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Effect of organic on paddy-castor cropping system

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ABSTRACT

Two year field investigation was carried out to study the effect of fertilizer(No fertilizer; 75% RDF;100:30:00NPK kg/ha) and organics(No organics; Sugarcane trash incorporation @20t/ha along with decomposing culture treatment; Bio-compost @ 20 t/ha; FYM @ 20 t/ha and in-situ green manuring with dhaincha) on transplanted paddy and its residual effect on successiding rabi castor. Fertilizer application improves growth, yield attributes and yield of paddy and castor. Applications of organics have positive effect on growth and yield of paddy and have residual effect on castor crop. Application of bio-compost @20 t/ha have significantly higher paddy grain yield(4591 kg/ha) which was 1.5 time higher than no organic application. Next effective treatment was in-situ green manuring with dhaincha followed by FYM @20 kg/ha. The residual effect of organic on castor in respect of grain yield was higher with bio-compost followed by FYM, Sugarcane stash incorporation and in-situ green manuring. Similar treand was observed in paddy based equivalent yield. Soil organic carbon content was improved after two year of study under organic application plots.

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INTRODUCTION

Intensive agriculture without organics has depleted the inherent soil fertility and productivity leading to deficiency of important plant nutrients. Adequate, supply of nutrients plays an important role for obtaining the high productivity, but the source of nutrient is of prime important. The soil became seak and unable to convert mineral nutrients in the utilizable form by plant due to reduction in biological activity in soil in absence of organic matter. Several long term experiments all over India indicated a decrease in rice productivity and deterioration of soil health due to continuous and excess use of costliest chemical fertilizers alone. Thus emphasis should be on reducing the use of chemical fertilizers. Integrated nutrient management (INM) has an important role here, owing to practice of combining organics and inorganics constitute an important component of INM and they provide regulated and balanced supply of plant nutrients. Sharma (2002) reported increased yield and nutrient use efficiency in rice with organics. Demand on organically produced farm products increasing with improvement in living standard and awareness of people for health. Nitrogen, the key nutrient element for paddy, is the major constituent of organic sources, which available after decomposition. Organic material degrades in soil as per its C : N ratios. Lower C : N ratio containing materials decomposed fast and released nutrients immediately available to the grouping crops which affect on crop growth and the yield.

The management of organics is considered for cropping system as a whole rather than for individual crop, because they can not be fully utilized by crop to which these are added and a subsequent crops to which these are added and a substantial amount is left into the soil for subsequent crops (Ali and Misra, 2000). Incorporation of residues as a means of nutrient recycling in the soil-plant ecosystem is and essential component of sustainable productivity in nutrient exhaustive cropping system, as it alters the soil environment which in turn influences the microbial population and activity in the soil and subsequent nutrient transformation (Kumar and Goh, 2000). Application of organic-inorganic combination is very effective in realizing of high yield and high responses to added nutrients, while imbalance use of nutrients has detrimental effect. Incorporation of farm wastes as straw, stalk and bhusa or straw as well as practices of green manuring are viable alternative to FYM and compost for improving soil fertility and sustaining productivity of crops. Organic recycling has generated a higher importance especially in the cereal-based cropping systems. The residual nature of organic sources makes them more value-based for the whole system as compared to individual crops (Sarkar *et al.,* 1997). Multiple cropping and intensive input management is practiced to enhance land-use efficiency and to increase production. Judicious use of chemical fertilizers in combination with organic manures or recycling of crop residues is require to improve the soil health as well as to achieve sustainable production. Hence, the present investigation was carried out to study

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the effect of organics on paddy-caster sequence with and without fertilizers.

MATERIALS AND METHODS

A field experiment was conducted during *Kharif* and *Rabi* seasons of 2006-07 and 2007-08 on clayey soil of Regional Rice Research Station, Navsari Agricultural University, Vyara (Tapi-Gujarat) to study the influence of various organic sources with and without chemical fertilizers on the productivity of irrigated rice and their residual effect on *Rabi* caster. The soil was normal in reaction with pH 7.6 and non-saline (Ec 0.23 ds/m). Organic carbon content was low (0.43%), available N was low(210 kg/ha) and the available P(38.2 kg/ha) and K (298 kg/ha) were high. The organic sources used were: Sugarcane trash, bio-compost, FYM and green manuring with *dhaincha* (*Sesbania aculeata*).

