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Research Communication

Influence of seed rate and foliar nitrogen on productivity and profitability of wheat (*Triticum aestivum*) in green manure basmati rice (*Oryza sativa*) wheat cropping system

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ABSTRACT

A field experiment was conducted during the winter (*rabi)* season of 2021–22 at Punjab Agricultural University, Ludhiana to study the effect of varied seed rate and 3% foliar nitrogen application at different stages on productivity and economics of wheat (*Triticum aestivum* L.) green manure basmati rice (*Oryza sativa* L.) (T) wheat cropping. The treatments consisted of T_1 recommended seed rate (100 kg/ha) with 3% foliar N application at 21 25 days after sowing (DAS), T_2 (45–50 DAS) and T_3 (60 65 DAS); T_4 (10% reduced seed rate (90 kg/ha) with 3% foliar N application at 21 25 DAS), T_5 (45 50 DAS) and T_6 (60–65 DAS); T_7 (20% reduced seed rate (80 kg/ha) with 3% foliar N application at 21 25 DAS), T_8 (45–50 DAS), T_9 (60–65 DAS) and T_{10} (control). The treatments were laid out in randomized block design with 3 replications. Significantly higher number of tillers (390.3 grains/pike (39.3), longer spike length (11.9 cm) were obtained from treatment T_9. Similarly, higher grain yield (5.41 t/ha), net returns (99,760/ha) and benefit cost ratio (2.33) were recorded with treatment (T_9). Thus 20% reduced seed rate (80 kg/ha) with 3% foliar nitrogen application at 60 65 DAS claimed better management practices in achieving higher yield, yield attributes and net returns.

***Key words*:** Economics, Foliar nitrogen, Green-manure, Seed rate, Wheat, Yield

Wheat (*Triticum aestivum* L.) is most important cereal crop cultivated widely around the world. After China, India leads in area and production of wheat by achieving 2nd position. It supports population by providing 40% of total food basket in country. In India, around 29.8 million hectares (m ha) land is under wheat cultivation, with production of 99.70 million tonnes. Rice (*Oryza stavia* L.) –wheat cropping system is a predominant cropping system around the world. It has been practiced over 13.5 m ha land under Indo-Gangetic region, out of which 10 m ha is in India. Due to intensive practices of rice wheat cropping system in this region, crop productivity has attained plateau sometimes it shows decreasing pattern and sustainability of this cropping system become questionable (Vijayakumar *et al.,* 2019). It compels scientist to feel for adopting different management practices like inclusion of green-manure crop in the system which helps in ameliorating problem related to sustainability as well as improving soil health (Saini *et al*., 2020). Now –a -days residue burning become a headache in north-western part of our country where farmers are forced to burn residue due to short window between harvesting of rice and sowing of wheat. Seed rate strongly determines yield by influencing competition among plant for various natural resources. So, optimum seed rate helps in attaining crop production and productivity by improving nutrient availability, light interception for photosynthesis, proper soil environment capable to take out nutrient and water. In order to maximize the use of natural resources without compromising the sustainability of the production system, plant population should be optimized for increased yield by reassessing seed rate. Nitrogen play crucial role for growth and development which must translocate photosynthates from vegetative to reproductive part that helps in enhancing grain yield. In this regard, foliar application of nitrogen can be a viable option by feeding directly to vegetative part as supplemental basis. Considering these points, present study was conducted to evaluate response of wheat in terms of productivity and profitability to varied seed rate and foliar nitrogen application in green manure basmati rice wheat cropping system.

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A field trial was carried out during 2021–22 starting from summer season with sowing of green manure crop up to the harvesting of wheat crop to assess the effect of seed rate with foliar nitrogen application at different stages on growth and yield of super seeder-sown wheat crop at Students' Research Farm, Punjab Agricultural University, Ludhiana. The experimental site is at 30.9° N and 75.8° E, 247 m above mean sea-level. The soil is loamy sand with 7.20 soil *p*H, 0.38% organic carbon, 208 kg/ha available nitrogen, 24.3 kg/ha available phosphorus and 199 kg/ha available potassium. Dhaincha as green manure crop was sown on 22 May; 2021 on some portion of field and another portion were kept free. Green-manure (38.77 t/ha) of green manure as fresh weight was incorporated on 5 July, 2021 before transplanting of basmati rice variety 'Punjab Basmati 7'on 15 July, 2021. Crop was maintained in submerged condition by keeping field in continuous flooding situation of 5-6 cm depth. Rice was harvested with the help of combine harvester. Data recorded at the time of basmati rice harvest was presented as:

