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Effect of seed rate and sowing methods on growth and yield of wheat (*Triticum aestivum* L.)

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Abstract
The particulars of experimental material used and techniques adopted during the course of investigation entitled "Find out the suitable method of sowing and seed rate on growth and yield of wheat (*Triticum aestivum* L.) crop". Field experiment was carried out during rabi season of 2021-22 at Agricultural Research Farm of Faculty of Agriculture sciences and allied Industries Rama University, Mandhana Kanpur (U.P). The experiment was laid out in Factorial Randomized block design with three replications keeping four seed rate 80 kg/ha, 100 kg/ha, 125 kg/ha and 150 kg/ha with combination three sowing methods broadcasting, line sowing raised bed. Results revealed that among the practices treatment combination 80 kg/ha seed rate and sowing method raised bed proved as superior than other treatments with respect to higher crop growth and yield attributes where as plant height, number of tillers m^{-2}, length of spike, grain per spike, test weight of 1000 grain grain and straw yield. Maximum gross return was found with 80 kg/ha seed rate and sowing method raised bed and cost of cultivation was found with 150 kg/ha and raised bed treatment combination. While maximum net return was found with treatment combination 80 kg/ha seed rate and sowing method raised bed. Maximum B:C ratio was obtained in combination of 80 kg/ha seed rate and sowing method raised bed. The planting was done on 4th December 2021. Among the various treatment combination 80 kg/ha seed rate and sowing method raised bed recorded highest B:C ratio and yield.

Keywords: Seed, sowing, wheat, *Triticum aestivum* L.

Introduction
Wheat (*Triticum aestivum* L.) is the major food crop cultivated globally on an area of 215.0 million hectares with the production of 772.4mt and serves as a staple food for billions of people. India is the second largest wheat producing countiy in the world, with contribution of 11.57% of the total world production.

In 2020, wheat production for India was 107,860 thousand tonnes. Wheat production of India increased from 23,832 thousand tonnes in 1971 to 107,860 thousand tonnes in 2020 growing at an average annual rate of 3.42%. Out of the total area of wheat in India, In 2020, wheat production for Uttar Pradesh was 32.59 million tonnes. Wheat production of Uttar Pradesh increased from 30.06 million tonnes in 2017 to 32.59 million tonnes in 2020 growing at an average annual rate of 2.76%.

The demand of wheat has been projected between 105 to 109 million tonnes in the country by 2020 AD. Increase in production will have to manage from the integrated use of resources, as the land area under wheat is now expected to expand further. The low productivity of wheat in Uttar Pradesh might be due to adoption of cereal-cereal (Rice- Wheat) cropping system, imbalance use of sub-optimum dose of fertilizer, method of sowing, late sowing and poor weed management. Among various factors for low productivity, use of imbalance and sub-optimum dose of nitrogen and use of the old method of sowing considered out most important.

Adoption of proper sowing methods substantially contributes to increase the productivity of late sown wheat. Generally, cross and line sowing had already been proved better than other methods of sowing, but due to increasing cost wages and unavailability of laborers, lack of time for land preparation and many other factors, force to the farmers to broadcast the seed in the field instead of line sowing (Dagash *et al*., 2014). (Chaudhary *et al*., 2000) [1] reported that seed rate of 150 kg ha 1 increased the number of grains spike 1 and depressed the number of fertile tillers m^2; Therefore, knowing the optimum seeding rate for bread and durum wheat varieties had great importance to improve production and productivity of both wheat types in the study area.

Result and Discussion

Initial plant population

Data pertaining to plant population in per meter^2 recorded at 15 Days After Sowing (DAP), have been presented in Table.1. Perusal of data presented in Table.1 clearly indicated that the plant population per meter^2 did not influenced significantly due to seed rate and sowing method of wheat.

Plant height

Data pertaining to plant height recorded at 60 DAS and at harvest as influenced by different experimental treatments have been presented in Table.1. A perusal of the data reveal that the seed rate and sowing method of wheat could produce variation on this attribute.

Seed rate influenced the plant height significantly at 60 DAS and at harvest. Higher plant height at harvest 82.00 cm was recorded in seed rate 80 kg/ha which was at par with seed rate 100 kg/ha while significant over the rest of the varieties.

Critical analysis of data revealed that method of sowing has significant effect on plant height at 60 DAS. The higher plant height was recorded 70.31 cm and 80.37 cm at 60 DAS and at harvest respectively was recorded with raised seed bed sowing method which was significantly superior over rest of the sowing method. Contrary to this, lowest plant height was recorded under broadcasting method of sowing due to a lower number of leaves caused by thinner and non-effective root system. The results are in close conformity with those of Pirzada *et al.* (2018) [5], Limochi *et al.* (2014), Kumar *et al.* (2017).

Table 1: Initial Plant population and plant height at successive stage of wheat as influenced by seed rate and method of sowing.

