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Interaction of different levels of Nitrogen and FYM on yield of Dry direct- seeded rice in North-West, India

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ABSTRACT

The simultaneous use of synthetic fertilizers and organic manure in combination can help promote sustainable agriculture by improving soil health, reducing environmental impacts, and increasing crop productivity. The research work entitled "Interaction of different levels of organic and inorganic fertilizer on growth and yield of dry-seeded rice (DSR)" was conducted in the field of Lovely Professional University, Phagwara, Punjab during the Kharif season of 2022. The study focused on the influence of various levels of inorganic and organic fertilizers on the growth and yield of DSR. The experiment was laid out in a split-plot design with three replications and twelve treatments. The main plots included three rates of farmyard manure (FYM) (0, 7.5, and 15 t ha^{-1}) and subplots with four nitrogen fertilizer rates (0, 50, 100, and 150 kg ha^{-1}). The treatment combinations were: T_1: FYM_0 N_0; T_2: FYM_0 N_{50}; T_3: FYM_0 N_{100}; T_4: FYM_0 N_{150}; T_5: $FYM_{7.5}$ N_0; T_6: $FYM_{7.5}$ N_{50}; T_7: $FYM_{7.5}$ N_{100}; T_8: $FYM_{7.5}$ N_{150}, T_9: FYM_{15} N_0, T_{10}: FYM_{15} N_{50}, T_{11}: FYM_{15} N_{100}, T_{12}: FYM_{15} N_{150}. The result showed that the application of 150 kg N ha^{-1} produced the highest yield attributes and grain yield. On the other hand, the highest number of effective tillers, panicle length, number of grains per panicle and 1000 grain weight resulted in the highest grain yield from 15 t FYM ha^{-1}. Simultaneous application of $F_{15}N_{100}$ gave a significant grain yield in DSR. The interaction between N and FYM was positive and linear. Therefore, the best-combined application of 150 kg N ha^{-1} and 15 t FYM ha^{-1} could be the best-integrated nutrient management practice for better yield of DSR.

Key words : *Direct-seeded rice, Nitrogen, FYM, Grain yield and straw yield.*

Introduction

Rice is the essential food for more than half the world's population, especially in southern and southeast countries, and an essential source of nutrients and calories for billions of people (Pathak, 2011). In India, rice is cultivated on about 43.86 million hectares with a productivity of 104.80 million tones and the productivity is about 2390 $kgha^{-1}$ (Agricultural Statistics, 2015). There is an abundant range of methods to raise the productivity of rice. The most popular method for rice establishment in India is transplanting young seedlings to puddled soil. However, this approach is labor, water and energy demanding and these resources are becoming increasingly rare thus it is becoming less viable these days (Kumar and Ladha, 2011). All these factors are influencing the switch from puddled transplanting to dry-seeded rice (DSR).

DSR is becoming a popular production system (Chauhan *et al*., 2012; Mahajan *et al*., 2013). Inorganic fertilizers have been widely adopted in modern agriculture to boost crop yields, including rice production. Nitrogen (N) is the most important nutrient which affects growth and quality in rice systems (De Datta *et al*., 1988). N is required more consistently

than other nutrients, which account for 67% of the total agricultural fertilizers (Cassman *et al*., 2002; Mahajan *et al*., 2011). DSR absorbs the basal N causing an increase in N loss and an increase in N fertilizer need (Norman *et al.,* 1997; Huang *et al*., 2012). To maximize DSR production, proper N application in DSR decreased N loss and satisfied crop growth requirements (Schnier *et al*., 1990). According to studies, in DSR N-utilization efficiency may reach up to 80% which is higher than transplanted rice which is 30–40% (Zheng *et al*., 2007). Organic sources of fertilizers, on the other hand, are derived from natural materials, such as animal manure, compost, and green manure. These organic sources of fertilizers have several benefits over inorganic fertilizers, including improving soil health and fertility, reducing soil erosion, and promoting sustainable agriculture. Farmyard manure use enhances SSP solubility from 32 to 40% and slows P fixation when combined with synthetic fertilizers (Sharif, 1985). The use of urea in conjunction with organic material (FYM) reduces N loss while enhancing N-use efficiency (Sharma *et al*., 2017).

