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Effect of seed rate and nutrient supply system on growth and yield of late sown wheat (*Triticum aestivum* L.) in inceptisol of eastern U.P. condition

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Abstract
A study was conducted during winter (rabi) season of 2018 - 19 and 2019 - 20 at Pili Kothi research farm of Jaunpur, U.P to evaluate the influence of seed rate and nutrient management on growth and yield of late sown wheat (*Triticum aestivum* L.). The experiment was conducted in factorial randomized block design comprising combination of three seed rate (S_1-100kg ha-¹, S_2 120kg ha-¹ and S_3-140kg ha-¹) and nutrient supply system (N_1-100%RDF, N_2-125%RDF, N_3-75%RDF+ 25%N through FYM and N_4-75%RDF+25%N through vermicompst),replicated thrice. The result revealed that LAI, number of spikes per unit area, spike length, number of grain per spike, grain yield, straw yield biological yield and harvest index increased with increasing rate of seed rate but significant differences was observed between 100 and 140 kg seed rate in respect to these parameters. Plant height was a parameter which remains statistical similar at various stage of crop growth under different level of seed rate during both the years. This investigation also observed that application of 125% RDF resulted significantly taller plant and higher LAI as compared to other nutrient supply system at 60 DAS, during both the years. Significantly higher yield attributes *viz* number of spikes/m², spike length and grains/spike were recorded under 125% RDF treatment which ultimately resulted higher grain yield, straw yield, biological yield and harvest index as compared to 75%RDF along with higher 25% N through FYM or through vermicompst.

Keywords: Wheat, RDF, seed rate, nutrients, growth, yield

Introduction
Wheat [*Triticum aestivum* (L.) emend. Fiori & Paol.]belong to family Poaceae is one of the most important cereal crop of the world that has been considered as integral component of food security system of several nations of the world. India contributes about 13 percent of total wheat production of the world, it ensures the food security and some wide adaptability in different agro-climatic conditions of over country. In India, wheat occupies second place after rice. It is cultivated on an area of 31.61 million ha with the production of 109.52 million tones and productivity of 3.46 million tones (Agricultural statistics at a glance, 2021). About 90% of the total wheat production is contributed by Northern states, among them Uttar Pradesh ranks first with respect to area (9.85 million hectares) and production (35.50 million tonnes) but the productivity 3604 (Kg ha^{-1}) is much lower as compared to Punjab (4862 Kg ha^{-1}) and Haryana(4836 Kg ha^{-1}) (Agricultural statistics at a glance, 2021). Poor productivity in the state like Uttar Pradesh is mainly due to different atmospheric, edaphic and agronomic factors such as insufficient and/or imbalanced nutrient application, delayed sowing, improper selection of varieties, inadequate seed rate/plant population, irrigation etc. The seed and nutrient source (fertilizer and manure) are monetary inputs and their optimum rate and use of suitable source may save the money along with higher crop production, profit income/unit, area per rupee investment and input use efficiency. Wheat is an annual grass growing to between 0.50 to 1.25 metre in height, with a long stalk that terminates in a tightly formed cluster of plump kernels enclosed by a beard of bristly spikes (Smith, 2010) [1].

The balance nutrition with optimum plant stand play an important role in realising the production potential of high yielding suitable cultivar of wheat. The wheat crop have been found highly responsive to nitrogen fertilization. However, in absence of phosphorus, nitrogen becomes ineffective and most of the applied nitrogen remain un-utilized.

The efficiency of both nitrogen and phosphorus is greatly enhanced in the presence of each other, potassium fertilization further improves the utilization of nitrogen and phosphorus stabilizes wheat yield. Hence, the application of Nitrogen, Phosphorous, and Potash, fertilizers and organic manures in proper proportion is necessary to augument the productivity of wheat. Keeping all the facts in mind, the present study was conducted to identify recent seed requirement and nutrient management approach, which can increase input use efficiency from view point of seed fertilizer costs and environmental concern as well as productivity of crops on sustainable basis.

