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Effect of sowing environment and varieties on growth and quality of durum wheat (*Triticum durum* L.)

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Abstract
A field experiment entitled "Effect of Sowing Environment and Varieties on Growth and Quality of Durum Wheat (*Triticum durum* L.)" was conducted during *Rabi* season of 2021-22 at Instructional Farm of Agronomy, Department of Agronomy, Rajasthan College of Agriculture (MPUAT) Udaipur, Rajasthan. The experiment was laid out in split plot design having four dates of sowing (D_1: 1st November, D_2: 10th November, D_3: 20th November and D_4: 30th November) as main plot treatments and four varieties (V_1: HI 8713, V_2: HI 8737, V_3: HI 8663 and V_4: HI 8759) as sub plot treatments. These sixteen treatment combinations were replicated three times. The results indicated that different dates of sowing and varieties significantly influenced the growth and quality of durum wheat. The results revealed that the crop sown on 20th November had significantly enhanced the plant growth parameters *viz.*, plant height, dry matter accumulation, dry matter partitioning, total tillers, flag leaf area and days to 50 per cent heading. Quality parameters *viz.* protein content of grain has no any significant effect under the various dates of sowing. Various durum wheat varieties caused a significant influence on the growth parameters of wheat. Among the different varieties, HI 8713 variety recorded the maximum improvement in the growth parameters *viz.*, plant height, dry matter accumulation, dry matter partitioning, total tillers, flag leaf area and days to 50 per cent heading. There was no any significant variation reported among different tested varieties for protein content in grain. But the maximum protein content was noted in wheat variety HI 8713 (12.75%).

Keywords: Wheat, sowing, growth, varieties

1. Introduction
The wheat (*Triticum Aestivum* L.) crop belongs to grassy family Poaceae or Gramineae and is one of the most imperative cereal crop of the world that has been considered as integral component of food security system of several nations. It is largest grown cereal in the world and it supplements around 19 per cent of our total calories in human dietary. This crop is commonly known as "king of cereals" because of its wider adaptability to diverse agro-climatic conditions and its productivity. It has virtuous nutrition profile with protein (12.1%), lipids (1.8%), ash (1.8%), reducing sugars (2.0%), pentose's (6.7%) and provides 314 Kcal.100g^{-1} of food apart these it has several minerals and vitamins *viz*., calcium (37mg 100g^{-1}), iron (4.1mg 100g^{-1}), thiamine (0.45mg 100g^{-1}), riboflavin (0.13mg 100g^{-1}) and nicotinic acid (5.4mg 100mg^{-1}). Wheat contains a high amount of gluten, the protein that provides the elasticity necessary for excellent bread making. It is highly valued for making semolina (Suji) and vermicelli. It is extensively used in the preparation of various traditional/ popular recipes like noodles, snacks, roasted doughs (batti), porridge, upma and ladoos (Choudhary and Ali, 2007) [4].

The tetraploid (2n = 28) species *i.e*., durum wheat (*Triticum durum* L.) is known as pasta or macaroni wheat. The typical durum wheat grain is very hard, vitreous and amber coloured with rich in protein content. The composition of durum wheat is comparable to that of ordinary wheat. In Durum wheat kernel starch and lipid have about equal amount but protein content is some more to bread wheat. Durum wheat is second most important cultivated species after common/chapati/ *aestivum* wheat, although this species is cultivated in 5 to 8 per cent of the total cultivated wheat area worldwide (about 17.0 million ha) and production 38 million tonnes (Xynias *et al*., 2020) [13]. Amongst durum wheat production, Canada is the leading country followed by Italy and Turkey in the world. However, the largest consumers of durum wheat are the Mediterranean countries, where most of the production process takes place. In India, durum wheat mainly grown in central and peninsular zone which includes Madhya Pradesh,

Gujarat, southern part of Rajasthan, Karnataka and Maharashtra states and produces around 1.0-1.2 million tonnes.

Date of sowing create differ environment that has a significant impact on wheat crop output. The ideal sowing date affects the crop's ability to obtain the best possible circumstances for water, temperature, relative humidity, and solar radiation. It also has a favorable impact on the growth, production, and quality of wheat by allowing for improved physiology and environmental adaptation.

