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EFFECT OF NUTRIENT MANAGEMENT ON YIELD ATTRIBUTES AND YIELDS IN RICE BASED CROPPING SYSTEM

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ABSTRACT

A field experiment was conducted during 2015 & 2016 at farmers' field is situated at latitude and longitudes location of Binuria village (23 ^{o} 40.392'N and 87 ^{o} 37.654'E) of Birbhum district of West Bengal under the red and lateritic belt of West Bengal. The experiment was laid out in randomized block design with three replication and twelve treatments in both during *boro* season rice.the plot size was 5 m x 4 m and the treatment combinations are T_1-$N_{120}P_{60}K_{60}Zn_{25}S_{20}$, T_2-$N_{60}K_{60}Zn_{25}S_{20}$, $T_3N_0K_{60}Zn_{25}S_{20}$, T_4-$N_{120}P_{30}K_{60}Zn_{25}S_{20}$, T_5-$N_{120}P_0K_{60}Zn_{25}S_{20}$, T_6-$N_{120}P_{60}K_{30}Zn_{25}S_{20}$, T_7-$N_{120}P_{60}K_0Zn_{25}S_{20}$, T_8-$N_{120}P_{60}K_{60}Zn_{12.5}S_{20}$, T_9-$N_{120}P_{60}K_{60}Zn_0S_{20}$, T_{10}-$N_{120}P_{60}K_{60}Zn_{25}S_{10}$, T_{11}-$N_{120}P_{60}K_{60}Zn_{25}S_0$, and T_{12}- Control. The hybrid rice of *boro* season was Arize 6444 GOLD which show positive influence on application of the ample dose of nutrient and recorded significantly better effect on the yield parameters and yield of *boro* rice.

Key words: Ample dose, grain yield, rice, nutrient management, hybrid rice

INTRODUCTION

Rice is an important crop in Indian agriculture; however, rice requires higher amounts of plant nutrients to achieve optimal return than many other crop species (Anonymous, 2001). As an example, Yoshida (1981) found that rice required 20.7 kg N, 5.17 kg P and 35.5 kg K during *boro* season for every metric tonne of grain produced. The judicious application of fertilizers, especially N, P and K results in higher yields of hybrid rice than has been seen with a high yielding variety (Singh and Virmani, 1990). Continued heavy application of NPK eventually resulted in an imbalance of other nutrients. Therefore, it is necessary to supplement crops with optimised inorganic fertilizer sources in order to maintaining nutrient supply and correct for marginal deficiencies of secondary and micro nutrients. The rice growing soils of North Bengal tend to be deficient in Zn (Ghosh *et al.*, 1992), and the addition of supplemental Zn has been found to increase rice yield by 10 to 12% (Parc, 1986). But at present, due to scarcity and unavailability of organic sources, plant nutrient may be supplied through organic and inorganic sources for sustaining the productivity of rice. Based on the above perspectives, this experiment was undertaken to examine the effects of inorganic inputs and the addition of supplemental Zn on the yields of a hybrid and a high yielding variety of rice during *kharif* season under West Bengal situation. Location specific certain nutrient management plans are essential for successful production of hybrid rice. Keeping these ideas in view and realising the importance of the problem, an investigation was carried out during the *boro* season of 2015-16 at the farmer field at Binuria, Bhirbhum with the objectives of study the nutrient management on the growth and yield of Rice-Rice based cropping system

