J. Farm Sci., 38(2): (119-123) 2025

RESEARCH PAPER

Influence of sowing dates and genotypes on yield, yield attributes and economics of wheat

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(Received: August, 2024 ; Accepted: May, 2025)

DOI: 10.61475/JFS.2025.v38i2.05

Abstract: A field experiment was conducted at Regional Agricultural Research Station, Vijayapura, during the *rabi* season 2023-24, to study the response of wheat genotypes to different growing environments. The experiment was laid out in Randomized Complete Block Design (factorial concept) with three replications. There were twelve treatment combinations, which consist of four sowing windows *viz*., II fortnight of October, I fortnight of November, II fortnight of November and I fortnight of December and three genotypes *viz*., UAS 304, UAS 334 and UAS 375. Significantly higher grain yield (2534.72 kg ha^{-1}) and straw yield (4915.12 kg ha^{-1}) was recorded when wheat was sown during II fortnight of October, it was followed by I fortnight of November sowing with grain yield of 2166.74 kg ha^{-1} and straw yield of 4244.29 kg ha^{-1}. Similarly, significantly higher yield attributes *viz*., number of panicles, panicle weight - and grain weight per metre row length and test weight were recorded under II fortnight of October sowing. Among the genotypes, UAS 334, recorded significantly higher grain yield of 2138.71 kg ha^{-1}, which was on par with genotype UAS 375. Different combination of treatments had significant influence on wheat yield. Sowing of genotype UAS 334 during II fortnight of October recorded significantly higher grain yield of 2684.95 kg ha^{-1}, maximum gross returns (₹ 117035 ha^{-1}), net returns (₹ 67933 ha^{-1}) and B:C (2.38).

Key words: Genotypes, Sowing dates, Wheat, Yield, Yield attributes

Introduction

Wheat is the world's largest cultivated cereal crop and a staple food crop of many countries across the globe. It is known as the king of cereals due to its adoptability to grow in different soil and agro-climatic conditions than any other cereals. It has been seen as a symbol of green revolution that curtailed the "ship to mouth" existence of our nation back in 1960's. Globally wheat is grown over an area of 220.7 million ha with a production of 781 million metric tons where China, India, Russia and Australia together contribute to 40% of world production and the productivity is 3.53 tons per ha (Anon, 2022a). India is the second largest producer of wheat with a production of 112.18 million tons in an area of 31.868 million ha and the productivity is 3.5 tons per ha (Anon, 2023). The major producing states are Uttar Pradesh, Punjab and Haryana (Anon, 2022b). In Karnataka area under wheat is 1.84 million ha with a production of 2.48 million tons where major producing districts are Belgaum, Vijayapura, Dharwad and the productivity is 1.352 tons per ha (Anon, 2022c,).

Photo-synthetically wheat is a C_3 plant, it thriving well in cool environment. Wheat can be grown from areas that receive an average annual precipitation of 300-1130 mm (Bhardwaj *et al*., 2010). It is a thermo sensitive long-day plant and requires a temperature range of 20°C to 25°C for sowing and germination and of 16°C to 22°C optimum for vegetative growth. At the time of grain development wheat requires a mean maximum temperature of about 25°C for at least 4-5 weeks. It's been noted that wheat crops sown at the usual time generally have longer crop duration, allowing for greater biomass accumulation compared to late-sown crops. Consequently, this leads to higher grain and biological yield (Gupta *et al*., 2017). The performance of different varieties varies according to their genetic potential and adaptability to specific environments. Therefore, there is an opportunity to enhance wheat yield by cultivating climate-resilient varieties (Hussain *et al*., 2018).

Optimizing the sowing time and selecting high-performing wheat varieties suitable for specific sowing times are crucial factors in achieving maximum yield and efficient conversion of biomass into economic yield. With this perspective in mind, the present investigation was carried out to find suitable sowing dates and genotypes to get higher productivity.