Various varieties in wheat have differ genetic makeup and perform as accordance with diverse environments. Different varieties are of greater significance and these are the main factors which determine the good crop stand which in turn influences the yield and monitory return (Kabesh *et al*., 2009) [8]. There is potential to increase wheat production by cultivating climate resilient varieties since performance of varieties varies according to their genetic potential and adaptable environment. Poor variety selection also negatively impacts on crop productivity (Hussain *et al*., 2012) [7]. Varieties with ability to tolerate high temperature perform well under late sown conditions, whereas varieties with no such genetic machinery are good under early sowing. Similarly, susceptible varieties matured earlier when planted late, indicating the forced maturity due to high temperature. The yield of wheat crop can enhance 10 to 80 per cent only through selection of suitable cultivars as environment suitability (Coventry *et al*., 2011) [5].

2. Materials and Methods

2.1 Description of the study area

The experiment was conducted at the Instructional Farm of Agronomy, Department of Agronomy, Rajasthan College of Agriculture, Udaipur (Rajasthan). The site is located at 24°35' N latitude and 74°42' E longitude in the South-Eastern part of Rajasthan, at an altitude of 582.17 metres above mean sea level and the region falls under NARP agro-climatic zone IVa *i.e.* Sub-Humid Southern Plain and Aravalli Hills of Rajasthan. The climate in this region is characteristic of the subtropics, with mild winters and cool summers, as well as high relative humidity from July to September. The average annual rainfall in the region is 600.8mm, with the South-West monsoon accounting for the majority of this (80-85%) from July to September. The texture of the soil was clay loam, medium in organic carbon, low in available nitrogen, medium in available phosphorus and medium in available potassium.

2.2 Experimental details

The experiment comprised of sixteen treatment combinations four date of sowing *i.e.* D_1 (1st November), D_2 (10th November), D_3 (20th November), D_4 (30th November) and four crop varieties *i.e.* HI 8713, HI 8737, HI 8663 and HI 8759. The trial was laid out in split plot design with 3 replications. Sowing was done on 1st November, 10th November, 20th November and 30th November using 100kg seed ha^{-1}. Line sowing was done at 20cm apart row opened through the manual labour and seeds were placed at 4 to 5cm depth. For the control of complex weed flora in experimental field, ready mix of post emergence selective herbicide *i.e.*, Vesta (Trade name) Clodinafop propargyl 15% + Metsulfuron methyl 1% WP was dissolved in one litres of water ha^{-1} and sprayed with the help of knapsack sprayer at 32 DAS. Irrigations were given to durum wheat crop according to the treatments. As per recommendation, a uniform dose of nitrogen @ 120kg ha^{-1}supplied through urea, phosphorus @ 60kg ha^{-1} through S.S.P. and potassium @ 40kg ha^{-1} through MOP was applied in to all plots. The half quantity of nitrogen and full quantity of phosphorus and potassium were applied in the field during final field preparation. The rest half dose of nitrogen was top-dressed in two splits, after first and second irrigation of the crop.

3. Results and Discussion

3.1 Growth parameters

3.1.1 Days to emergence

Data pretested in the Table 1 shows that the sowing dates and various varieties did not cause any significant variation on days to emergence of wheat crop. These results are in line with that of Babiker *et al*. (2017) [1] who observed non-significant effect of sowing dates on seed germination.

3.1.2 Plant population

Different date of sowing and various varieties did not cause any significant variation on plant population 0.5 m row length at 15 DAS (Table 1).

3.1.3 Plant height

An analysis of data from Table 1 indicates that different sowing dates and various varieties did not affect the plant height at 25 DAS and significantly differ at 50 DAS, 75 DAS and at harvest.

Wheat crop was sown on 20th November recorded the maximum plant height at 50 DAS (44.17cm), 75 DAS (77.23cm) and at harvest (101.24cm) which was statistically at par with 10th November (42.71cm, 74.22cm and 97.04cm at 50 DAS, 75 DAS and at harvest, respectively) but statistically higher over 1st and 30th November sown crop. In case of different varieties, the maximum plant height at 50 DAS (43.29cm), 75 DAS (75.97cm) and at harvest (97.63cm) was observed in wheat variety HI 8713 but it was statistically at par with another variety HI 8759 (42.59cm, 74.86cm and 97.01cm at 50 DAS, 75 DAS and at harvest, respectively) but statistically higher over other two durum varieties *viz*., HI 8737 and HI 8663. It might be due to maximization of growing phase, favorable temperature and other climatologically parameters which were essential for the growth. These results were similar with findings of Singh (2016) [11] and Khatik and Yadav (2020) [3].

3.1.4 Dry matter accumulation

A result from Table 1 indicates that dry matter accumulation at 25 DAS did not show any significant variation among different dates of sowing and various varieties but significantly differ at 50 DAS, 75 DAS and at harvest.