The experimental design was a factorial randomized block design with total 10 treatments, including 2 fertilizer treatments, *viz.,* no chemical fertilizer and 75% of RDF (100-30-0 NPK kg/ha) and 5 organics treatments *viz.*, no organics, sugarcane trash incorporation @ 20 t/ha along with decomposing culture treatment, bio-compost @ 20 t/ha; FYM @ 20 t/ha and *in-situ* green manuring with *dhaincha.* The organics (Sugarcane trash, bio compost and FYM) were incorporated one week before transplanting seedlings, where as *dhainch* seeds @ 100 kg/ha sown in situ 50 days before transplanting and incorporated *in situ* one week before transplanting of paddy seedlings in respected plots. Each plot was of 10m x 15m ($150m^2$) size and experiment was taken as large as plot techniques, each plot was divided then in 4 plots of 3m x 6m and all the observations were taken from these small plots. The plots were fertilized with 75% recommended dose as per recommendation *viz.,* whole quantity of phosphorus and 40% of nitrogen was added through DAP and ammonium sulphate at the time of transplanting, remaining nitrogen was applied at tillering (40%) and panicle-initialization stage. During the *Rabi* season, the residual effect of organics applied to paddy in *Kharif* season was studied in term of productivity of castor, castor was grown without organics as well as chemical fertilizers. Irrigation and plant protection measures were taken as per the recommended schedules of practices. Paddy variety 'Gurjari' of 25 days old seedlings were transplanted at a spacing of 20x10 cm in the month of July and harvested in October. Caster 'GCH-4' was dibbled at the distance of 90x60 cm immediately after paddy harvested (November) and spikes were harvested as matured (February to April) yield were recorded. Soil samples were taken after paddy harvested and analyzed for pH, EC, OC and available P_2O_5 and K_2O as per standard procedure.

RESULTS AND DISCUSSION

The results obtained from the present investigation have been duscussed below:

Growth and yield attributes of crops:

Plant growth and yield attributes were recorded significantly lower values under no chemical fertilizer treatments. Significantly lower plant height of paddy and castor plants, panical length, panical number, spike length and spike number were reduced under without fertilizer treatment (Table 1) during both the years of study as well as in pooled results. This was due to lack of availability of major plant nutrients especially N and P during vegetative growth as paddy like cereals require large amount of nutrients during active tillering to panicle initiation stage, so adequate nutrient not available during vegetative phase will cause adversely on the growth and yield attributes of crops(Prasad, 2007). The growth and yield attributes such as panicles/m^2, panicle length, number of spikes and spike length were reported higher with second year of study, it could be due to residues effect of added organic sources where availability of nutrient increased gradually which improve plant growth and yield attributes(Surekha, 2007).

Application of various organics influenced significantly the growth and yield attributes of paddy and also have residual effect on castor crops. Among the various organics applied, bio-compost @ 20 t/ha (4) recorded significantly higher plant height, and yield attributes followed by greenmanuring with dhencha in paddy growth while residual effect on castor was more due to biocompost followed by application of FYM @ 20 t/ha (Table 1). Data presented in Table 1 also show that when organics were applied the growth and yield parameters during second years were higher compared with no organics in case of paddy, it could be attributed to the gradual increase in nutrient availability due to organic sources. Similar observations were also reported by Surekha (2007) and Ali and Misra (2000). Such results are obvious as application of fertilizer in combination with organic manures is known to improve various physico-chemical properties resulted in enhanced nutrient absorption or uptake resulted in rapid conversion of synthesized photosynthates into protein to form more protoplasm, thus increasing the number and site of cell which might have increased the plant height and related

Table 1 : Effect of organics with and without fertilizer on growth and yield attributes of paddy-castor