Material and methods

A field experiment was conducted to study the response of wheat to different sowing dates and genotypes during *rabi* 2023-24 at Regional Agricultural Research Station, Vijayapura, Karnataka on *vertisol* having pH 8.21 and EC 0.23 dSm^{-1}. Low in available Nitrogen (178.5 kg N ha^{-1}), medium in available Phosphorus (29.2 P_2O_5 ha^{-1}), high in available Potassium (407.8 kg K_2O ha^{-1}. The experimental site was located at 16° 49' North latitude, 75° 43' East longitudes and at an altitude of 593 m above the mean sea level in the Northern Dry Zone of Karnataka (Zone 3). During the year 2023, a total rainfall of 327 mm was received in 30 rainy days from January to December 2023 as against the normal rain of 594.4 mm which was received in 38 rainy days. Rainfall of 13.2 mm received during the experimental period (October 2023 to March 2024).

The experiment was laid out in Randomized Complete Block Design (factorial concept) with three replications. There were 12 treatment combinations consisting of four sowing windows *viz*., II fortnight of October, I fortnight of November, II fortnight of November and I fortnight of December and four genotypes

Table 1. Number of panicles per metre row length, Panicle weight per metre row length, Grain weight per metre row length and 1000 grain weight of wheat as influenced by sowing dates and genotypes

Treatments	Number of panicles per metre row length	Panicle weight (g) per metre row length	Grain weight (g) per metre row length	1000 grain weight (g)
Sowing dates (D)				
D_1: II FN of October	115	203.89	167.60	40.04
D_2: I FN of November	111	185.56	125.46	36.35
D_3: II FN of November	101	116.34	73.63	34.72
D_4: I FN of December	89	91.65	57.55	33.00
S. Em ±	2.44	3.32	1.90	0.58
C. D. at 5%	7.18	9.72	5.57	1.69
Genotypes (V)				
V_1: UAS 304	96	130.90	85.45	34.28
V_2: UAS 334	110	163.02	128.12	37.83
V_3: UAS 375	106	154.17	104.62	35.98
S. Em ±	2.12	2.87	1.64	0.50
C.D. at 5%	6.22	8.42	4.82	1.46
Interaction (D × V)				
D_1V_1	105	177.18	135.96	36.03
D_1V_2	131	230.06	225.92	45.21
D_1V_3	110	204.44	140.93	38.87
D_2V_1	98	171.64	102.54	34.66
D_2V_2	116	197.59	140.34	35.24
D_2V_3	119	187.46	133.52	38.16
D_3V_1	96	95.36	58.37	34.44
D_3V_2	101	113.28	73.63	36.84
D_3V_3	107	140.39	88.89	33.89
D_4V_1	86	79.41	44.93	31.99
D_4V_2	93	111.16	72.57	34.02
D_4V_3	87	84.37	55.14	32.99
S. Em±	4.24	5.74	3.29	1.00
C.D. at 5%	12.44	16.84	9.65	2.92

FN: fortnight; DAS: days after sowing

viz., UAS 304, UAS 334 and UAS 375. The crop was raised with a spacing of 30 cm × 5 cm. Recommended packages of practices and dose of fertilizer were uniformly followed for all the treatments.

The crop was harvested at maturity by cutting manually at ground level. The plants were dried properly under the sun and threshing was done manually. Yield attributes and yield observations of wheat were recorded from the net plots. Grains were cleaned and weight was recorded plot wise, the grain yield of sampled plants were also added to net plot grain yield and finally expressed as kg ha^{-1}. The economics of each treatment was computed with prevailing market prices. The yield was further computed for gross and net returns as well B:C ratio to assess the profitability. The data collected from the experiment were subjected to statistical analysis as described by Gomez and Gomez (1984).

Results and discussion

Effect of sowing dates, genotypes and their interaction on yield and yield attributes of wheat

The data on yield parameters of wheat are presented in Table 1. Number of panicles per metre row length was significantly affected by sowing dates. Among dates of sowing, higher number of panicles per metre row length was observed in II fortnight of October sowing (115.70), followed by I fortnight of November sowing (111.26). Similar findings were observed by Bankar *et al.* (2018) where, all yield attributes were found maximum under timely sown condition over late sowing in peninsular zone. This could be attributed to the favourable environmental conditions and enhanced translocation of photosynthates during the crop's reproductive stage. Among genotypes, higher number of panicles per meter row length was recorded in UAS 334 (110.72), which was on par with genotype UAS 375 (106.17). There was significant difference in interaction between sowing dates and genotypes for number of panicles per metre row length. Genotype UAS 334 sown during II fortnight of October (D1V2) recorded significantly higher number of panicles per meter row length (131.44).