Wheat crop was sown on 20th November recorded the maximum dry matter accumulation at 50 DAS (41.68g), 75 DAS (167.76g) and at harvest (417.74g) which was statistically at par with 10th November (38.31 g, 161.24 g and 400.56g at 50 DAS, 75 DAS and at harvest, respectively) but statistically higher over 1st and 30th November sown crop. In case of different varieties, the maximum plant height at 50 DAS (42.27g), 75 DAS (166.26g) and at harvest (419.40g) was observed in wheat variety HI 8713 but it was statistically at par with variety HI 8759 (40.76g, 162.32g and 401.30g at 50 DAS, 75 DAS and at harvest, respectively) but statistically higher over rest two durum varieties *viz*., HI 8737 and HI 8663. It might be due crop recorded highest plant height, number of tillers and flag leaf area thus all these characters

play an active role in increasing dry matter production. This finding is supported by Yadav *et al*. (2017) [14] and Singh *et al*. (2021) [12].

3.1.5 Dry matter partitioning plant^{-1}

3.1.5.1 Stem

It is clarifying from Table 2 that highest dry matter partitioning of stem (122.82g) was found under 3rd date of sowing (20th November), which was statistically at par with crop sown on 10th November (117.77g) however, statistically superior over crop sown on 1st and 30th November. In case of different wheat varieties, HI 8713 had recorded higher dry matter partitioning (123.30g) of stem, which was statistically at par with variety HI 8759 (117.98g) however, statistically higher over rest of varieties *viz*., HI 8737 and HI 8663.

3.1.5.2 Leaves

A critical study of data in Table 2 shows that the maximum dry matter partitioning of leaves (113.29g) in case of dates of sowing was obtained from sowing done on 20th November, which was statistically at par with sowing date is 10th November (108.63g) but statistically superior over 1st sowing date (1st November) and last (30th November) sowing. In case of different wheat varieties, higher dry matter partitioning (113.74g) of leaves was obtained from variety HI 8713, it was statistically at par with variety HI 8759 (108.83g) however, statistically higher over variety HI 8737 and HI 8663.

3.1.5.3 Spikelet

Data from (Table 2) indicates that the maximum dry matter partitioning (181.63g) of spikelet was found under 20th November sowing date, which was statistically at par with crop sown on 10th November (174.16g) but statistically greater over first (1st November) and last (30th November) sowing date. In case of different wheat varieties, HI 8713 had found the higher dry matter partitioning (182.35g) of spikelet, it was statistically at par with variety HI 8759 (174.48g) but, statistically superior over remaining variety HI 8737 and HI 8663.

3.1.6 Total tillers at harvest

In reference to the Table 2 shows that 3rd date of sowing (20th November) listed the maximum number of tillers (41.67) which was statistically at par with 2nd date (10th November) of sowing (38.58) but statistically higher over first (1st November) and last (30th November) sowing date. In case of different durum wheat varieties, variety HI 8713 recorded the highest number of tillers (39.28), which was statistically at par with variety HI 8759 (38.62) but statistically superior over other examined varieties *i.e*., HI 8737 and HI 8663. Higher tillering might be due to higher leaf area (source) to accumulate and translocate higher values of photosynthates and also variation in tillering might be due to their genetic makeup. The results of this study are in close conformism Hussain *et al*. (2018) [7].

3.1.7 Flag leaf area at 70 DAS

Data from the Table 2 elucidates that 3rd date of sowing (20th November) leads to maximum flag leaf area (48.42cm^2) and it was statistically at par with 10th November (48.02cm^2) but it is statistically superior over 1st November and 30th November date of sowing. In case of different durum wheat varieties, variety HI 8713 recorded the highest flag leaf area (47.66cm^2) which was significantly superior over other examined durum wheat varieties. Similar results have been reported in wheat by Bachhao *et al*. (2018) [2].

3.1.8 Days to 50 per cent heading

Data persuaded from the Table 2 indicates that the maximum days taken for 50 per cent heading was under 20th November (69.83) sowing date and it was statistically at par with 10th November (69.52) sown crop but significantly higher over 1st November and 30th November date of sowing. In case of different durum wheat varieties, maximum days for 50 per cent heading was recorded from variety HI 8713 (69.08) that was statistically at par with variety HI 8759 (68.68) but significantly higher over crop variety HI 8738 and HI 8663. Similar trend have been observed by Mumtaz *et al*. (2015) [10].