The integrated nutrient supply system (INSS) is a holistic approach to managing soil fertility and productivity in agriculture (Ramesh *et al*., 2009). It involves the combination of various nutrient sources, including chemical fertilizers, organic manures, and biofertilizers, in a balanced and sustainable manner. Using chemical fertilizers and organic manures in combination has been a promising strategy for improving soil health and productivity. Chemical fertilizers can provide readily available nutrients to crops, while organic manures can improve soil structure and provide slow-release nutrients over time. Together, they can correct marginal deficiencies of secondary and micro-nutrients, micro-flora, and fauna, and promote the physical and biological properties of the soil (Upadhyay *et al*., 2011).

Materials and Methods

The research work entitled with "Interaction of different levels of organic and inorganic fertilizer on growth and yield of DSR" was conducted in the field of Lovely Professional University, Phagwara, Punjab during the *Kharif* season of 2022. The agriculture farm is situated at a latitude of 31º15.435'N and a longitude of 75º42.426' E which falls under the central plain zone of agro-climatic zones of Punjab at an altitude of about 252 m above the Arabian Sea level and average annual rainfall of 436 mm, minimum temperature of 0- 6 °C in the month of January and maximum temperature of 40- 45°C in June. The soil is sandy clay loam having ph 8.6, EC 0.11dS m^{-1}, available nitrogen 221.5 kg ha^{-1}, organic carbon 0.24%, available phosphorous 7.25 kg ha^{-1} and available potassium 132 kg ha^{-1}.

The experiment was laid out ina split-plot design with three replications and twelve treatments. The main plots include three rates of FYM (0, 7.5 and 15 t ha^{-1}) and subplots with four nitrogen fertilizer rates (0, 50, 100 and 150 kg ha^{-1}). PR 126 (123 days growth duration) variety of rice was sown in well-prepared land with two ploughing by disc harrow and one planking and seed rate of 20-25 kg ha^{-1} was direct-seeded in rows to row distance of 22.5 cm. Nitrogen was applied in the form of urea in three split doses (30, 60 and 90 DAS). Full doses of phosphorus (30 kg ha^{-1}) and potassium (30 kg ha^{-1}) was applied as basal dose at the time of sowing. First irrigation was given immediately after sowing, then at 4-5 days intervals, followed by 8-10 days before harvest.

Pre-emergence herbicide pendimethalin (2.5 l ha^{-1}) was applied followed by hand weeding and post-emergence application of bispyribac sodium (247 ml ha^{-1}) was applied at 30 DAS. Chloropyriphos (2.5 l ha^{-1}) and Godiva super (l ml l^{-1}) were applied to control pests and diseases. The data on growth, yield and yield attributes were recorded at the time of harvesting. The crop was harvested when the panicles turned yellow to golden. Harvesting was done manually using a sickle and the yield obtained was converted to kg ha^{-1} for presentation result.

The treatment combinations were: T_1: $FYM_0 N_0$; T_2: $FYM_0 N_{50}$; T_3: $FYM_0 N_{100}$; T_4: $FYM_0 N_{150}$; T_5: $FYM_{7.5} N_0$; T_6: $FYM_{7.5} N_{50}$; T_7: $FYM_{7.5} N_{100}$; T_8: $FYM_{7.5} N_{150}$, T_9: $FYM_{15} N_0$, T_{10}: $FYM_{15} N_{50}$, T_{11}: $FYM_{15} N_{100}$, T_{12}: $FYM_{15} N_{150}$.

