

Performance of tall wheat under different sowing times and methods using various nutrient sources in western Haryana

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Summary

To study the effect of different sowing times, methods and nutrient sources on the growth and productivity of tall wheat, a field experiment was conducted in a split-plot design with three replications. The analysis of data revealed that tall wheat crop sown in the last week of October on FIRBS recorded significantly higher plant height, dry matter accumulation (at different growth stages), yield attributes, grain yield (2599 kg ha⁻¹) and biological yield (7212 kg ha⁻¹) as compared to conventionally sown wheat crop in 1st and 2nd week of November. Among the different nutrient sources, the recommended doses of chemical fertilizers provided significantly higher values of growth parameters, yield attributes, grain yield (2658 kg ha⁻¹) and biological yield (7426 kg ha⁻¹) compared to organic fertilizers/ biofertilizers. Maximum temperature showed a significant and positive correlation with yield and yield attributes. In light of the results to maximize the productivity of tall wheat, it may be sown in the last week of October on FIRBS supplied with recommended doses of fertilizers on the basis of soil test.

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Introduction

Wheat is likely to continue to play a crucial role in ensuring global food security as the world's population is projected to rise from 7.7 billion to 9.7 billion by 2050 (Jat et al., 2022). Wheat provides food for more than 4.5 billion people in 94 countries, accounting for 40% of the world's population. It contains 20% protein and 21% joules (Farooq et al., 2015; Devi et al., 2017a; Harender et al. 2021). But under the changing climatic conditions and loss of soil health & virginity, the growth and productivity of the crop is gradually falling day by day. Thus, choosing suitable sowing times, promising cultivars, suitable planting techniques and seeds treatments are very important variables to increase the productivity of wheat (Devi et al. 2017b; Dawlatzay et al. 2022). The final yield of wheat is an outcome of the interaction of genetic, environmental conditions and agronomic management. Sowing time is one of the most important agronomic factors involved in fetching higher yield of small grain cereal crops, which affects the timing and duration of vegetative and reproductive stages (El-Sarag & Ismaeil 2015; Sachin et al. 2019). Optimum sowing time also affects the water, temperature and solar radiation available for the crop (Silva et al. 2014). It is possible to increase wheat grain yield by 10% to 80% with the management of the sowing dates, cultivars and environmental conditions (Coventry et al. 2011).

Seleiman et al. (2011) showed that the wheat crop sown in November gave the highest values of all growth parameters, yield attributes, grain yield and grain quality characters compared to other sowing dates. In north India, due to the prevailing of low temperature in December month, it may reduce germination and retard vegetative growth by inducing metabolic imbalance and can delay or prevent reproductive devolvment. Abdel-Nour et al. (2011) found that plant height, number of spikes/ spike, number of grains per spike, test weight, biological and grain yield of wheat crop were significantly higher in the optimum sowing date compared to the late and early sowing dates. Sowing methods also play an important role in germination, growth and development of wheat crop. The crop output and product quality can be greatly enhanced by using the right sowing techniques since they play a vital part in giving plants the space they need to utilise air, water, sunlight, and nutrients efficiently (Bodner et al. 2015; David Israel Mansingh & Suresh 2019; Raghuvanshi et al. 2021)

For getting higher yield nutrient management is also one of the factors. Nutrient application system aims to improve and maintain soil fertility for sustaining crop productivity and involves the use of chemical fertilizers in conjunction with organic manure. Incorporation of organic sources, i.e. farmyard manure (FYM), vermicompost, press mud, biofertilizers i.e. phosphate solubilizing bacteria (PSB), *Azotobacter* etc. along with chemical fertilizers is effective in increasing the nutrient availability, improving physical-chemical properties and organic carbon status of soil. FYM improves the physical condition of soil by increasing water holding capacity for maximum utilization of water. Utilising bio-fertilizers like

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Azotobacter and *Azospirillum* separately or together, as well as the biostimulant, may boost wheat productivity (Kumar & Ahlawat 2004; Bhardwaj et al. 2011). Organic sources of nutrients improve the chemical and biological condition of the soil by increasing cation exchange capacity and providing various hormones and organic acids. These are very useful for soil aggregation and beneficial micro-organisms involved in various biochemical processes and the release of nutrients (Subhan et al. 2017). To meet food demand of challenging population size and improving the soil health without reducing the present productivity of wheat crop, this field study was conducted to evaluate the effect of different sowing time, methods, nutrient sources on growth and productivity of tall wheat in western Haryana.