MATERIALS AND METHODS

The experiment was conducted during 2015-2016 at farmers' field is situated at latitude and longitudes location of Binuria village (23 ^{o} 40.392'N and 87 ^{o} 37.654'E) of Birbhum district of West Bengal under the red and lateritic belt of West Bengal .The experiment was laid out in Randomized Block Design with three replication and twelve treatments in both during *boro* season rice. The plot size was 5 m x 4 m and the treatment combinations for *boro* season the treatment combinations are T_1- $N_{120}P_{60}K_{60}Zn_{25}S_{20}$, T_2-$N_{60}K_{60}Zn_{25}S_{20}$, $T_3N_0K_{60}Zn_{25}S_{20}$, T_4-$N_{120}P_{30}K_{60}Zn_{25}S_{20}$, T_5-$N_{120}P_0K_{60}Zn_{25}S_{20}$, T_6-$N_{120}P_{60}K_{30}Zn_{25}S_{20}$, T_7-$N_{120}P_{60}K_0Zn_{25}S_{20}$, T_8-$N_{120}P_{60}K_{60}Zn_{12.5}S_{20}$, T_9-$N_{120}P_{60}K_{60}Zn_0S_{20}$, T_{10}-$N_{120}P_{60}K_{60}Zn_{25}S_{10}$, T_{11}-$N_{120}P_{60}K_{60}Zn_{25}S_0$, and T_{12}- Control. The ample dose of nutrients was 120:60:60:25:20 kg/ha of N: P_2O_5: K_2O:.Zn:S in *Boro* season respectively. The hybrid rice variety used in *Boro* season was Arize 6444 GOLD. The experimental soil was sandy loam in texture, acidic

in reaction (pH 5.65), medium in organic carbon (0.35%) and medium in available nitrogen (230.0 kg ha^{-1}), medium in available phosphorus (11.2 kg ha^{-1}), medium in available potassium (125. kg ha^{-1}) and low in available zinc (0.22 ppm) and sulphur (10.5 kg ha^{-1}).

At optimum moisture condition, the land was first ploughed thoroughly cross wise with tractor drawn harrow and final land preparation with mould board plough (10-15 cm deep) for obtaining good tilth followed by planking. After that, the clods and all stubbles of previous crops were removed from the land. The field was flooded with water and the puddling was done under saturated condition. After proper leveling, the field was laid out properly by making bund in each channel for irrigation as well as drainage. The fertilizers were applied considering 120:60:60 kg of N: P_2O_5:K_2O ha^{-1} as recommended dose in *kharif* and *boro* season respectively. The sources of fertilizers were urea for N, Single super phosphate (SSP) for P and Muriate of potash (MOP) for K. Half dose of nitrogen and full dose of phosphorus & potassium were applied as basal dose before transplanting. The remaining half of nitrogen was applied as top dressing at 30 days after transplanting and 60 DAT i.e. at active tillering stage and panicle initiation stage.

The panicle length was recorded from 10 panicles of 5 hills of each plot at maturity and average length of panicle was worked out for each plot. Total number of spikelets from 10 panicles of 2 randomly selected hills of each plot was counted at maturity and then average number of spikelets per panicle was calculated for each plot. Total number of filled grains from above 10 panicles of each plot was counted and then average number of filled grains per panicle was calculated for each plot. The cleaned grains were dried in the sun for two days. The weight of grains was recorded for each plot and converted into kg ha^{-1}.

The experimental data recorded for various parameters under study were subjected to statistically analysed ANOVA given by Gomez and Gomez (1984) to draw a valid conclusion. The variation in the treatments mean was tested by using critical difference (CD) values at 5% level of significance.

RESULTS

Number of panicles per unit area

The number of panicles per unit area were statistically analyzed and presented in the Table 1. During *boro* season of 2015-2016, the number of panicles of rice has varied significantly in rice. The successive increase in dose of NPKZnS fertilization has resulted in corresponding increase in number of panicles. Application of 100% recommended dose of NPK along with Zn and S to rice has recorded maximum effective number of panicles which was statically at par with T_2-$N_{60}P_{60}K_{60}Zn_{25}S_{20}$, T_5-$N_{120}P_0K_{60}Zn_{25}S_{20}$, T_6-$N_{120}P_{60}K_{30}Zn_{25}S_{20}$, T_8-$N_{120}P_{60}K_{60}Zn_{12.5}S_{20}$ and T_{10}- $N_{120}P_{60}K_{60}Zn_{25}S_{10}$. during both the years of experimentation. The results are conformity with those of Sikdar and Gupta (1979).

Number of spikelets per panicle

The number of spikelets per panicle were presented in the Table 1. In 2015-16 of *boro* season the data which was closely followed by 50% and 0% NPKZnS supplied through chemical fertilizer, where as 100% chemical fertilizer was higher each as chemical fertilizer compared to no application of fertilizers application which statically at par with at other the treatment except T_3 and control. (Buresh, 2009).

