Vol. 44, No. 3, pp 284-289, 2016
Indian Journal of Soil Conservation
Online URL:http://indianjournals.com/ijor.aspx?target=ijor:ijsc&type=home

Effect of different sources of organic manures and inorganic fertilizers on productivity, profitability of rice (*Oryza sativa.* L) and soil health

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ARTICLE INFO

Article history :
Received : March, 2014
Revised : May, 2016
Accepted : June, 2016

Key words:
Economics,
Energy,
Growth and yield,
Organic and inorganic fertilizers,
Paddy,
Poultry manure and Nutrient uptake

ABSTRACT

A field experiment was conducted at Research Farm of ICAR Research Complex for NEH Region, Nagaland Centre, Medziphema during 2010 and 2011 to study the effect of different sources of organic manures and inorganic fertilizers on productivity, profitability of rice and soil health in Eastern Himalayan Region on a sandy loam soil. Among the organic sources of nutrient poultry manure (2.5 t ha^{-1}) was found to be the best in terms of productivity, profitability and soil health. The results showed significant improvement in all yield attributes and yield (5.6 t ha^{-1}) as well as nutrient uptake and crop profitability (₹ 340.73 $ha^{-1}day^{-1}$) due to the application of 2.5 t ha^{-1} of poultry manure along with 60-13.1-25.0 kg ha^{-1} N, P and K fertilizers over other treatments. The same treatment recorded highest net energy output (184.20 x 10^3 MJ), benefit cost ratio (2.66) and had significantly improved in soil organic carbon, nitrogen, phosphorous and potassium content of soil after harvest of the crop.

1. INTRODUCTION

Fertilizer management issue in rice production is drawing attention among farmers, especially under current climate change situation. Efficient fertilizer management under environment-friendly condition is crucial to increase rice production worldwide. Appropriate amount of fertilizers applied onto soils reduced greenhouse gas emissions, NO_3 leaching and eutrophication. Appropriate use of chemical fertilizers is needed to boost rice production and mitigate poverty in Asia. About 50% of all mineral fertilizer nutrients are used for the production of cereals (wheat, rice and maize), and 50% of total mineral fertilizer nutrients are consumed by China, the United States of America and India. Worldwide mineral fertilizer nutrient use is expected to increase annually about 1.7% from 2007-08 to 2011-12, which is an equivalent to 1662 of about 15 million tons (m t). Among them, 69% will take place in Asia and 19% in America (FAO, 2008). The yield plateau of rice and adverse environmental impacts due to imbalance use of chemical fertilizers illustrate worldwide attention for efficient nutrient management. Rice, the staple food for most of the people in South and Southeast Asia, removes about 16 to 19 kg of N, 2.5 to 3.5 kg P and 19 to 25 kg K from soil to produce one tone of rough rice (Dobermann *et al.,* 2000). With the green revolution, the use of chemical fertilizer increases several folds and inefficient use of these fertilizers has resulted in serious environmental consequences. Additionally, the production of chemical fertilizers using fossil fuel is another issue of environmental pollution. Besides environmental pollution, farmers are losing their money due to application of excessive amount of expensive fertilizers. Nowadays, global fertilizer market has become a political issue. In this regard, the resource poor countries of the world need a solution to this predicament. Proper soil management practices and especially efficient fertilizer application increase crop yield (Li *et al.,* 2001; Shen, 2002). In sustainable agriculture, nutrient management practices include both crop and soil fertilization. Crop fertilization refers to fertilizer application according to the crop demands, while soil fertilization is targeted to replenish its fertility level. So, the present investigation was undertaken to meet the urgent need for the farmers of Eastern Himalayan Region.