Material and methods

The field experiment was conducted during *Rabi* season of three consecutive years (2015-2018) on sandy loam soils at the Research area of Agronomy, College of Agriculture, Chaudhary Charan Singh Haryana Agricultural University (CCS HAU), Hisar; located at 29°10' N latitude, 75°46'E longitude and altitude of 215.2 m above mean sea level. The soil of the experimental field was slightly alkaline, low in organic carbon and available nitrogen, medium in phosphorus and well supplied with potassium. The prevailing weekly weather during *Rabi* season of three consecutive years is given in Fig 1.

Data regarding to weather parameters (Tmax, Tmin and Rainfall), which prevailed during crop seasons of 2015-16, 2016-17 and 2017-18 is given in Fig. 1.

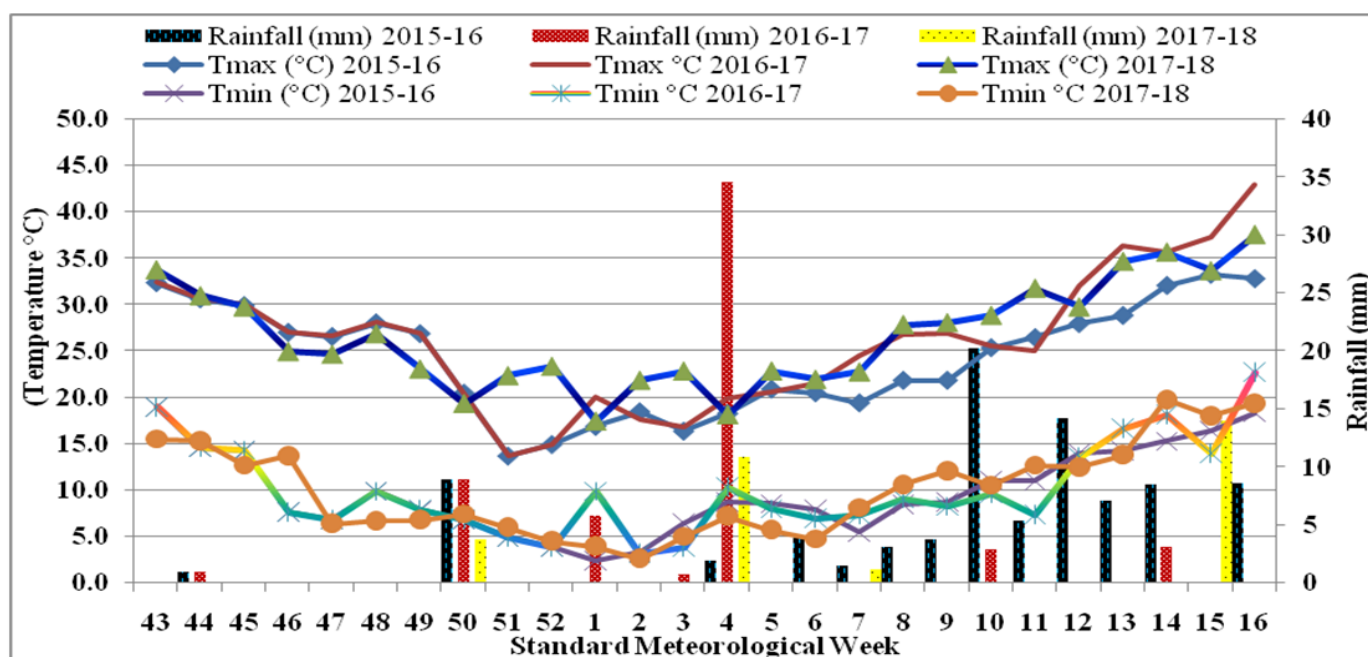


Figure 1. Weather parameters during *Rabi* seasons of 2015-18

The land was thoroughly prepared as required for wheat sowing. This experiment was laid out in split plot design and replicated thrice having sub plot size (4.2m x 5m). The six combinations of sowing times and methods {last week of Oct + FIRBS (furrow irrigated raised bed system) - D₁, last week of Oct + CT (conventional technique) - D₂, 1st week of Nov + FIRBS - D₃, 1st week of Nov + CT - D₄, 2nd week of Nov + FIRBS - D₅ and 2nd week of Nov + CT - D₆} were allotted to main plots, while nutrient sources {RDF (recommended dose of fertilizers - 60kg N ha⁻¹ + 30 kg P₂O₅ ha⁻¹) - N₁, Vermicompost (6 t ha⁻¹) + phosphate solubilizing bacteria (PSB) + *Azotobacter* - N₂ and Farm yard manure (12 t ha⁻¹) + PSB + *Azotobacter* - N₃} were kept in sub plots. The tall wheat cultivar C 306 was chosen for this experiment and other agronomic practices were followed as per package practice given by CCS HAU, Hisar. In FIRBS method, the field was prepared as per the conventional method followed by preparation of beds which were 70 cm wide. While in case of conventional sown wheat, 20 cm row to row spacing was kept. Recommended doses of nitrogen (N) and phosphorus (P) were applied through urea and diammonium phosphate (DAP), respectively. No potash was applied dose of P and half dose of N were applied at

sowing time and the remaining N was applied with first irrigation. The experimental data regarding to all parameters was recorded scientifically and properly on time. Data was statistically analyzed by the variance analysis methods (ANOVA) described by Panse & Sukhatme (1985).

Results and Discussion

Effect of sowing time and methods

Different sowing times and methods significantly influenced growth parameters, yield attributes and yield of wheat, and the pooled data (of three consecutive years) related to these parameters is given in Table 1. Tall wheat crop planted on FIRBS in last week of October, recorded significantly higher plant height (132.1 cm) and dry matter accumulation (949.3 g m⁻²) at harvest, it was statistically at par with D₃. Maximum number of effective tillers per meter square were counted in D₁ (332), followed by D₃ (327), D₂ (321), D₄ (314), D₅ (284) and significantly lower effective tillers i.e. 269 were recorded in 2nd week of Nov + CT sown wheat crop. Statistically higher number of grains per spike (58), spike length (9.8 cm), test weight (44.7 g), grain yield (2599 kg ha⁻¹) and biological yield (7212 kg ha⁻¹) were recorded in D₁ (last week of Oct + FIRBS). Tall wheat sown as conventionally