The data on panicle weight per metre row length showed a declining trend with delay in sowing. Among dates of sowing, higher panicle weight per metre row length was observed in treatment II fortnight of October sowing (203.89 g), followed by I fortnight of November (185.56 g). However, the lowest panicle weight per metre row length was observed with delayed sowing (I fortnight of December). This reduction of panicle weight per metre row length might be because of acceleration of senescence due to extreme temperature and heat. As per Lobell *et al.* (2012), temperature greater than 34°C resulted in early onset of senescence that limit grain filling. The results of the investigation found that genotype UAS 334 recorded the

Table 2. Grain yield, straw yield and harvest index of wheat as influenced by sowing dates and genotypes

Treatments	Grain yield (kg/ha^{-1})	Straw yield (kg/ha^{-1})	Harvest index(%)
Sowing dates (D)			
D_1: II FN of October	2534.72	4915.12	34.01
D_2: I FN of November	2166.74	4244.29	33.78
D_3: II FN of November	1735.42	3760.03	31.55
D_4: I FN of December	1516.40	3642.44	29.36
S. Em ±	75.04	84.17	0.52
C.D. at 5%	220.10	246.86	1.52
Genotypes (V)			
V_1: UAS 304	1849.22	3985.53	31.43
V_2: UAS 334	2138.71	4198.61	33.53
V_3: UAS 375	1977.03	4237.27	31.57
S. Em ±	64.99	72.89	0.45
C.D. at 5%	190.61	213.79	1.32
Interaction (D × V)			
D_1V_1	2337.50	4625.00	33.57
D_1V_2	2684.95	5002.31	34.93
D_1V_3	2581.71	5118.06	33.53
D_2V_1	2041.09	4064.81	33.43
D_2V_2	2355.21	4274.54	35.52
D_2V_3	2103.93	4393.52	32.38
D_3V_1	1610.88	3664.35	30.54
D_3V_2	1864.00	3805.56	32.88
D_3V_3	1731.37	3810.19	31.24
D_4V_1	1407.41	3587.96	28.17
D_4V_2	1650.69	3712.04	30.78
D_4V_3	1491.09	3627.31	29.13
S. Em ±	129.98	145.79	0.90
C.D. at 5%	246.226	NS	NS

NS: Not significant; FN: fortnight; DAS: days after sowing

highest panicle weight per metre row length (163.02 g), followed by UAS 375 (154.17 g) and lowest was recorded in genotype UAS 304 (130.90 g). This could be attributed to greater grain weight per metre row length and test weight recorded in genotype UAS 334 compared to other genotypes, resulting in higher panicle weight per metre row length. Among interactions, UAS 334 genotype sown during II fortnight of October recorded higher panicle weight per metre row length (230.06 g) and lowest was observed in genotype UAS 304 sown during I fortnight of December.

In the present study, higher grain weight per metre row length was recorded under II fortnight of October sowing (167.60 g), followed by the crop sown during I fortnight of November (D2, 125.46). The possible reason could be early sowing during II fortnight of October resulted in more accumulation of heat units, more assimilate production, number of panicles per metre row length and panicle weight per metre row length. Among the different genotypes studied in the experiment, wheat genotype UAS 334 recorded the highest grain weight per metre row length (128.12 g), followed by genotype UAS 375. The increased grain weight can be attributed to their capacity to produce greater biomass and effectively channel photosynthates to the economically valuable parts of the plant. UAS 334 genotype sown during II fortnight of October recorded higher grain yield per metre row length (225.92 g) and lowest was observed in genotype UAS 304 sown during I fortnight of December. The favourable weather conditions during flowering likely contributed to improved pollination and seed setting. However, when sowing is delayed, the flowering stage coincides with higher temperatures, which can hinder pollination and lead to reduced grain yield.

