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Phenological changes of different wheat genotypes (*Triticum aestivum* L.) in high temperature imposed by late seeding

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Key words: Phenology, High temperature, Heat tolerant genotypes.

Abstract

The experiment was carried out in the field of Wheat Research Centre (WRC), Bangladesh Agricultural Research institute (BARI), Nashipur, Dinajpur, Bangladesh in the *Rabi* season, 2012-13 to observe the effect of high air temperature on phenological traits of some advanced spring wheat genotypes and to screen heat tolerant genotypes at irrigated late sowing (ILS) conditions.. The treatments were 4 dates of sowing viz. 30 Nov (D_1), 15 Dec (D_2), 30 Dec (D_3) & 14, Jan (D_4) and 4 genotypes viz. BARI Gom 26 (V_1), BAW 1051 (V_2), BAW 1120 (V_3) & BAW 1141(V_4) The genotypes V_2, V_3, and V_4 were undertaken as test genotypes and V_1 as check. The design was split-plot with 3 replications. In ILS conditions, the genotypes faced higher temperature i.e. 19.3 to 26.8 °C mean temperature from 28 November, 2012 to 09 April, 2013 which reduced the duration of booting, heading, anthesis and physiological maturity stages resulting of decreasing the yield of different genotypes along with late seeding conditions. Among the tested genotypes, V_4 exhibited the best performance of all in all ILS conditions compared to Irrigated timely sowing (ITS) condition since its phenological stages lasted longer than those of other genotypes. That means, it could tolerate high temperature. It concludes that BAW 1141 can be cultivated on D_2 and D_3 seeding to get yield more than 4.0 and 3.0 t ha^{-1}, respectively as the most heat tolerant and one of the shortest life span genotype of all, even of all WRC released varieties till now.

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Introduction

Wheat is the very nutritious food grain of all grains in the world. According to its genotypic adaptability it grows world-wide. Due to various reasons, it is the stable food of the universe people and the second main food of the people of Bangladesh also. Accounting for a fifth of humanity's food, wheat is second after rice as a source of calories in the diets of consumers in developing countries and is first as a source of protein (Braun *et al*., 2010). Wheat is an especially critical "staff of life" for the approximately 1.2 billion "wheat-dependent" to 2.5 billion "wheat-consuming" poor-men, women and children-who live on less than $US 2/day (FAOSTAT, 2010). The International Food Policy Research Institute (IFPRI) projections indicate that the world demand for wheat will rise from 552 million tons in 1993 to 775 million tons by 2020, and 60% in total by 2050 (Rosegrant *et al*., 1997; Rosegrant and Agcaoili, 2010).

The temperature of Bangladesh rises day by day. The annual mean temperature of Bangladesh is 25.75°C, which is expected to rise about 0.21°C by 2050 (Karmakar and Shrestha, 2000). The Organization for Economic Co-operation and Development (OECD) (2003) estimated a rise in temperature of 1.4°C by 2050 and 2.4°C by 2100 in Bangladesh. Islam (2009) estimated, from 34 meteorological climate sites in Bangladesh, that temperature increases over the past 100 years-for all Bangladesh-of 0.62°C (maximum) and 1.54°C (minimum) occurred in February. Poulton and Rawson (2011) reported that temperature in Bangladesh increased over the past two decades by 0.035°C/year. If this trend continues, temperatures will have increased 2.13°C more than 1990 levels by 2050.

The heat tolerant spring wheat variety release is a demand of time in context of Bangladesh due to global warming or from the insight of the worst effect aspect of climate change. The optimum time of wheat seeding is 15 to 30 November in our country but it can delay up to 7 December in Northern part of Bangladesh due to cold weather compared as that of other parts of the country. Generally, the farmer of our country cultivates wheat in *Rabi* season after harvesting of T. *aman* rice. This rice cultivation fully depends on natural rainfall. Due to lack of timely or sufficient rainfall, T. *aman* rice can't be planted in time. Ultimately harvesting is done lately. So farmers can't sow wheat seeds in optimum time. Most of the farmers sow wheat seeds on last 15 days of December.