recorded lower plant height, dry matter accumulation, yield parameters and yield as compared FIRBS sown wheat crop. This may be due to judicious use of nutrient, water, space etc. by FIRBS sown wheat crop over conventionally sown. Devi et al. (2017b)⁵ found in a field study that wheat crop sown on bed recorded higher yield as compared to conventional drill sowing. Singh et al. (2021a) also observed that FIRBS sown wheat crop gave significantly higher crop yield as compared to conventional sown wheat. Early sown tall wheat crop recorded significantly higher dry matter accumulation at 30, 60, 90 & 120 DAS over late sown wheat crop (in second week of November) irrespective of sowing methods. This may be due to availing of longer period for reproductive phase by last week of Oct sown tall wheat crop. Wheat crop sown in second week of Nov meet out with short (shrink) reproductive phase due to rise in minimum and maximum temperatures during later stage of crop. These results are in confirmatory with Yusuf et al. (2019) and Singh et al. (2021b).

Effect of nutrient sources

Pooled data on growth parameters, yield attributes and yield of tall wheat as significantly affected by nutrient sources is given in Table 1. Application of recommended fertilizers (N₁) doses recorded significantly higher dry matter accumulation and plant height at different crop growth stages over other nutrient sources treatment. N₂ (Vermi+PSB+Azato) and N₃ treatments were statistically at par with each other in respect of growth parameters. This may be attributed to better cell division due to the increased availability of primary major nutrients. Sohu et al. (2015) also reported that plant height was

significantly higher in inorganic fertilizer treatments over organic fertilizers and control. At harvest minimum plant height (114.8 cm) and dry matter accumulation (812.4 g m⁻²) was obtained under FYM + PSB + *Azotobacter* treatment. The sole application recommended doses of chemical fertilizers recorded statistically higher values of yield attributes viz. number of effective tillers (339), grains per spike (59), spike length (10.1 cm) and test weight (46 g) than organic nutrient sources i.e. VAM + PSB + *Azotobacter* and FYM + PSB + *Azotobacter*. Grain and biological yield of tall wheat was also recorded maximum in N₁ (2658 and 7426 kg ha⁻¹) followed by N₂ (2290 and 6418 kg ha⁻¹) and N₃ (2207 and 6171 kg ha⁻¹). Singh et al. (2021a) also observed that supply of nutrients through RDF resulted in higher crop yield of wheat as compared with vermi-compost application alone. The higher grain yield in N₁ may attribute to better growth and higher value of yield attributes. These results are also in confirmatory with the results of Subhan et al. (2017).

