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Response of Rice Genotypes to Levels of Seed Rates and Micronutrients under Drill Sown Condition during Summer in Tunga Bhadra Project Irrigation Command During Summer Season

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ABSTRACT

The field experiment conducted to assess the performance of rice genotypes (GGV 0501, RNR 15048 and BPT 5204) to levels of seed rates (25, 30 and 35 kg ha^{-1}) and micronutrients (control, $FeSO_4$ (Soil @ 25 kg ha^{-1}+ foliar @ 0.5% twice at 15 and 30 DAS, $ZnSO_4$ (Soil @ 25 kg ha^{-1}+ foliar @ 0.5% twice at 15 and 30 DAS, $FeSO_4$ + $ZnSO_4$ (each to soil @ 25 kg ha^{-1} + foliar @ 0.5% at 15 and 30 DAS) under drill sown conditions in Tunga Bhadra project irrigation command during summer revealed significantly higher dry matter accumulation in leaves, stem and panicle (17.9, 39.2 and 50.1 g plant^{-1}, respectively) in cv. GGV 0501 with medium seed rate of 30 kg ha^{-1} and application of $FeSO_4$ and $ZnSO_4$ both to soil and to the foliage. Similar was the trend in yield components (panicles m^{-2} – 411.5, grains panicles^{-1}- 156.9, and test weight – 27.6g). Consequently grain (6277 kg ha^{-1}) and straw (8241 kg ha^{-1}) yields were higher with the treatment closely followed by same cultivar and seed rate but supplied with $ZnSO_4$ only, while the lowest grain yield (3513 kg ha^{-1}) was recorded with cv. RNR 15048 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient.

Key words: *Genotypes, Seed rates, Micronutrients, Direct seeded rice, Dry matter, Yield*

INTRODUCTION

Rice is the most important and widely cultivated staple crop in the world, Asia is the home of rice and more than two billion people are getting 60-70 per cent of their energy requirement from rice and its derived products (Rekha *et al*., 2015). Rice cultivation differs in different ecosystems depending upon resource availability particularly water; though transplanting which is being done after puddling the field is a common practice in most of irrigated areas in the world. Due to resource constraints, especially water and labourers, direct seeding of rice under dry (drill sown rice-DSR) condition is now the emerging trend in rice cultivation. However, production often is handicapped by lack of availability of suitable production technologies. Evolving new cultivars and their testing for adoptability and productivity in different agro-ecological regions is fundamental for good harvests.

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Besides, a cultivar cannot produce to its potential unless it is established in optimum stand density and provided with enough nutrition particularly the micronutrients which are critical in DSR as the aerobic condition prevailing initially make crop suffer from deficiencies of Fe and Zn which limit production under DSR. These nutrients especially in rice play critical role in plant processes such as respiration, protein synthesis, reproduction phase and thereby affect grain yield. Therefore, to realize the maximum production potential, it is essential to develop suitable package of agronomic practices for successful cultivation DSR. Tunga Bhadra project (TBP) irrigation command is one important rice growing region in Karnataka with highest rice acreage both during rainy season and summer and water scarcity because of volatile monsoon and in the tail end region with farmers obsessed with rice forcing them to switch over to DSR. This welcome change warrants agricultural technologists to work on crop agronomy. With this background field experiment was carried out to identify suitable cultivars, optimum seed rate and need, time and method of micronutrient application for DSR rice during summer in the TBP irrigation command.

MATERIAL AND METHODS

The experiment was conducted during the summer 2016 at Agriculture Research Station, Dhadesugur, UAS, Raichur, Bellary, Karnataka representing Northern dry zone of the state, receiving water from Tunga Bhadra river for irrigation. Geographically it is located at 15° 6' North lattitude, longitude of 76° 8' East and at an elevation of 358 meters above mean sea level. The soil was neutral in reaction (7.21), relatively high in soluble salts (1.07 dS m^{-1}), medium in organic carbon (0.62%), available nitrogen (285.1 kg ha^{-1}) and P_2O_5 (23.4 kg ha^{-1}) and high in K_2O (440.9 kg ha^{-1}), while it was medium in exchangeable calcium (1124 mg kg^{-1}) and high in magnesium content (216.0 mg kg^{-1}). The DTPA extractable micronutrient content revealed deficiency of zinc (0.49 mg kg^{-1}) and iron (4.41 mg kg^{-1}). The experiment was laid out in a Split split plot design keeping cultivars in main plots (V_1- Gangavathi sona (GGV 05 01),V_2- RNR 15048 and V_3- BPT 5204), seed rates in sub plots (S_1- 25 kg ha^{-1},S_2- 30 kg $ha^{-1}$and S_3- 35 kg ha^{-1}), and levels of micro nutrients in sub-sub plot (M_1- Control (no micronutrients), M_2- $FeSO_4$ (Soil application @ 25 kg ha^{-1}+ foliar application @ 0.5% twice at 15 and 30 DAS), M_3- $ZnSO_4$ (Soil application @ 25 kg ha^{-1} + foliar application @ 0.5% twice at 15 and 30 DAS) and M_4- M_2 + M_3). Normal crop husbandry practices such as row distance, NPK fertilization, irrigation and prophylactic measures were adopted for raising the crop. The data on growth and yield components and yield were obtained following scientific procedures and subjected to statistical analysis at five percent level of significance and interpreted[4].

