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EFFECT OF DIFFERENT NUTRIENT LEVELS ON GROWTH, YIELD ATTRIBUTES AND UPTAKE OF HYBRID AND INBRED RICE VARIETIES

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ABSTRACT:

A field experiment was conducted at the Central Research Station, Orissa University of Agriculture and Technology, Bhubaneswar during season of 2013-14. Testing variables consisted of four varieties (Hybrids DRRH 2, BIO 795, BIO 799 and HYV Pratiskhya), and two sources of fertilizer of NPK through inorganic source and organic source was FYM. Two micronutrients Zn, S and B through $ZnSO_4$ and Borax were tested in different combinations either on soil or as foliar application both 25 kg/ha and 10 kg /ha. Plants of rice hybrid DRRH 2 grew rapidly at all the stages of growth and obtained maximum grain and straw yield than the ruling cultivar Pratiskhya and other hybrids BIO 795 and BIO 799. Combined application of FYM, NPK, $ZnSO_4$ and Borax accumulated more dry matter, obtained more number of panicle/m^2, longer panicles, higher thousand grain weight, maximum grain yield, straw yield and also the highest uptake of N, P, K as well as S, Zn and B over other nutrient management practices. Hybrid rice DRRH 2 had the highest uptake of N, P, K and S, Zn, B both in the grain and straw and also the total uptake followed by BIO 795, BIO 799 and HYV Pratiskhya.

KEY WORD: *Hybrid Rice, Growth Attributes, Harvest Index, N, P, K, Zn, S, B Uptake, Yield.*

INTRODUCTION:

Rice is the most important cereal food crop of the world providing major source of the food energy for more than half of the human population. Rice is grown in 114 countries across the world on an area about 150 million hectares (nearly 11 percent of the world's cultivated land) with an annual production of over 525 million tonnes (Rai, 2006). In recent year's use of fertilizers coupled with intensive cropping have accelerated the exhaustion of micronutrient reserves of soils. Yet by 2025, a 40 percent increase in global demand for rice is anticipated in response to increasing population. It is expected that Indian population will be 1.28 billion by 2020 and rice requirement is estimated to be 140 million tonnes by then. Thus, to maintain the present level of self-sufficiency as well as to meet the growing demand of rice, an increase of 55 million tonnes of rice has to be achieved within 2020 AD. So it is required to increase rice production by at least 2 million tonnes per year. As there is no scope for horizontal expansion, rice production and productivity per unit area have to be increased to meet the future demand.

Modern HYVs of rice producing around 5 tonnes of rice and an equal amount of straw per hectare, remove about 110 kg N, 15 kg P, 130 kg K, 200 gm Zn, 150 gm B, 5 kg S from the soil. Under Bhubaneswar soil and climatic condition, rice hybrids producing an average yield of 6.0 tonnes/ha removes about 183.5 kg N, 46.3 kg P, 247.4 kg K, 17.5 kg S, 408.7 gm Zn and 243.8 gm of B/ha (Mohapatra, 2004). Thus, there exists the problem of multiple nutrient deficiencies in our soils during this post green revolution period which is largely attributed to accelerated removal of nutrients through bigger crop harvests and the widening gap between nutrient removals and additions (Annual Report, DRR, Hyderabad, 1995 and 1996). Crop yield potential can never be realized even if a single nutrient deficiency or imbalance remains uncorrected as it pulls down the efficacy of all other nutrients. Application of recommended doses of major nutrients with farmyard manure is crucial to obtain the desired yield in hybrid rice varieties. But due to injudicious and imbalanced fertilizer application with little or no organic manure and use of high analysis fertilizers containing no micronutrients in intensively practiced rice-rice cropping systems, deficiencies or hidden hunger of secondary nutrients especially sulphur and micronutrients mostly zinc and boron have been observed. In India, among micro-nutrients, Zn deficiency is the most widespread under the area of high yielding crop varieties particularly in low land rice (Singh *et al.,* 2010). Therefore, it was worthwhile to study the effect of N, P, K as well as Zn, B, S, and FYM on growth and yield.

