The Pharma Innovation Journal 2022; 11(6): 1064-1067

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(6): 1064-1067

www.thepharmajournal.com
Received: 01-02-2022
Accepted: 08-05-2022

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Response of rice genotypes to split application of nitrogen and potassium on growth and yield parameters of direct seeded rice

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Abstract
The experiment was conducted at Agricultural Research Station, Siruguppa, University of Agricultural Sciences (UAS), Raichur, Karnataka, during *kharif* season of 2017 and 2018 to know the response of rice genotypes to split application of nitrogen and potassium on growth and yield parameters of direct seeded rice. Pooled mean of two years indicated that GNV-10-89 recorded significantly higher number of tillers m^{-2} (564.7), leaf area $hill^{-1}$ (871.2 cm^{-2}), leaf area index (4.36) and total dry matter production (91.95 g $hill^{-1}$) at harvest, number of panicles (385.6 m^{-2}), panicle length (24.32 cm), panicle weight (3.54), test weight (23.94 g) over RP Bio-226 and RNR-15048 but it was at par with GGV-05-01 (44.0, 514.9, 803.5 cm^{-2}, 4.02, 86.06 g $hill^{-1}$, 358.2 m^{-2}, 23.11 cm, 3.26 g, 23.05 g respectively). Among the nutrient management practices, S_3 (50% N and K and full dose of P as basal + 25% N and K at tillering + 25% N at panicle initiation + 25% K at dough stage) recorded significantly higher number of panicles m^{-2} (367.1), length of panicle (23.02 cm), panicle weight (3.28 g), test weight (23.31 g), number of tillers m^{-2} (514.8), leaf area $hill^{-1}$ (796.1), leaf area index (3.98) and total dry matter production (84.77 g $hill^{-1}$) as compared to other nutrient management practices. Hence, on the basis of the results obtained in the pooled data of the two years, genotypes GNV-10-89 with Split application of nitrogen and potassium 50% N and K and full dose of P as basal + 25% N and K at tillering + 25% N at panicle initiation + 25% K at dough stage was found to be better option to obtain higher growth and yield parameters.

Keywords: Direct seeded rice, genotypes, nitrogen, potassium

Introduction
Rice (*Oryza sativa* L.) is a grain plant belonging to the family poaceae and genus *Oryza*. It is one of the most important food grains produced and consumed all over the world. Global rice demand was 439 million tonnes in 2010 and is expected to rise to 496 million tonnes in 2020 and further increase to 553 million tonnes in 2035 (Anon., 2013) [1]. It is the staple food in Asia but also the single biggest user of freshwater. It is mostly grown under submerged soil conditions and requires more water compared to other crops. It plays a vital role in our food as well as nutritional security for millions of livelihood. Thus, the slogan “Rice is life” by IRRI during 2004 seems to be most appropriate (Chandrasekaran *et al*., 2007) [4]. Rice ranks second to wheat in terms of area harvested but in terms of importance as a food crop, rice provides more calories ha^{-1} than any cereal crop (De Dutta, 1981) [5]. Besides its importance as food, rice provides employment to the largest sector of the rural population in most of the Asia. India occupies a pride place in rice production among the food crops cultivated in the world. Rice production system, without constant standing water in non-puddled soils, referred to as ‘Direct seeded rice’ is considered to be one of the most promising technologies in terms of water saving. In this system, rice is sown directly into dry soil and irrigation is given to keep the soil sufficiently moist for good plant growth, but the soil is never flooded (Bouman, 2001) [3].

Current high yielding rice varieties are only for transplanted rice and little is known about the yield potential and plant type requirements under direct seeding. Promising research findings with the development of cost-efficient, ecologically sound production technologies and rice varieties with higher yield potential will help to make direct seeding an important production system in the rice tract in the command area. Greater fertilizer N and K efficiency in rice can be achieved by using N and K efficient varieties, improving timing and application methods and better incorporation of basal N and K fertilizer application without standing water.

Split application of N and K has been reported to be the best method to improve N and K fertilizer use efficiency, reduce denitrification losses, synchronize with plant demand, and improve N and K uptake, straw and grain yield, and harvest index in DSR (Singh *et al*., 1983) [6]. Normally, the farmers apply the entire recommended fertilizer dose as basal dose. In recent times, information is mounting on rice, response to split application of nitrogen and potassium in direct seeded rice keeping these points in view the present investigation was undertaken with response of rice genotypes and split applications of nitrogen and potassium under direct seeded rice.