Higher test weight was recorded with the treatment II fortnight of October sowing (40.04 g), followed by I fortnight of November sowing (D_2) (36.35 g), while the lowest test weight was observed in wheat crop sown during I fortnight of December (D_4) (33 g). This might be due to temperature stress, shorter grain filling period, reduced photosynthesis and inadequate maturity of late sown crop. Similar findings were noted by Coventry *et al.* (2011), where lowest yield was observed in December sown crop for all varieties as late sowing resulted in lower test weight of the crop. Among the different genotypes studied in the experiment, wheat genotype UAS 334 recorded the highest test weight (37.83g), followed by genotype UAS 375. Test weight is probably associated with the genetic characteristics of the genotypes. Among interaction between sowing dates and genotypes there was significant variation observed in test weight. UAS 334 genotype sown during II fortnight of October recorded higher test weight (45.21 g).

The yield of wheat were greatly influenced by sowing dates and genotypes. This study revealed that, among the sowing dates, the II fortnight of October (D_1) sowing resulted in significantly higher grain yield (2534.72 kg ha^{-1}) as compared to other treatments (Table 2), and the lower grain yield (1516.40 kg ha^{-1}) was recorded under I fortnight of December sowing (D_4). II fortnight of October sowing (D_1) recorded 16.9%, 46.05% and 67.15% higher grain yield than I fortnight of November (D_2) II fortnight of November (D_3) and I fortnight of December sowing (D_4), respectively. This was likely because the crops sown in II fortnight of October benefited from favourable climatic conditions for longer period, including optimal temperatures, relative humidity, and other weather factors that support various growth stages. Similar results were recorded by Tripathi *et al.* (2013) in wheat. The genotype UAS 334 registered a -significantly higher grain yield (2138.71 kg ha^{-1}), which was on par with genotype UAS 375 (1977.03 kg ha^{-1}). This could be due to the genetic potential of the genotype that results in increased reproductive efficiency and overall plant productivity. This can also be linked to its better accumulation of dry matter and advantageous traits, such as number of panicles per metre row length, harvest index, panicle weight per metre row length, and improved test weight, all contributing to higher yield. Among interactions, sowing of wheat genotype UAS 334 during II fortnight of October recorded significantly higher grain yield (2684.95 kg ha^{-1}), which is on par with genotype UAS 375 sown during II fortnight of October. The notable increase in grain production can be attributed to favourable temperatures during various growth stages. Similar findings were also reported by Jatti (2013), where, wheat variety DWR-162 sown during II fortnight of October recorded higher grain yield.

Table 3. Cost of cultivation (₹ ha $^{-1}$), Gross returns (₹ ha $^{-1}$), Net returns (₹ ha $^{-1}$) and B:C of wheat as influenced by sowing dates and genotypes

Treatments	Cost of cultivation (₹ ha $^{-1}$)	Gross Returns (₹ ha $^{-1}$)	Net Returns (₹ ha $^{-1}$)	B:C
Sowing dates (D)				
D_1: II FN of October	49,102	111065	61963	2.26
D_2: I FN of November	49,102	95069	45967	1.94
D_3: II FN of November	49,102	77226	28124	1.57
D_4: I FN of December	49,102	68550	19448	1.40
S. Em±	-	597	597	0.01
C.D. at 5%	-	1750	1750	0.03
Genotypes (V)				
V_1: UAS 304	49,102	82227	33125	1.67
V_2: UAS 334	49,102	93867	44765	1.91
V_3: UAS 375	49,102	87839	38737	1.79
S. Em±	-	517	517	0.01
C.D. at 5%	-	1515	1515	0.03
Interaction (D × V)				
D_1V_1	49,102	102700	53598	2.09
D_1V_2	49,102	117035	67933	2.38
D_1V_3	49,102	113459	64357	2.31
D_2V_1	49,102	89756	40654	1.83
D_2V_2	49,102	102322	53220	2.08
D_2V_3	49,102	93130	44028	1.90
D_3V_1	49,102	72206	23104	1.47
D_3V_2	49,102	82249	33147	1.68
D_3V_3	49,102	77223	28121	1.57
D_4V_1	49,102	64245	15143	1.31
D_4V_2	49,102	73862	24760	1.50
D_4V_3	49,102	67543	18441	1.38
S.Em±	-	1033	1033	0.02
C.D. at 5%	-	3030	3030	0.06