MATERIALS AND METHOD:

The experiment was conducted on a well-drained site in the Central Research Station of the Orissa University of Agriculture and Technology during the *kharif* seasons of 2013-14. The soil was sandy loam in texture having fairly good drainage with pH 5.62, low in total nitrogen 0.048 (%), medium in available P (22.50 kg/ha) and K (210.35 kg/ha) while Zn (0.541 mg/kg) S (13.50 kg/ha) and B (0.141 mg/kg). The experiment was conducted in a split plot design with three replication. The treatments consisting of 4 main plot treatments, with combination of four varieties (DRRH 2, BIO 795, BIO 799 and Pratiskhya) were randomly allocated to the main plots and four nutrient combinations (F_1=FYM 5 tonne/ha+ N: P: K@ 120: 60: 60 kg/ha, F_2= F_1+ $ZnSO_4$ @ 25 kg/ha, F_3=F_2+ Borax @ 10 kg/ha and F_4 was farmers practice N: P: K @ 100: 50: 50 kg/ha) to the sub-plots. FYM, P and K applied in soil as basal. Half of N and Zn were applied through basal and half of N and Zn applied through foliar. B was also applied through foliar. Zn as soil and foliar application thorough $ZnSO_4$ and B as soil and foliar application through Borax. NPK were applied in soil and foliar as urea, SSP and MOP respectively.

The duration of DRRH 2, BIO 795 and BIO 799 and Pratiskhya were 115-120 days, 130-140 days, 130-135 days and 135-140 days, respectively which was planted at a spacing of 20 × 15 cm with two-three seedling $hill^{-1}$. Observations on various growth parameters (plant height, number of leaves $hill^{-1}$, leaf area index, dry matter accumulation and number of tillers m^{-2}). Estimations of total N were done by the methods given by Modified Kjeldhal method (Jackson, 1967), P and K (Jackson, 1973), available Zinc estimated (Lindsay and Norvel, 1978), available Boron estimated by Spectro photometer method (Page, 1982), Sulphur estimated by (Massoumi and Cornfield, 1963).

RESULT AND DISCUSSION:

Plant growth is generally expressed in the terms of plant height, tiller number, leaf area index, dry matter accumulation as well as various growth analysis components like leaf area index and crop growth rate recorded during growth stages of the crop. Most of the growth parameters are influenced significantly by the genotypes and nutrients management practices in most of the growth phases. Data revealed that variety DRRH 2 produced significantly higher plant height, number of leaves $hill^{-1}$, leaf area index, number of tillers and crop growth rate over BIO 795 and BIO 799 and Pratiskhya, whereas dry matter accumulation $hill^{-1}$ remained statistically at par in their effectiveness at 80 DAT during crop season (Table 1).

Rice hybrid DRRH 2 produced 16.6 per cent and 20.0 per cent more grain compared to the hybrids BIO 795 and BIO 799, respectively. Check variety Pratiskhya could record grain yield of 3.34 tonne/ha which was 32.2 per cent less than DRRH 2 which was contributed mainly due to production of more number of panicles/m^2 (292.66) larger in size (28.00 cm) with maximum grains (90.17) which were also bolder (27.20 g per thousand grains). Singh and Subbiah (2007) also observed that PHB-71 and KRH-2 hybrids produced significantly more panicles over the variety Jaya resulting in higher grain yield.

More dry matter with the treatment FYM 5 t/ha +NPK 120:60:60 kg/ha+ $ZnSO_4$ 25 kg/ha + Borax 10 kg/ha over other nutrient management practices is attributed to increased plant height, more number of tillers per $hill^{-1}$, higher LAI (leaf area index) and crop growth rate. Most of the workers have reported beneficial effect of S, Zn and B along with recommended N, P, and K for better manifestation of growth characters. (Dixit and Patro (1994), Akhter *et al*. (1994). Rattan *et al*. (1995) is an S and Zn deficient soils of western Uttar Pradesh reported synergistic interaction between S and N, S and P, S and Zn which resulted in dry matter production of rice. Combined application of FYM 5 tonne/ha +NPK 120:60:60 kg/ha+ $ZnSO_4$ 25 kg/ha + Borax 10 kg/ha recorded more number of panicle/m^2 (287.25), grains/panicle (91.00), longer panicles (26.50 cm) with bolder grains (26.86 g per thousand grain) (Table 2).

The yield attributes recorded in treatments FYM 5 tonne/ha +NPK 120:60:60 kg/ha+ $ZnSO_4$ 25 kg/ha or FYM 5 t/ha +NPK 120:60:60 kg/ha or application of NPK 120:60:60 kg/ha alone also differed among themselves significantly. The results were in conformity with the findings of Srivastava *et al*, (2006), Mishra *et al*, (2007) and Varshney *et al,* (2008). Such type of response to S and Zn application as $ZnSO_4$ is expected as the available S and Zn status of the soil was below the critical level. But yield increase due to B application in soils deficient in available B was significant but the increase was not commensurate with the dose of application which may be described to low boron levels applied to the hybrid rice crop. These findings suggest that hybrids require more boron for fullest expression of yield potential. The results were in agreement with the findings of Singh (2009) who obtained smaller yield increase with application of Boron and correlated the yield with available soil boron content.