2. MATERIALS AND METHODS

The field experiment was conducted at the Research farm of ICAR Research complex for North Eastern Hill Region (NEHR), Nagaland Centre, Medziphema during *kharif* season of 2010 and 2011 in paddy. The experimental site was located between 25.45^{0}N latitude 93.53^{0}E longitudes with a mean altitude of 295 m above msl. Temperature and relative humidity during the experiment ranged from 15.6 to 32.6^{0}C and 81 to 85%, respectively. The experiment was conducted in randomized block design with three replications in 16 treatment combinations. The treatments consisted of different sources of organic manures and inorganic fertilizers *viz.,* Dhainsa (5 t ha^{-1}), Dhainsa (5 t ha^{-1}) + 50% CDF (Chemical fertilizers dose), Dhainsa (5 t ha^{-1}) + 75% CDF, Dhainsa (5 t ha^{-1}) + 100% CDF, FYM (5 t ha^{-1}), FYM (5 t ha^{-1}) + 50% CDF, FYM (5 t ha^{-1}) + 75% CDF, FYM (5 t ha^{-1}) + 100% CDF, Vermicompost (1 t ha^{-1}), Vermicompost (1 t ha^{-1}) + 50% CDF, Vermicompost (1 t ha^{-1}) + 75% CDF, Vermicompost (1 t ha^{-1}), + 100% CDF, Poultry manure (2.5 t ha^{-1}), Poultry manure (2.5 t ha^{-1}) + 50% CDF, Poultry manure (2.5 t ha^{-1}) + 75% CDF and Poultry manure (2.5 t ha^{-1}) + 100% CDF. The chemical dose of paddy used by the farmers is 60-13.1-25.0 N, P and K. The percent N, P and K content of Dhainsa, FYM, vermicompost and poultry manure were 0.7-0.5-0.6, 0.50-0.29-0.61, 1.20-0.65-0.80 and 1.52-0.82-0.87, respectively was estimated before experimentation. Organic manures were applied based on their availability and economically affordable by the farmers of the region before 15 days of transplanting. The soil fertility dynamics under various treatments were estimated by soil analysis of composite soil sample from each plot before transplanting and after harvesting of crops. The total nutrient (organic/inorganic) added to the soil was estimated to study their effect on crop production, soil health and economic analysis (Table 1). The soil of the experimental site was sandy loam, acidic in reaction with pH = 5.4, medium in organic carbon 0.67%, deficient in nitrogen 156 kg ha^{-1} moderate in phosphorous 22.08 kg ha^{-1} and low in potash 49.31 kg ha^{-1}. The experiment site comes under sub humid region where monsoon normally starts by the middle of April and extends up to September. The annual rainfall during crop growing season from 25th June to 10th November was 1047.5 mm in 2010 and 1235.1 mm during 2011 which was less than annual average rainfall 1570 mm. The crop variety IET-16313 was transplanted when sufficient rain was received (last week of June). Observations for yield and yield attributes *viz.,* plant height, no of effective tillers, length of panicle were recorded. The crop was harvested at maturity, dried in the sun and weight for yield. The yield was recorded net plot wise and converted into t ha^{-1}. The crop was harvested at maturity, then dried in the sun and weight for yield. Economics of different treatment was worked out by taking into account the cost of inputs and income obtained from output (grain and straw yield). Net returns (₹ ha^{-1}) was calculated by using formula = Gross returns - cost of cultivation. Benefit: cost ratio was calculated by using formula = Gross returns/cost of cultivation. Minimum support price (Fixed by government of India) of Rice in 2011= ₹ 10800 t^{-1} was used for economic analysis. The N, P and K uptake by the crop and available N, P and K content of soil after two years of the experimentation was estimated with standard procedure.

Table: 1
Nutrient added in various treatments for different nutrient management practices of rice