FN: fortnight; DAS: days after sowing

Higher straw yield was recorded with treatment II fortnight of October sowing (4915.12 kg ha^{-1}) (Table 2), followed by I fortnight of November sowing (D_2) (4244.29 kg ha^{-1}) and lower straw yield was recorded with I fortnight of December sowing (D_4) (3642.44 kg ha^{-1}). This might be due to crop sown in October benefiting from favourable climatic conditions, including optimal temperatures and other weather factors throughout their growth stages. This conducive environment enhances overall growth and better assimilation of nutrients. Favourable weather conditions during the cropping season are closely linked to the ideal sowing timing. The genotype UAS 375 recorded higher straw yield of 4237.27 kg ha^{-1} and which is on par with genotype UAS 334 (4198.61 kg ha^{-1}). In the present study, genotype UAS 375 was noted with higher straw yield but slightly lower grain yield. This might be due to more allocation of resources to vegetative growth rather than grain production. This can also occur due to a greater emphasis on developing robust stems and leaves, which enhances straw yield but slightly reduces the energy available for grain filling. Among interaction between sowing dates and genotypes, no significant variation in straw yield.

Significantly higher harvest index was recorded with II fortnight of October sowing (34.01%) (Table 2), which was on par with I fortnight of November sowing (D_2) (33.78%). The probable reason could be that sowing of wheat in the second fortnight of October often coincides with adequate soil moisture levels from post-monsoon rains. The data pertaining to harvest index was significantly higher in genotype UAS 334 (33.53%). The probable reason for higher harvest index in genotype UAS 334 may be due to higher total dry matter and other yield contributing parameters when compared to other genotypes. Among interaction between sowing dates and genotypes, no significant variation in harvest index were observed. This might be because harvest index is less directly influenced by the interaction between sowing dates and genotypes as they are more related to overall biomass production and resource allocation rather than specific grain quality attributes.

Effect of sowing dates, genotypes and their interaction on economics of wheat

A significant difference in economics was observed due to different sowing dates of wheat genotype (Table 3). The wheat sown during II fortnight of October out performed other sowing dates and recorded higher gross returns (₹ 111065 ha^{-1}), net returns (₹ 61963 ha^{-1}) and B: C (2.26) and the lowest was recorded with I fortnight of December (Table 3). This is due to the fact that II fortnight of October sowing resulted in higher grain yield compared to other sowing dates leading to greater returns. Similar results were noted by Tripathi *et al.* (2013), where October sowing resulted in higher B: C, net returns and gross returns compared to November sown crop. Additionally, third week of October sowing noted a higher B: C of 2.10 compared to other sowing dates (Dhaka *et al.* 2018). Among all genotypes, UAS 334 genotype recorded significantly higher gross returns (₹ 93867 ha^{-1}), net returns (₹ 44765 ha^{-1}) and B: C (1.91). This might be due to more effective utilization of available resources by genotype UAS 334 than remaining genotypes which resulted in better growth and higher yield. Among the interactions, genotype UAS 334 sown during II fortnight of October recorded significantly higher gross returns (₹ 117035 ha^{-1}), net returns (₹ 67933 ha^{-1}) and B: C (2.38). Jatti (2013) noted higher net returns and B: C for wheat variety DWR 162 sown during 43^{rd} SMW.

Conclusion

The study concludes that sowing wheat genotype UAS 334 in the II fortnight of October provides ideal weather conditions for growth and development. This sowing window optimizes soil moisture utilization, resulting in enhanced growth, higher yield and improved yield attributes and also recorded the highest economic returns.

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