Material and Methods

The experiment was conducted at Agricultural Research Station, Siruguppa, University of Agricultural Sciences (UAS), Raichur, Karnataka, on medium black with clay loam texture having organic carbon 0.44%, pH 7.85, EC 0.37, available nitrogen 235.0 kg ha^{-1} (low), available phosphorus 25 kg ha^{-1} (medium) and available potassium 357.0 kg ha^{-1} (high).during *kharif* season of 2017 and 2018. The experiment was carried out in Split plot design. There were four main plots and five sub plot treatments comprising of four genotypes [GNV-10-89 (G_1), GGV-05-01 (G_2), RP Bio-226 (G_3) and RNR-15048 (G_4)] with five nutrient management practices (S_1 - 50% N and full dose of P and K as basal + each 25% N at tillering and panicle initiation stage, respectively, S_2 - 25% N and full dose of P and K as basal + each 25% N at tillering, panicle initiation and flowering stage, respectively, S_3 - 50% N and K and full dose of P as basal + 25% N and K at tillering + 25% N at panicle initiation + 25% K at dough stage, respectively, S_4 -50% N and K and full dose of P as basal + each 25% N at tillering and panicle initiation stage + 50% K at dough stage, respectively and S_5 - 50% N and 75% K and full dose of P as basal + each 25% N at tillering and panicle initiation stage + 25% K at dough stage, respectively). The cost Includes expenditure on seeds, fertilizers, weed management and plant protection chemicals. At maturity, the crop was harvested and plot wise yields were recorded. The data recorded at different stages of crop was subjected to statistical analysis at 5% probability by Gomez and Gomez (1984) [7].

Results and Discussion

Performance of rice genotypes

In the current investigation, rice genotype, GNV-10-89 recorded significantly superior in terms of growth parameters *viz*. number of tillers m^{-2} (564.7), leaf area hill^{-1} (871.2 cm^{-2}), leaf area index (4.36) and total dry matter production (91.95 g hill^{-1}) at harvest over RP Bio-226 and RNR-15048 but it was at par with GGV-05-01 (514.9, 803.5 cm^{-2}, 4.02, 86.06 g hill^{-1}, respectively) and yield attributes like number of panicles, panicle length, panicle weight, test weight and total grains (385.6 m^{-2}, 24.32 cm, 3.54 g, 23.94 g and 160.0 panicle^{-1}, respectively) were significantly higher in GNV-10-89 when compared to RP Bio-226 and RNR-15048 but it was at par with GGV-05-01 (358.2 m^{-2}, 23.11 cm, 3.26 g, 23.05 g and 154.2 panicle^{-1}, respectively) (Table 1 and 2). The difference in the yield attributing characters in rice genotypes may be due to inheritance of genetic characters of the genotype and wider adaptability under different environmental conditions, GNV-10-89 early maturing genotype, medium fine rice cultivar with kernels little bolder, harvest early by 10-15 days, could be preferred under moisture constraint situations to make best use of the scarce moisture and efficient transport of assimilates from leaves and stems (source) into panicles (sinks), thus resulting in the increased yield parameters of rice and also variation the growth parameters of rice. These results are finding with Similarly, Swain *et al.* (2006); Singh and Bharadwaj (2007); and Kuldeep *et al.* (2017) [8, 9, 10] who reported yield parameters differs with respect to rice cultivars and variation growth parameters like total dry matter accumulation, leaf area, leaf area index and number of tillers may is attributed to better growth and development of particular genotype and different in the genetic makeup of genotypes. Similar results were recorded by Srilaxmi *et al.* (2005); Meena *et al.* (2015) [11, 12] noticed that MTU 1010 recorded higher leaf area and leaf area index compared to other varieties in rice because of its genotypic characters and Lafitte *et al.* (2006) [13] who found that IR-64 recorded higher number of tillers plant-1 as compared to other variety.

Table 1: Growth parameters at harvest as influenced by genotypes and nutrient management practices in direct seeded rice

Treatments	Pooled data over two years				
	Plant height	Number of tillers (m^{-2})	Leaf area (cm^2 hill^{-1})	Leaf area index	Total dry matter production (g hill^{-1})
Main plot: Genotypes (G)					
G_1	87.48	564.7	871.2	4.36	91.95
G_2	84.23	514.9	803.5	4.02	86.06
G_3	78.18	441.2	673.2	3.37	74.56
G_4	95.14	386.0	567.5	2.84	66.19
S.Em±	1.40	14.8	20.0	0.10	1.90
C. D. (P=0.05)	4.83	51.2	69.1	0.34	6.58
Sub plot: Nutrient management practices (S)					
S_1	84.48	456.6	696.6	3.48	77.39
S_2	82.50	437.1	660.3	3.30	74.34
S_3	90.85	514.8	796.1	3.98	84.77
S_4	87.90	493.4	756.7	3.78	81.86
S_5	85.57	481.5	734.6	3.67	80.09
S.Em±	0.35	4.5	7.7	0.04	0.55
C. D. (P=0.05)	1.01	12.9	22.2	0.11	1.58
Interaction (G × S)					
S.Em±	0.70	9.0	15.4	0.08	1.10
C. D. (P=0.05)	NS	NS	NS	NS	NS

Main plot: Genotypes (G)
G_1: GNV-10-89 G_3: RP Bio-226
G_2: GGV-05-01 G_4: RNR-15048
Sub plot: Nutrient management practices (S)
S_1 - 50% N and full dose of P and K as basal + each 25% N at tillering and panicle initiation stage, respectively
S_2 - 25% N and full dose of P and K as basal + each 25% N at tillering, panicle initiation and flowering stage, respectively
S_3 - 50% N and K and full dose of P as basal + 25% N and K at tillering + 25% N at panicle initiation + 25% K at dough stage, respectively
S_4 -50% N and K and full dose of P as basal + each 25% N at tillering and panicle initiation stage + 50% K at dough stage, respectively
S_5 - 50% N and 75% K and full dose of P as basal + each 25% N at tillering and panicle initiation stage + 25% K at dough stage, respectively
DAS: Days after sowing