In late sowing condition, wheat crop faces high temperature stress. Heat stress lowers the grain yield significantly. Researchers have pointed out that wheat yield is considerably affected by sowing date (Chio *et al*., 1992; Liszewski, 1999; Michiyama *et al*., 1998; Pecio and Wielgo, 1999). In fact, due to variation of sowing time the air temperature varies widely that affects the phenology of crop plants. On the other hand, Genetic diversity for heat tolerance in cultivated wheat is well established (Midmore *et al*., 1984; Al-Khatib and Pausen, 1990; Reynolds *et al.,* 1994). Different in photosynthesis under heat stress have been shown to be associated with a loss of chlorophyll and a change in a: b chlorophyll ratio due to premature leaf senescence (Al-Khatib and Paulsen, 1984; Harding *et al.,* 1990). Under heat stress, wheat crop completes its life cycle much faster than under normal temperature conditions (Reynolds *et al.,* 1985). If the crop has a short duration consequently, it gets fewer days to accumulate assimilates during life cycle and biomass production is reduced.

Reproductive processes are remarkably affected by high temperature in most plants, which ultimately affect fertilization and post-fertilization processes leading to reduce crop yield (Wahid *et al*., 2007). Several research findings noticed that temperature below (<10°C) or above (>25°C) the optimum (12 to 25°C) alter phenology, growth and development and finally reduce the yield of existing Bangladeshi wheat varieties (Hakim *et al*., 2012; Hossain *et al*., 2009, 2011, 2012a, 2012b, 2012c; Nahar *et al*., 2010; Rahman *et al*., 2009). Thus, heat is the greatest threat to food security in Bangladesh where wheat is the second most important food grain and where population is rapidly increasing (Indexmundi, 2011). The IPCC (2007), CIMMYT-ICARDA (2011), CGIAR

(2009) and OECD (2003) reported that world wheat production will decrease due to global warming and developing countries, like Bangladesh, will be highly affected.

Wheat Research Center (WRC), BARI developed some suitable variety (s) having heat tolerant which can be grown after harvest of T. *aman* rice. Recently, some advanced genotypes have been identified (Barma *et al.*, 2008). As plant responses to high temperature varies with plant species, varieties, locations and phenological stages, it is essential to observe the performance of advanced genotypes of wheat in respect of phonological traits. Therefore, the trial was undertaken to find out heat tolerant suitable genotype (s) for growing in late sowing conditions.

Materials and Methods

Experimental site

The experiment was carried out in the *Rabi* season of 2012-13 (from November to April) in the research field of Wheat Research Centre (WRC), Bangladesh Agricultural Research institute (BARI), Nashipur, Dinajpur, Bangladesh. The soil of the experimental field belongs to under the Old Himalayan Piedmont Plain designated as Agro Ecological Zone 3 (FAO/UNDP, 1988), characterized by flood free highland, fine in texture (Sandy loam and Silty loam), poor in organic matter content and strongly acidic (pH ranges from 4.5 to 5.5) (WRC, 2009). It is situated in northern part of Bangladesh and geographically the area lies between 25°38´ N, 88°41´ E and 38.20 m above sea level.

Treatments and Design

Three advanced genotypes viz. BAW 1051 (V_2), BAW 1120 (V_3) and BAW 1141 (V_4) used as test genotypes and BARI Gom (V_1) as check. One irrigated timely sowing (ITS) and three irrigated late sowings (ILSs) were imposed to provide terminal high temperature over the test genotypes. The ITS was Nov 30 (D_1) and three ILSs were Dec 15 (D_2), Dec 30 (D_3) & Jan 14 (D_4). Sowing times were accommodated in main-plot and the test genotypes were assigned to sub-plot. The unit plot size was 4×5 m.

Fertilizering and Seeding

The land was ploughed four times horizontally with power tiller followed by 12-15 cm depth. Each of the sub-plots was fertilized @ 100-27-50-20-1-4.5-5000 kg ha^{-1} as N-P-K-S-B-Zn-Cow dung. The source of N, P, K, S, B and Zn were used as urea, TSP, MoP, gypsum, boric acid and Zinc sulphate, respectively. All of TSP, MoP, gypsum, boric acid, Zinc Sulphate, Cow dung and two-third of urea were used as basal during final land preparation. Seeds were treated with Provax 200 WP @ 3g/Kg seed, a seed-treated fungicide containing Carboxin and Thiram. Research conducted at the WRC (2009) indicated that Provax-200 WP is a perfect match for controlling fungi in Bangladesh soil, for achieving excellent seed germination and for protecting wheat cultivars from fungal infection during the seedling stage. This fungicide is marketed by Hossain Enterprise CC Bangladesh Ltd., an agrochemical company engaged in crop protection and seed treatment, in association with Chemtura Corp., USA. After well preparation of land seeds @ 120 kg ha^{-1} of each variety/lines were sown continuously in lines 20 cm apart in 2-4 cm depth.