RESULTS AND DISCUSSION

Dry matter accumulation: Significantly higher dry matter accumulation (DMA) in leaves, stem and panicles per plant were obtained with the cv. GGV 0501 (13.6, 34.0 and 41.4 g plant $^{-1}$, respectively) across other factors. Similarly, medium seed rate at 30 kg ha^{-1} recorded significantly higher dry matter accumulation in leaves, stem and panicles (13.2, 32.3 and 35.2 g $plant^{-1}$, respectively) over lower or higher seed rates (Table 1). Earlier,[11] working with hybrids reported the maximum dry matter accumulation with hybrid cultivar DRRH 3 and PAC 837, but with higher seed rate of 35 kg ha^{-1} which with further rise in seed rate of 45 kg ha^{-1} declined. This is acceptable because these are coarse cultivars while in the present investigation fine to medium fine rice cultivars were used.

Further, combined application of $ZnSO_4$ and $FeSO_4$ to the soil and to the foliage recorded significantly higher dry matter accumulation in leaves, stem and panicle (14.6, 36.6 and 37.4 g $plant^{-1}$) (Table 1). In the present investigation soil being deficient in Fe and Zn and DSR being sensitive to these nutrients beneficial effects were on the expected line. Besides, their involvement in plant physiological process and their specific role particularly of Zn in enhancing the transfer of photosynthates from shoot to grain[9] probably helped in greater accumulation of DM in these plant parts.

Overall, the three way interactions also revealed significant differences in dry matter accumulation (Table 1). Significantly higher DMA in leaves, stem and panicles was recorded with cv. GGV 0501 at medium seed rate of 30 kg ha^{-1} and with application of both $ZnSO_4$ and $FeSO_4$ to the soil and to the foliage closely followed by application of zinc sulphate (Table 1). That means, both nutrients being deficient in the rhizosphere need supplementation to soil as well as to the foliage to ensure their adequate availability, and of the two micronutrients zinc appears more critical as regards to individual role in augmenting growth process to achieve crop potential. Importance of Zn and Fe lies in the fact that these are involved in the synthesis of growth promoting hormones and the reproduction process of many plants which are vital in grain formation[7].

Yield components: Significantly higher panicles m^{-2}, number of grains $panicle^{-1}$ and test weight (328.2, 118.5 and 24.4 g, respectively) were recorded with cv. GGV 0501 (V_1) (Table 2). Among seed rates, seed rate of 30 kg ha^{-1} (S_2) recorded significantly higher panicles m^{-2}, number of grains $panicle^{-1}$ and test weight (307.5, 108.4 and 22.2 g, respectively). Gill *et al.* (2006) also reported maximum grains $panicle^{-1}$ with low seed rate of 25 kg ha^{-1} irrespective of the methods of sowing compared to higher seed rate of 50 and 75 kg ha^{-1}. That is higher the seed rate lower will be the grain load per panicle. Similarly, combined application $FeSO_4$ + $ZnSO_4$ to soil and to the foliage resulted in higher panicles m^{-2}, number of grains $panicle^{-1}$ and test weight (337.6, 125.6 and 22.4 g, respectively). The results are in line with those of Cheema *et al.*[1] who observed more paddy grain due more number of spikelet and lesser spikelet sterility with application of 10 kg $ZnSO_4$ ha^{-1} produced.

Further, the three way interaction revealed significantly higher panicles m^{-2}, number of grains $panicle^{-1}$ and test weight (411.5, 156.9 and 27.6g, respectively) with cv. GGV 0501 sown using 30 kg seed rate and applied with both $FeSO_4$ and $ZnSO_4$ ($V_1S_2M_4$) . These responses confirm the findings of Gill and Walia[2] who reported significant improvement in growth and yield attributes with foliar sprays of micronutrients.