Materials and Methods

The research trial of present investigation was performed in two consecutive *Rabi* seasons of 2018-2019 and 2019-2020 at Pili-Kothi Student Research Farmand also in the Laboratory Department of Agronomy of T.D.P.G. College Jaunpur. The research plot is situated at Pili-Kothi which situated at the distance of 5 km. from the institution. Located 83 meter above sea level with latitude $25^0$43'58" N & longitude$82^0$41'10" E. Plots of homogeneous fertility were selected from the field and well connected, keeping in view with irrigation channel and with the source of irrigation.

There were 12 treatments combination of three seed rate and four nutrients management treatments. The experiment was laid out in factorial randomized block design with three seed rate treatments (S_1: 100 kg ha^{-1}, S_2: 120 kg ha^{-1}, S_3: 140 kg ha^{-1}) and four nutrients management treatments (F_1: 100% RDF, F_2: 125% RDF, F_3: 75% RDF+25% N through FYM, F4: 75% RDF+N through Vermicompost) with three replications. The experimental field was divided in to 36 plots. Each gross plot size was 3.6 x 5.0 m^{2}and net plot size was 3.6 x 4.5m^{2}and row to row spacing was maintained 18 cm each.

Results and Discussion

Plant height (cm): Nutrient management had a significant influence on plant height. At 30 DAS treatment F_2 25% RDF (NPK)) produced significantly taller plants than F_3 75% RDF (NPK)+ 25%N through FYM, but remained at par with rest of the treatments. At later growth stages F2 100% RDF (NPK)) produced significantly taller plants than F1 100% RDF, but remained at par with treatment F_3 and F_4.Whereas, significantly minimum plant height was recorded under F_3 at all the growth stages during both the years.

Leaf area index

Scrutiny of data against nutrient supply reveals that at 30 DAS treatment F_2 recorded significantly higher leaf area index as compared to F_3, but remained on par with rest of the treatments during both the years. At 60 and 90 DAS F_2 recorded significantly higher leaf area index as compared to F_3. F_1 were found statistically at par with treatment F_4.Treatment F_3 was statistically on par with F_4 during all the growth stages. Moreover, significantly minimum leaf area index was recorded under F3 treatment during both of the year.

Number of spike (m^{-2})

Number of spikes of wheat was significantly affected by nutrient supply system. The highest number of spike (407.15 during 2018-10 and 407.31 during 2019-20) was recorded under (F_2) 125% RDF which was at par with (F_1) 100% RDF, (F_3) 75% RDF + 25% N through VC which was superior over (F_3) 75% RDF + 25% N through FYM.

Length of spike (cm)

The higher value of length of spike (9.81 during 2018-19 and 9.78 during 2019-20) was obtained with (F_4) 125% RDF. The same values of length of spike was also recorded with the application of (F_1) 100% RDF, (F_4) 75% RDF + 25% N through VC. The lowest length of spike (8.83 during 2018-19 and 8.91 during 2019-20) was computed with (F_3) 75% RDF + 25% N through FYM.

Grain yield (Mg ha^{-1})

The various nutrient supply systems affected the grain yield significantly. The higher grain yield of (4.30 Mg ha^{-1}during 2018-19 and 4.08 during 2019-20) was recorded under (F_2) 125% RDF which was significantly superior to (F_1) 100% RDF and statistically at par with (F_4) 75% RDF + 25% N through VC and (F_3) 75% RDF + 25% N through FYM the rest of the nutrient supply system.

Straw yield (Mg ha^{-1})

The various nutrient supply system affected the straw yield significantly. The higher straw yield of (6.85 Mg ha^{-1} during 2018-19 and 6.93 Mg ha^{-1} during 2019-20) was recorded under (F_2) 125% RDF which was significantly superior to (F_1) 100% RDF and at par with (F_4) 75% RDF + 25% N through VC and (F_3) 75% RDF + 25% N through FYM the rest of the nutrient supply system.

