International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 8; Issue 05 (E); May 2019; Page No.18823-18827
DOI: http://dx.doi.org/10.24327/ijcar.2019.18827.3606

Research Article

COMPARATIVE STUDY ON RICE AND MAIZE BASED CROPPING SYSTEM AS INFLUENCED BY ORGANIC NUTRIENT MANAGEMENT IN HILL AREAS OF NE INDIA

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A R T I C L E I N F O

Article History:
Received 06th February, 2019
Received in revised form 14th March, 2019
Accepted 23rd April, 2019
Published online 28th May, 2019

Key words:
Cropping system, organic nutrient management, yield

A B S T R A C T

The experiment was carried out at the experiment farm of ICAR, Nagaland Centre, Medziphema during 2015-16 and 2016-17 with the objectives to study the yield potential of rice and maize based cropping system under organic nutrient management. The experiment was laid out in SPD with three replications. The main plot treatment consisted of four combinations of two cropping systems (C), viz.,rice-greengram and maize-greengram and two organic nitrogen management (N)., viz., 75 % RD through vermicompost and 100 % RD through vermicompost and the sub-plot treatment consisted of two organic phosphorus management practices (P)., viz., 75 % RD through vermicompost and 100 % RD through vermicompost in greengram. Inglongkiri (upland rice), RCM-76 (maize) and Pratap (greengram).The study revealed that application of 100 % N through vermicompost showed significant effect on yield and yield attributes both in rice and maize. The effect of the main plot factor also showed significant carry over effect on the following greengram crop. It was observed that the sub plot factor showed significant effect with the application of 100 % P as compared with the application of 75 % P in greengram. The system economic analysis revealed that maize-greengram system with the application of 100% N and 75% P resulted in the highest economic returns with a B:C ratio of 1.12 as compared with the rice-greengram system with the same treatment.

INTRODUCTION

Cropping system in the NER is also predominantly rice based with little exception in the state of Sikkim where maize is the main food crop. Rice cultivation in the region is under low input low risk and low yield condition. In the lowland mostly, mono-cropping of rice is practiced with the little exception in Tripura, Assam, parts of Garo hills etc, where rice-rice system is practiced. The production of food grains in NE region is 5.97 million tonnes and the requirement are 7.6 million tonnes and the requirement would be 15.24 million tonnes by 2021 (Sharma and Datta, 2006). In order to make the region self sufficient in food grain production, the productivity of rice and maize has to be increased from the present level. Rice is also cultivated in Jhum under zero input supply and gives very low level of yield (1 to 1.5 t ha^{-1}). The productivity of rice in the state of Tripura (23.57 q ha^{-1}) and Manipur (25.87 q ha^{-1}) are higher than the national average, whereas all other states have lower productivity compared to national average (Das *et al.*, 2011). In case of maize, the state of Manipur (22.00 q ha^{-1}), Mizoram (18.75 q ha^{-1}) and Nagaland (20.00 q ha^{-1}), has comparatively better productivity than national average (Das *et al.*, 2011). Simply by adopting low cost agro-techniques like improved variety, proper time of sowing, intercultural practices, effective recycling of resources etc, yield can be increased significantly.

The importance of highly intensive crop sequence is well recognized to meet the growing demands of ever increasing population. To fulfill the demand of food, oil etc, intensification of cropping sequence is essential depending on the need of the area. Oilseeds and pulses are receiving more attention owing to higher prices due to increased demand. Inclusion of these crops in sequence has been found more beneficial. It is well established that the basic requirement for stabilizing the crop productivity lies in the betterment of soil fertility. But continuous intensive cropping sequence aggravates the problems of weed infestation, reduced soil fertility and infestation of other pests and diseases, which ultimately result in declining the efficiency and productivity of the system. After the resounding success of green revolution, a decline in rate of growth of food production was seen during the recent past in respect of crop productivity and fertilizer input response. Current generalized recommendations with

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respect to NPK fertilizers alone are pointing to soil fatigue; proving their decreased efficiency and thus need upward refinement and proper balance among the required nutrients.

Farming in the north-east hill region is regarded as organic by default as the application of fertilizers and pesticides is meagre in this part compared to the other parts of the country. However, with increase in population and lesser production and productivity from traditional system of crop production in this region, there is need to increase the cropping intensity and convert the subsistence agriculture into a sustainable form like organic agriculture.