Yield: Cv. GGV 0501 recorded higher grain yield (5524 kg ha^{-1}) than cvs. RNR 15048 (4429 kg ha^{-1}) and BPT 5204 (4270 kg ha^{-1}) and the improvements in yield with cv. GGV 0501 over cvs. RNR 15048 and BPT 5204 were to the tune of 24.7 and 29.4 per cent, respectively (Table 3). Again, similar was the trend in straw yield (6409, 6269 and 5767 kg ha^{-1} with GGV 0501, RNR 15048 and BPT 5204, respectively). A medium seed rate of 30 kg ha^{-1} across cultivars and levels of micronutrients fared better with higher grain (4984 kg ha^{-1}) and straw yields (6301 kg ha^{-1}) (Table 2). Similarly in China, Wu *et al.*[10] found a seed rate of 20-25 kg ha^{-1}as optimum for DSR under zero till condition (ZT-dry-DSR). In the Indo-Gangetic plain, also a seed rate of 20-25 kg ha^{-1} was found optimum for medium fine grain rice cultivars[5]. Combined application of $FeSO_4$ and $ZnSO_4$ both basally to the soil and subsequently to the foliage recorded high grain and straw yields (5185 and 7164 kg ha^{-1}, respectively, Table 3). The results corroborate well with Jadhav *et al*.[6] who also obtained significantly higher yields with combined application of $FeSO_4$ and $ZnSO_4$ at 10 kg ha^{-1} each. This improvement in yield could be traced back improvement in growth and yield components with the treatments discussed previously (Table 1 and2) where similar trend prevailed among the different factors and their levels.

Interactions due to variety and seed rate were significant and among them cv. GGV 0501 sown using 30 kg ha^{-1}seed rate (V_1S_2) recorded higher grain and straw yields (5912 and 7351 kg ha^{-1}, respectively), while lower grain and straw yields among all was recorded with cv. BPT 5204 irrespective of seed rates used (Table 3). Yadav *et al.*[11] obtained higher yield of hybrid cultivars DRRH-3 and PAC 837 with higher seed rate of 35 kg ha^{-1} under aerobic cultivation, and cultivars being coarse with bold grains higher seed rate could be expected unlike the cultivars used in present study. Variety X micronutrient also revealed significant variations, in that cv. GGV 0501 with combined application of $FeSO_4$ and $ZnSO_4$ (V_1M_4) recorded higher grain and straw yields (6029 and 7373 kg ha^{-1}, respectively) and in the absence of micronutrient application yield decreased irrespective of cultivars used and recorded lower grain yield with cv. RNR 15048 (V_2M_1- 3779 kg ha^{-1}) and straw yield with cv. BPT 5204 (V_3M_1- 4614 kg ha^{-1}). Similarly, interactions due to micronutrients and seed rates were significant wherein 30 kg seed rate with the application of $FeSO_4$ + $ZnSO_4$ (S_2M_4) recorded higher grain and straw yields (5419 and 7631 kg ha^{-1}, respectively) while 25 and 35 kg ha^{-1} seed rate without supplementation of micronutrient ($S_{1\&3}M_1$) recorded lower grain and straw yields.

The three factor combination revealed significantly higher grain and straw yields (6277 and 8241 kg ha^{-1}, respectively) with cv. GGV 0501 sown using 30 kg seed rate and supplied with both $FeSO_4$ and $ZnSO_4$ ($V_1S_2M_4$), closely followed by same cultivar and seed rate but supplied with $ZnSO_4$ ($V_1S_2M_3$), while the lowest grain yield (3513 kg ha^{-1}) was recorded with cv. RNR 15048 sown using 25 kg ha^{-1} seed rate and supplied with no micronutrient ($V_2S_1M_1$), and BPT 5204 sown using 25 kg ha^{-1} without any micronutrient supply ($V_3S_1M_1$) recorded significantly lower straw yield (4131 kg ha^{-1}) among all (Table 3). Similarly, in a study carried out at Ludhiana using Bhasmati cultivar, Gill and Walia[2] obtained higher yield with foliar nutrition of $FeSO_4$ in combination with $MnSO_4$, unlike ZnSO4 as found in the present study probably for the reason that for that soil and cultivar, a scented rice, Mn is critical along with $FeSO_4$.

Harvest index (HI) varied significantly due to cultivars, micronutrients and their interaction except seed rates. Among all cv. GGV 0501 (V_1) recorded significantly higher HI (0.46), while the other two cultivars were at par (V_2- 0.41 and V_3- 0.42). Similarly, use of micronutrients produced significant variations individually and no application of micronutrient (M_1) recorded significantly higher HI (0.45) and was on par with application of $FeSO_4$ to soil and to the foliage, while significantly lower (0.41) HI was recorded in combined application of FeSO4 + $ZnSO_4$. Interactions due to variety and seed rate were significant. GGV 0501 at 25 kg ha^{-1} seed rate (V_1S_1) recorded higher HI (0.48), while lower (0.39) HI was recorded with cv. RNR 15048 with seed rate of 35 kg ha^{-1} (V_2S_1). Variety X micronutrient also revealed significant variations, in that cv. GGV 0501 with all levels of micronutrients and cv. BPT 5204 without application of micronutrient recorded higher HI (0.47). Combined application $FeSO_4$ + $ZnSO_4$ to soil and to the foliage in cv. BPT 5204 (V_3M_1) recorded lower HI (0.39).