Relationship between yield attributes and grain yield presented in Fig. 2 (a, b, c & d) showed that number of grains/spike had highest determination factor ($R^2 = 1$) followed by test weight ($R^2 = 0.9979$), spike length ($R^2 = 0.9969$) and least value for No of tillers/m² ($R^2 = 0.9932$), but as all the yield attributes shows determination factor above 0.9 indicates a comparatively strong relationship among yield attributes and grain yield of the crop. So in order to improve productivity of the crop more focus should be laid on these agronomic practices (sowing time, method of sowing and amount of fertilizer application) for enhancing these yield parameters.

Table 1. Effect of sowing time, sowing method and nutrient sources on dry matter accumulation, plant height, yield attributes and yield of tall wheat (pooled of three years)

Treatment	Dry matter accumulation (g/m ²)					Plant Height (cm)					Number of tillers (No./m ²)	No. of grains/spike	Spike length (cm)	Test weight (g)	Grain yield (kg/ha)	Biological yield (kg/ha)
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest						
D ₁	47.4	204.1	419.7	851.1	949.3	21.3	42.8	91.6	124.2	132.1	332	58	9.8	44.7	2599	7212
D ₂	45.9	197.5	406.2	823.7	918.8	20.6	41.5	88.7	120.2	127.8	321	56	9.5	43.2	2500	6980
D ₃	46.7	200.9	413.3	838.2	934.9	21.0	42.2	90.3	122.4	130.2	327	57	9.6	44.0	2555	7102
D ₄	45.0	193.8	398.5	808.2	901.5	20.2	40.7	87.1	118.0	126.1	314	54	9.3	42.5	2446	6848
D ₅	40.3	173.6	357.1	724.2	807.8	18.1	36.5	78.0	108.6	117.5	284	48	8.3	38.1	2172	6137
D ₆	37.8	162.7	334.7	678.6	757.0	17.0	34.2	73.1	101.9	111.3	269	45	7.8	35.6	2038	5751
CD at 5%	1.8	7.6	15.6	31.7	35.3	0.8	1.6	3.4	4.7	5.0	14.5	2.2	0.4	1.7	99	268
N ₁	48.8	210.1	432.2	876.4	977.5	21.9	44.1	94.3	129.0	138.0	339	59	10.1	46.0	2658	7426
N ₂	42.2	181.6	373.5	757.4	844.8	19.0	38.1	81.6	111.5	119.3	295	51	8.7	39.8	2290	6418
N ₃	40.6	174.6	359.1	728.3	812.4	18.2	36.7	78.4	107.2	114.8	289	49	8.4	38.3	2207	6171
CD at 5%	2.0	8.7	17.9	36.3	40.5	0.9	1.8	3.9	5.4	5.7	18.4	2.6	0.4	1.9	118	308