Treatments	Paddy								
	Plant height			Length of panicle(cm)			Number of panicles/m^2		
	1st year	2nd year	Pooled	1st year	2nd year	Pooled	1st year	2nd year	Pooled
Fertilizer									
F_1: No fertilizer	80.10	87.45	83.78	19.45	21.15	20.30	170.55	201.45	186.00
F_2: 757 of RDF	103.95	105.35	104.65	23.45	24.95	24.20	225.15	233.55	229.35
C.D. (P=0.05)	3.28	3.05	6.10	1.23	1.94	0.86	5.75	7.24	23.12
Organics									
O_1: No organics	77.63	77.38	77.50	17.88	17.88	17.88	145.00	143.13	144.06
O_2: FYM @ 10t/ha	94.88	99.00	96.94	22.38	22.75	22.56	212.38	233.00	222.69
O_3: Sugarcane Trash @ 20 t/ha	83.75	88.88	86.31	20.63	22.88	21.75	191.38	223.38	207.38
O4: Bio comport @ 20 t/ha	102.00	108.00	105.00	23.13	26.38	24.75	221.25	244.38	232.81
O5: Green Tran	101.88	108.75	105.31	23.25	25.38	24.31	219.25	243.63	231.44
C.D. (P=0.05)	5.19	4.82	3.49	1.94	2.05	1.42	9.09	11.45	25.05

Contd… Table 1

Treatments	Castor								
	Plant height(cm)			Spike length(cm)			Total number of spike/plant		
	1st year	2nd year	Pooled	1st year	2nd year	Pooled	1st year	2nd year	Pooled
Fertilizer									
F_1: No fertilizer	120.95	125.10	123.03	35.75	39.60	37.68	4.30	4.95	4.63
F_2: 757 of RDF	130.05	135.10	132.58	41.35	43.40	42.38	5.05	5.90	5.48
C.D. (P=0.05)	2.32	1.55	1.36	1.71	2.10	1.33	0.53	0.61	0.39
Organics									
O_1: No organics	110.88	113.50	112.19	31.00	31.87	31.44	3.63	4.88	4.25
O_2: FYM @ 10t/ha	129.63	136.00	132.81	44.50	45.50	45.00	5.25	5.00	5.13
O_3: Sugarcane Trash @ 20 t/ha	121.88	129.25	125.57	35.00	40.00	37.50	3.75	4.88	4.31
O4: Bio comport @ 20 t/ha	134.75	139.38	137.06	47.75	50.38	49.06	6.13	7.13	6.63
O5: Green Tran	130.38	132.38	131.38	34.50	39.75	37.13	4.63	5.25	4.94
C.D. (P=0.05)	3.67	2.45	2.25	2.70	3.32	2.16	0.85	0.96	0.64

yield attributes on this soil.

The interaction effect shows that combined application of organic manure and 75 per cent of RDF gave higher value of all the growth and yield characters (Table 2). All the characters gave maximum value with bio-compost along with chemical fertilizer followed by either green manuring or FYM along with fertilizer. The sugarcane trash applied plots had lower value due to more C:N ratio of this material which release nutrient later and it might be also due to immobilization of available nitrogen during decomposition of high lignin containing materials. Treatment without fertilizer and organics recorded significantly minimum value of growth and yield attributes. It is very natural that high yielding fertilizer responsive crop variety not perform well under nutrient scarcity and resulted in poor growth.

Grain and seed yield:

Grain yield of paddy was the highest(4499 kg/ha) in the plots supplied with the 75% recommended NPK through fertilizer as compared to no fertilizer application (3079 kg/ha). Similar effect was also observed with straw yield (Table 2). The residual effect of fertilizer on castor seed yield also observed that there was significant yield was response obtained with fertilizer application to paddy crop resulted in higher yield of successiding castor crop without fertilizer (Table 2). Paddy equivalent yield worked out also showed significant response of inorganic fertilizer on the yield. The enhancement in growth with increase in fertility was owing to rapid conversion of synthesized photosynthates into protean to form more protoplasm, thus increasing the number and site of cell which might have increased the growth and yield attributes and resulted in improvement in yield. Similar result was also reported by Singh *et al.* (2006) and Surekha (2007).