Results and Discussion

Effect of FYM levels on the yield and yield attributing character of DSR

The plant height is significantly affected by different levels of FYM. It was recorded that with the increase in each level of FYM, the plant height increased significantly. The maximum height was obtained from 15 t FYM ha^{-1} (88.2 cm) whereas the control recorded the lowest plant height (83.4 cm). The finding by Babu *et al.* (2001) found that increased levels of FYM

increased the plant height significantly. Similarly, the effective number of tillers m^{-2} increased significantly with the application of 15 t FYM ha^{-1} and was recorded to be the highest as compared to the control. The panicle length recorded from 15 t FYM ha^{-1} (23.5 cm) was significantly higher (22.8) whereas the controlled condition (22.9 cm) recorded the panicle length statistically at par with the panicle length (22.8 cm) produced by 7.5 t FYM ha^{-1}. It was recorded that the application of 15 t FYM ha^{-1} increased the number of grains $panicle^{-1}$ (166) and 1000 grain weight (23.4 gm) followed by 7.5 t FYM ha^{-1}over control. This result contributes to similar findings of Usman *et al*. (2003), Islam *et al.* (2013), Hasanuzzaman *et al*. (2010), who found that increased levels of FYM increase the effective number of tillers, number grains $panicle^{-1}$ and 1000 grain weight significantly. The highest grain yield (6.3 t ha^{-1}) and straw yield (9.6 t ha^{-1}) were recorded at 15 t FYM ha^{-1} whereas the control produced the lowest grain and straw yield. The result of the present study is in line with the report of Meena *et al.* (2017).

Effect of N levels on the yield and yield attributing character of DSR

Among the different levels of N, N_{150} showed the highest plant height (90.7 cm) which was at par with N_{100} (89.6 cm) (Table 1). Bama *et al*. (2021) and Mahajan *et al*. (2012) reported that the plant height was maximum at 100 kg N ha^{-1} further increase in dose failed to cause a significant increase in the plant height. The effective number of tillers m^{-2} recorded was significantly highest at N_{150} (281) and lowest for the control (170). It was recorded that the highest panicle length (24.4 cm), number of grains $panicle^{-1}$ (182), and 1000 grain weight (24.5 g) was shown by N_{150} then followed by N_{100}. The result contributed to similar findings of Mahoto *et al*. (2019), Singh *et al*. (2014), and Uddin *et al*. (2013), who found that increased levels of N increased the number of effective tillers, panicle length, number of grains $panicle^{-1}$ and 1000 grain weight significantly. The grain yield (7.9 t ha^{-1}) was significantly highest for N_{150} compared to other treatments. However, the highest straw yield recorded at N_{150} (10.4 t ha^{-1}) was at par with N_{100} (10.1 t ha^{-1}). Similar findings by Pathak *et al.* (2011) reported that higher grain yield was observed at 120-150 kg Nha^{-1}on dry direct-seeded rice. Nayak *et al*. (2015) and Munda *et al*. (2017) reported a similar result found in the present experiment that increasing the levels of N the yield increases.

Interaction effect of N and FYM on yield and yield attributing character of DSR

The interaction effect of FYM and N was significant in all the parameters. The combination of $F_{15}N_{150}$ significantly produced the highest plant height (96.2 cm) followed by the treatment $F_{15}N_{100}$ and then $F_{7.5}N_{100}$. The highest number of effective tillers m^{-2} was observed in $F_{15}N_{150}$ followed by $F_{7.5}N_{150}$. The findings of Babu and Reddy (2000) reported that the slow release of nutrients from organic matter provided a sustained source of nutrients to the plant height and number of effective tillers at later stages of the crop for better growth. However, the panicle length obtained at $F_{15}N_{150}$ (24.5 cm) was statically at par with the treatment $F_{15}N_{100}$. The maximum number of grains per panicle (190) and highest 1000-grain weight (27.3 g) was observed in $F_{15}N_{150}$. This