Treatments	GM (t ha^{-1})	FYM (t ha^{-1})	VC (t ha^{-1})	PM (t ha^{-1})	Nutrient from organic sources (kg ha^{-1})			Nutrient from inorganic sources (kg ha^{-1})			Total nutrients (kg ha^{-1})			Total N+P+K (kg ha^{-1})
					N	P	K	N	P	K	N	P	K	
Dhainsa (t ha^{-1})	5.0	-	-	-	35.0	25.0	30.0	-	-	-	35.0	25.0	30.0	90.0
Dhainsa (5 (t ha^{-1}) + 50% RDF	5.0	-	-	-	35.0	25.0	30.0	30.0	6.5	12.5	65.0	31.5	32.5	129.0
Dhainsa (5 (t ha^{-1}) + 75% RDF	5.0	-	-	-	35.0	25.0	30.0	45.0	9.7	18.7	80.0	34.7	38.7	153.4
Dhainsa (5 t ha^{-1}) + 100% RDF	5.0	-	-	-	35.0	25.0	30.0	60.0	13.1	25.0	95.0	38.1	55.0	188.1
FYM (5 t ha^{-1})	-	5.0	-	-	25.0	14.5	30.5	-	-	-	25.0	14.5	30.5	70.0
FYM (5 t ha^{-1}) + 50% RDF	-	5.0	-		25.0	14.5	30.5	30.0	6.5	12.5	45.0	21.0	43.0	109.0
FYM (5 t ha^{-1}) + 75% RDF	-	5.0	-	-	25.0	14.5	30.5	45.0	9.7	18.7	70.0	24.2	49.2	143.4
FYM (5 t ha^{-1}) + 100% RDF	-	5.0	-	-	25.0	14.5	30.5	60.0	13.1	25.0	85.0	27.6	55.5	168.1
Vermi compost (1 t ha^{-1})	-	-	1.0	-	12.0	6.48	8.0	-	-	-	12.0	6.5	8.0	26.48
Vermi compost (1 (t ha^{-1}) + 50% RDF	-	-	1.0		12.0	6.48	8.0	30.0	6.5	12.5	13.0	22.7	20.5	115.2
Vermi compost (1 t ha^{-1}) + 75% RDF	-	-	1.0	-	12.0	6.48	8.0	45.0	9.7	18.7	57.0	16.2	26.7	99.88
Vermicompost (1 t ha^{-1})+ 100% RDF	-	-	1.0		12.0	6.48	8.0	60.0	13.1	25.0	72.0	19.6	33.0	124.6
Poultry manure (2.5 t ha^{-1})	-	-	-	2.5	38.0	20.5	21.7	-	-	-	38.0	20.5	21.7	80.2
Poultry manure (2.5 t ha^{-1}) + 50% RDF	-	-	-	2.5	38.0	20.5	21.7	30.0	6.5	12.5	68.0	27.0	34.2	129.2
Poultry manure (2.5 t ha^{-1}) + 75% RDF	-	-	-	2.5	38.0	20.5	21.7	45.0	9.7	18.7	83	30.2	40.4	153.6
Poultry manure (2.5 t ha^{-1}) + 100% RDF	-	-		2.5	38.0	20.5	21.7	60.0	13.1	25.0	98	33.6	46.7	178.3

Crop profitability was computed using the formula:

Crop profitability (₹ $ha^{-1}day^{-1}$) = Net returns (₹ ha^{-1}) ÷ Number of days field occupied.

The primary data on various inputs and management practices were used for computation of energy consumption. For estimation of energy inputs and outputs, energy equivalents (Table 2) were utilized as suggested by Ghosh *et al.* (2006). The Energy Use Efficiency (EUE) was calculated as:

EUE = Energy output / Energy input

3. RESULTS AND DISCUSSION

Growth and Yield

Growth in vegetative stage and development in reproductive phases determines yield attributes of a crop. Various sources of organic manures and inorganic fertilizers had influenced positively on growth and yield of paddy (Table 3). It was observed that the crop receiving higher amount of nutrients through organic or inorganic sources recorded higher in growth and yield. Among all the nutrient management practices, the crop receiving poultry manure (2.5 t ha^{-1}) along with 100% CDF (60-13.1-25.0 kg ha^{-1}) recorded the higher no of effective tillers (14.17), panicle length (23.2 cm), grain yield (5.60 t ha^{-1}) and straw yield (8.63 t ha^{-1}) which was closely followed by the nutrient management practices, vermicompost (1 t ha^{-1}) along with 100% CDF (60-13.1-25.0 kg ha^{-1}) and FYM (5 t ha^{-1}) along with 100% CDF (60-13.1-25.0 kg ha^{-1}). In the said nutrient management practices, the crop received a total amount of 98-33.6-46.7 kg N P K (Table 1) and it was found to be significantly superior over other nutrient management practices. The growth and yield of paddy was found to be lower in case of application of organic manures alone as compared to integrated nutrient management practices. However, among the organic sources the crop receiving poultry manure (2.5 t ha^{-1}) recorded higher in growth and yield which was very closely followed by FYM and vermicompost. This might be due to better nutrients received by the crop from the poultry manure (2.5 t ha^{-1}) as compared to other sources of organic manure under the study. This is in conformity with the findings of Kumar *et al.,* 2012, where he recorded superiority of poultry manure