Significantly the highest grain yield of paddy was reported with application of bio-compost @ 20 t/ha (4591 kg/ha) followed by *in-city* green manuring and FYM @ 20 t/ha. The sugarcane trash incorporation along with decomposting culture plot have lower yield than other organic application plots (Table 2). The lowest yield was reported without organics application (2934 kg/ha). The

Table : 2 Effect of organics with and without fertilizer on yield of paddy and castor

Treatments	Grain yield (kg/ha)			Straw yield (kg/ha)			Grain yield (kg/ha)			Paddy equivalent yield (kg/ha)		
	Ist year	IInd year	Pooled	Ist year	IInd year	Pooled	Ist year	IInd year	Pooled	Ist year	IInd year	Pooled
Fertilizer												
F_1: No Fertilizer	2849	3310	3079	4132	5063	4597	1029	867	948	6522	6405	6463
F_2: 757 of RDF	4095	4908	4499	5625	7456	6541	1408	964	1186	9124	8362	8743
CD. (P=0.05)	164.22	145.75	356.28	138	255	922	92	89	288	431	356	660
Organics												
O_1: No organics	2934	2934	2934	4840	5524	5182	1049	819	934	6679	5902	6291
O_2: FYM @ 10t/ha	3560	4201	3881	4677	6069	5373	1299	958	1129	8198	7624	7911
O_3: Sugarcane Trash @ 20 t/ha	3088	3906	3497	4271	5566	4918	1203	944	1074	7385	7279	7332
O_4: Bio comport @ 20 t/ha	4089	5094	4591	5108	7601	6354	1396	1083	1240	9073	8963	9018
O_5: Green Tran	3688	4396	4042	5500	6535	6017	1146	971	1058	7780	7149	7464
CD. (P=0.05)	260	230	747	217	403	986	145	141	1058	681	563	432

yield improvement due to bio-compost application over no organics was about 1.5 times while that with green manuring and FYM was 1.3 times higher. Almost similar tred was observed in straw yield of paddy. The residual effect of organics on successiding castor crop was also significantly influenced the castor seed yield and found more residual response from bio-compost followed by FYM, sugarcane trash and green manuring. Higher availability of nutrient because of favourable effect of organic sources might have improved physiological and metabolic function inside the plant body which in turn laid down the foundation for higher yield in both the crops. The bio-compost and FYM has advantage over sugarcane trash in being fully decomposed before application which supplied available pant nutrient directly to plants and created favourable soil environment, ultimately increased the nutrients and soil condition, which resulted in better yield. It has higher quantum of organic matter than green manure crops. The green manure crops have less residual effect than bio-compost and FYM so less benefit to castor crop. While sugarcane trash is high C:N ratio residue and take more time to decomposition and might have initial immobilized of available soil nutrients which may create deficiency of nutrient at initial stage to first crop. However, such recycling in the soil plant ecosystem alters the soil environment which in turn influence the microbial population and activity in soil and subsequent nutrient transformation resulted in more growth and yield of crops after decomposition of such materials (Kumar and Goh, 2000). Addition of residues and subsequent decomposition released nutrients particularly after the first crop in a cycle that helped increase the yield attributes and yield of both rice and castor. Similar results were also reported by Kachroo and Dixit (2005), Singh *et al.* (2006), Ghosh (2007).

Paddy equivalent yield was worked out and statistically analyzed (Table 2) show that there was significant effect of fertilizer and organic sources on paddy based equivalent yield with 75% recommended dose of NPK to paddy crops. Among organics bio-compost application significantly highest equivaled yield (9018 kg/ha) followed FYM (7911 kg/ha), green manuring (7464 kg/ha) and sugarcane trash incorporation (7332 kg/ha). Significantly lower (6291 kg/ha) equivalent yield was recorded with no organic application plot. The paddy equivalent grain yield of the system due to organics is about 1.2 to 1.5 times higher as compare to no application plots.

The interaction effect of organics with and without fertilizer shows that conjoint applications of organics + fertilizer had effect and observed significant difference. The highest grain yield of paddy and castor was ontained with bio-compost application along with 75% of RDF, followed by green manuring and FYM application. Plots without organic and fertilizer had lowest value. Between the individual organics, plot with only organics have some what lower value than with inorganic fertilizers. Similar trend was obtained with paddy straw yield.