Similarly, interactions due to micronutrients and seed rates were significant wherein 30 kg seed rate without any micronutrient (S_2M_1) recorded higher HI (0.46), while S_2M_4 with 30 kg ha^{-1}seed rate and $FeSO_4$ + $ZnSO_4$ (S_2M_4) recorded lower HI (0.41). Of the three way interactions, significantly higher HI (0.50) was observed with cv. BPT 5204 sown with 35 kg seed rate without application of micronutrients ($V_3S_3M_1$), while lower harvest index (0.36) was recorded with cv. RNR 15048 sown using 35 kg ha^{-1} seed rate and supplied with $FeSO_4$ micronutrient ($V_2S_3M_2$) among all (Table 3). Moderate HI with high performing treatment cv. GGV 0501 sown using 30 kg ha^{-1} seed rate and supplied with both the micronutrient could be attributed to relative large accumulation of dry matter in vegetative parts in comparison to low performing treatment combination. In other words optimum seed rate and supply of micronutrient helped in attaining better plant architecture are evidenced in the study.

Thus, the study reveals better revenue with cv. GGV 0501 sown using 25 kg ha^{-1} seed rate and supplied with $FeSO_4$ and $ZnSO_4$ basally to soil (25 kg ha^{-1} each) and subsequently to foliage (each @ 0.5% twice at 15 and 30 DAS) during summer in TBP irrigation command.

Table 1: Effect of rice genotypes, seed rates and micronutrients on dry matter accumulation in different parts of ice plant (g $plant^{-1}$) under direct seeded condition during summer

V x S x M		Leaves				Stem				Panicles			
		V_1	**V_2**	**V_3**	**S x M**	**V_1**	**V_2**	**V_3**	**S x M**	**V_1**	**V_2**	**V_3**	**S x M**
S_1	**M_1**	8.4^{j-l}	5.7^{m}	5.8^{m}	**6.6^{g}**	26.7^{g-j}	38.8^{ab}	21.4^{k}	**29.0^{ef}**	28.1^{g-i}	20.1^{kl}	23.5^{i-k}	**23.9^{f}**
	M_2	10.0^{h-j}	9.8^{i-k}	7.7^{k-m}	**9.2^{ef}**	29.4^{f-i}	26.7^{g-j}	24.1^{h-j}	**23.4^{e}**	35.7^{d-g}	22.6^{j-l}	22.3^{j-l}	**29.1^{e}**
	M_3	13.9^{c-f}	11.8^{f-i}	10.7^{g-i}	**12.1^{c}**	31.5^{c-g}	31.5^{c-g}	26.5^{g-j}	**29.8^{d}**	45.8^{a-c}	27.3^{h-k}	29.7^{f-j}	**34.3^{b-d}**
	M_4	14.3^{c-e}	12.7^{d-g}	10.8^{g-i}	**12.6^{bc}**	36.4^{a-e}	33.3^{a-f}	32.1^{b-g}	**33.9^{bc}**	45.8^{a-c}	31.1^{e-i}	28.0^{g-j}	**34.9^{b-d}**
S_2	**M_1**	12.8^{d-g}	5.7^{m}	11.8^{f-i}	**10.1^{de}**	26.7^{g-j}	21.8^{jk}	16.7^{k}	**21.7^{f}**	37.3^{d-f}	32.2^{d-h}	15.8^{l}	**28.4^{e}**
	M_2	15.7^{bc}	10.7^{g-i}	12.3^{e-h}	**12.9^{bc}**	37.1^{a-c}	36.3^{a-e}	27.2^{f-j}	**33.5^{bc}**	44.8^{a-c}	33.8^{d-h}	22.3^{j-l}	**33.6^{ce}**
	M_3	17.1^{ab}	11.7^{f-i}	12.7^{d-g}	**13.8^{b}**	39.1^{a}	37.5^{a-c}	30.4^{e-g}	**35.7^{ab}**	49.7^{a}	34.1^{d-h}	29.7^{f-j}	**37.9^{ab}**
	M_4	17.9^{a}	15.7^{bc}	14.3^{c-e}	**16.0^{a}**	39.2^{a}	38.2^{ab}	37.1^{a-c}	**38.2^{a}**	50.1^{a}	40.0^{b-d}	32.d-h	**40.8^{a}**
S_3	**M_1**	10.1^{h-j}	7.8^{k-m}	6.5^{lm}	**8.1^{f}**	29.4^{f-i}	26.7^{g-j}	21.5^{jk}	**25.9^{e}**	35.7^{d-g}	29.7^{f-j}	28.0^{g-j}	**31.1^{de}**
	M_2	10.3^{h-j}	11.1^{g-i}	10.7^{g-i}	**10.7^{d}**	36.5^{a-d}	30.7^{d-g}	27.1^{g-j}	**31.4^{cd}**	37.6^{de}	29.7^{f-j}	28.1^{g-j}	**31.8^{de}**
	M_3	14.5^{c-e}	12.7^{d-g}	11.2^{g-i}	**12.8^{bc}**	37.7^{ab}	29.3^{f-i}	30.2^{f-h}	**32.4^{cd}**	39.0^{cd}	32.2^{d-h}	29.4^{f-j}	**33.5^{cd}**
	M_4	17.7^{ab}	14.8^{cd}	12.8^{d-g}	**15.1^{a}**	38.5^{ab}	37.7^{ab}	36.3^{a-e}	**37.5^{a}**	47.2^{ab}	32.2^{d-h}	29.7^{f-j}	**36.4^{bc}**
Variety		**13.6^{a}**	**10.9^{b}**	**10.6^{b}**		**34.0^{a}**	**31.5^{b}**	**27.6^{c}**		**41.4^{a}**	**30.4^{b}**	**26.6^{c}**	
		Variety x Seed rate			**S**	**Variety x Seed rate**			**S**	**Variety x Seed rate**			**S**
S	**S_1**	11.7^{c}	10.0^{f}	8.8^{g}	**10.2^{c}**	31.0^{bc}	30.1^{de}	26.1^{e}	**29.1^{b}**	38.7^{b}	25.3^{e}	27.7^{de}	**30.6^{c}**
	S_2	15.9^{a}	10.9^{de}	12.8^{b}	**13.2^{a}**	35.6^{a}	33.5^{ab}	27.9^{de}	**32.3^{a}**	45.5^{a}	35.0^{c}	25.0^{e}	**35.2^{a}**
	S_3	13.1^{b}	11.6^{cd}	10.3^{ef}	**11.7^{b}**	35.6^{a}	31.1^{bc}	28.8^{cd}	**31.8^{ab}**	39.9^{b}	30.9^{d}	28.8^{d}	**33.2^{b}**
		Variety x Micro			**M**	**Variety x Micro**			**M**	**Variety x Micro**			**M**
M	**M_1**	10.4^{de}	6.4^{g}	8.1^{f}	**8.3^{d}**	27.6^{ef}	29.1^{g}	19.9^{h}	**25.5^{d}**	33.7^{cd}	27.3^{ef}	22.4^{g}	**27.8^{c}**
	M_2	12.0^{c}	10.5^{de}	10.2^{e}	**10.9^{c}**	34.4^{bc}	27.9^{de}	26.2^{eg}	**29.5^{c}**	39.1^{b}	28.7^{ef}	26.7^{f}	**31.5^{b}**
	M_3	15.2^{b}	12.1^{c}	11.5^{cd}	**12.9^{b}**	36.1^{ab}	32.8^{cd}	29.1^{ef}	**32.7^{b}**	44.8^{a}	31.2^{a-e}	29.6^{d-f}	**35.2^{a}**
	M_4	16.6^{a}	14.4^{b}	12.7^{c}	**14.6^{a}**	38.1^{a}	36.4^{ab}	35.2^{a-c}	**36.6^{a}**	47.7^{a}	34.4^{c}	30.0^{d-f}	**37.4^{a}**