Table: 2
Energy equivalent for different inputs and outputs

Particulars	Units	Equivalent energy (MJ)
A. Inputs		
1. Human labour		
a Adult man	Man-hour	1.96
b woman	Woman-hour	1.57
2. Diesel	L	56.31
3. Patrol	L	48.23
4. Electricity	Kw h	11.93
5. Machinery		
a. Electric motor	kg	64.8
b. Farm machinery including self propelled machine	kg	62.7
6. Chemical fertilizers		
a. Nitrogen	kg	60.6
b. Phosphorus	kg	11.1
c. Potash	kg	6.7
d. Biofertilizers	kg	0.3
e. Organic manures	kg	0.3
7. Chemicals		
a. Superior chemicals	kg	120
8. Seed as output of crop production system		14.7
B. Output		
1. Main product		
a. Rice	kg	14.7
2. By product		
a. Rice bran	kg	6.3
b. Straw	kg	12.5

Table: 3
Effect of different sources of organic manures and inorganic fertilizers on growth and yield of rice (pooled)

Treatments	Plant height (cm)	No of tillers	Length of panicle (cm)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Green manure (Dhainsa 5 t ha^{-1})	93.067	9.967	17.733	2.167	3.820
Dhainsa (5 t ha^{-1}) + 50% RDF	98.567	12.200	18.100	3.333	5.793
Dhainsa (5 t ha^{-1}) + 75% RDF	101.967	12.767	17.500	3.867	6.535
Dhainsa (5 t ha^{-1}) + 100% RDF	104.267	13.267	17.933	4.667	7.290
FYM(5 t ha^{-1})	94.567	10.433	20.133	3.433	6.200
FYM (5 t ha^{-1}) + 50% CDF	97.367	11.400	20.667	4.000	6.800
FYM (5 t ha^{-1}) + 75% CDF	103.600	12.100	20.233	4.333	7.256
FYM (5 t ha^{-1}) + 100% CDF	108.867	12.967	19.767	5.033	8.070
Vermi compost (1 t ha^{-1})	92.567	10.167	20.900	3.333	5.687
Vermi compost (1 t ha^{-1}) + 50% RDF	97.433	11.867	23.167	3.900	6.293
Vermi compost (1 t ha^{-1}) + 75% CDF	100.333	12.333	23.967	4.433	6.925
Vermicompost (1 t ha^{-1}) + 100% CDF	104.800	12.533	22.400	5.167	7.989
Poultry manure (2.5 t ha^{-1})	89.933	10.500	22.767	3.467	5.873
Poultry manure (2.5 t ha^{-1}) + 50% CDF	98.200	13.200	22.967	4.533	7.163
Poultry manure (2.5 t ha^{-1}) + 75% CDF	102.733	13.767	22.833	4.967	7.831
Poultry manure (2.5 t ha^{-1}) + 100% CDF	106.767	14.167	22.200	5.600	8.63
SEm	4.52	0.65	0.98	0.09	0.34
CD	N/A	1.90	2.85	0.26	3.82

over vermicompost and FYM. The higher yield with the increase in levels of fertilizers might be due to response of the crop to higher amount of nutrients (Baishya *et al.,* 2013). Sarker *et al*. (2004) also reported that chemical fertilizer offers nutrients which are readily soluble in soil solution and thereby instantly available to plants and nutrient availability from organic sources. The favourable effect of integrated nutrient management through both inorganic fertilizers and organic manures on increasing crop growth and yield was also noticed by Sepehya *et al*. (2012) and Baishya *et al*. (2013).

N, P and K Uptake

The effect of organic manures and chemical fertilizers was found to be significant in the uptake of N, P and K. The highest uptake was recorded in the treatment combination 100% CDF along with poultry manure (2.5 t ha^{-1}), which was closely followed by 100% CDF along with vermicompost (1 t ha^{-1}) and 100% CDF along with FYM. This might be due to balanced nutrition to the crops receiving 100% CDF along with the sources of organic manures (Baishya *et al.,* 2010). The organic manures recorded comparatively lower uptake of N, P and K as compared to integration of organic manures with inorganic fertilizers. This might be due to slow mineralization of organic manures and plant could not uptake the same at early growth period. This is in conformity with Baishya *et al.,* 2010. However, poultry manures (2.5 t ha^{-1}) along with 100% CDF found to be superior over all the nutrient management practices under study. This may be due to balanced nutrition from poultry manure and fertilizer sources.