MATERIALS AND METHOD

The present investigation was carried out during 2015-2016 and 2016-2017 at the experimental farm of ICAR, Nagaland Centre, Medziphema where the climatic condition of the experimental area is sub-tropical humid. The annual average rainfall varies from 1500 mm to 2000 mm which is mainly received during April to October and from November to March the weather is generally dry. The mean summer temperature ranges between 19^{o} C to 35^{o} C, while in winter it rarely goes below 5^{o}C. The soil was sandy loam in texture with pH 4.84, organic carbon (0.47%), N (147.39 kg ha^{-1}), P_2O_5 (19.04 kg ha^{-1}) and K_2O (170.02 kg ha^{-1}).

The experiment was laid out in split plot design with three replications. The treatment included cropping system (C), *viz*., rice-greengram (C^1) and maize-greengram (C_2), organic N management (N), *viz*., 75 % RD through vermicompost (N_1) and 100 % RD through vermicompost (N_2) and organic phosphorus management (P) in the sub plot viz., 75 % RD through vermicompost (P_1) and 100 % RD through vermicompost (P_2) in greengram.

RESULT AND DISCUSSION

Yield Attributing Characters and yield of rice and Maize

It was observed that the yield and yield attributes of rice and maize was significantly higher with application of 100 % RD of N as compared with the application of 75 % RD of N through vermicompost (Table 1-4).

Yield Attributing Characters and yield of Greengram

The Table 5 represents the effect of the main plot factor *i.e.,* cropping system (C) and organic N management (N) on the yield attributes which were found to be significant. The data showed that in C_2 as compared to C_1, greengram produced significantly more number of pods/plant, seeds/pod, test weight, seed and stover yield and HI. And, N_2 was observed to significantly improve upon these yield attributes in greengram compared to N_1.

Effect of Organic Phosphorus Management (P)

The data shown in Table 6 indicated that the significant effect of P, the sub-plot factor on the mentioned yield attributes in greengram. The data revealed that application of 100 % RD of P through vermicompost (P_2) in greengram resulted in significantly more number of pods/plant, number of seeds/pod, test weight, seed and stover yield and HI as compared with the application of 75 % RD of P through vermicompost in greengram.

Table 1 Effect of cropping system, organic n and weed management on yield parameters of rice

Treatment	Tillers per hill		Grains per panicle		Panicle length(cm)		Panicle weight(g)	
	2015	2016	2015	2016	2015	2016	2015	2016
$C_1N_1L_1$	7.751	8.872	115.282	126.352	26.801	27.882	4.652	5.870
$C_1N_1L_2$	9.382	10.241	132.003	144.571	28.292	31.273	5.650	7.543
$C_1N_2L_1$	8.813	9.453	125.591	137.592	27.283	29.481	5.562	6.452
$C_1N_2L_2$	10.640	11.444	148.334	162.544	30.344	35.284	6.244	8.881

Table 2 Effect of cropping system, organic n and weed management on yield parameters of rice

Treatment	Test weight(g)		Seed yield(q ha^{-1})		Stover yield (q ha^{-1})		Harvest Index (%)	
	2015	2016	2015	2016	2015	2016	2015	2016
$C_1N_1L_1$	17.430	19.430	15.170	16.270	29.591	30.272	33.9270	34.5922
$C_1N_1L_2$	19.982	21.542	17.442	18.872	33.062	35.473	35.0503	35.0080
$C_1N_2L_1$	19.283	21.142	16.743	17.883	31.033	33.471	34.5662	34.7393
$C_1N_2L_2$	20.681	22.874	20.481	22.470	35.020	37.244	36.9041	37.6214

C_1-Rice-greengram, C_2-Maize-greengram, N_1- 75% N as vermicompost, N_2- 100% N as vermicompost, L_1-Control (No mulching), L_2-Live mulching with cowpea

Table 3 Effect of cropping system, organic n and weed management on yield parameters of maize

Treatment	Grains /cob		Plants m^{-2}		Cob length(cm)	
	2015	2016	2015	2016	2015	2016
$C_2N_1L_1$	410.001	425.630	6.762	7.240	18.512	20.470
$C_2N_1L_2$	475.962	489.573	7.853	8.142	20.283	22.511
$C_2N_2L_1$	441.054	452.272	7.141	7.843	20.070	21.474
$C_2N_2L_2$	507.131	534.241	7.980	8.372	20.301	23.453