During the winter season wheat variety 'PBW 752' was sown on 24 November 2021 with the help of super seeder in all plots to incorporate rice residue except control where the conventional sowing was followed. Ten different treatments were imposed on field during the winter season in plot size 6.5 m 3.3 m (21.45 m^2) in randomized block design with 3 replications. Treatments were selected as recommended seed rate (100 kg/ha) with 3% foliar N application at 21 25 days after sowing (DAS) (T_1), recommended seed rate (100 kg/ha) with 3% foliar N application at 45 50 DAS (T_2), recommended seed rate (100 kg/ha) with 3% foliar N application at 60 65 DAS (T_3),10% reduced seed rate (90 kg/ha) with 3% foliar N application at 21 25 DAS (T_4),10% reduced seed rate (90 kg/ha) with 3% foliar N application at 45 50 DAS (T_5),10% reduced seed rate (90 kg/ha) with 3% foliar N application at 60 65 DAS (T_6), 20% reduced seed rate (80 kg/ha) with 3% foliar N application at 21 25 DAS (T_7), 20% reduced seed rate (80 kg/ha) with 3% foliar N application at 45 50 DAS (T_8), 20% reduced seed rate (80 kg/ha) with 3% foliar N application at 60 65 DAS (T_9), the control (T_{10}). Residual effect of green manuring was studied on succeeding wheat crop. All the management practices were followed as per package of practices and crops were fed with recommended dose of fertilizers. Irrigation was applied according to crop requirement, considering climatic condition. Field kept in weed-free situation by hand-weeding and insect-pests free by adopting various plant-protection measures. Urea as nitrogen source was applied for foliar spray at the crown-root initiation, maximum tillering stage and jointing stage as per treatments. Standard procedures were maintained during taking field data on yield attributes and yield. Economics was calculated by including market prices of input as well as output and benefit cost ratio was calculated. Data recorded during field study were compiled and analysed with the help of analysis of variance (ANOVA) technique.

Varied seed rate and 3% foliar N application had significant influence on yield attributes of wheat (Table 2). Significantly longer spike length (11.9 cm), more number of effective tillers (390.3), more grains/spike (39.3) were recorded from treatment T_9, i.e. 20% reduced seed rate with 3% foliar N application at 60 65 days after sowing (DAS), being statistically at par with 20% reduced seed rate and 3% foliar nitrogen application at either 45 50 DAS or 21 25 DAS and 10% reduced seed rate with 3% foliar nitrogen application at either 60 65 DAS or 45 50 DAS or 21-25 DAS (Table 2) whereas the control treatment i.e. 100 kg seed rate without foliar N application resulted in lower spike length (8.9 cm), number of effective tillers (358.3), grains/spike (33.2). Less competition for natural resources like congenial soil environment helps in improving nutrient availability, enhanced light interception for photosynthesis leading to translocate photosynthates to the assimilates of grains, resulted in more number of yield attributes. Our results confirmed the findings of Tigabu and Asfaw (2016) who recorded more number of tillers/plant and productive tillers/plant by using lower seed rate (75 kg/ha). Side-by-side foliar N application at different stages resulted in more assimilation of photosynthates compared to without foliar application. Our findings confirm the results of Ransing and Tomar (2019). However, 1000-grain weight was not significantly influenced by seed rate and foliar N application.

Data pertaining to yield parameters like grain yield, straw yield of wheat reflected significant influence of varied seed rate with 3% foliar N application (Table 2). Significantly higher grain yield, straw yield and biological yield were obtained from T_9 treatment whereas lower grain yield was recorded from the control treatment. It was observed that 10 20% reduced seed rate with 3% foliar

Table 1. Effect of green–manure crop on yield and yield attributing characters of Basmati rice (*Oryza sativa* L.)

Treatment	Plant height (cm)	Effective tillers/m^2 (No)	Panicle length (cm)	Grain yield (q/ha)	Straw yield (q/ha)
With green manure	114.13	530	26.1	45.3	73.4
Without green manure	112.6	456	22.1	43.1	71.8

Table 2. Effect of reduced seed rate and 3% foliar nitrogen application at different days after sowing (DAS) on yield attributes of wheat crop under green manure basmati rice wheat cropping system