Hybrid DRRH 2 produced significantly more straw 5.66 tonne/ha followed by 5.04, 4.94 and 4.12 tonne/ha in BIO 795, BIO 799 and Pratiskhya, respectively mainly due to production of taller plants, better tillering ability and more dry matter accumulation capacity. The results are in accordance with the findings of Rao and Moorthy (2002), Zaidi and Tripathi, (2007) and Singh and Bharadwaj, (2007) and opined that hybrids had higher straw yield than the HYVs because of profuse tillering and more dry matter production. The highest straw yield of 5.53

tonne/ha was recorded due to combined application of FYM 5 t/ha +NPK 120:60:60 kg/ha+ ZnSO4 25 kg/ha + Borax 10 kg/ha which was closely followed by FYM 5 t/ha +NPK 120:60:60 kg/ha+ $ZnSO_4$ 25 kg/ha 5.06 tonne/ha and FYM 5 t/ha +NPK 120:60:60 kg/ha (4.78 tonne/ha). NPK 100:50:50 kg/ha could record only 4.37 tonne/ha. Hybrid rice DRRH 2 that produced the highest grain yield had the highest uptake of S, Zn and B both in the grain and straw and also the total uptake followed by BIO 795 and BIO 799. HYV Pratiskhya recorded lower uptake values of S, Zn and B than all the hybrids tested (Table 4). Similar was the trend with regard to uptake of N, P and K also (Table 3).

These results are in agreement with the findings of Kavitha *et al*., (2008), Vandana and Kewat (2009). Findings of All India Coordinated Research Project on Micronutrients suggest higher uptake of N, P, K and micro nutrients in hybrids over HYVs irrespective of seasons of cultivation and nutrient management practices.

The uptake in the grain, straw and total uptake of S, Zn and B were positively influenced by different nutrient management practices. The highest uptake of S, Zn and B was found in the treatment FYM 5 t/ha + NPK 120:60:60 kg/ha + $ZnSO_4$ 25 kg/ha + Borax 10 kg/ha. Islam *et al*., (1997) and Mohapatra, (2004) reported about synergistic effect of these nutrients on their uptake and correlated higher uptake with grain and straw yield. Single application of S, Zn or B had lower uptake of N, P and K as compared to their combined application. This was due to synergistic effect of S, Zn and B on uptake of these nutrients (Saradeep Kour *et al*. 2005). Muralidharan and Jose, (1995); Zaidi and Tripathi, (2007) and Mahendra Singh Pal *et al*. (2008) reported synergistic effect of S, Zn and B on uptake of N and K only.

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Table 1: Effect of Rice hybrids and nutrient management practices on growth attributes of hybrid rice at 80 DAT

Treatments	Growth attributes					
	Plant height (cm)	No of leaves clump^{-1}	LAI	No of tillers hill^{-1}	CGR	DMA (g/hill)
	80 DAT	80 DAT	80 DAT	80 DAT	80 DAT	80 DAT
Variety						
DRRH 2	102.83	49.50	5.13	18.25	6.90	22.56
BIO-795	100.75	49.08	5.10	17.66	6.38	20.73
BIO-799	99.92	48.83	5.02	17.33	6.04	19.87
Pratikshya	96.17	47.33	4.90	16.91	5.38	17.52
CD (P=0.05)	1.69	1.36	0.16	0.63	0.33	0.48
Nutrient management practices						
FYM @5t/ha+ 120: 60: 60 N: P_2O_5: K_2O kg/ha.	99.67	48.33	5.04	17.33	5.93	19.87
FYM @5t/ha+ 120: 60: 60:20: N: P_2O_5: K_2O: $ZnSO_4$ kg/ha.	101.17	49.42	5.09	18.25	6.28	20.58
FYM @5t/ha+ 120: 60: 60: 20: 10 N: P_2O_5: K_2O: $ZnSO_4$: Borax kg/ha.	102.50	50.50	5.16	18.75	7.08	21.56
100: 50: 50 N: P_2O_5: K_2O kg/ha.	96.33	46.50	4.86	15.83	5.41	18.66
CD (P=0.05)	1.02	1.33	0.12	0.89	0.32	0.53

*** LAI-Leaf area index, CGR- Crop growth rate, DMA-Dry matter accumulation.**

Table 2: Effect of Rice hybrids and nutrient management practices on yield attributes and yields of rice