Table 2: Yield parameters as influenced by genotypes and nutrient management practices in direct seeded rice

Treatments	Pooled data over two years				
	Number of panicles (m^{-2})	Panicle weight (g)	Panicle length (cm)	Test weight (g)	Grain yield (kg ha^{-1})
Main plot: Genotypes (G)					
G_1	385.6	3.54	24.32	23.94	5692
G_2	358.2	3.26	23.11	23.05	5433
G_3	321.1	2.84	21.01	22.59	5005
G_4	294.6	2.52	19.20	22.07	4635
S.Em±	8.1	0.12	0.38	0.23	78
C. D. (P=0.05)	28.1	0.45	1.32	0.81	268
Sub plot: Nutrient management practices (S)					
S_1	330.8	2.95	21.53	22.72	5087
S_2	319.5	2.81	20.77	22.58	4922
S_3	360.5	3.28	23.02	23.31	5449
S_4	347.9	3.12	22.32	23.06	5294
S_5	340.7	3.05	21.90	22.91	5205
S.Em±	2.8	0.04	0.16	0.10	46
C. D. (P=0.05)	8.0	0.12	0.48	0.28	134
Interaction (G × S)					
S.Em±	5.6	0.23	0.31	0.20	93
C. D. (P=0.05)	NS	NS	NS	NS	NS

Main plot: Genotypes (G)
G_1: GNV-10-89 G_3: RP Bio-226
G_2: GGV-05-01 G_4: RNR-15048
Sub plot: Nutrient management practices (S)
S_1 - 50% N and full dose of P and K as basal + each 25% N at tillering and panicle initiation stage, respectively
S_2 - 25% N and full dose of P and K as basal + each 25% N at tillering, panicle initiation and flowering stage, respectively
S_3 - 50% N and K and full dose of P as basal + 25% N and K at tillering + 25% N at panicle initiation + 25% K at dough stage, respectively
S_4 -50% N and K and full dose of P as basal + each 25% N at tillering and panicle initiation stage + 50% K at dough stage, respectively
S_5 - 50% N and 75% K and full dose of P as basal + each 25% N at tillering and panicle initiation stage + 25% K at dough stage, respectively

Split application of nitrogen and potassium

With respect to nutrient management practices, S_3 (50% N and K and full dose of P as basal + 25% N and K at tillering + 25% N at panicle initiation + 25% K at dough stage) recorded significantly higher value for all the yield attributing characters of rice *viz*., number of panicles m^{-2} (367.1), length of panicle (23.02 cm), panicle weight (3.28 g), total grains $panicle^{-1}$ (154.8), test weight (23.31 g) and growth parameters of rice *viz*., number of tillers m^{-2} (514.8), leaf area $hill^{-1}$ (796.1), leaf area index (3.98) and total dry matter production (84.77 g $hill^{-1}$) when compared to other nutrient management practices (Table 1 and 2). split application of nitrogen and potassium will increase the yield attributing characters, it may be due to the fact that application of nitrogen and potassium in splits fulfilled the nutrient requirement of the direct seeded rice crop throughout the crop growing season, there by maximum development of source and sink capacity leads to increase in yield parameters like panicle length, panicle weight and grains per panicle and further increased accumulation of photosynthetic from the source to the sink. These results are in accordance with Amrutha *et al.* (2016) [2]. The crop's demand for nitrogen and its supply synchronized through proper timing and application rate and Mahfuza *et al.* (2008) [14] noticed that application of potassium in three split help to better supply of potassium lead to increase in the grains per panicle, test weight and yield of rice. and increase in the yield parameters also attributed to increasing in growth parameters like dry matter production, leaf area, leaf area index and tillers m^{-2} its mainly due to split application of nitrogen and potassium attributed to better supply of nutrient throughout the growing period of crop and nitrogen and potassium are inter-relationship with auxin, an important growth promoter regulating the stem elongation and cell enlargement helps to produce the higher plant height, leaf area, leaf area index and number of tillers finally increases the total dry matter production of rice crop. These findings are in accordance with those of Basavaraj (2006); Youseftabar *et al.* (2012) and Payman (2018) [15, 16, 17].

Conclusion

Performance of GNV-10-89 and GGV-0501 was found better as compared to RP Bio-226 and RNR-15048 with respect to growth attributes, yield parameters and Nutrient management practices *i.e.*, S_3 (50% N and K and full dose of P as basal +

25% N and K at tillering + 25% N at panicle initiation + 25% K at dough stage) is a better option in direct seeded rice with respect to growth and yield parameters.

Acknowledgement
I acknowledge with great pleasure to Department of Science and Technology, Ministry of Science and Technology, INSPIRE Programme, New Delhi, for providing INSPIRE fellowship to conduct research.

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