Number of filled grains per panicle

During *boro* (2015), has shown in significant increase in number of filled grains per panicle due the ample dose of NPKZn and S which was applied (T_1) recorded highest number of filled grains per panicle which was significantly superior over all treatments. This wasclosely followed by T_2-$N_{60}P_{60}K_{60}Zn_{25}S_{20}$, T_4-$N_{120}P_{30}K_{60}Zn_{25}S_{20}$, T_5-$N_{120}P_0K_{60}Zn_{25}S_{20}$,$T_6$- $N_{120}P_{60}K_{30}Zn_{25}S_{20}$, T_7-$N_{120}P_{60}K_0Zn_{25}S_{20}$, T_8-$N_{120}P_{60}K_{60}Zn_{12.5}S_{20}$,$T_9$- $N_{120}P_{60}K_{60}Zn_0S_{20}$, T_{10}-$N_{120}P_{60}K_{60}Zn_{25}S_{10}$ and T_{11}-$N_{120}P_{60}K_{60}Zn_{25}S_0$. T_{12} (control) recorded the lowest number offertile grains per panicle. In 2016 data the ample dose of NPKZnS recorded increase in number of grains per panicle overno application of fertilizers which was at par with T2- $N_{60}P_{60}K_{60}Zn_{25}S_{20}$, T4-$N_{120}P_{30}K_{60}Zn_{25}S_{20}$,T5-$N_{120}P_0K_{60}Zn_{25}S_{20}$, T6-$N_{120}P_{60}K_{30}Zn_{25}S_{20}$,T8- $N_{120}P_{60}K_{60}Zn_{12.5}S_{20}$,T9- $N_{120}P_{60}K_{60}Zn_0S_{20}$,T10- $N_{120}P_{60}K_{60}Zn_{25}S_{10}$ and T11-$N_{120}P_{60}K_{60}Zn_{25}S_0$. This result is in conformity with the findings of Uddin et al.(1981).

Test weight of grain

The test weight of rice grain also followed a trend similar to that of filled grain. It did not vary significantly among the different treatment combinations under the study. The test weight character and does not vary much due to different management practices. Our results also indicated that test weight was same where the character and did not vary much by varying the nutrient management practices. Similar findings were recorded by Yadav et al. (2008).

Table 1. Effect of nutrient management on Yield Attributes of *boro* rice at maturity

Treatment	Number of Panicles m^{-2}		[1]Number of Spikelets $panicle^{-1}$		Number of filled grains $panicle^{-1}$		Test weight (g)	
	2015	2016	2015	2016	2015	2016	2015	2016
T_1-$N_{120}P_{60}K_{60}Zn_{25}S_{20}$	281.0	282.2	155.1	159.4	140.0	145.4	24.0	25.6
T_2-$N_{60}P_{60}K_{60}Zn_{25}S_{20}$	269.7	280.4	151.0	152.2	133.0	136.0	22.9	22.8
T_3-$N_0P_{60}K_{60}Zn_{25}S_{20}$	259.8	254.7	146.2	145.1	90.0	101.0	21.0	20.3
T_4-$N_{120}P_{30}K_{60}Zn_{25}S_{20}$	260.4	274.3	154.9	156.1	125.0	140.1	23.3	23.5
T_5-$N_{120}P_0K_{60}Zn_{25}S_{20}$	273.9	276.4	151.3	156.0	131.2	130.0	22.7	22.6
T_6-$N_{120}P_{60}K_{30}Zn_{25}S_{20}$	277.6	279.5	155.0	158.0	130.0	132.3	22.3	23.8
T_7-$N_{120}P_{60}K_0Zn_{25}S_{20}$	252.5	257.7	150.4	151.7	123.0	121.1	23.1	23.4
T_8-$N_{120}P_{60}K_{60}Zn_{12.5}S_{20}$	278.0	281.4	150.6	153.0	134.9	136.3	23.0	23.2
T_9-$N_{120}P_{60}K_{60}Zn_0S_{20}$	252.0	255.2	154.4	157.9	130.0	132.0	23.8	24.9
T_{10}-$N_{120}P_{60}K_{60}Zn_{25}S_{10}$	267.0	268.1	151.1	155.3	137.9	138.2	22.6	23.6
T_{11}-$N_{120}P_{60}K_{60}Zn_{25}S_0$	246.6	250.2	150.7	151.0	133.9	131.2	22.0	23.1
T_{12}-Control	215.3	210.0	121.0	120.0	80.0	76.0	20.2	20.0
SEm(±)	6.7	7.3	4.9	5.0	6.0	6.7	1.8	1.0
CD (p=0.05)	19.6	21.3	14.4	14.7	17.4	19.6	5.2	2.8
CV(%)	4.4	4.8	5.7	5.7	8.3	9.1	NS	NS