3.1.9 Days to 50 per cent maturity

When we compared the data given in the Table 2 it was concluded that the maximum number of days taken for 50 per cent maturity (130.27) was recorded under 2nd date of sowing (10th November) but it was statistically superior over rest of all sowing dates i.e., 1st, 20th and 30th November. In case of different durum wheat varieties, days taken for 50 per cent maturity were no significant variation. The results of this study are in close conformism by Chauhan *et al*. (2020) [3].

3.2 Quality parameter

3.2.1 Protein content

Data persuaded in Table 2 did not notice any significant variation for protein content of grain under the different dates of sowing and various durum varieties.

Table 1: Effect of sowing environment and varieties on days to emergence, plant population at 15 DAS, plant height and dry matter accumulation at 25 DAS, 50 DAS, 75 DAS and harvest of durum wheat

Treatments	Days to emergence	Plant population at 15 DAS (0.5 m row length)	Plant height (cm)				Dry matter accumulation (g) (0.5 m row length)			
			25 DAS	50 DAS	75 DAS	At harvest	25 DAS	50 DAS	75 DAS	At harvest
Date of sowing										
1st November	7.00	13.18	20.87	40.55	71.85	91.56	7.47	34.66	152.42	312.61
10th November	7.33	13.50	21.55	42.71	74.22	97.04	7.81	38.31	161.24	400.56
20th November	7.50	13.58	22.17	44.17	77.23	101.24	8.27	41.68	167.76	417.74
30th November	8.08	13.42	22.08	42.10	73.23	93.49	7.87	36.84	157.08	366.95
SEm±	0.25	0.27	0.31	0.56	1.05	1.92	0.19	1.01	2.58	8.32
CD (p = 0.05)	NS	NS	NS	1.95	3.62	6.65	NS	3.49	8.94	28.80
Varieties										
HI 8713	7.42	13.33	21.70	43.29	75.97	97.63	7.94	42.27	166.26	419.40
HI 8737	7.67	13.51	21.52	42.12	73.01	96.57	7.61	32.83	154.83	349.17
HI 8663	7.33	13.44	21.66	42.03	72.68	92.13	7.94	35.63	155.11	328.00
HI 8759	7.50	13.41	21.64	42.59	74.86	97.01	7.92	40.76	162.32	401.30

SEm±	0.19	0.16	0.30	0.33	0.43	0.85	0.09	0.56	2.04	8.29
CD (p = 0.05)	NS	NS	NS	0.95	1.27	2.47	NS	1.63	5.96	24.19

Table 2: Effect of sowing environment and varieties on leaf, stem and spikelet dry matter partitioning plant^{-1} (g), total tillers, flag leaf area at 70 DAS, Days to 50 per cent heading, days to 50 per cent maturity and protein content (%) of durum wheat

Treatments	Dry matter partitioning plant^{-1} (g)			Total tillers (0.5 m row length)	Flag leaf area at 70 DAS	Days to 50 per cent heading	Days to 50 per cent maturity	Protein content (%)
	Stem	Leaves	Spikelet					
Date of sowing								
1st November	91.91	84.78	135.92	35.68	45.30	64.68	123.60	12.58
10th November	117.77	108.63	174.16	38.58	48.02	69.52	130.27	12.69
20th November	122.82	113.29	181.63	41.67	48.42	69.83	120.36	12.70
30th November	107.88	99.52	159.55	36.16	44.66	64.68	120.14	12.64
SEm±	2.45	2.26	3.62	0.97	0.75	0.77	0.39	0.14
CD (p = 0.05)	8.47	7.81	12.52	3.37	2.58	2.67	1.36	NS
Varieties								
HI 8713	123.30	113.74	182.35	39.28	47.66	69.08	124.16	12.75
HI 8737	102.65	94.69	151.82	37.51	46.24	67.78	123.50	12.62
HI 8663	96.43	88.95	142.61	36.68	46.09	67.51	122.82	12.60
HI 8759	117.98	108.83	174.48	38.62	46.41	68.68	123.88	12.65
SEm±	2.44	2.25	3.60	0.40	0.41	0.34	0.38	0.14
CD (p = 0.05)	7.11	6.56	10.52	1.18	1.20	0.99	NS	NS

4. Conclusion

On the basis of one year investigation entitled "Effect of Sowing Environment and Varieties on Growth and Quality of Durum Wheat (*Triticum durum* L.)", it can be concluded that the highest growth and quality parameter were obtained with D_3: 20th November sowing date, which was statistically at par with D_2: 10th November date. In case of different durum wheat varieties, highest growth and quality parameter were fetched from V_1: HI 8713 variety and it were statistically at par with V_4: HI 8759 variety.

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