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Evaluation of Rice (*Oryza sativa* L.) under integrated nitrogen management practices and succeeding maize (*Zea mays* L.) under residual nutrient and weed management practices

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Abstract
A field experiment was conducted at Central Research Station of the College of Agriculture, OUAT, Bhubaneswar, during two consecutive *kharif* and *rabi* seasons of 2017-18 and 2018-19 to study the influence of integrated nitrogen management practices on rice and its residual effects on growth, yield attributes and yield of maize with different weed management practices. The field experiment was laid out in a RBD design for rice with four treatments and 15 replications and split-plot design for maize with three replications. The four Integrated nitrogen management (INM) treatments for rice were D1=100% STBN (Soil test based nitrogen) D2=50%STBN+50%FYM, D3=50%STBN+50%VC and D4=50%STBN+50%PM. Maize is taken as the succeeding crop grown with RDF (120-60-60Kg/ha, N-P-K respectively). There were altogether 20 treatment combinations for maize with Main Plot (Nutrient management, *i.e.* residual nutrients of rice crop) and Sub-Plot (Weed management): W1= Topramezone@25g a.i./ha, W2=Tembotrione@105g a.i./ha,W3=Topramezone@25g a.i. + Atrazine@ 250g a.i./ha as tank mix, W4=Tembotrione@105g a.i./ha + Atrazine@ 250g a.i./ha and W5=Weedy check. Rice yield was found to be maximum under 50% STBN+ 50% VC followed by 50% STBN+ 50% PM. The residual effects of these nutrients practices have found to be influence the growth and yield of succeeding maize crops. Among the nutrient management practices, 50% STBF+ 50% VC gives the highest kernel yield (6.36t/ha) and among the weed management practices combined application of Topramezone@25g a.i. +Atrazine@ 250g a.i./ha as tank mix resulted the maximum kernel yield (7.18t/ha) over both the years. Highest kernel yield of maize, 7.59t/ha was recorded in the treatment combination, comprising 50%STBN+50%VC with Topramezone@25g a.i. +Atrazine@ 250g a.i./ha as tank mix application in maize at 15 DAS.

Keywords: Evaluation, nitrogen management, *Oryza sativa* L., *Zea mays* L.

Introduction
Rice-maize system is an emerging system in Southeast Asia particularly in Bangladesh and North and southern part of India. Over the years the performance of the system is either stagnant or in a declining state. Moreover the health of the system to sustain long term product ion is doubtful. The future of food security system, not only in India but the whole South East Asia, depends upon the ability to achieve a trend of growth towards productivity and profitability of rice farming system on an ecologically sustainable basis (Swaminathan, 1993) [7].

Material and Methods
A two year field experiment was conducted during 2017-18 and 2018-19 at Central Research Station of the College of Agriculture, OUAT- Bhubaneswar, taking two crops, rice in *kharif* and maize *in rabi*. The soil of the experimental plot was loamy sand in texture, low in available nitrogen (198 kg/ha), high in available phosphorus (51 kg/ha) and low in available potassium (182 kg/ha), organic carbon 0.46% and pH (4.68), EC dsm-1 (046). The field experiment was laid out in a RBD design for rice with four treatments and 15 replications and split-plot design for maize with three replications. The four INM treatments for rice were D1=100% STBN, D2=50% STBN+50% FYM, D3=50% STBN+50% VC and D4=50%

STBN+50% PM. There were altogether 20 treatment combinations for maize with Main Plot (Nutrient management, *i.e.* residual effects of treatments given to rice crop) and Sub-Plot (Weed management): W1= Topramezone@ 25g a.i/ha, W2=Tembotrione@ 105g a.i./ha,W3=Topramezone@ 25ga.i.+Atrazine@ 250ga.i./ha as tank mix, W4= Tembotrione@ 105g a.i./ha++Atrazine@ 250g a.i./ha and W5=Weedy check. Tested varieties are Nabeen (Rice) and DHM 117 (maize). Rice was transplanted at 20cmX10cm spacing and maize was sown with spacing of 45cm×25cm on opening of shallow furrows of 5 cm deep. Inorganic nutrients to both the crops were provided with Urea, Single Super Phosphate and Murate of Potash. Herbicides in maize was applied at 15 DAS. Data on growth parameters was taken as pre specified interval and that of yield attributes and yield was taken after harvest of the crop. Harvest Index and Weed Index are two derived data, calculated with the following formulas.

$$\text{Harvest Index (HI)} = \frac{\text{Economic yield}}{\text{Biological yield}} \text{ X } 100$$

$$\text{Weed Index (HI)} = \frac{\text{Yield in best treatment-Yield in concerned treatment}}{\text{Yield in best treatment}} \text{ X } 100$$

Results and Discussion

Yield and yield attributes of rice

Among the treatments in rice, plots applied with 50% STBN+ 50% VC gives the best result with respect to yield attributes and economic yield over two years. This recorded highest number of effective tillers/m^2(371.8), Maximum number of filled grain per panicle (133), highest test weight (23.71g) as well as maximum grain yield(5.15t/ha). The second best treatment with respect to grain yield was recorded in 50% STBN + 50% PM i.e. (4.99t/ha). [3], [4], [5] also mentioned similar findings.