Biological yield (Mg ha^{-1})

The various nutrient supply system affected the biological yield significantly. The higher biological yield of (11.15 Mg ha^{-1} during 2018-19 and 11.01 Mg ha^{-1} during 2019-20) was recorded under (F_2) 125% RDF which was significantly superior to (F_1) 100% RDF and at par with (F_4) 75% RDF + 25% N through VC and (F_3) 75% RDF + 25% N through FYM the rest of the nutrient supply system.

Harvest index

The various nutrient supply systems affected the harvest index significantly. The higher value of harvest index of (38.54 during 2018-19 and 38.63 during 2019-20) was recorded under (F_2) 125% RDF which was significantly superior to (F_1) 75% RDF + 25% N through FYM and statistically at par with (F_4) 75% RDF + 25% N through VC and (F_1) 100% RDF the rest of the nutrient supply system.

Table 1: Plant height (cm) of wheat as influenced by seed rate and Nutrient Management at different stages at different growth stages

Treatment	Plant height (cm)							
	30 DAS		60 DAS		90 DAS		At harvest	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Seed rate (kg ha^{-1})								
100 kgha^{-1}	17.33	17.50	49.94	50.18	87.13	87.30	92.65	90.00
120 kgha^{-1}	17.61	17.77	48.47	49.22	87.63	88.47	93.00	92.14

140 kgha^{-1}	17.09	17.30	50.34	51.41	88.76	89.46	92.89	94.16
S.Em±	0.36	0.35	0.76	0.85	1.33	1.18	1.31	1.34
C.D. (P=0.05)	1.06	1.02	2.23	2.49	3.90	3.46	3.86	3.94
Nutrient supply system								
100% RDF	17.29	17.45	49.13	49.66	86.10	87.75	91.10	92.20
125% RDF	17.95	18.12	52.33	53.66	89.62	91.51	95.28	95.60
75% RDF + 25% N Through FYM	17.08	17.25	48.10	48.45	88.40	86.89	93.03	89.25
75% RDF + 25% N Through VC	17.06	17.27	48.77	49.31	87.23	87.49	91.96	91.35
S.Em±	0.42	0.40	0.88	0.98	1.54	1.36	1.52	1.55
C.D. (P=0.05)	1.22	1.18	2.57	2.87	4.51	4.00	4.45	4.55

Table 2: Leaf area index (LAI) as influenced by seed rate and Nutrient Management at different stages on wheat crop

Treatment	**Leaf area index (LAI)**					
	30 DAS		**660 DAS**		**90 DAS**	
	2018-19	**201922019-20**	**2018- 2018-19**	**2019-2019-20**	**2018-2018-19**	**2019-2019-20**
Seed rate (kg ha^{-1})						
100 kgha^{-1}	1.11	1.17	3.29	3.35	4.21	4.21
120 kgha^{-1}	1.17	1.22	3.64	3.70	4.36	4.38
140 kgha^{-1}	1.23	1.26	3.70	3.75	4.80	4.51
S.Em±	0.02	0.02	0.05	0.05	0.17	0.06
C.D. (P=0.05)	0.05	0.04	0.16	0.15	0.51	0.18
Nutrient supply system						
100% RDF	1.14	1.23	3.52	3.57	4.30	4.36
125% RDF	1.20	1.24	3.81	3.88	4.82	4.54
75% RDF + 25% N Through FYM	1.16	1.18	3.42	3.49	4.36	4.27
75% RDF + 25% N Through VC	1.17	1.22	3.41	3.46	4.34	4.29
S.Em±	0.02	0.02	0.06	0.06	0.20	0.07
C.D. (P=0.05)	0.06	0.05	0.18	0.17	0.22	0.21

Table 3: Number of spike m^{-2}, length of spike and number of grain spike^{-1}as influenced by seed rate and nutrient management on wheat crop

