Research Article

Integrated Nutrient Management of Maize in Rice-Gingelly-Maize Cropping System through Integrated Farming System

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Abstract

Field experiments were conducted at Wetland farm of Tamil Nadu Agricultural University, Coimbatore during 2014-2015 and 2015-2016 to study the effect of integrated nutrient management in rice-gingelly-maize cropping system. The field experiments were laidout in randomized block design with three replications and the same layout was maintained both the years. The experiment consisted of thirteen treatments comprising of three level of recommended dose of fertilizer (100, 75 and 50% RDF combination with various organic sources (turkey, quail and goat manure as pond silt and vermicompost) and 100% RDF along with FYM. Crop varieties Co H (M) 6 (maize) were used as test crops for both the years of study. In maize, among the integrated nutrient management, application of 100% RDF + vermicompost at 5 t/ha recorded higher gross return (₹ 85728 and ₹ 87680/ha), net return (₹54888 and ₹56840/ha) and B:C ratio of 2.78 and 2.84, respectively during 2014-2015 and 2015-2016. It was comparable with application 100% RDF + goat manure at 5 t/ha recorded higher gross return and net return and 75% RDF + vermicompost at 5 t/ha recorded higher B:C ratio of 2.69 and 2.78 during 2014-2015 and 2015-2016. Compare to conventional practices increased percentage of gross return (10.74 and 11.11) and net return (17.86 and 18.23) respectively during 2014-2015 and 2015-2016.

Keywords: INM, Integrated farming system, Maize, grass return, net return, B:C ratio

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Introduction

Agriculture faces significant challenges to meet the need of food production without significantly increasing the area under cultivation [1] and degrading the environment [2]. In recent years, challenges in sustainable food production have remained in part due to climate change [3] and [4].

Improved management practices such as reduced or no tillage management, crop residue addition, crop rotation and balanced nutrient application increases soil organic carbon (SOC) and improves agricultural sustainability [5]; The problem of high cost of chemical fertilizers is that they provide only major nutrients and do not meet the nutrient requirement of crop by single source. Continuous use of chemical fertilizers, increased the crop yield during initial stage, but adversely affected the sustainability at a later stage. Indiscriminate use of chemical fertilizers especially, urea resulted in deficiency of nutrients other than the applied and caused decline in soil organic carbon [6]. Therefore, integrated nutrient management such as use of organic manures like farmyard manure, vermicompost, manure as pond silt, crop residue and biofertilizers has become necessary.

Cereal crops generally require a good supply of major nutrients especially nitrogen during most of their crop growth period. The availability of N in the soil has been known to be prime factor in determining overall growth and yield. Thus N in the soil plays a dominant role in the nutrition of crops. Integrated nutrient management reduces the cost of production by utilization of organic wastes or its by-products against chemical fertilizers, which are said to be potential source for pollution unless they are used in productive and efficient way. Organic materials such as bio-digested slurry, poultry manure, green leaf manures, vermicompost and FYM can supplement inorganic fertilizers to maintain productivity and environmental quality.

Integrated nutrient supply approach for the crop by judicious mixture of organic manure and biofertilizers along with the inorganic fertilizers has a number of agronomical and environmental advantages. Integrated nutrient management is not only a reliable way for obtaining fairly high productivity with substantial fertilizer economy but a concept of ecological soundness leading to sustainable agriculture.

Keeping this in view the present investigation was undertaken to study the effect of integrated nutrient management of maize on rice-gingelly-maize cropping system in lowland to improve soil fertility, crop productivity, resource use efficiency and income/unit area.

Materials and Methods

Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore during *rabi-summer-kharif* seasons (Sep-Oct, Feb-Mar, June-July, respectively) in 2014-15 and 2015-16 to study the effect of integrated nutrient management for rice-gingelly-maize cropping system. The details of the experimental materials used and the methods adopted during the course of investigations are presented in this chapter. Experiments were conducted in Field No. M-8 at wetland farm of the Department of Farm Management, Tamil Nadu Agricultural University, Coimbatore. The experimental site is geographically situated in the western agro-climatic zone of Tamil Nadu at 11ºN latitude and 77ºE longitude and at an altitude of 426.7 meters above mean sea level (MSL).