Treatment	Effective tillers/m^2	Grains/ spike	Spike length (cm)	1,000-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)	Harvest index (%)
T_1 (Recommended seed rate and 3% foliar N application at 21 25 DAS)	361.3	34.5	9.2	38.6	4.79	7.09	11.88	40.3
T_2 (Recommended seed rate and 3% foliar N application at 45 50 DAS)	363.2	34.9	9.4	38.7	4.81	7.11	11.92	40.4
T_3 (Recommended. seed rate and 3% foliar N application at 60 65 DAS)	364.5	35.1	9.5	39.0	4.83	7.12	11.95	40.4
T_4 (Reduced 10% seed rate and 3% foliar N application at 21 25 DAS)	380.0	36.4	10.6	39.3	5.12	7.53	12.65	40.5
T_5 (Reduced 10% seed rate and 3% foliar N application at 45 50 DAS)	386.4	38.8	11.4	39.7	5.32	7.81	13.13	40.5
T_6 (Reduced 10% seed rate and 3% foliar N application at 60 65 DAS)	388.7	39.1	11.8	40.0	5.38	7.86	13.24	40.7
T_7 (Reduced 20% seed rate and 3% foliar N application at 21 25 DAS)	385.1	38.5	11.1	39.5	5.29	7.77	13.06	40.5
T_8 (Reduced 20% seed rate and 3% foliar N application at 45 50 DAS)	387.2	39.0	11.6	39.9	5.36	7.84	13.20	40.6
T_9 (Reduced 20% seed rate and 3% foliar N application at 60 65 DAS)	390.3	39.3	11.9	40.1	5.41	7.89	13.30	40.7
T_{10} (Control)	358.3	33.2	8.9	38.4	4.54	6.73	11.27	40.3
CD (P=0.05)	19.51	3.14	1.40	NS	0.440	0.622	1.081	NS

nitrogen application at different days of sowing resulted in 12.8–19.2% and 11.9–17.2% more grain and straw yield respectively over the control treatment. This might be attributed to more number of yield attributing characters like number of tillers, spike length, grains/spike. Aulakh *et al*., (2018) and Matsuyama and Ookawa (2020) also pointed out that higher grain yield was achieved from using lower seed rate rather than higher seed rate. In addition, the higher grain yield in super seeder-sown treatments was recorded owing to better growth, development and partitioning of biomass in different phasic changes, longer time duration of greenness in crop, which resulted higher light interception and cop up with adverse effects of abiotic factors and synchronising in maturity of the crop (Islam *et al*., 2017). This leads to production of better and longer reproductive phases and transfer of assimilates to the ear. Thus, delayed maturity of crop in these treatments, awns contributed a lot than the crop sown with recommended seed rate with recommended N and 3% foliar N application treatments. Harvest index was found to be non-significant.

Economics of wheat (Table 4) indicated that treatment T_{10} i.e. control plot recorded higher cost of cultivation than

Table 3. Effect of reduced seed rate and 3% foliar nitrogen appli cation at different days after sowing (DAS) on economics of wheat crop under green-manure–basmati rice–wheat cropping system.

Treatments	Gross return (₹/ha)	Variable cost (₹/ha)	Net return (₹/ha)	Benefit: Cost
T_1(Recommended seed rate and 3% foliar N application at 21 25 DAS)	1,26,651	43,679	82,972	1.90
T_2 (Recommended seed rate and 3% foliar N application at 45 50 DAS)	1,27,139	43,679	83,460	1.91
T_3 (Recommended seed rate and 3% foliar N application at 60 65 DAS)	1,27,585	43,679	83,906	1.92
T_4 (Reduced 10% seed rate and 3% foliar N application at 21 25 DAS)	1,35,171	43,169	92,002	2.13
T_5 (Reduced 10% seed rate and 3% foliar N application at 45 50 DAS)	1,40,391	43,169	97,222	2.25
T_6 (Reduced 10% seed rate and 3% foliar N application at 60 65 DAS)	1,41,005	43,169	97,836	2.27
T_7 (Reduced 20% seed rate and 3% foliar N application at 21 25 DAS)	1,39,616	42,784	96,832	2.26
T_8 (Reduced 20% seed rate and 3% foliar N application at 45 50 DAS)	1,41,324	42,784	98,540	2.30
T_9 (Reduced 20% seed rate and 3% foliar N application at 60 65 DAS)	1,42,544	42,784	99,760	2.33
T_{10} (Control)	1,20,084	47,805	72,279	1.51

the other treatment, whereas less cost of cultivation was observed from treatments where 20% reduced seed rate and 3% foliar nitrogen application were used. The reason behind higher cost of cultivation was conventional sowing and higher seed rate which leads to higher variable cost. Higher gross, net returns and benefit: cost were recorded in 20% reduced seed rate and 3% foliar nitrogen application. This was owing to higher grain and straw yield.

Based on the study, it was concluded that 10–20% reduced seed rate with 3% foliar nitrogen application at different days of sowing resulted in 12.8 to 19.2% and 11.9 to 17.2% more grain and straw yield, respectively, over the control treatment. Higher economic benefit and lower cost of cultivation were obtained from reduced seed rate with 3% foliar nitrogen application.

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