Grain yield (t ha^{-1})

The Grain yield (t ha^{-1}) was statistically analysed and was presented in the Table 2During *boro* season(2015) the highest yield was achieved were 100% N+P+K+Zn+Sapplied which was statically at par with T_2-$N_{60}P_{60}K_{60}Zn_{25}S_{20}$, T_4-$N_{120}P_{30}K_{60}Zn_{25}S_{20}$,$T_5$- $N_{120}P_0K_{60}Zn_{25}S_{20}$,$T_6$-$N_{120}P_{60}K_{30}Zn_{25}S_{20}$,$T_7$-$N_{120}P_{60}K_0Zn_{25}S_{20}$,$T_8$-$N_{120}P_{60}K_{60}Zn_{12.5}S_{20}$, T_9-$N_{120}P_{60}K_{60}Zn_0S_{20}$,$T_{10}$-$N_{120}P_{60}K_{60}Zn_{25}S_{10}$ and T_{11}-$N_{120}P_{60}K_{60}Zn_{25}S_0$ with compared to control plot. Whereas in 2016 *boro* season the data revealed that the yield has been significantly less at 50% level of recommended dose.There is a considerably reduction in grain yield when 50% and 0% of NPKZnS was supplied. Treatment with 50% NPKZnS through chemical fertilizer has given the second highest grain yield of rice in both the years. Application of 100% recommended level of NPKZnS has given higher grain yield and at par with T2- $N_{60}P_{60}K_{60}Zn_{25}S_{20}$, T4- $N_{120}P_{30}K_{60}Zn_{25}S_{20}$,T5- $N_{120}P_0K_{60}Zn_{25}S_{20}$,T6- $N_{120}P_{60}K_{30}Zn_{25}S_{20}$,T7-$N_{120}P_{60}K_0Zn_{25}S_{20}$,T8-$N_{120}P_{60}K_{60}Zn_{12.5}S_{20}$,T9- $N_{120}P_{60}K_{60}Zn_0S_{20}$,T10- $N_{120}P_{60}K_{60}Zn_{25}S_{10}$,T11-$N_{120}P_{60}K_{60}Zn_{25}S_0$ than 50 and 0% NPKZnS through inorganic sources to hybrid rice crop. There is a considerably reduction in grain yield when 50 and 0% of the nutrient was supplied though inorganic source compared to control. This higher yield may be attributed to release plant nutrients which might have better crop growth. The overall improvement in growth and yield attributes due to synergistic effects of combined use of higher availability of macro- and micro-nutrients with the addition are reflected on the increased grain yield (Maragatham et al., 2010).

Straw yield (t ha^{-1})

The straw yield (t ha^{-1}) was statistically analysed and was presented in the Table 2. Treatment comprising 100% recommended dose of NPKZnS has broughtabout significant improvement in straw yield of rice over treatments omission of 50 and 0% of NPKZnS of recommended dose. 100 % of recommended dose of nutrient has proved appreciably andsignificantly superior to all other the treatments. Application of 100 % recommended dose ofNPKZnS has recorded themaximum straw yield of rice-rice cropping system in both the years at par with T_2,T_4,T_5, T_6,, T_7, T_8, T_9, T_{10} and T_{11}.

Application of 100 and 50% recommended dose of NPKZnS through inorganic recorded higher yield of straw over 0% NPKZnS and Control. The lowest straw yield has been recorded in the control plot. Higher biological yield might be owing to better growth and metabolism of carbohydrates which readily translocated the reproductive parts which conjunctive use of inorganics fertilizers. Inorganics have a favourable effect on the enzymes and biological activities. Similar observations was recorded and made by Yadav et al. (2008).