Treatments	Initial plant population at 15 DAS		
	Initial plant population at 15 Das	60 DAS	At harvest
Seed rate Kg/ha			
80	80.44	71.71	82.00
100	122.33	70.28	80.33
125	139.73	68.04	77.76
150	150.85	65.78	75.18
S.Em+	0.88	0.79	0.90
CD at 5%	**2.62**	2.33	2.65
Sowing method			
Broad casting	122.15	67.14	76.76
Line sowing	123.63	69.41	79.33
Raised bed	124.23	70.31	80.37
S.Em+	0.76	0.69	0.78
CD at 5%	**NS**	2.02	2.30

Number of tillers (m^{-2})

The data pertaining to number of tillers m^{-2} as affected by different treatments recorded at 30, 60, 90 DAS and at harvest have been presented in Table.2.

Number of tillers m^{-2} was significantly affected due to seed rate at all the stages (Table-2) significantly higher number of haulms (m^{-2}), at 30 DAS was recorded in 80 kg/ha as compared to rest of the seed rate under study. The increasing seed rate increased the fertile tillers and total tillers significantly reported by Iqbal *et al.*, (2010) [3].

Table 2: Number of tillers at successive stage of wheat as influenced by seed rate and method of sowing.

Treatments	Number of tillers			
	30 DAS	60 DAS	90 DAS	At harvest
Seed rate Kg/ha				
80	222.10	410.03	434.23	438.51
100	217.01	400.53	424.29	428.47
125	191.78	354.13	375.11	378.81
150	185.03	341.61	361.88	365.44
S.Em+	1.45	2.12	2.30	2.88
CD at 5%	4.28	6.22	6.74	8.61
Sowing method				
Broad casting	197.35	364.25	385.85	389.66
Line sowing	205.28	378.88	401.35	405.31
Raised bed	209.41	386.59	409.43	413.458
S.Em+	1.26	1.83	1.99	2.49
CD at 5%	3.70	5.38	5.84	7.32

The number of tillers followed the similar trend at 60, 90 DAS and at harvesting stages of the crop. The lowest tillers was recorded in seed rate 150 kg/ha at all the stages.

An examination of data indicated that sowing method have significant effect on number of tillers m^{-2} at 30 DAS. At later stage of the growth 60, 90 DAS and at harvest, the higher number of tillers m^{-2} was recorded with raised bed sowing method 368.59 m^{-2}, 409.43 cm^{-2} and 413.45 m^{-2} respectively over water stress 25.00 m^{-1} and 25.50 m^{-1}.

Grain weight / Spike (gm)

Data pertaining to grain weight per spike (gm) as affected by seed rate and method of sowing have been presented in Table 3.

Significant difference in grain weight per spike (gm) was recorded between various seed rate. Higher grain weight 2.36/spike (gm) notied in 80 kg/ha seed rate which was at par with 100 kg/ha superior over rest of the seed rate.

Data presented in table 4.5 clearly indicate that the grain weight per spike (gm) was influenced significant by due to ssowing method. Higher grain weight 2.27/spike (gm) recorded under raised bde sowing metod which was superior over the rest of sowing method.

Table 3: Yield attributes at successive stage of wheat as influenced by seed rate and method of sowing.

Treatments	Grain weight/Spike (gm)	Spike length (cm)	Test weight (gm)
Seed rate Kg/ha			
80	2.36	10.37	40.98
100	2.28	10.06	40.60
125	2.13	9.43	39.96
150	2.02	8.84	38.88
S.Em+	0.04	0.07	0.15
CD at 5%	0.11	0.22	0.46
Sowing method			
Broad casting	2.11	9.28	39.56
Line sowing	2.21	9.69	40.15
Raised bed	2.27	10.06	4061
S.Em+	0.03	0.06	0.13
CD at 5%	0.10	0.19	0.40

Spike length (cm)

Data pertaining to spike length (cm) as affected by seed rate and method of sowing have been presented in Table 3.

Significant differences in spike length (cm) was recorded with various seed rate 80 kg/ha. Higher spike length (10.37cm) recorded in seed rate 80 kg/ha which was significantly superior over rest of the sed rate.

The wheat with the spike length (cm) was influenced significant due to sowing metod. Higher spike length (10.06cm) was recorded under raised bed sowing method M_3 which was significantly superior over broad casting and line sowing.

Test weight (gm)

Data pertaining to number of grain per spike as affected by seed rate and method of sowing have been presented in Table.3.

Significant difference in test weight (gm) was recorded under various seed rate. Higher test weight (40.98gm) was recorded with 80 kg/ha seed rate which was at par with 100 kg/ha seed rater while significantly superior over the seed rate.

Critical analysis of data presented in Table.3, clearly reveal that difference in test weight (gm) under different treatment of sowing method were found significant and the higher test weight (gm) was found in raised bed (M_3) i.e. 40.61 which was significantly superior over broad casting (M_1) and line sowing (M_2). The heaviest weight of 1000 grains was observed under plants sown at seed rate of 100 kg/ha (35.336 g) and lightest weight under 160 kg/ha (34.256 g) reported Iqbal *et al.*, (2010) [3].