Table 4 Effect of cropping system, organic n and weed management on yield parameters of maize

Treatment	Test weight(g)		Seed yield(q ha^{-1})		Stover yield (q ha^{-1})		Harvest Index (%)	
	2015	2016	2015	2016	2015	2016	2015	2016
$C_2N_1L_1$	71.342	72.140	30.361	31.272	60.250	63.470	32.2712	32.9892
$C_2N_1L_2$	89.071	90.872	39.452	41.123	73.583	75.583	35.0360	35.0913
$C_2N_2L_1$	75.343	76.440	35.922	36.470	71.224	73.781	32.5801	33.0740
$C_2N_2L_2$	90.490	92.243	44.920	45.581	79.260	81.240	35.9713	36.5774

C_1-Rice-greengram, C_2-Maize-greengram, N_1- 75% N as vermicompost, N_2-100% N as vermicompost L_1-Control (No mulching), L_2-Live mulching with cowpea

Table 5 Effect of cropping system, organic N and weed management on yield parameters of greengram

Treatment	Number of pods/plant		Number of seeds/pod		Test weight (g)	
Cropping System	2015	2016	2015	2016	2015	2016
C_1-Rice-greengram	28.701	23.032	9.848	7.552	34.392	31.372
C_2-Maize-greengram	31.331	26.784	10.162	8.326	35.767	32.762
Organic N management in 1st *kharif* crop (N)						
N_1- 75% N as vermicompost	28.749	23.888	9.787	7.711	34.216	31.199
N_2-100% N as vermicompost	31.283	25.928	10.224	8.137	35.943	32.935
SEm (±)	0.763	0.602	0.144	0.139	0.512	0.516
CD(P=0.05)	1.634	1.288	0.309	0.297	1.095	1.105
Organic P management in 2nd *kharif* crop (P)						
P_1- 75% P as vermicompost	27.723	22.890	9.677	7.611	33.851	30.838
P_2- 100% P as vermicompost	32.309	26.926	10.334	8.237	36.309	33.295
SEm(±)	0.412	0.526	0.197	0.127	0.395	0.439
CD(P=0.05)	0.874	1.127	0.417	0.272	0.838	0.939
Interactions	NS	NS	NS	NS	NS	NS
CV (%)	8.811	8.370	5.001	6.074	5.051	5.576
	4.757	7.322	6.814	5.565	3.903	4.739

NS- Not significant

Table 6 Effect of cropping system, organic N, weed and P management on yield parameters of greengram

Treatment	Seed yield (q ha^{-1})		Stover yield (q ha^{-1})		Harvest Index (%)	
Cropping system (C)	2015	2016	2015	2016	2015	2016
C_1-Rice-greengram	9.218	6.782	19.307	17.010	29.716	27.730
C_2-Maize-greengram	9.542	7.497	22.262	19.376	32.282	28.648
Organic N management in 1st *kharif* crop (N)						
N_1- 75% N as vermicompost	9.164	6.871	20.383	17.770	30.294	27.786
N_2-100% N as vermicompost	9.595	7.408	21.186	18.616	31.704	28.591
SEm (±)	0.124	0.144	0.379	0.284	0.422	0.365
CD (P=0.05)	0.265	0.307	0.810	0.609	0.903	0.782
Organic P management in 2nd *kharif* crop (P)						
P_1- 75% P as vermicompost	8.984	6.719	19.922	17.463	29.626	27.291
P_2- 100% P as vermicompost	9.775	7.560	21.648	18.923	32.372	29.087
SEm (±)	0.150	0.121	0.503	0.390	0.483	0.383
CD (P=0.05)	0.317	0.260	1.067	0.835	1.023	0.820
Interactions	NS	NS	NS	NS	NS	NS
CV (%)	4.581	6.967	6.304	5.416	4.718	4.488
	5.523	5.890	8.383	7.429	5.393	4.709

