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Date of Sowing and Varietal Effects on Physiological Parameters in Wheat (*Triticum aestivum* L.)

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ABSTRACT

A field experiment was conducted during *rabi* 2015-16 at Instructional Farm, Department of Agronomy, College of Agriculture JAU, Junagadh to identification of suitable date of sowing and variety of wheat (*Triticum aestivum* L.) for South Saurashtra, Gujarat under changing climatic conditions. The experiment consisting of 12 treatment combinations of four dates of sowing in main plots (05th November, 15th November, 25th November and 05th December) and three varieties in sub plots (GW 322, GW 366 and GW 173) was carried out in split plot design with three replications. Total Growing Degree Days, Helio Thermal Unit, and Photo Thermal Unit was found maximum with sowing on 05th November and canopy temperature at 60 DAS and soil temperature, at emergence, at 7.5 and 15 cm depth was also observed significantly higher with sowing on 05th November. Heat use efficiency was significantly higher with sowing of GW 366 on 15th November. Occurrence of phenological stages viz. CRI, tillering, jointing, anthesis, milking, soft dough and physiological maturity took significantly maximum number of days with sowing of GW 366 on 05th November. Number of irrigations applied was significantly higher at 05th November sowing and water use efficiency was significantly higher with sowing of GW 366 on 15th November.

Key words: *Triticum aestivum* L., Crop production, Sowing dates, Variety, Growth

Wheat (*Triticum aestivum* L.) is a thermo-sensitive and long day plant. Mexican dwarf wheat (*Triticum aestivum* L.) presently grown in India, also known as common bread wheat. Weather is one of the key factors influencing agricultural production and productivity. Studies indicate that weather during cropping season strongly influences crop growth and it accounts for two third of the variation in productivity while other factors including soil and nutrient management accounts for only one third of productivity. The predominant influence of weather is operative even before the crop is sown as the moisture availability and the thermal regime of the seed zone determine the date of sowing and the appropriate genotype to be sown. Among the climatic factors, temperature plays a key role in determining sowing time and consequently the duration of different phenophases and thus the crop productivity of wheat in almost all wheat growing regions starting from germination to maturity (Tewari and Singh 1993). The physiological functions and growth stages are severely affected with temperature which decides the duration of life cycle of wheat plant. Therefore, it is important to identify suitable croping strategies to reduce adverse effects of climate change related increase in temperature on wheat. Optimum date of sowing is an important parameter, which affects the growth and yield attributes of wheat among others and it is one such adaptation strategy which can help to reduce temperature related adverse affects on growth and development of plants. Similarly, selection of suitable cultivar is another important adaptation strategy to minimize the yield losses due to increased temperature (Jat *et al.* 2012).

MATERIALS AND METHODS

A field experiment was conducted during *rabi* 2015-16 at Instructional Farm, Department of Agronomy, College of Agriculture, JAU, Junagadh to identify suitable date of sowing and variety of wheat (*Triticum aestivum* L.) for South Saurashtra, Gujarat under changing climatic conditions. The experiment consisting of 12 treatment combinations of four dates of sowing in main plots (05th November, 15th November, 25th November and 05th December); and three varieties in sub plots (GW 322, GW 366 and GW 173) was carried out in split plot design with three replications. The soil of experimental plot was clayey

in texture and slightly alkaline in reaction with pH 7.8 and EC of 0.35 dS m^{-1}. The soil was medium in available nitrogen (241.0 kg ha^{-1}) and high in available phosphorus (25.5 kg ha^{-1}) and available potassium (259.0 kg ha^{-1}). The crop was sown with the help of hand plough in 22.5 cm apart rows using 120 kg/ha seed rate. Half dose of nitrogen, and full dose phosphorus and potassium was applied at the time of sowing in rows below the seed. While half dose of nitrogen was given in two equal splits at 25 and 45 day after sowing at every sowing. N was applied through DAP and urea, P through DAP, and K through MOP, respectively. Pendimethalin was applied after sowing as pre emergence followed by one hand weeding at 30 days after sowing. Available N was estimated following Kjeldahl method, available P_2O_5 by Olsen method, and available K_2O by flame photometric method.