Grain yield q/ha

Data pertaining to grain yield q/ha as affected by various seed rate and method of sowing have been presented in Table 4.

Significant difference in grain yield was recorded between different seed rate. Higher grain yield (53.33 q/ha) was recorded under seed rate 80 kg/ha which was significantly superior over rest of the seed rate.

Significant difference in grain yield was recorded between different seed rate. Higher grain yield 48.72 q/ha was recorded under raised bed sowing method which was significantly superior over the broad casting (M_1) and line sowing (M_2) method of sowing.

Straw yield q/ha

Straw yield (qha^{-1}) as influenced by various seed rate and method of sowing have been presented in Table 4.

Result showed that the wheat seed rate significantly affects the straw yield. Higher straw yield 93.85 qha^{-1} was recorded under seed rate 125 kg/ha which was significantly superior over rest of the seed rate 80 kg/ha, 100 kg/ha, 150 kg/ha.

Results also showed significant difference in straw yield among all the sowing method. sowing method raised bed (M_3) recorded significantly higher straw yield 80.10 qha^{-1} as compared to sowing method with broad casting 77.20 qha^{-1}78.67 qha^{-1}.

Table 4: Yield studies at successive stage of wheat as influenced by seed rate and method of sowing.

Treatments	Grain Yield q/ha	Straw yield q/ha	Biological yield q/ha	Harvesting index (%)
Seed rate Kg/ha				
80	53.33	84.13	137.46	38.79
100	40.35	68.97	109.32	37.88
125	49.50	93.85	143.35	37.11
150	44.45	77.67	122.12	36.39
S.Em+	0.50	0.70	1.18	0.12
CD at 5%	1.47	2.07	3.47	0.35
Sowing method				
Broad casting	45.78	77.20	122.98	37.19
Line sowing	47. 51	78.67	126.18	37.63
Raised bed	48.72	80.10	128.82	37.81
S.Em+	0.43	0.61	1.02	0.10
CD at 5%	1.27	1.80	3.00	0.36

Biological yield q/ha

Biological yield (qha^{-1}) as influenced by various seed rate and method of sowing have been presented in Table 4.

Result showed that the wheat seed rate significantly affects the biological yield. Higher straw yield 143.35 qha^{-1} was recorded under seed rate 125 kg/ha which was significantly superior over rest of the seed rate 80 kg/ha, 100 kg/ha, 150 kg/ha. Among the various sowing methods, raised bed method recorded significantly higher percentage of harvest index as compared to other sowing methods during the years.

This was probably due to proportion increase in grain was more than straw yield under raised bed sowing while trend was reversed in other sowing methods. Ahuja *et al.*, (1996) [2] and Raj *et al.*, (1992) [4] also reported positive correlation of harvest index with grain yield.

Results also showed significant difference in biological yield among all the sowing method. Sowing method raised bed (M_3) recorded significantly higher straw yield 128.85 qha^{-1} as compared to sowing method with broad casting 126.18 qha^{-1} 122.98 qha^{-1}.

Table 5: Economics of wheat as influenced by seed rate and method of sowing.

Treatments	Cost of cultivation (Rs. ha^{1})	Gross return (Rs. ha^{-1})	Net return (Rs.ha^{-1})	Benefit: Cost ratio (Rs^{-1} invested)
S_1 M_1	46134	1,41,691	95557	2.07
S_1 M_2	46434	1,46,295	99861	2.15
S_1 M_3	46734	1,47,993	101259	2.16
S_2 M_1	46774	1,11,891	65117	1.39
S_2 M_2	47074	1,15,815	68741	1.46

S_2 M_3	47374	1,19,804	72427	1.52
S_3 M_1	47414	1,34,303	86889	1.83
S_3 M_2	47714	1,38,470	90756	1.90
S_3 M_3	48014	1,39,655	91641	1.90
S_4 M_1	48374	1,30,120	71746	1.48
S_4 M_2	48674	1,23,989	75310	1.54
S_4 M_3	60834.00	97335.00	36501.00	1.60

Economics

It is obvious from the data the (S_4) seed rate 150 kg/ha and different sowing method (S_4M_1), (S_4M_2) and (S_4M_3) incurred maximum cost of cultivation Rs. 48374.00 ha^{-1}, 48674.00 ha^{-1} and 48974.00 ha^{-1}. Minimum cost of cultivation was incurred in 80 kg/ha seed rate and different sowing method of wheat (S_1M_1), (S_1M_2) and (S_1M_3) (Rs. 46134.00 ha^{-1}, 46434.00 ha^{-1}, 46734.00 ha^{-1}). S_1M_3 accrued the highest gross income and net return Rs. 147993.00 ha^{-1} and Rs. 101259.00 ha^{-1} respectively. (S_1M_3) treatment combination was recorded highest benefit cost ratio (2.16).

The variation in cost of cultivation were recorded on account of seed rate and sowing method which increases and decreases in different treatments. Yield was major factor, which caused differences in gross income and net return per rupees invested (Table 5).

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