Comparison	Leaves S.Em±	Stem S.Em±	Panicles S.Em±
Variety (V)	0.1	0.6	0.7
Seed (S)	0.1	0.4	0.6
Micro (M)	0.2	0.7	0.8
V x S	0.2	0.8	1.0
V x M	0.4	1.2	1.3
S x M	0.4	1.2	1.3
V x S x M	0.7	2.2	2.3

Varieties (**V**) : **V_1**- GGV 0501, **V_2**- RNR15048, **V_3**- BPT 5204
Seed Rate(**S**) : **S_1**- 25 kg ha^{-1}, **S_2**- 30 kg ha^{-1}, **S_3**- 35 kg ha^{-1}
Micronutrient (**M**): **M_1**- Control, **M_2**- $FeSO_4$ (Soil @ 25 kg ha^{-1}+ foliar @ 0.5% twice at 15 and 30 DAS)
M_3- $ZnSO_4$ (Soil @ 25 kg ha^{-1}+ foliar @ 0.5% twice at 15 and 30 DAS)
M_4- $FeSO_4$ + $ZnSO_4$ (each to soil @ 25 kg ha^{-1} + foliar @ 0.5% at 15 and 30 DAS)

Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 2: Effect of genotypes, seed rates and micronutrients on panicles m^{-2}, number of grains panicle^{-1} and test weight (g) under direct seeded condition during summer