During 2014-15, the crop received 198.4 mm of rainfall. The maximum and minimum temperatures ranged from 27.6ºC to 36.2ºC and 18.1ºC to 25.5ºC, respectively. The mean relative humidity ranged from 65.8 to 93.1 per cent and 23.7 to 66.4 per cent during forenoon and afternoon, respectively. The mean bright sunshine hours ranged from 1.5 to 12.4 hours/day.

During 2015-16, the crop received 163.7 mm of rainfall. The maximum and minimum temperatures ranged from 27.3ºC to 37.9ºC and 16.7ºC to 26.0ºC, respectively. The mean relative humidity ranged from 76.9 to 89.4 per cent and 25.4 to 64.6 per cent in forenoon and afternoon, respectively. The mean bright sunshine hours ranged from 1.0 to 0.1 hours/day.

OM (turkey, quail, goat manures as pond silt and vermicompost) were applied to first crop (rice) only in the cropping system at 5 t/ha.

Table 1 Physico - chemical characteristics of the experimental field

S.No.	Particulars	Values	Methods used	Authors
I. Physical properties				
1.	Clay (%)	44.24	International pipette method	[7]
2.	Silt (%)	19.3		
3.	Coarse sand (%)	15.2		
4.	Fine sand (%)	21.3		
5.	Texture	clay loam		
II. Chemical properties				
1.	pH	8.4	1:2 soil: water suspension	[8]
2.	EC (dS/m)	0.4	Conductometry (1:2 soil water suspension)	[8]
3.	Organic carbon (%)	0.5	Wet chromic acid digestion	[9]
4.	Available nitrogen (kg/ha)	310	Alkaline permanganate	[10]
5.	Available phosphorus (kg/ha)	12.9	Colorimetry	[11]
6.	Available potassium (kg/ha)	482	Neutral normal ammonium acetate	[12]

Table 2 Details of treatments

T_1 - 100% RDF + vermicompost
T_2 - 100% RDF + turkey manure as pond silt
T_3 - 100% RDF + quail manure as pond silt
T_4 - 100% RDF + goat manure as pond silt
T_5 - 75% RDF + vermicompost
T_6 - 75% RDF + turkey manure as pond silt
T_7 - 75% RDF + quail manure as pond silt
T_8 - 75% RDF + goat manure as pond silt
T_9 - 50% RDF + vermicompost
T_{10} - 50% RDF + turkey manure as pond silt
T_{11} - 50% RDF + quail manure as pond silt
T_{12} - 50% RDF + goat manure as pond silt
T_{13} - 100% RDF + FYM at 12.5 t/ha
Note: RDF - As per the recommendation to the individual crop.

Preliminary trial

Experimental Methods

Preliminary Experiment

Quantification of fish pond silt fed with fresh manures

Pond I: Turky (20 Nos.)
Pond II: Quail (80 Nos.)
Pond III: Goat (5+1 Nos.)

The preliminary experiment was conducted 9 months in fish pond for pond silt and manure production. The nutrient analysed pond silt and manure was utilized for main experiment (**Table 3**) but the pond silt and manure cost was taken by at the time of marketing price. Here not added for any special cost of cultivation for pond silt and manure production through integrated farming system. Fish pond fallow in 3 months.

Table 3 Nutrient analysis of the different manure components

S.No.	Manures	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potash (kg/ha)
1.	Vermicompost (5t)	60	30	40
2.	Turkey pond silt (5t)	30	15	20
3.	Quail pond silt (5t)	30	10	15
4.	Goat pond silt (5t)	40	20	25
5.	Farm Yard Manure (12 t)	35	15	20

Fingerlings for Integrated Farming System

Fingerlings ready for Integrated Farming System

Fingerlings releasing by chairperson

Fingerlings releasing by research scholar

Main field experiment

Maize: Crop management: Field preparation: After the harvest of gingelly crop, each plot were prepared with ridges and furrows without disturbing layout plan.