This was attributed to the supplementary effects owing to faster nutrient availability from inorganic fertilizer which encouraged better primary growth, where as organics sources supplemented nutrient availability for sustaining the growth. Their integral effects helped the crop thrive better during early as well as later stage of

Table 3 : Soil analysis

	2006-07						2007-08					
	After paddy			After castor			After paddy			After castor		
	No fertilizer	75% RDF	Average	No fertilizer	75% RDF	Average	No fertilizer	75% RDF	Average	No Fertilizer	75% RDF	Average
Organic	7.19	6.37	6.78	7.25	7.16	7.21	7.90	7.08	7.49	8.13	7.96	8.05
FYM	7.24	6.62	6.93	7.54	7.07	7.31	7.51	6.92	7.22	7.97	7.78	7.88
Sun Trace	6.63	6.78	6.71	7.19	7.21	7.20	6.84	6.93	6.89	7.87	7.93	7.90
BioCompost	6.66	6.52	6.59	7.24	7.51	7.38	7.35	6.64	7.00	7.99	8.24	8.12
Green Tran	6.51	6.64	6.58	7.15	7.32	7.26	7.19	7.09	7.14	7.95	7.84	7.90
Average	6.85	6.59		7.27	7.25		7.36	6.93			7.98	7.97
No Organic	0.19	0.18	0.19	0.19	0.19	0.19	0.15	0.16	0.16	0.15	0.18	0.17
FYM	0.17	0.16	0.17	0.18	0.14	0.16	0.13	0.13	0.13	0.14	0.12	0.13
Sun Trace	0.16	0.15	0.16	0.16	0.16	0.16	0.12	0.12	0.12	0.14	0.19	0.15
BioCompost	0.20	0.17	0.19	0.22	0.19	0.21	0.12	0.14	0.13	0.14	0.11	0.13
Green Tran	0.14	0.17	0.16	0.15	0.16	0.16	0.13	0.13	0.13	0.15	0.14	0.15
Average	0.17	0.17		0.18	0.17		0.13	0.14		0.15	0.14	
No Organics	0.40	0.41	0.41	0.38	0.41	0.40	0.38	0.40	0.39	0.34	0.38	0.36
FYM	0.42	0.52	0.47	0.40	0.51	0.46	0.49	0.68	0.59	0.69	0.74	0.72
Sun Trace	0.41	0.54	0.48	0.40	0.52	0.46	0.48	0.63	0.56	0.58	0.55	0.57
BioCompost	0.45	0.63	0.54	0.42	0.61	0.52	0.64	0.60	0.62	0.71	0.61	0.66
Green Tran	0.52	0.60	0.56	0.51	0.60	0.56	0.58	0.61	0.60	0.70	0.69	0.70
Average	0.44	0.54		0.42	0.53		0.51	0.58		0.60	0.59	
No Organics	48	54	51	44	52	48	56	60	58	50	54	52
FYM	58	62	60	56	58	57	72	56	64	67	53	60
Sun Trace	49	58	54	48	58	53	66	64	65	63	55	59
BioCompost	62	68	65	58	64	61	72	51	62	67	49	58
Green Tran	49	58	54	46	52	49	70	66	68	63	60	62
Average	53.2	60		50.4	56.8		67.2	59.4		62	54.2	
No Organics	191	172	181.5	167	159	163	190	171	180.5	178	160	169
FYM	226	217	221.5	204	201	202.5	301	204	252.5	242	198	220
Sun Trace	189	202	195.5	208	195	201.5	194	267	230.5	204	185	194.5
BioCompost	253	184	218.5	227	180	203.5	351	201	276	238	185	211.5
Green Tran	206	196	201	198	189	193.5	192	184	188	195	181	188
Average	213	194.2		200.8	184.8		245.6	205.4		211.4	181.8	

growth. Grain and straw yield of paddy, seed yield of castor as well as paddy equivalent yield were higher with bio-compost, green manuring, FYM and sugarcane trash was attributed to its prolonged and consistent nutrient availability due to its physicochemical and biological improvement of soil and there by improvement in plant uptake. Surekha (2007), Ali and Mishra (2000). Ghosh (2007) and Kumar and Goh (2008) also observed similar effect of organics / recycling of residues along with inorganic fertilizers on rice based cropping system.

Change in soil :

Application of organics with and without fertilizer to paddy crops and residual study of castor shows that there was not much effect of these treatments on pH, Ec, available P_2O_5 and K_2O. It remained almost similar after complition of 2 cycles. However, critically it is found that there was slight variation in available P_2O_5 and K_2O with and without inorganic fertilizers. Inorganic fertilizer plots had slightly higher value as compared to no fertilizer application. However, in organic carbon content the change was notable and recorded higher organic carbon content at the end of 2nd cycle of crops in organic added plots (Table 3).

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