Other intercultural operations

Rest amount of urea was applied as top-dress at CRI stage followed by first irrigation (at 20 DAS). The second irrigation was applied at late booting stage (55 DAS) and another was applied at early grain filling stage (75 DAS). Each sub-plot was kept free from weeds by applying affinity @ 2.5g/litre water at 27 DAS after 1st irrigation. Tilt was sprayed two times @ 0.5 ml/litre water, one just before spike initiation and another was applied 15 days after full heading to control Bipolaris leaf blight (BpLB) disease caused by *Bipolaris sorokiniana.* Each of genotypes was harvested after its maturity.

Data collection and their processing

The crop was harvested plot-wise at full maturity according to treatments. Before harvesting, spikes were counted in one m length from randomized selected 5 rows of sub-plot. Sample plants were harvested separately with sickle from an area of 3×3 m (i.e., 3 m long, 15 middle rows), avoiding border effects. The harvested sample crop of each sub-plot was bundled separately, tagged and taken to a threshing floor. The bundles were thoroughly dried under bright sunshine until fully dried, then weighed and threshed. Threshed grains of each sub-plot were again dried with sunshine and weighed; lastly grain yield was converted into t ha^{-1}. On the other hand, 10 plants were chosen randomly outside sample area from standing crop of the field to measure spike length (cm), to count spikelet (s) $spike^{-1}$ and grain (s) $spike^{-1}$. Thousand grains was counted and weighed, expressed in gram (g).

To obtain the actual yield of all genotypes, grain yield weight was adjusted at 12% moisture by the following equation (Hellevang, 1995):

$$Y(M_2) = \frac{100 - M_1}{100 - M_2} \times Y(M_1)$$

Where, Y (M2) = weight of grain at expected moisture percentage (generally 12% for wheat);

Y (M1) = weight of grain at present moisture percentage;

M1 = present moisture percentage;

Temperature data was recorded regularly by HOBO U12 Family of Data Loggers (MicroDAQ.com) at the meteorological station, WRC, Dinajpur, Bangladesh and is presented in Fig. 1.

Data was analyzed using MSTAT-C (Russell, 1994). Treatment means were compared for significance by the least significant difference (LSD) test at P= 0.05.

Results and Discussion

Booting

In ITS condition, all the genotypes phased booting stage between 53 and 55 days (Table 1). After ITS i.e. in ILS (D_2, D_3, D_4) conditions, the days of booting of all genotypes decreased gradually except D_2 seeding. In D_2 sowing, all genotypes completed booting stage between 55 and 61 days. It was observed that booting duration of all genotypes seeded on 15 December was more than that of all sown on 30 November. Because, during early stage of D_2 seeding, relative humidity {RH (%)} was high i.e. 79-90 % from 19 December, 2012 to 29 January, 2013 and temperature was being decreased from then (Fig. 2). Finally, on 12 January, 2013 average minimum and mean temperature stood at 5.2 °C and 12.8 °C, respectively which affect the booting stage of different genotypes while those genotypes were seeded on 30 November and 15 December. In ILS conditions i.e. after 26 January temperature was being increased gradually, but RH (%) was being decreased which lower the duration of booting stage resulted the low yield of different genotypes (Table 1 and 5). Similar result was also observed by Hossain *et al.*, (2012), Nahar *et al.*, (2010) and Reynolds *et al.*, (1985). Among the genotypes, V_4 took significantly less time on D_1 seeding (53 days). On the contrary, V_2 required maximum days (55) at same time sowing. In D2 sowing, all genotypes took 3.77 -13.0% more days than those of ITS condition. The genotypes, V_1, V_4, V_3 and V_2 required 1.85-16.7%, 3.8-17.05, 20%, 1.7-8.6% and 5.56-18.5 less days, respectively in D3 and D4 sowings compared as D1 seeding. It is remarkable that in D2 seeding, V_4 required 3.77% more days compared as its timely sowing since temperature was low and relative humidity was high. But in D3 seeding, it required only 3.80% less days compared as its timely sowing although temperature was high and relative humidity was low. That is, temperature and relative humidity fluctuation slightly affected booting stage duration. So, it is said that V_4 has vast genetic adaptability to environmental metrological factors.