Harvest index

In *boro* seasn of 2015-16, harvest index recorded in each plot was analyzed statistically and presented in the Table 2. The harvest index did not vary significantly among the different nutrient management practices in hybrid rice. As the grain and straw yields responded similarly to the nutrient management practices, the harvest index did not vary much. However, the crop receiving 100% RDF through chemical fertilizers recorded relatively higher harvest index than that of the other treatments. It was further noticed that the crop having 50% and 0 % RDF only through chemical fertilizers, tended to reduce the harvest index due to higher vegetative growth. The harvest index increase with ample application of fertilizers probably due to higher availability of NPKZnS is an effect of heavy vegetative growth on light relationship within canopy (Pandey and Tripathi,1994).

Table 2.Effect of nutrient management on Yield of *boro* rice at maturity

Treatment	Grain yield (t ha^{-1})		Straw yield (t ha^{-1})		Harvest index (%)	
	2015	**2016**	**2015**	**2016**	**2015**	**2016**
T_1-$N_{120}P_{60}K_{60}Zn_{25}S_{20}$	6.59	6.61	8.45	8.58	43.8	43.5
T_2-$N_{60}P_{60}K_{60}Zn_{25}S_{20}$	5.81	5.96	7.92	8.20	42.3	42.1
T_3-$N_0P_{60}K_{60}Zn_{25}S_{20}$	3.50	3.37	5.99	5.93	36.9	36.3
T_4-$N_{120}P_{30}K_{60}Zn_{25}S_{20}$	6.17	6.20	8.32	8.45	42.6	42.3
T_5-$N_{120}P_0K_{60}Zn_{25}S_{20}$	6.01	6.11	7.85	7.96	43.4	43.4
T_6-$N_{120}P_{60}K_{30}Zn_{25}S_{20}$	6.21	6.23	8.40	8.50	42.5	42.3
T_7-$N_{120}P_{60}K_0Zn_{25}S_{20}$	6.06	6.18	8.32	8.28	42.1	42.7
T_8-$N_{120}P_{60}K_{60}Zn_{12.5}S_{20}$	6.25	6.36	8.40	8.51	42.7	42.8
T_9-$N_{120}P_{60}K_{60}Zn_0S_{20}$	6.21	6.24	8.45	8.50	42.4	42.3
T_{10}-$N_{120}P_{60}K_{60}Zn_{25}S_{10}$	6.24	6.27	8.50	8.51	42.3	42.4
T_{11}-$N_{120}P_{60}K_{60}Zn_{25}S_0$	6.10	6.12	8.36	8.24	42.2	42.6
T_{12}-Control	2.11	2.00	4.77	4.79	30.7	29.5
SEm(±)	0.25	0.24	0.33	0.39	1.86	1.98
CD (p=0.05)	0.73	0.69	0.98	1.14	NS	NS
CV(%)	7.68	7.23	7.39	8.51	5.45	5.80

DISCUSSION

Application of N (120 kg ha^{-1}) as urea in equal splits during transplanting, tillering, panicle initiation and 50 per cent flowering resulted in the highest number of panicles, number of filled grains panicle^{-1}, 1000 grain weight, grain yield, straw yield and harvest index Mandal and Swamy (2003). The higher value of yield parameter was attributed to the adequate supply of nutrients and higher uptake with recovery of nutrients from higher levels of nutrient application. The improvement in growth and yield attributes on addition of fertilizers was responsible for increase in grain yield. In turn mineralized and released nutrients to the succeeding rice crop and thereby producing higher grain and straw yield. Sudha (1990) and Yadav et al. (2008) reported that maximum rice grain yield was obtained (7152 kg ha^{-1}) with 120 kg N, 60 kg P_2O_5, 60 kg K_2O ha^{-1}.

CONCLUSION

In *boro* rice of 2015-16 the application of 100% recommended dose of nitrogen, phosphorous, potash, zinc and sulphur from chemical fertilizers gave better result compared to other treatments. It was interesting to observe that in the 50 % treatments at par with amount of 100% RDF were applied

through chemical fertilizer produced significantly better yield and yield attributes than control practice.

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