Available Soil Nutrient Status

The available organic carbon, nitrogen, phosphorous and potassium contents of soil increased due to application of recommended dose of nitrogen through organic manure or through integrated application of inorganic fertilizers and organic manure (Table 6). The plot receiving poultry manure (2.5 t ha^{-1}) along with 100% CDF registered highest available OC, N, P and K status in the soil. The application of organic manures along with inorganic fertilizers increased available soil organic carbon (0.31% to 0.47%), nitrogen (59.86-80.53 kg ha^{-1}), phosphorous (01.25-8.92) and potassium (41.69-71.02 kg ha^{-1}) which can be considered as good carbon budget. However, it was observed that crop receiving same source of organic manures along with different levels of inorganic fertilizers did not vary significantly in case of organic carbon content of soil. Similar favourable effect of integrated nutrient management involving inorganic fertilizers and organic manures on increasing the available N,P and K content have been noticed by Kumar *et al*., 2011.

Energy Budget

The total net energy output was found to be highest in the nutrient management practices 100% CDF along with 2.5 t ha^{-1} of poultry manure (184.20 x 10^3 MJ) which was closely followed by the plot receiving 100% CDF along with 1 t ha^{-1} of vermicompost over the other nutrient management practices under study (Table 6). However, the highest EUE (75.42) energy productivity (5696.20 g MJ^{-1}) was recorded in the crop receiving vermicompost (1 t ha^{-1}) which was closely followed by poultry manure (2.5 t ha^{-1}). This might be due to low energy input under control.

Table: 4
Effect of different sources of organic manure and inorganic fertilizer on nitrogen, phosphorous and potassium uptake (kg ha^{-1}) by rice grain and straw

Treatments	Nitrogen		Phosphorous		Potassium		Total N	Total P	Total K
	Grain	Straw	Grain	Straw	Grain	Straw			
Green manure (Dhainsa 5 t ha^{-1})	17.33	19.50	6.28	11.31	8.67	52.65	36.83	17.59	61.32
Dhainsa (5 t ha^{-1}) + 50% RDF	30.00	29.75	10.00	17.50	14.00	79.33	59.75	27.50	93.33
Dhainsa (5 t ha^{-1}) + 75% RDF	38.67	33.78	11.99	20.14	16.63	88.99	72.45	32.12	105.62
Dhainsa (5 t ha^{-1}) + 100% RDF	51.33	39.57	14.93	23.89	20.53	103.04	90.91	38.83	123.57
FYM(5 t ha^{-1})	27.47	30.90	9.96	17.92	13.73	83.430	58.37	27.88	97.16
FYM (5 t ha^{-1}) + 50% CDF	36.00	34.68	12.00	20.40	16.80	92.48	70.68	32.40	109.28
FYM (5 t ha^{-1}) + 75% CDF	43.33	37.63	13.43	22.43	18.63	99.14	80.96	35.87	117.78
FYM (5 t ha^{-1}) + 100% CDF	55.37	42.68	16.11	25.77	22.15	111.13	98.05	41.88	133.28
Vermicompost (1 t ha^{-1})	26.67	28.33	9.67	16.44	13.33	76.50	55.00	26.10	89.83
Vermicompost (1 t ha^{-1}) + 50% RDF	35.10	31.82	11.70	18.72	16.38	84.86	66.92	30.42	101.24
Vermicompost (1 t ha^{-1}) + 75% CDF	44.33	36.194	13.74	21.58	19.06	95.36	80.53	35.32	114.42
Vermicompost (1 t ha^{-1}) + 100% CDF	56.83	42.99	16.53	25.96	22.73	111.94	99.83	42.49	134.67
Poultry manure (2.5 t ha^{-1})	27.733	29.47	10.05	17.09	13.87	79.53	57.20	27.14	93.43
Poultry manure (2.5 t ha^{-1}) + 50% CDF	40.80	36.99	13.60	21.76	19.04	98.64	77.79	35.36	117.69
Poultry manure (2.5 t ha^{-1}) + 75% CDF	49.67	40.81	15.40	24.327	21.357	107.510	90.47	39.72	128.87
Poultry manure (2.5 t ha^{-1}) + 100% CDF	61.60	46.30	17.92	27.96	24.640	120.553	107.90	45.88	145.20
SEm	0.91	0.77	0.81	1.33	1.127	2.03	1.98	0.79	2.50
CD	2.65	2.23	0.28	0.46	0.388	5.89	5.94	2.29	7.51