Table 1: Yield attributed and yield of rice as influenced by nutrient management practices (mean over two years)

Treatment	No. of effective tillers/m^2	No. Filled grains/ panicle	Test wt (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest Index (%)
100% STBN	309.0	121.1	23.39	4.56	5.92	43.5
50% STBN + 50% FYM	351.5	130.2	23.45	4.85	6.09	44.3
50% STBN+ 50% VC	371.8	133.0	23.71	5.14	6.03	46.0
50% STBN + 50% PM	346.7	130.8	23.55	4.99	6.02	45.3
S.Em±	2.13	0.93	0.05	0.03	0.03	0.23
CD (0.05)	6.09	2.68	0.16	0.08	0.11	0.67

Yield and yield attributes of maize

Nutrient management (influence of residual nutrients) though does not significantly influence the yield attributes but found to be influence the kernel yield of maize. Among the nutrient management practices highest kernel yield was recorded in 50% STBF+ 50% VC, 6.36t/ha. Which show parity with the yield 50% STBF+ 50% PM, 6.12t/ha. Both these yield are significantly higher than the sole 100% STBF plot.

Among the weed management practices, Best weed management practices in terms of yield and yield attributes was found to be combined application of Topramezone@25g a.i. +Atrazine@ 250g a.i./ha as tank mix at 15 DAS followed by Tembotrione@105g a.i./ha++Atrazine@ 250g a.i./ha as tank mix at 15 DAS. The number of kernels per cob in these treatments were found to be 407.1 and 400.8 respectively as compared to weedy check (221.8). Maximum kernel yield was also recorded in the Topramezone + Atrazine treatment (7.18t/ha) followed by Tembotrione + Atrazine combined treatment (6.91t/ha) which is significantly higher as compared to the kernel yield of weedy check (2.77t/ha).

Weed index is the relative yield reduction of a treatment over the best treatment. Weed Index of the treatments as presented in table-2, with these data it can be interpreted that the two novel herbicides Topramezone and Tembotrione is effective both in case as a tank mixture with atrazine as well as in sole application. Similar findings can also be observed in [8], [9].

Table 2: Yield attributes and yield of maize as influenced by residual nutrients and weed management practices (mean over two years)

Treatments	No. of cobs/ plant	Cob length (cm)	Cob Girth (cm)	Cob weight (g)	No. of rows / cob	No of grains/ cob	1000 seed weight (g)	Kernel yield (t/ha)	Stover yield (t/ha)	HI (%)	WI (%)
Nutrient management											
100% STBF	1.56	18.0	14.3	83.0	14.11	362.5	267.7	5.57	7.58	42.4	22.4
50% STBF + 50% FYM	1.57	18.6	14.2	80.2	14.78	352.3	272.7	6.06	7.52	44.6	15.6
50% STBF+ 50% VC	1.63	19.5	14.3	88.9	15.64	366.7	272	6.36	7.80	44.9	11.4
50% STBF+ 50% PM	1.59	19.1	14.3	87.4	15.03	365.3	271.2	6.12	7.50	44.9	14.8
S.Em±	0.01	0.22	0.03	0.9	0.16	2.2	1.44	0.07	0.06	0.03	-
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	0.26	NS	NS	-
Weed management											
Topramezone	1.70	19.5	44.45	92.7	15.47	392.7	272.7	6.74	8.29	44.8	6.1
Tembotrione	1.67	18.5	14.3	89.3	15.33	383.6	271.1	6.54	8.23	44.3	8.9
Topramezone+Atrazine	1.73	21.1	14.5	94.3	16.34	407.1	271.4	7.18	8.50	45.8	0.0
Tembotrione+Atrazine	1.70	20.5	14.6	93.2	15.61	400.8	271.8	6.91	8.48	44.9	3.8
Weedy check	1.17	14.5	12.5	55.0	11.71	221.8	134.3	2.77	4.48	38.2	61.4
S.Em±	0.01	0.17	0.05	1.5	0.19	3.4	1.90	0.06	0.17	0.05	-
CD (0.05)	0.04	0.59	0.16	4.9	0.63	11.5	NS	0.21	0.59	NS	-
Interaction											
S.Em±	0.02	0.43	0.10	3.07	0.42	7.25	4.12	0.04	0.06	0.03	
CD (0.05)	NS	NS	NS	NS	NS	24.25	NS	0.13	NS	NS	

Interaction effect on yield of maize

Interaction effects of residual nutrient and weed management practices on kernel yield of maize is presented in table-3. Highest kernel yield of maize, 7.59t/ha was recorded in the treatment combination, comprising 50%STBN+50%VC in rice with Topramezone + Atrazine application in maize at 15 DAS. The second best result for maize yield, 7.41t/ha was recorded for 50%STBN+50%VC in rice with Tembotrione + Atrazine combined application at 15 DAS.

Kernel yield was lower in 100% STBN treatment compared to other combined nutrient sources and being least, 2.60t/ha in 100% STBN+ Weedy checks. Similar findings also given by [2].

Table 3: Interaction effect of nutrient management and weed management kernel yield of maize

Treatment	100% STBN	50%STBN+50%FYM	50%STBN+50%VC	50%STBN+50%PM	Mean
Topramezone	6.05	6.47	6.89	6.77	6.54
Tembotrione	6.27	6.85	6.99	6.86	6.74
Topramezone+Atrazine	6.57	7.17	7.59	7.37	7.18
Tembotrione+Atrazine	6.38	6.95	7.41	6.91	6.91
Weedy check	2.60	2.88	2.91	2.71	2.77
mean	5.57	6.06	6.36	6.12	
	D within W		W within D		
S.Em±	0.11		0.04		
CD(0.05)	0.37		0.13		

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