Manures and fertilizer application: Recommended dose of fertilizer 250:75:75 kg/ha of NPK in the form of urea (46% N), single super phosphate (16% P_2O_5) and muriate potash (60% K_2O) were applied. Nitrogen and was applied in quarter dose as basal, remaining in 45 DAS, respectively. The entire dose of phosphorus and Potassium was applied as basal.

Seeds and sowing: Maize hybrid, CoH(M) 6 seeds were dibbled at the rate of one seed/hill adopting a spacing of 60 cm between rows and 25 cm within the row. A seed rate of 15 kg/ha was adopted. Seeds were dibbled manually.
Gap filling and thinning: Gap filling was done on seventh day after sowing and thinning on 15th day after sowing.
Irrigation: First irrigation was given immediately after sowing. Life irrigation was given on third day after sowing. Subsequent irrigations were given on need basis at an interval of 7-10 days.
Weed management: Application of pre-emergence herbicide atrazine 0.25 kg/ha was done on third day after sowing. Hand weeding was done on 30th DAS.
Plant protection: Adequate need based plant protection measures were taken up periodically during the crop growth period as per recommendation of crop production guide (2012).
Harvesting and processing: Two border rows on all four sides of each treatment plot were harvested first and then the net plots harvested separately. The harvested cobs were dried, dehusked, shelled and cleaned separately. After cleaning, the grains were sun dried to 14 per cent moisture content. Grain weight of each treatment was recorded and expressed in kg/ha. Stover yield was also recorded and expressed in kg/ha.

Scientist visit INM of maize in rice-gingelly-maize cropping system through IFS

General field view of maize through integrated farming system

Economics

Cost of cultivation: The expenditure incurred from field preparation upto harvest was worked out and expressed in ₹/ha. The expenditure incurred from integrated farming system component arrangement upto manure as pond silt production cost was not worked out and the organic inputs was worked out at the time of market rate and expressed in ₹/t.
Gross return: Total income obtained from grain/seed and straw/stover yield was worked out, considering the current market price for inputs and outputs and expressed in ₹/ha.

Net return: Net return was obtained by subtracting the cost of cultivation from the gross return and expressed in ₹/ha.
Benefit cost ratio (BCR): Benefit cost ratio was calculated as follows, Benefit: Cost ratio= Gross returns (₹/ha)/ Total cost of cultivation (₹/ha).
Statistical analysis: The data on various characters studied during the course of investigation were statistically analysed as suggested by Gomez and Gomez (1984). Wherever statistical significance was observed, critical difference (CD) at 0.05 level of probability was worked out for comparison. If there are no significant differences between treatments, it was denoted as 'NS'.


Pond ready for Fish collection


Fish collection by fishnet


Collection of Fish from IFS pond


Silt manure ready for next cropping system from IFS


Integrated farming system via a fish weight 3.5 kg/9months

Result

Economics of maize in rice-gingelly-maize cropping system

Economic efficiency and the viability of crop cultivation are mainly the outcome of the yield of crop. Higher crop productivity with lesser cost of cultivation could result in better economic parameters like net returns and B:C ratio. The cost of cultivation, gross return, net return and B:C ratio was worked out for different INM treatments of maize in rice-gingelly-maize cropping system was given in the **Table 4**.

