures and inorganic fertilizers. Application of 100% RDF + 75% organic manure recorded higher no. of grains/head (1398) filled grains/head (1302) and 100 grains weight (7.65 g) which was followed by 50% RDF + 50% organic manure (T_3) which was *on par* with 75% RDF + 25% organic manure. The least value

Table 3. Effect of organic manure* and inorganic fertilizers on uptake of NPK by sunflower and soil availability

Treatments	Maize uptake (kg/ha)			Soil available nutrients (kg/ha)		
	N	P	K	N	P	K
T1	131	23.4	51.60	195	31.6	318
T2	141	26.7	54.80	217	34.6	333
T3	141	27.8	55.70	220	35.3	336
T4	131	20.4	46.90	180	25.6	301
T5	149	30.5	59.70	236	42.8	369
T6	125	17.8	43.30	172	22.9	281
T7	109	13.1	35.80	161	18.4	265
SEd	0.664	0.092	0.148	0.817	0.796	0.808
CD $_{(0.05)}$	1.448	0.201	0.322	1.780	1.736	1.760

* Organic manure (Silkworm rearing waste + Animals waste + Poultry birds waste + Crop waste)

Table 4. Effect of organic manure* and inorganic fertilizers on economics of hybrid maize-sunflower sequential cropping system

Treatments	Gross return (Rs.ha?¹)	Cost of cultivation (Rs.ha?¹)	Net return (Rs.ha?¹)	B: C ratio
T1 – 100% Recommended dose (RDF) of NPK	99241	25531	73710	3.89
T2 – 75% RDF + 25% *organic manure	103181	24166	79015	4.27
T3 – 50% RDF + 50% *organic manure	106971	24540	82431	4.36
T4 – 25% RDF + 75% *organic manure	86403	24214	62189	3.57
T5 – 100% RDF + 75% *organic manure	115676	24615	91061	4.70
T6 – 100% *organic manure alone	84710	24232	60478	3.50
T7 – Absolute Control	72913	23742	49171	3.07

*Organic manure (Silkworm waste + Animals waste + Poultry birds waste + Crop waste)

Data not statistically analyzed

Price of Maize grain	:	Rs. 9 / kg
Price of Sunflower grain	:	Rs. 30 / kg
Price of Urea	:	Rs. 5.30 / kg
Price of SSP	:	Rs. 3.50 / kg
Price of MOP	:	Rs. 4.90 / kg

of yield parameters were obtained in the absolute control (T_7) irrespective the treatments studied. (Table 2).

Yield:

Yield of sunflower (Grain and stalk) was significantly altered by application of organic manures and inorganic fertilizers. Higher grain yield (1691 kg ha{ ¹) and stalk yield (5285 kg ha^{-1}) were recorded with the application of 100% RDF + 75% of organic manure which was followed by 50% RDF + 50% organic manure (T*f*) which was *on par* with the application of 75% RDF + 25% organic manure (T_2). The grain yields were lowest (1266 kg ha^{-1} and 4017 kg ha^{-1}) with the absolute control (T_7) (Table 2). The combined application of organic and inorganic fertilizer led to a significant increase in yield of sorghum as reported earlier by Gangwar and Niranjan, 1991.

Nutrient uptake by maize plant

Nitrogen (N) uptake was significantly influenced by organic and inorganic fertilizers at the time of harvest. Among the different treatments 100% RDF + 75% organic manure (T_5) recorded more N uptake (149 kg ha{ ¹) followed by 50% RDF + 50% organic manure (T_3) and 75% RDF + 25% organic manure (T,) (141 kg ha^{-1}) as compared to other treatments (Table 3). Similar trend was also observed in P and K uptake of 30.5 and 59.70 kg ha^{-1} as in N uptake at the time of harvest. Application of organic manure at different levels recorded higher available N, P and K and least values were obtained under absolute control. Improved nutrients availability with graded levels of fertilizers was reported by Jayanthi, *et al.,* 1997 and Malewar, *et al.,* 1999. The favourable and beneficial effect of organic manures on available soil nutrient status of which might be the reason for greater availability of nutrients to crop in the presence of organic manures and their solubilising effect of different forms of nutrients present in soil (Ghosh, *et al.,* 2002.

Post harvest soil available nutrients :

Among the different treatments, 100 % RDF + 75 % organic manure registered more soil available N (236 kg ha{ ¹) followed by 50% RDF + 50 % organic manure and 75% RDF + 25% organic manure with values of (220 and 217 kg ha^{-1}). The absolute control (T_7) recorded lowest soil available nitrogen (161kg ha^{-1}) than that of other treatmental combinations (Table 3). This might be due to the increased dry matter production of maize crop as a result of increased N, P and K availability through organic manures. Similar results of increased nutrient uptake due to application of organics were reported by Rajkhowa, *et al.,* 2000 and Subha and Gajendragiri, 2004. This may be attributed to the direct addition and slow release of N, P and K through organic manures added to the soil (Jat and Ahlawat, 2004). Similarly, nutrient balance studied earlier by Malewar, *et al.,* 1999 revealed that there was a considerable improvement in the NPK status of the soil with the application of organic manures coupled with full-recommended dose of fertilizer in sunflower and cotton.Soil available P was found to be higher in the 100% RDF + 75% organic manure (42.8 kg ha^{-1}) followed by 50% RDF + 50% organic manure and 75% RDF + 25% organic manure similar trend was also observed in soil available K status as in soil P status (Table 3). The absolute control recorded lowest soil available phosphorus (18.4 kg ha^{-1}). Increased uptake was also due to higher fertility status of the soil. Similar findings were also reported by Gangwar and Niranjan, 1991 and Misra, *et al.* 1994.

Economics of maize – sunflower cropping system

The economics worked out for maize – sunflower sequential cropping system during 2011-2012 revealed that the cost of cultivation was found to be the highest (Rs.25531ha^{-1}) with 100 per cent recommended dose of fertilizer (Table 4). This was followed by 100% RDF + 75% organic manure (T_5) (Rs.24615ha^{-1}). The gross return, net return and B: C ratio were higher in 100% RDF + 75% organic manure (Rs.115676ha^{-1}, Rs.91061and 4.70 respectively), which was followed by 50% RDF + 50% organic manure (T_3). The least values were noticed in the absolute control (T_7) as compared to all other treatments in the present investigation. This was mainly due to increased productivity of both maize and sunflower in the cropping system as a whole.

Thus, it was concluded that application of 100% RDF (150:75:75 kg NPK ha^{-1}) + 75% organic manure and 50% RDF + 50% organic manure increased the productivity of maize as well as succeeding sunflower with enhanced net return and B:C ratio in Maize-Sunflower sequential cropping system without any harmful residual effect.

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