Table: 5
Effect of different sources of organic manure and inorganic fertilizers on energy budget of rice

Treatments	Energy input ($X\ 10^3$) MJ	Energy output ($X\ 10^3$)	Net energy MJ ($X\ 10^3$) MJ	EUE	Energy productivity (g/Mj)
Green manure (Dhainsa 5 t ha^{-1})	2.78	80.17	77.39	28.84	2182.25
Dhainsa (5 t ha^{-1}) + 50% RDF	4.87	121.25	116.38	24.90	1882.27
Dhainsa (5 t ha^{-1}) + 75% RDF	5.91	137.27	131.36	23.23	1753.41
Dhainsa (5 t ha^{-1}) + 100% RDF	6.95	161.00	154.05	23.17	1745.80
FYM(5 t ha^{-1})	2.78	127.03	124.25	45.70	3458.03
FYM (5 t ha^{-1}) + 50% CDF	4.87	143.00	138.13	29.36	2217.66
FYM (5 t ha^{-1}) + 75% CDF	5.91	153.29	147.38	25.94	1957.70
FYM (5 t ha^{-1}) + 100% CDF	6.95	173.65	166.70	24.99	1882.97
Vermi compost (1 t ha^{-1})	1.58	119.17	117.59	75.42	5696.20
Vermi compost (1 t ha^{-1}) + 50% RDF	3.67	134.55	130.88	36.66	2762.94
Vermi compost (1 t ha^{-1}) + 75% CDF	4.71	151.29	146.58	32.12	2419.04
Vermicompost (1 t ha^{-1}) + 100% CDF	5.75	176.31	170.56	30.66	2309.28
Poultry manure (2.5 t ha^{-1})	2.03	123.93	121.90	61.05	4610.84
Poultry manure (2.5 t ha^{-1}) + 50% CDF	4.12	156.40	152.28	37.96	2860.84
Poultry manure (2.5 t ha^{-1}) + 75% CDF	5.16	170.11	164.95	32.97	2483.33
Poultry manure (2.5 t ha^{-1}) + 100% CDF	6.20	190.40	184.20	30.71	2312.26

Table: 6
Effect of different sources of organic manure and inorganic fertilizers on economics of rice

Treatments	Cost of cultivation (₹)	Gross return (₹)	Net return (₹)	B:C ratio (₹)	Crop profitability (₹ ha^{-1} day^{-1})
Green manure (Dhainsa 5 t ha^{-1})	17400	28080	10680	1.61	82.15
Dhainsa (5 t ha^{-1}) + 50% RDF	19534	43000	23466	2.20	180.51
Dhainsa (5 t ha^{-1}) + 75% RDF	20601	49555.2	28954.2	2.41	222.72
Dhainsa (5 t ha^{-1}) + 100% RDF	21668	59360	37692	2.74	289.94
FYM (5 t ha^{-1})	22400	44496	22096	1.99	169.97
FYM (5 t ha^{-1}) + 50% CDF	23467	51360	27893	2.19	214.56
FYM (5 t ha^{-1}) + 75% CDF	24536	55484	30948	2.26	238.06
FYM (5 t ha^{-1}) + 100% CDF	26668	64024	37356	2.40	287.35
Vermicompost (1 t ha^{-1})	27400	42800	15400	1.56	118.46
Vermicompost (1 t ha^{-1}) + 50% RDF	28467	49608	21141	1.74	162.62
Vermicompost (1 t ha^{-1}) + 75% CDF	29534	56232.4	26698.4	1.90	205.37
Vermicompost (1 t ha^{-1}) + 100% CDF	31668	65534	33866	2.07	260.51
Poultry manure (2.5 t ha^{-1})	22400	44512	22112	1.99	170.09
Poultry manure (2.5 t ha^{-1}) + 50% CDF	23467	57664	34197	2.46	263.05
Poultry manure (2.5 t ha^{-1}) + 75% CDF	24536	63056.8	38520.8	2.57	296.31
Poultry manure (2.5 t ha^{-1}) + 100% CDF	26668	70963.2	44295.2	2.66	340.73

DHAINSA @ ₹ 1/-; FYM @ ₹ 2/-; V.C @ ₹ 8/-; PM @ ₹ 2/-; 60-30-30 NPK IC UREA: 123 KG @ ₹ 10/- 1230; SSP= ₹ 2437/-; MOP= ₹ 601/-; TOTAL ₹ 4268/-