V x S x M		Panicles m^{-2}				Number of grains panicle^{-1}				Test weight (g)			
		V_1	**V_2**	**V_3**	**S x M**	**V_1**	**V_2**	**V_3**	**S x M**	**V_1**	**V_2**	**V_3**	**S x M**
S_1	**M_1**	297.9^{d-k}	202.7^{m}	223^{j-m}	241.2^{f}	95.5^{i-m}	76.0^{n-q}	53.9^{r}	**75.1^{f}**	22.1^{a-f}	17.4^{f}	18.7^{c-f}	**19.4^{ab}**
	M_2	329.2^{b-g}	217.3^{k-m}	234.7^{i-m}	260.4^{d-f}	121.3^{c-g}	87.9^{l-o}	81.7^{l-p}	**97.0^{d}**	23.0^{a-f}	17.7^{ef}	19.5^{c-f}	**20.1^{ab}**
	M_3	348.4^{a-f}	256.3^{g-m}	250^{g-m}	284.9^{c-e}	129.0^{f-e}	133.3^{bc}	68.4^{p-r}	**110.2^{c}**	23.4^{a-f}	18.5^{ef}	20.5^{c-f}	**20.8^{ab}**
	M_4	378.2^{a-d}	273.9^{f-l}	259.7^{g-m}	303.9^{b-d}	133.5^{bc}	130.9^{b-d}	76.6^{n-q}	**113.7^{bc}**	24.7^{a-e}	19.2^{c-f}	20.6^{b-f}	**21.5^{ab}**
S_2	**M_1**	259.1^{g-m}	287.5^{f-k}	264^{f-m}	270.2^{d-f}	99.0^{h-l}	85.8^{l-p}	61.6^{qr}	**82.1^{ef}**	25.6^{a-d}	19.7^{c-f}	17.7^{ef}	**21.0^{ab}**
	M_2	305.7^{c-j}	292.0^{e-k}	269.8^{f-l}	289.2^{cd}	110.5^{f-j}	109.1^{g-k}	72.4^{o-q}	**97.3^{d}**	25.7^{a-c}	20.3^{c-f}	18.6^{d-f}	**21.5^{ab}**
	M_3	321.2^{b-h}	299.7^{d-k}	280.3^{f-l}	300.4^{f-d}	128.1^{b-f}	111.7^{e-i}	92.6^{k-n}	**110.8^{bc}**	27.5^{ab}	20.9^{a-f}	20.1^{c-f}	**22.8^{a}**
	M_4	411.5^{a}	389.2^{ab}	310.1^{b-i}	370.3^{a}	156.9^{a}	143.0^{ab}	129.0^{b-e}	**143.0^{a}**	27.6^{a}	21.1^{a-f}	21.1^{a-f}	**23.3^{a}**
S_3	**M_1**	243.4^{h-m}	266^{f-m}	186.3^{m}	231.9^{f}	107.7^{g-k}	80.1^{m-p}	84.5^{l-p}	**90.8^{de}**	21.2^{a-f}	18.0^{ef}	16.9^{f}	**18.7^{b}**
	M_2	287.7^{f-k}	282.3^{f-l}	263.7^{f-m}	277.9^{de}	112.5^{e-i}	92.9^{k-n}	88.3^{l-o}	**97.9^{d}**	22.2^{a-f}	19.9^{c-f}	20.5^{c-f}	**20.9^{ab}**
	M_3	372^{a-e}	299.3^{d-k}	303.7^{c-j}	325.0^{bc}	113.2^{d-h}	89.9^{l-o}	94.1^{j-n}	**99.1^{d}**	23.7^{a-f}	19.6^{c-f}	21.1^{a-f}	**21.5^{ab}**
	M_4	384.3^{a-c}	320.7^{b-h}	311.3^{b-i}	338.8^{ab}	115.3^{d-h}	121.8^{c-g}	122.7^{c-g}	**119.9^{b}**	25.7^{a-c}	20.6^{b-f}	20.7^{a-f}	**22.3^{ab}**
Variety		**328.2^{a}**	**282.2^{b}**	**263.1^{b}**		**118.5**	**105.2^{b}**	**85.5^{c}**		24.4^{a}	19.4^{b}	19.7^{b}	
		Variety x Seed rate			**S**	**Variety x Seed rate**			**S**	**Variety x Seed rate**			**S**
S	**S_1**	338.4^{a}	237.6^{e}	241.8^{e}	272.6^{b}	119.8^{a}	107.0^{b}	70.2^{e}	99.0^{b}	23.3^{b}	18.2^{c}	19.8^{c}	20.4^{b}
	S_2	324.4^{ab}	317.1^{a-c}	281.1^{cd}	307.5^{a}	123.6^{a}	112.4^{b}	89.1^{d}	108.4^{a}	26.6^{a}	20.5^{c}	19.4^{c}	22.2^{a}
	S_3	321.9^{ab}	292.1^{b-d}	266.3^{de}	293.4^{ab}	112.2^{b}	96.2^{c}	97.4^{c}	101.9^{b}	23.2^{b}	19.5^{c}	19.8^{c}	20.8^{b}
		Variety x Micro			**M**	**Variety x Micro**			**M**	**Variety x Micro**			**M**
M	**M_1**	266.8^{d-f}	252.1^{ef}	224.4^{f}	247.8^{d}	100.7^{e}	80.7^{f}	66.7^{g}	82.7^{d}	23.0^{a-c}	18.4^{d}	17.8^{d}	19.7^{b}
	M_2	307.6^{b-d}	263.9^{d-f}	256.1^{ef}	275.9^{c}	114.8^{cd}	96.6^{e}	80.8^{f}	97.4^{c}	23.6^{ab}	19.3^{cd}	19.5^{cd}	20.8^{b}
	M_3	347.2^{b}	285.1^{c-e}	278de	303.4^{b}	123.4^{bc}	111.6^{d}	85.0^{f}	106.7^{b}	24.9^{a}	19.7^{cd}	20.6^{b-d}	21.7^{ab}
	M_4	391.3^{a}	327.9^{bc}	293.7^{c-e}	337.6^{a}	135.2^{a}	131.9^{ab}	109.7^{d}	125.6^{a}	26.0^{a}	20.3^{b-d}	20.8^{b-d}	22.4^{a}