Treatment						
	Number of spike/m^2		**Length of spike (cm)**		**Grain spike^{-1}**	
	2018-19	**2019-20**	**2018-19**	**2019-20**	**2018-19**	**2019-20**
Seed rate (kg ha^{-1})						
100 kgha^{-1}	358.44	358.50	8.99	9.05	38.27	38.33
120 kgha^{-1}	376.16	376.23	9.29	9.28	40.05	40.10
140 kgha^{-1}	417.40	417.50	9.50	9.58	40.96	40.89
S.Em±	6.30	6.29	0.14	0.15	0.60	0.63
C.D. (P=0.05)	18.48	18.46	0.41	0.44	1.76	1.84
Nutrient supply system						
100% RDF	399.32	399.38	9.44	9.51	40.24	40.09
125% RDF	407.15	407.31	9.81	9.78	40.88	40.95
75% RDF + 25% N Through FYM	363.97	364.06	8.83	8.91	38.48	38.56
75% RDF + 25% N Through VC	365.57	365.56	8.96	9.01	39.43	39.49
S.Em±	7.28	7.27	0.16	0.17	0.69	0.73
C.D. (P=0.05)	21.34	21.31	0.47	0.51	2.03	2.13

Table 4: Grain, straw yield, Biological yield, Harvest Index and test weight as influenced by nutrient management and seed rate on wheat crop

Treatment	**Grain yield (Mg ha^{-1}.)**		**Straw yield (Mg ha^{-1}.)**		**Biological yield (Mg ha^{-1}.)**		**Harvest Index (%)**	
	2018-19	**2019-20**	**2018-19**	**2019-20**	**2018-19**	**2019-20**	**2018-19**	**2019-20**
Seed rate (kg ha^{-1})								
100 kgha^{-1}	3.85	3.84	6.56	6.61	10.41	10.45	36.99	36.75
120 kgha^{-1}	4.08	4.07	6.67	6.74	10.75	10.81	37.95	37.65
140 kgha^{-1}	4.25	4.21	6.97	7.03	11.22	11.24	37.86	37.46
S.Em±	0.06	0.05	0.13	0.13	0.19	0.33	0.57	0.58
C.D. (P=0.05)	0.18	0.15	0.38	0.39	0.56	0.45	1.66	1.69
Nutrient supply system								
100% RDF	4.12	3.89	6.67	6.74	10.79	10.63	38.13	36.60
125% RDF	4.30	4.08	6.85	6.93	11.15	11.01	38.54	37.01
75% RDF + 25% N Through FYM	3.86	3.66	6.70	6.77	10.56	10.43	36.56	35.15
75% RDF + 25% N Through VC	3.95	3.75	6.70	6.73	10.65	10.48	37.11	35.80
S.Em±	0.07	0.05	0.15	0.15	0.22	0.17	0.65	0.66
C.D. (P=0.05)	0.21	0.15	0.44	0.45	0.65	0.52	1.92	1.95

Conclusion

The research conducted at Pili Kothi Research Farm in Jaunpur, U.P. during the winters of 2018-19 and 2019-20 aimed to evaluate the impact of seed rate and nutrient management on the growth and yield of late-sown wheat (*Triticum aestivum* L.). Employing a factorial randomized block design with varying seed rates (S1-100kg ha-¹, S2-120kg ha-¹, and S3-140kg ha-¹) and nutrient supply systems (N1-100%RDF, N2-125%RDF, N3-75%RDF+25%N through FYM, and N4-75%RDF+25%N through vermicompost), replicated thrice, revealed significant correlations. The higher seed rates notably between 100kg and 140kg showcased improvements in LAI, spike attributes, grain yield, straw yield, biological yield, and harvest index. Interestingly, plant height showed consistency across various growth stages under differing seed rate levels. Notably, the 125% RDF application showcased taller plants and higher LAI at 60 DAS in both study years. Moreover, this treatment exhibited superior spike-related parameters, resulting in increased grain yield, straw yield, biological yield, and harvest index in comparison to 75% RDF supplemented with 25% N through FYM or vermicompost. These findings underscore the substantial influence of both seed rate and nutrient management on enhancing wheat productivity, particularly under late-sown conditions.

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