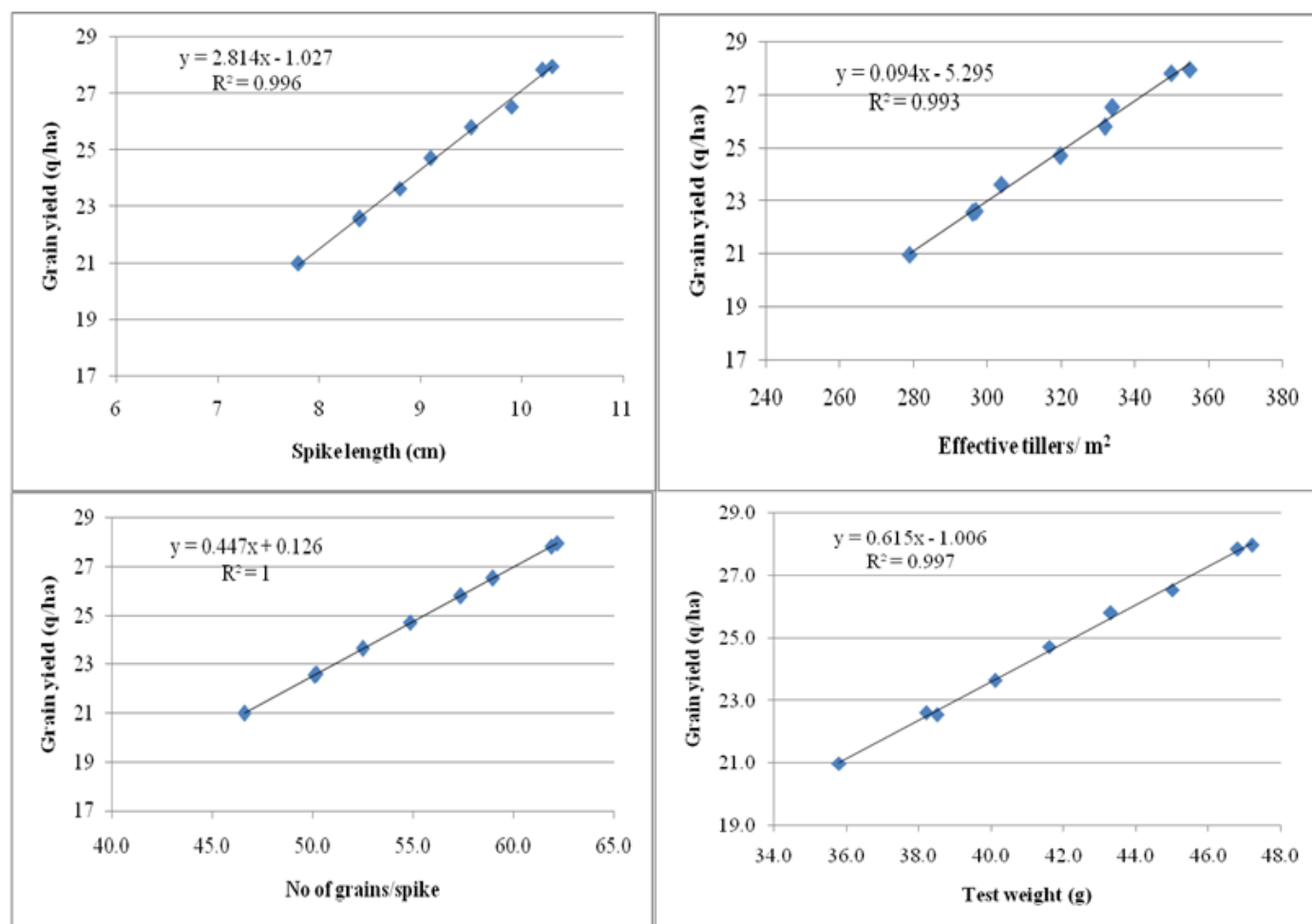


Figure 2. Relation between yield attributes and grain yield of Wheat

Among weather parameters Tmax, Tmin and rainfall are positively correlated with yield and its attributes, whereas, morning and evening relative humidity, wind speed and bright sunshine hour are negatively correlated (Table 2). Maximum temperature throughout the season

showed significant and positive correlation with yield and its attributes. Temperature effects the growth and development of a crop directly by influencing photosynthesis, transpiration, water uptake, translocation of photosynthates and nutrient uptake.

Table 2. Correlation between weather parameters and yield and its attributes

Parameters	Tmax	Tmin	RHm	RHe	WS	BSH	PE	RF
Grain yield	0.61*	0.22	-0.23	-0.29	-0.38	-0.34	0.23	0.06
Biological yield	0.60*	0.24	-0.20	-0.26	-0.34	-0.33	0.19	0.07
Effective tillers	0.61*	0.25	-0.27	-0.34	-0.36	-0.37	0.28	0.04
Spike length	0.62*	0.21	-0.23	-0.29	-0.38	-0.34	0.23	0.06
Grains/ spike	0.59*	0.35	-0.05	-0.12	-0.22	-0.20	0.07	0.18
Test weight	0.60*	0.34	-0.06	-0.13	-0.22	-0.21	0.09	0.17

Tmax- maximum temperature, Tmin-minimum temperature, RHm&RHe – morning and evening relative humidity, WS- wind speed, BSH- bright sunshine hours, PE- pan evaporation, RF- rainfall

*Values are significant at 0.05 probability level (N=18)

Conclusion

Different sowing time, method and nutrient sources had significant effects on growth and productivity of tall wheat. Among the combinations of sowing time and sowing methods, sowing of tall wheat in last week of October on FIRBS recorded higher plant height, drymatter accumulation, yield attributes and yield of tall wheat. Among nutrient sources, higher plant growth, yield attributes and yield of tall wheat was obtained in RDF application (of inorganic fertilizers). Organic sources supply essential plant nutrients slowly throughout the

crop season, but may not in enough quantity which increase the yield of tall wheat.

Declaration of interests

The authors have no conflict of interest to declare.

Data sharing

All relevant data are within the manuscript.

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