Comparison	S.Em±	S.Em±	S.Em±
Variety (V)	9.5	1.9	0.5
Seed (S)	6.7	1.1	0.4
Micro (M)	8.1	1.8	0.7
V x S	11.9	1.9	0.8
V x M	14.1	3.1	1.2
S x M	14.1	3.1	1.2
V x S x M	24.4	5.4	2.0

Varieties (**V**) : **V_1**- GGV 0501, **V_2**- RNR15048, **V_3**- BPT 5204
Seed Rate(**S**) : **S_1**- 25 kg ha^{-1}, **S_2**- 30 kg ha^{-1}, **S_3**- 35 kg ha^{-1}
Micronutrient (**M**): **M_1**- Control, **M_2**- $FeSO_4$ (Soil @ 25 kg ha^{-1}+ foliar @ 0.5% twice at 15 and 30 DAS)
M_3- $ZnSO_4$ (Soil @ 25 kg ha^{-1}+ foliar @ 0.5% twice at 15 and 30 DAS)
M_4- $FeSO_4$ + $ZnSO_4$ (each to soil @ 25 kg ha^{-1} + foliar @ 0.5% at 15 and 30 DAS)
Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

Table 3: Effect of genotypes, seed rates and micronutrients on grain yield, straw yield and harvest index under direct seeded condition