Growing degree days (GDD) was calculated by followed formula:

$$GDD\ (°C\ day) = [(T_{max} - T_{min})/2] - Tb$$

Where,

T_{max} is the daily maximum air temperature,

T_{min} is the daily minimum air temperature, and

Tb is base temperature. Base temperature for wheat is 4.5°C

Helio thermal unit (HTU) was calculated by followed formula:

$$HTU = GDD \times n$$

Where,

n = actual sunshine hours

Photo thermal unit (PTU) was calculated by following formula:

$$PTU\ (°C\ day\ hours) = GDD \times day\ length$$

Heat use efficiency (HUE) was calculated by followed formula:

$$HUE\ (Kg/ha/°days) = \frac{Grain\ yield\ (kg/ha)}{GDD\ (°C\ days)}$$

Table 1 Effect of date of sowing and varieties on germination percentage

Treatments		Germination percentage
Main plot (Dates of sowing)		
S_1	05 November	90
S_2	15 November	96
S_3	25 November	92
S_4	05 December	88
S.Em±		1.6
C.D. at 5%		5.8
C.V.%		2.8
Sub plot (Varieties)		
V_1	GW 322	91
V_2	GW 366	92
V_3	GW 173	90
S.Em±		0.90
C.D. at 5%		NS
C.V.%		1.69

RESULTS AND DISCUSSION

Effect on germination

The dates of sowing were found to significantly affect germination percentage of wheat. The crop sown on 15th November recorded the highest seed germination which was at par with sowing on 15th November and lowest seed germination was observed in 05th December sowing. Temperature is considered an important factor to decide germination, and dates of sowing determine temperature regimes. The optimal temperature favors a good aptitude to germinate, whereas low and high temperature extends delay in germination (Table 1). However, non-significant difference was observed in germination percentage due to different varieties. Similar results were also reported by Mishra *et al.* (2003).

Table 2 Effect of date of sowing and varieties on GDD, HTU and PTU

Treatments		GDD (°C day)	HTU	PTU (°C day hrs.)
Dates of sowing				
S_1	05 Nov.	1884	19098	84058
S_2	15 Nov.	1770	13712	76935
S_3	25 Nov.	1555	14097	72200
S_4	05 Dec.	1379	14023	62350
Varieties				
V_1	GW 322	1647	15232	73886
V_2	GW 366	1647	15232	73886
V_3	GW 173	1647	15232	73886

Effect on growing degree day, Helio Thermal unit, photo thermal unit and heat use efficiency

Maximum growing degree days, Helio Thermal Unit and Photo Thermal Unit from sowing to maturity was recorded with sowing on 05th November (Table 2) while heat use efficiency was found significantly higher with sowing on 15th November. This could be explained by the fact that delayed sowing resulted in forced maturity and reduced the growth period of wheat because of high temperature prevailed during reproductive phase of late sown crop.

Table 3 Effect of date of sowing and varieties on heat use efficiency

Treatments		HUE (kg/ha/°C day)
Main plot (Dates of sowing)		
S_1	05 Nov.	2.25
S_2	15 Nov.	3.29
S_3	25 Nov.	3.04
S_4	05 Dec.	2.67
S.Em±		0.15
C.D. at 5%		0.53
C.V.%		16.49
Sub plot (Varieties)		
V_1	GW 322	2.87
V_2	GW 366	2.98
V_3	GW 173	2.58
S.Em±		0.03
C.D. at 5%		0.10
C.V. %		3.97

Heat use efficiency (HUE) was found significantly maximum with sowing on 15th November and variety GW 366 (Table 3). These results support the findings of Hariram and Mavi (2012), Nainwal and Singh (2000).

Effect on phenological stages

The occurrence of phenological stages of CRI, tillering, jointing, anthesis, milking, soft dough, and physiological maturity took maximum number of days with sowing on 05th November. The occurrence of soft dough and physiological maturity was statistically at par with 05th November and 15th November sowing. CRI occurred on similar time when sown on 05th November and 15th November. The high temperature observed during vegetative and maturity stages with sowing on 05th November and 05th December, respectively adversely affected growth and development of plants. The number of days taken to attain different phenophases decreased with delay in sowing date. The results are in corroboration with Pande *et al.* (2009). The occurrence of all the phenological stages took maximum number of days in variety GW 366. Occurrence of jointing, anthesis, and soft dough stage was found statistically at pat with GW 322 and GW 173 (Table 4). Similar results have also been reported by Chakrabarti *et al.* (2011).