Table 1. Effect of FYM and N on yield and yield attributes of DSR

Nutrient	Plant height (cm)	Number of effective tillers	Panicle length (cm)	Number of grains $panicle^{-1}$	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index
FYM_0	83.4	206	22.9	146	19.3	5.1	6.7	42.0
$FYM_{7.5}$	85.7	210	22.8	153	20.8	5.8	8.7	39.2
FYM_{15}	88.2	243	23.5	166	23.4	6.3	9.6	38.6
CD at 0.05%	1.15	0.56	0.29	0.43	0.27	0.19	0.25	0.31
CV%	2.71	23.5	5.78	16.0	12.8	40.5	29.1	9.09
N_0	77.9	170	21.3	125	18.2	2.9	5.5	35.2
N_{50}	84.8	189	23.0	147	20.1	4.8	7.2	39.5
N_{100}	89.6	239	23.6	167	21.9	7.2	10.1	41.6
N_{150}	90.7	281	24.4	182	24.5	7.9	10.4	43.4
CD at 0.05%	1.32	0.65	0.33	0.49	0.31	0.23	0.29	0.36
CV%	3.12	11.0	1.78	6.79	10.0	17.9	19.3	5.11

Table 2. Interaction effect of FYM and N on yield and yield attributes of DSR

Nutrient	Plant height (cm)	Number of effective tillers	Panicle length (cm)	Number of grains panicle^{-1}	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index
F_0N_0	75.8	159	21.4	116	16.7	2.4	4.1	36.8
F_0N_{50}	82.8	170	22.9	140	18.3	4.0	5.6	41.9
F_0N_{100}	87.7	218	23.2	153	19.7	6.2	8.5	42.0
F_0N_{150}	87.4	276	24.2	174	22.4	7.5	8.7	46.4
F7.5 N0	78.2	141	21.4	126	17.4	2.9	5.3	36.1
F7.5 N50	86.7	182	22.5	145	20.2	5.0	8.1	37.9
F7.5 N100	89.5	236	23.0	161	22.0	7.2	10.4	41.0
F7.5 N150	88.5	282	24.5	180	23.7	8.0	11.1	41.8
F15 N0	79.8	209	21.2	132	20.4	33	7.0	32.3
F15 N50	85.2	215	23.6	157	21.9	5.4	8.5	38.8
F15 N100	91.8	263	24.5	186	24.1	8.1	11.4	41.4
F15 N150	96.2	285	24.5	190	27.3	8.2	11.6	41.5
CD at 0.05%	2.30	1.13	0.57	0.86	0.54	0.39	0.49	0.62
CV%	1.42	0.53	1.44	0.69	1.29	3.77	2.99	4.89

parameter contributes to better grain and straw yield of DSR. The highest grain yield (8.2 t ha^{-1}) and straw yield (11.6 t ha^{-1}) (Table 2) were obtained in $F_{15}N_{150}$ but were statically at par with $F_{15}N_{100}$ grain yield (8.1 t ha^{-1}) and straw yield (11.4 t ha^{-1}). The use of inorganic fertilizers in combination with organic manures contributes to higher yields in rice by increasing the translocation of photosynthates from the source to the sinkas reported by Barik *et al*. (2000). Lamichhane *et al.* (2020), reported that the yield attributes and grain yield was observed highest at 50% RDF + 31.3 Mt FYM ha^{-1}. These results are similar to the present experiment of the combined effect of inorganic and organic fertilizers increased the grain and straw yield as reported by Tilahun *et al*. (2013), Naing *et al*. (2010) and Mahajan *et al*. (2008).

Conclusion

The result revealed that application increased the level of N the grain yield and yield attributing characters recording the highest grain yield (7.9 t ha^{-1}) at 150 kg N ha^{-1}. However, the application of 15 t FYM ha^{-1} produced the highest grain yield (6.3 t ha^{-1}). The combined use of N and FYM at 100 kg ha^{-1} and 15 t ha^{-1}produced significant grain yield compared to other treatments. Therefore, it can be concluded that the best-combined application of 100 kg N ha^{-1} and 15 t FYM ha^{-1}could be the best-integrated nutrient management practice for better yield of DSR.

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