Table 4 Effect of integrated nutrient management on economics (₹/ha) of maize in rice-gingelly-maize cropping system

Treatment	2014-2015				2015-2016			
	Cost of Cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio	Cost of Cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
T_1 - 100% RDF + vermicompost	30840	85728	54888	2.78	30840	87680	56840	2.84
T_2 - 100% RDF + turkey manure as pond silt	30840	76768	45928	2.49	30840	81920	51080	2.66
T_3 - 100% RDF + quail manure as pond silt	30840	73824	42984	2.39	30840	80576	49736	2.61
T_4 - 100% RDF + goat manure as pond silt	30840	82112	51272	2.66	30840	83840	53000	2.72
T_5 - 75% RDF + vermicompost	29790	80064	50274	2.69	29790	82880	53090	2.78
T_6 - 75% RDF + turkey manure as pond silt	29790	71328	41538	2.39	29790	74880	45090	2.51
T_7 - 75% RDF + quail manure as pond silt	29790	66784	36994	2.24	29790	69696	39906	2.34
T_8 - 75% RDF + goat manure as pond silt	29790	75008	45218	2.52	29790	77152	47362	2.59
T_9 - 50% RDF + vermicompost	27710	70208	42498	2.53	27710	74560	46850	2.69
T_{10} - 50% RDF + turkey manure as pond silt	27710	62048	34338	2.24	27710	62880	35170	2.27
T_{11} - 50% RDF + quail manure as pond silt	27710	57408	29698	2.07	27710	59360	31650	2.14
T_{12} - 50% RDF + goat manure as pond silt	27710	67488	39778	2.44	27710	69440	41730	2.51
T_{13} - 100% RDF + FYM at 12.5 t/ha	30840	77408	46568	2.51	30840	78912	48072	2.56
T_1 to T_{12} - Organic manure at 5t/ha; Data not statistically analysed								

During 2014-15, gross return was ranged from ₹ 57408/ha to ₹ 85728/ha of maize in rice-gingelly-maize cropping system. Higher gross return (₹ 85728/ha) and net return (₹ 54888/ha) were observed with application of 100% RDF + vermicompost at 5 t/ha (T_1) and was followed by application of 100% RDF + goat manure as pond silt at 5 t/ha (T_4), with a gross return of ₹ 82112/ha and net return of ₹ 51272/ha was given in the Table 1. The lower gross return and net return of ₹ 57408/ha and ₹ 29698/ha, respectively were recorded with application of 50% RDF + quail manure as pond silt at 5 t/ha (T_{11}). Higher B: C ratio of 2.78 was registered with application of 100% RDF + vermicompost at 5 t/ha (T_1), which was followed by application of 75% RDF + vermicompost at 5 t/ha (T_5). The lower B:C ratio was obtained with application of 50% RDF + quail manure as pond silt at 5 t/ha (T_{11}).

During 2015-16, the gross return and net return of maize in rice-gingelly-maize cropping system varied from ₹ 59360/ha to ₹ 87680/ha and from ₹ 31650/ha to ₹ 56840/ha, respectively. Application of 100% RDF + vermicompost at 5 t/ha (T_1) recorded higher gross return (₹ 87680/ha) and net return (₹ 56840/ha) followed by application of 100% RDF + goat manure at 5 t/ha (T_4) as pond silt with the gross return of ₹ 83840/ha and 75% RDF + vermicompost at 5 t/ha (T_5) with the net return of ₹ 53090/ha, respectively. The least gross return (₹ 59360/ha) and net return (₹ 31650/ha) was registered with application of 50% RDF + quail manure as pond silt at 5 t/ha (T_{11}). Higher B:C ratio was (2.84) was observed with application of 100% RDF + vermicompost at 5 t/ha (T_1) and which was followed by application of 75% RDF + vermicompost at 5 t/ha (T_5) of 2.78. The lower B: C ratio (2.14) was obtained with application of 50% RDF + quail manure as pond silt at 5 t/ha (T_{11}).

Discussion

Maize

Economics of maize was influenced by integrated nutrient management practices during both the years of study. Application of 100% RDF + vermicompost at 5 t/ha was recorded higher gross return (₹ 85728 and ₹ 87680/ha), net return (₹ 54888 and ₹ 56840/ha) and B: C ratio (2.78 and 2.84) (**Figure 1**). Application 100% RDF + goat manure at 5 t/ha recorded comparable gross return (₹ 82112 and ₹ 83840/ha) and net return (₹ 51272 and ₹ 53000/ha).