Treatments	Yield attributes					
	Panicle No m^2	Test Weight	Panicle Weight (g/panicle)	Grain yield (t/ha)	Straw Yield (t/ha)	Harvest Index (%)
Variety						
DRRH 2	292.66	27.20	3.23	4.93	5.66	46.43
BIO-795	280.33	26.65	3.12	4.23	5.04	45.60
BIO-799	278.92	26.34	3.08	4.11	4.94	45.38
Pratikshya	271.00	25.38	2.84	3.34	4.12	44.73
CD (P=0.05)	7.03	0.83	0.11	0.35	0.26	1.15
Nutrient management practices						
FYM @5t/ha+ 120: 60: 60 N: P_2O_5: K_2O kg/ha.	279.25	26.21	3.03	3.99	4.78	45.41
FYM @5t/ha+ 120: 60: 60:20: N: P_2O_5: K_2O: $ZnSO_4$ kg/ha.	283.00	26.50	3.13	4.26	5.06	45.65
FYM @5t/ha+ 120: 60: 60: 20: 10 N: P_2O_5: K_2O: $ZnSO_4$: Borax kg/ha.	287.25	26.86	3.28	4.77	5.53	46.20

Treatments	Yield attributes					
	Panicle No m^2	Test Weight	Panicle Weight (g/panicle)	Grain yield (t/ha)	Straw Yield (t/ha)	Harvest Index (%)
100: 50: 50 N: P_2O_5: K_2O kg/ha.	273.42	25.98	2.83	3.57	4.37	44.88
CD (P=0.05)	3.57	1.23	0.14	0.23	0.18	0.89

Table 3: Uptake of N, P and K in hybrid rice as influenced by nutrient management practices

Genotype	Nitrogen (kg/ha)			Phosphorus (kg/ha)			Potassium (kg/ha)		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Variety									
DRRH 2	115.85	69.82	185.67	27.63	17.70	45.33	48.76	205.91	254.67
BIO-795	99.32	61.26	160.58	22.00	14.00	36.00	47.33	198.67	246.00
BIO-799	110.54	67.72	178.26	24.60	16.15	40.45	44.23	188.33	232.56
Pratikshya	92.67	64.13	156.80	21.21	13.55	34.76	44.35	196.98	241.33
Nutrient management practices									
FYM @5t/ha+ 120: 60: 60 N: P_2O_5: K_2O kg/ha.	97.33	63.11	160.44	20.56	14.30	34.86	46.33	196.78	243.11
FYM @5t/ha+120: 60: 60:20: N: P_2O_5: K_2O: $ZnSO_4$ kg/ha.	105.21	68.57	173.78	27.33	15.61	42.94	47.00	200.27	247.27
FYM @5t/ha+ 120: 60: 60: 20: 10 N: P_2O_5: K_2O: $ZnSO_4$: Borax kg/ha.	118.57	82.66	201.23	28.22	18.64	46.86	49.67	204.17	253.84
100: 50: 50 N: P_2O_5: K_2O kg/ha.	87.48	58.40	145.88	18.67	12.21	30.88	43.89	186.45	230.34

Table 4: Uptake of S, Zn and B in hybrids rice as influenced by nutrient management practices

Genotype	Sulphur (kg/ha)			Zinc (gm/ha)			Boron(gm/ha)		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Variety									
DRRH 2	8.46	10.28	18.74	224.54	240.79	465.33	96.32	179.45	275.77
BIO-795	7.58	8.24	15.82	188.36	204.32	392.67	79.24	150.71	229.95
BIO-799	8.22	8.44	16.66	206.55	215.40	421.95	86.25	165.90	252.15
Pratikshya	6.88	8.42	15.30	184.56	193.99	378.55	81.23	157.21	238.44
Nutrient management practices									
FYM @5t/ha+ 120: 60: 60 N: P_2O_5: K_2O kg/ha	7.94	8.39	16.33	182.00	191.56	373.56	83.00	161.00	244.00
FYM @5t/ha+ 120: 60: 60:20: N: P_2O_5: K_2O: $ZnSO_4$ kg/ha.	8.35	9.03	17.38	229.82	214.46	444.28	88.21	169.89	258.10
FYM @5t/ha+ 120: 60: 60: 20: 10 N: P_2O_5: K_2O: $ZnSO_4$: Borax kg/ha.	8.83	9.87	18.70	246.78	224.44	471.22	92.28	176.90	269.18
100: 50: 50 N: P_2O_5: K_2O kg/ha.	6.75	7.36	14.11	175.25	194.19	369.44	77.12	147.58	224.70