V x S x M		Grain yield (kg ha^{-1})				Straw yield (kg ha^{-1})				Harvest index			
		V_1	V_2	V_3	S x M	V_1	V_2	V_3	S x M	V_1	V_2	V_3	S x M
S_1	M_1	4714^{d-h}	3513^{j}	4095^{h-j}	**4107^{e}**	4909^{n-p}	5692^{i-n}	5055^{l-p}	**5219^{h}**	0.49^{ab}	0.38^{gh}	0.45^{a-f}	**0.44^{a-c}**
	M_2	4857^{d-h}	3989^{h-j}	4295^{f-j}	**4380de**	5580^{j-n}	5908^{h-m}	5578^{j-n}	**5687^{eg}**	0.47^{ab}	0.40^{e-h}	0.43^{b-g}	**0.44^{a-c}**
	M_3	5626^{a-d}	4578^{e-i}	4327^{f-j}	**4844^{b-d}**	6026^{f-k}	6090^{e-k}	6107^{e-k}	**6074de**	0.49^{ab}	0.43^{b-g}	0.42^{c-h}	**0.44^{a-c}**
	M_4	5843^{a-c}	4924^{c-h}	4337^{f-j}	**5035^{ab}**	6681^{b-h}	7085^{f-d}	6550^{b-i}	**6772^{bc}**	0.47^{a-d}	0.41^{d-h}	0.40^{e-h}	**0.43^{a-c}**
S_2	M_1	5173^{f-g}	4184^{g-h}	4140^{h-j}	**4499^{c-e}**	7043^{b-e}	4273^{p}	4656^{op}	**5324^{f-h}**	0.42^{c-h}	0.49^{ab}	0.47^{a-d}	**0.46^{a}**
	M_2	5981^{ab}	4507^{e-j}	4152^{h-j}	**4880^{b-d}**	7031^{b-e}	5008^{m-p}	5270^{lp}	**5770^{ef}**	0.46^{a-e}	0.47^{a-d}	0.44^{a-g}	**0.46^{a}**
	M_3	6215^{a}	4858^{d-h}	4337^{f-j}	**5137^{ab}**	7089^{b-d}	6941^{b-f}	5409^{k-o}	**6480^{cd}**	0.47^{a-d}	0.41^{d-h}	0.44^{a-g}	**0.44^{a-c}**
	M_4	6277^{a}	5400^{a-e}	4580^{e-i}	**5419^{a}**	8241^{a}	7407^{b}	7246^{bc}	**7631^{a}**	0.43^{b-g}	0.42^{c-h}	0.39^{f-h}	**0.41^{c}**
S_3	M_1	4519^{e-i}	3639^{ij}	4127^{h-j}	**4095^{e}**	4634^{p}	6434^{c-j}	4131^{p}	**5066^{h}**	0.494^{ab}	0.36^{h}	0.50^{a}	**0.45^{ab}**
	M_2	5237^{b-f}	3993^{h-j}	4147^{h-j}	**4459^{c-e}**	5678^{i-n}	6444^{c-j}	5974^{g-l}	**6032de**	0.48^{a-c}	0.38^{gh}	0.41^{d-h}	**0.42^{bc}**
	M_3	5880^{ab}	4659^{d-h}	4270^{f-j}	**4936^{a-c}**	6802^{b-h}	6742^{b-h}	6350^{c-k}	**6631^{bc}**	0.46^{a-e}	0.41^{d-h}	0.40^{e-h}	**0.42^{bc}**
	M_4	5966^{ab}	4899^{d-h}	4435^{e-j}	**5100^{ab}**	7197^{bc}	7198^{d-k}	6874^{b-g}	**7090^{b}**	0.45^{a-f}	0.40^{e-h}	0.39^{f-h}	**0.42^{bc}**
Variety		**5524^{a}**	**4429^{b}**	**4270^{b}**		**6409^{a}**	**6269^{a}**	**5767^{b}**		**0.46^{a}**	**0.41^{b}**	**0.42^{b}**	
		Variety x Seed rate			**S**	**Variety x Seed rate**			**S**	**Variety x Seed rate**			**S**
S	S_1	5260^{b}	4252^{d}	4264^{d}	**4592^{b}**	5799^{cd}	6193^{c}	5823^{cd}	**5938^{b}**	0.48^{a}	0.41^{de}	0.42^{cd}	0.43^{a}
	S_2	5912^{a}	4737^{c}	4302^{d}	**4984^{a}**	7351^{a}	5907^{cd}	5645^{d}	**6301^{a}**	0.45^{bc}	0.45^{bc}	0.44^{c}	0.44^{a}
	S_3	5401^{b}	4298^{d}	4245^{d}	**4648^{b}**	6078^{cd}	6705^{b}	5832^{cd}	**6205^{ab}**	0.47^{ab}	0.39^{e}	0.44^{cd}	0.43^{a}
		Variety x Micro			**M**	**Variety x Micro**			**M**	**Variety x Micro**			**M**
M	M_1	4802^{cd}	3779^{g}	4121^{fg}	**4234^{c}**	5528^{e}	5466^{e}	4614^{f}	**5203^{d}**	0.47^{a}	0.41^{cd}	0.47^{a}	0.45^{a}
	M_2	5358^{b}	4163^{fg}	4198^{e-g}	**4573^{b}**	6096^{d}	5785de	5608^{dc}	**5830^{c}**	0.47^{a}	0.42^{b-d}	0.43^{bc}	0.44^{ab}
	M_3	5907^{ab}	4699^{c-e}	4311^{d-f}	**4972^{ab}**	6639^{c}	6591^{c}	5956^{dc}	**6395^{b}**	0.47^{a}	0.42^{b-d}	0.42^{f-d}	0.43^{b}
	M_4	6029^{a}	5074^{bc}	4451^{d-f}	**5185^{a}**	7373^{a}	7230^{ab}	6890^{bc}	**7164^{a}**	0.47^{a}	0.41^{cd}	0.39^{d}	0.41^{c}

Comparison	S.Em±	S.Em±	S.Em±
Variety (V)	104	109	0.010
Seed (S)	73	87	0.011
Micro (M)	96	94	0.009
V x S	126	152	0.019
V x M	167	164	0.015
S x M	167	164	0.015
V x S x M	290	284	0.026

Varieties (**V**) : **V_1**- GGV 0501, **V_2**- RNR15048 (summer), **V_3**- BPT 5204
Seed Rate(**S**) : **S_1**- 25 kg ha^{-1}, **S_2**- 30 kg ha^{-1}, **S_3**- 35 kg ha^{-1}
Micronutrient (**M**): **M_1**- Control, **M_2**- $FeSO_4$ (Soil @ 25 kg ha^{-1}+ foliar @ 0.5% twice at 15 and 30 DAS)
M_3- $ZnSO_4$ (Soil @ 25 kg ha^{-1}+ foliar @ 0.5% twice at 15 and 30 DAS)
M_4- $FeSO_4$ + $ZnSO_4$ (each to soil @ 25 kg ha^{-1} + foliar @ 0.5% at 15 and 30 DAS)
Note: The values between the same set of classes for each treatment followed by the same letter are not significantly different under DMRT

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