Application of 75% RDF + vermicompost at 5 t/ha was the following treatment recorded 2.69 and 2.78 during 2014-2015 and 2015-2016. This might be due to higher productivity owing to increased economic returns. The higher yield realized under the above treatments would be the reason for more economic return as against the cost of cultivation with higher net gain and benefit: cost ratio. The results are in agreement with findings of Kumar and [13], [14] and [15].

Lower gross return (₹ 57408 and ₹ 59360), net return (₹ 2968 and ₹ 31650) and B:C ratio (2.07 and 2.14) were obtained with application of 50% RDF + quail manure as pond silt at 5 t/ha due to lower grain and stover yield of maize. The result was confirmed with the findings of [16], who also realized higher economic return due to integrated nutrient management practices.

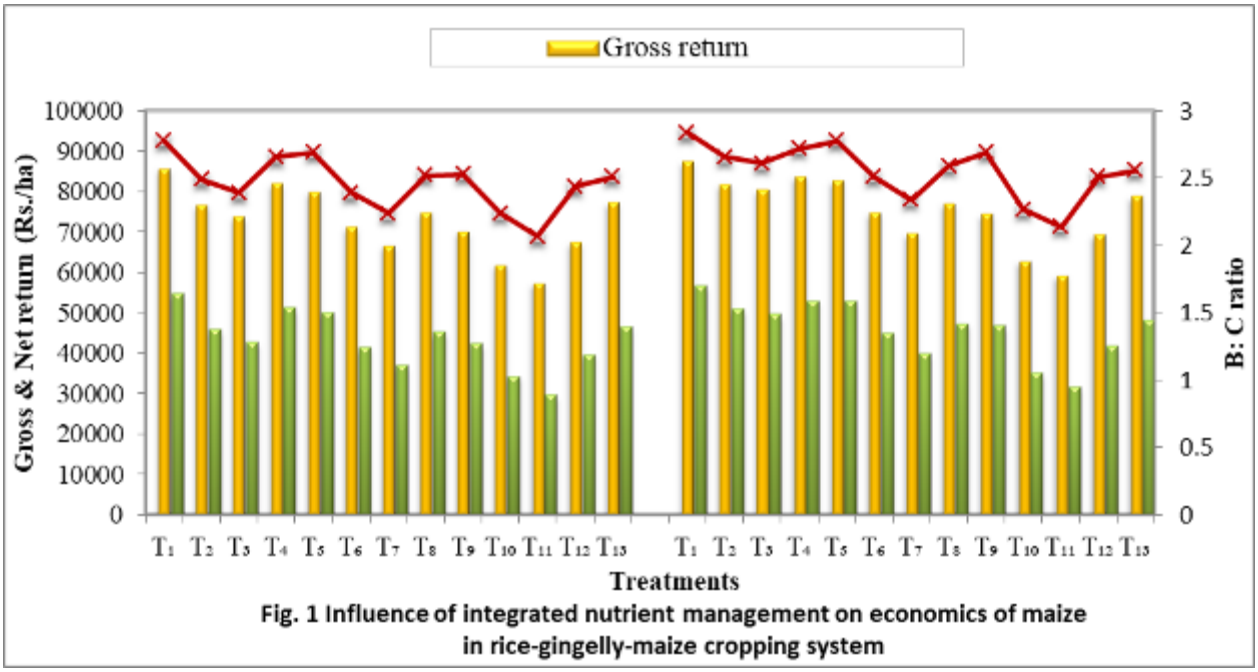

Fig. 1 Influence of integrated nutrient management on economics of maize in rice-gingelly-maize cropping system

Conclusion

In maize crop in addition to 100% RDF + vermicompost at 5 t/ha, 75% RDF + vermicompost at 5 t/ha recorded higher economic return. The highest benefit cost ratio was higher in 75% RDF + vermicompost at 5 t/ha in both the years of maize crop.

Recommendations

Maize crop 75% recommended dose of fertilizer along with 5 t/ha vermicompost can be recommended for better yield and economics.

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