Economics

The results showed that the gross return (₹ 70963/-) and net return (₹ 44295/-) were markedly higher in the nutrient management practices receiving 100% CDF + 2.5 t ha^{-1} of poultry manure which was closely followed by the nutrient management practices 75% CDF + 2.5 t ha^{-1}of poultry manure and 50% CDF + 2.5 t ha^{-1} of poultry manure. However, benefit cost ratio (2.74) was found to be highest in the nutrient management practices 100% CDF + 5 t ha^{-1} of Dhainsa which was closely followed by 100% CDF + 2.5 t ha^{-1} of poultry manure which was closely followed by the nutrient management practices 75% CDF + 2.5 t ha^{-1} of poultry manure and 50% CDF + 2.5 t ha^{-1} of poultry manure. The highest crop profitability (₹ day^{-1} ha^{-1} = 340.73/-) was recorded in the nutrient management practices 100% CDF + 2.5 t ha^{-1} of poultry manure which was closely followed by the nutrient management practices 75% CDF + 2.5 t ha^{-1} of poultry manure, 100% CDF + 5 t ha^{-1} Dhainsa.

4. CONCLUSIONS

From the above study, it can be revealed that 60-13.1-25.0 kg ha^{-1} N, P and K along with 2.5 t ha^{-1} of poultry manure found to be most effective methods for integrated nutrient management of paddy under low fertilizer use zones of the region for sustainable crop production, profitability and soil health.

Table: 7
Available soil organic carbon, nitrogen, phosphorous and potassium on rice after experimentation

Treatments	Organic carbon%		Available N (kg ha^{-1})		Available P_2O_5 (kg ha^{-1})		Available K_2O (kg ha^{-1})	
	After harvest	Addition/ Deletion	After harvest	Addition/ Deletion	After harvest	Addition/ Deletion	After harvest	Addition/ Deletion
Green manure (Dhainsa 5 t ha^{-1})	0.98	0.31	216.66	59.86	23.33	1.25	91.00	41.69
Dhainsa (5 t ha^{-1}) + 50% RDF	0.96	0.29	211.66	54.86	25.53	3.45	100.60	51.29
Dhainsa (5 t ha^{-1}) + 75% RDF	0.99	0.32	221.66	64.86	28.10	6.02	104.03	54.72
Dhainsa (5 t ha^{-1}) + 100% RDF	1.01	0.34	223.33	66.53	28.47	6.39	108.66	59.35
FYM(5 t ha^{-1})	0.91	0.24	222.00	65.2	25.70	3.62	111.60	62.29
FYM (5 t ha^{-1}) + 50% CDF	0.94	0.27	226.16	69.36	26.10	4.02	101.93	52.62
FYM (5 t ha^{-1}) + 75% CDF	0.96	0.29	232.66	75.86	26.83	4.75	103.86	54.55
FYM (5 t ha^{-1}) + 100% CDF	0.99	0.32	230.10	73.3	27.77	5.69	108.56	59.25
Vermicompost (1 t ha^{-1})	0.84	0.17	195.00	38.2	23.50	1.42	118.60	68.69
Vermicompost (1 t ha^{-1}) + 50% RDF	0.83	0.16	197.00	40.2	24.93	2.85	103.00	53.69
Vermicompost (1 t ha^{-1}) + 75% CDF	0.92	0.25	204.33	47.53	24.77	2.69	105.00	55.69
Vermicompost (1 t ha^{-1}) + 100% CDF	0.95	0.28	210.00	53.2	25.30	3.22	106.33	57.02
Poultry manure (2.5 t ha^{-1})	0.97	0.3	223.50	66.7	25.67	3.59	109.66	60.35
Poultry manure (2.5 t ha^{-1}) + 50% CDF	1.04	0.37	227.33	70.53	28.20	6.12	112.66	63.35
Poultry manure (2.5 t ha^{-1}) + 75% CDF	1.09	0.42	232.66	75.86	28.83	6.75	118.33	69.02
Poultry manure (2.5 t ha^{-1}) + 100% CDF	1.14	0.47	237.33	80.53	31.00	8.92	120.33	71.02
SEm	0.02	-	2.35	-	0.59	-	0.95	41.69
CD	0.06	-	6.82	-	1.71	-	2.76	-
Initial	0.67	-	156.80		22.08	-	49.31	-

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