NS- Not significant

Table 7 Economic analysis of the system

Treatments	Cost of cultivation of the system		Total gross return of the system		Total net return of the system		B:C ratio of the system	
	2015	2016	2015	2016	2015	2016	2015	2016
$C_1N_1P_1$	111700	111700	10308015	152465.00	76315	40765.00	0.68	0.36
$C_1N_1P_2$	129580	129580	10308015	165615.00	71085	36035.00	0.55	0.28
$C_1N_2P_1$	119620	119620	11374830	168375.00	78610	48755.00	0.66	0.41
$C_1N_2P_2$	137500	137500	11374830	183175.00	76380	45675.00	0.56	0.33
$C_2N_1P_1$	121350	121350	22921800	249348.34	155000.00	127998.34	1.28	1.05
$C_2N_1P_2$	139230	139230	22921800	261398.34	147620.00	122168.34	1.06	0.88
$C_2N_2P_1$	133350	133350	27119600	283091.67	176991.67	149741.67	1.33	1.12
$C_2N_2P_2$	151230	151230	27119600	292050.00	168070.00	140820.00	1.11	0.93

System Economics

The economic analysis of the system revealed that the application of 100 % RD of N and 75 % RD of P through vermicompost in maize-greengram system gave the highest economic return which obtained a B: C ratio of 1.61 as compared with the rest of the treatment combinations (Table7).

The finding on the influence of organic nitrogen application that the application of 100 % RD of N through vermicompost in rice and maize significantly increased the yield and yield attributes as compared with the application of 75% N through vermicompost. Similar findings was also reported by Murali and Setty, 2000; Sethil *et al.*, 2010; Thirunavukkarasu *et al.*, 2010 and Davari and Sharma, 2010.

The finding on maize was also supported by Jayaprakash *et al.*, 2003; Atiyeh *et al.*, 2000, Aracon *et al.,* 2004, Kumar *et al.*, 2007 and Meena *et al.,* 2011, where they reported that application of vermicompost increased the yield and yield attributes. It was observed that with the increase in the levels of N, the effect on the yield and yield attributes increased. This observation was also supported by Mohadeseh *et al.*, 2015, where they reported that the growth and yield attributes showed significant increase with the increase in the dose of vermicompost.

The efficacy of vermicompost application on increasing the yield of greengram was also reported by Rajkhowa *et al*., 2002; Bhatt *et al*., 2012 and Sushil *et al*., 2015, which confirms to the findings of the present investigation. The significant residual effect of vermicompost application on the succeeding greengram and other crops on yield and yield attributes were also reported by, Faujdar and Sharma, 2013; Dey and Paul, 2013; Pate *et al.*, 2014; Tushar *et al.*, 2014 and Alagappan and Venkitaswamy, 2016.

SUMMARY AND CONCLUSION

Upon application of 100% N through vermicompost, the yield and yield attributes of rice increased significantly as compared with the application of 75 % RD of N through vermicompost. Similar response was obtained from the maize crop where application of 100 % RD of N through vermicompost recorded the highest yield as compared with application of 75 % RD of N through vermicompost.

Cropping system and organic nitrogen management showed significant carry over influence on the succeeding greengram crop, where the application of 100 % N through vermicompost proved to be better in maize-greengram system as compared with rice-greengram system. The application of 100 % P and 75 % P through vermicompost in greengram also exhibited similar response on the yield of the greengram.

With regard to the treatments combined effect on the yield, the maize-greengram system with 100 % N and P outperformer the rest of the treatment interactions which is quickly followed by the application of 75 % N and P through vermicompost.

For profitable and sustainable farming, maize-greengram cropping sequence may be practiced which was found to be more profitable as compared to rice-greengram under rainfed situation organic approach. Application of 100 % N in maize and 75 % P in greengram through vermi-compost not only increased the yield of maize but also the productivity of the sequence. However, in areas where there is limitation of vermicompost availability, application of vermicompost at 75 % N in maize and 75 % P in greengram may also be considered in maize-greengram sequence since the B:C ratio between the levels were almost *at par* with each other. Vermicompost, which formed an important component of this research, if it can be produced within the farm itself by the farmers' where the crop biomass is readily available, the income of the farmers' will be further increased.

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How to cite this article:

N.Khumdemo Ezung, J.K.Choudhary and Tiatula Jamir (2019) 'Comparative Study on Rice and Maize Based Cropping System as Influenced by Organic Nutrient Management in Hill Areas of Ne India', *International Journal of Current Advanced Research,* 08(05), pp.18823-18827. DOI: http://dx.doi.org/10.24327/ijcar.2019.18827.3606

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