Table 4 Effect of different date of sowing and varieties on different phenological stages on wheat

Treatments		Phenological stages (number of days)							
		Emergence	CRI	Tillering	Jointing	Anthesis	Milking	Soft dough	Physiological maturity
					Dates of sowing				
S_1	05 Nov.	4	19	26	45	59	71	79	99
S_2	15 Nov.	4	19	24	42	53	69	77	95
S_3	25 Nov.	4	18	23	39	50	67	73	88
S_4	05 Dec.	4	15	22	34	47	61	67	76
S.Em±		0.06	0.10	0.28	0.56	0.87	0.44	1.48	3.07
C.D @ 5%		NS	0.33	0.96	1.92	3.01	1.52	5.11	10.67
C.V.%		4.12	1.60	3.40	4.80	4.97	1.96	6.01	10.36
					Varieties				
V_1	GW 322	4	18	24	39	52	67	73	89
V_2	GW 366	4	19	26	42	55	69	76	92
V_3	GW 173	4	16	23	38	50	65	71	87
S.Em±		0.05	0.12	0.24	0.48	0.67	0.35	1.10	0.98
C.D @5%		NS	0.35	0.72	1.44	2.01	1.05	3.29	3.93
C.V.%		4.14	2.27	3.40	4.16	4.41	1.80	5.16	3.80

Table 5 Effect of date of sowing and varieties on canopy temperature and soil temperature

Treatments		Canopy temperature	Soil temperature (°C)	
		60 DAS (°C)	7. 5 cm	15 cm
		Main plot (Dates of sowing)		
S_1	05 Nov.	28.18	20.00	21.34
S_2	15 Nov.	25.05	18.20	20.76
S_3	25 Nov.	24.89	15.98	16.80
S_4	05 Dec.	23.13	14.47	15.51
S.Em±		0.39	0.45	0.23
C.D @5%		1.36	1.54	0.81
C.V.%		4.56	8.03	3.72
		Sub plot (Varieties)		
V_1	GW 322	25.83	17.16	18.96
V_2	GW 366	25.82	17.22	18.08
V_3	GW 173	25.81	17.11	18.72
S.Em±		0.10	0.09	0.15
C.D @5%		NS	NS	NS
C.V.%		1.31	1.97	2.71

Effect on canopy temperature, soil temperature, number of irrigation, and water use efficiency

Canopy temperature at 60 DAS and soil temperature at emergence at 7.5 and 15 cm depth was observed significantly higher with sowing on 05th November. Canopy temperature was not significantly different among the varieties, (Table 5). Number of irrigations applied was significantly highest with sowing on 05th November.

Table 6 Effect of date of sowing and varieties on number of irrigations and water use efficiency

Treatments		Number of irrigations	Water use efficiency (kg/ha cm)
		Dates of sowing	
S_1	05 Nov.	9	94
S_2	15 Nov.	8	133
S_3	25 Nov.	8	127
S_4	05 Dec.	6	111
S.Em±		0.06	5.7
C.D @5%		0.2	19.9
C.V.%		2.2	14.8
		Varieties	
V_1	GW 322	7.7	120
V_2	GW 366	7.7	124
V_3	GW 173	7.7	106
S.Em±		0.05	1.5
C.D @5%		NS	4.4
C.V.%		2.2	4.4

The higher ambient temperature encountered with early sowing caused faster depletion of soil moisture due to high evapotranspiration losses. The Water use efficiency was significantly higher with sowing on 15th November, being at par with 25th November sowing and significantly maximum water use efficiency was recorded in GW 366 which was statistically at par with GW 322. This may be due to higher grain yield and lower amount of irrigation water applied with sowing on 15th November (Table 6). Similar results have also been reported by Saikia (2011), Kour *et al.* (2013).

Effect on grain yield

Maximum grain yield was found with sowing on 15th November. Ouda *et al.* (2005), Sanghera and Thind (2014) reported that delay in sowing resulted in reduction of grain yield because of exposure of crop to high temperature which reduces length of growing duration of crop. Among the varieties significantly highest yield was recorded with variety GW 366, (Table 7).

The occurrence of phenological stages of CRI, tillering, jointing, anthesis, milking, soft dough, and physiological maturity took maximum number of days with sowing of GW 366 on 05th November. The high temperature observed during vegetative and maturity stages with sowing on 05th November and 05th December, respectively adversely affected growth and development of plants. The number of days taken to attain different phenophases decreased with delay in sowing date resulting decreased yield of wheat crop.

Table 7 Effect of date of sowing and varieties on grain yield

Treatments		Grain yield (kg/ha)
	Main plot (Dates of sowing)	
S_1	05 Nov.	4238
S_2	15 Nov.	5070
S_3	25 Nov.	4704
S_4	05 Dec.	3733
S.Em±		232.3
C.D @5%		803.9
C.V.%		15.7
	Sub plot (Varieties)	
V_1	GW 322	4538
V_2	GW 366	4696
V_3	GW 173	4070
S.Em±		46.5
C.D @5%		139.4
C.V.%		3.6

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