Heading

High temperature imposed by late sowing also influenced days to heading of all the genotypes. In ITS condition, all the genotypes phased their heading stage between 68 and 76 days (Table 2). After ITS, days to heading of all genotypes were decreased gradually except V_4 in D_2 seeding (This genotype needed 2.94% more days compared to ITS seeding

(Fig. 3). This might be due to higher temperature prevailed in ILS conditions (Fig. 1). Hossain *et al.*, (2012) and Nahar *et al.*, (2010) also observed the similar result. Among the genotypes, V_4 took significantly less time in all sowing times (57 to 70 days). On the contrary, V_1 required maximum days in ITS condition (76 days). It (V_1) took 1.32 -27.6% less days in ILS conditions than that of ITS condition. The advanced lines, V_4, V_3 and V_2 required 8.8-16.2%, 9.2-26.3% and 5.33-25.3% less days, respectively in all ILS conditions compared to those of ITS condition i.e. the advanced lines needed less days to attain heading stage as compared to V_1. These results implied that the performance in respect of heat tolerance of advanced genotypes were as in order of $V_4 > V_2 > V_3$.

Table 1. Effect of terminal high temperature on days to booting of wheat genotypes (V) imposed by late sowing times (D).

D × V	D_1	D_2	D_3	D_4
V_1	54	61	53	45
V_2	54	60	51	44
V_3	55	60	44	44
V_4	53	55	51	44
LSD(0.05)))	=0.699	CV (%)	=0.58	

Legend: D = *Date of sowing*, D_1 = 30 Nov, D_2 = 15 Dec, D_3 = 30 Dec, D_4 = 14 Jan

V = *Genotpe*, V_1 = BARI Gom 26, V_2 = BAW 1051, V_3 = BAW 1120, V_4= BAW 1141

LSD = Least significance difference, CV = Coefficient of varience.

Anthesis

Under high temperature conditions, earlier heading is advantageous in the retention of more green leaves at anthesis, leading to a smaller reduction in yield (Tewolde *et al.*, 2006). Growth chamber and greenhouse studies suggest that high temperature is most deleterious when flowers are first visible and sensitivity continues for 10-15 days. Among the reproductive phases, fertilization (13 days after anthesis) is one of the most sensitive stages to high temperature in various plants (Foolad, 2005). In the present experiment, terminal high temperature imposed by late sowing had a significant influence on days to anthesis of tested genotypes. There was also a significant variation among the genotypes to complete anthesis stage. Of the tested genotypes, V_4 took less time (71 days) to reach the anthesis stage as compared to other genotypes in ITS condition (Table 3). After ITS condition, the days required to anthesis of all the genotypes decreased gradually except V_4 in D_2 seeding (This genotype needed 1.41% more days compared to it's ITS sowing) (Fig. 5). In ILS conditions, V_4 required the shortest duration and other two advanced genotypes needed longer duration to reach the anthesis stage. In high temperature stress condition, the days to anthesis reduced by 5.6-16.9% in V_4, 7.50-27.5 % in V_3, 6.25-26.3 in V_2 and 2.47-28.4 % in V_1 compared to their ITS condition. Ubaidullah *et al.* (2006) reported the same findings and observed that generally late sowing imposed negative effects on all the traits. That is, the advanced lines needed fewer days to complete anthesis stage compared to V_1. These results implied that in case of anthesis, the performance in respect of heat tolerance of tested genotypes were as in order of $V_4 > V_3 > V_3 > V_1$.

Table 2. Effect of terminal high temperature on days to heading of wheat genotypes (V) imposed by late sowing times (D).

D × V	D_1	D_2	D_3	D_4
V_1	81	79	67	58
V_2	80	75	65	59
V_3	80	74	58	58
V_4	71	72	67	59
LSD(0.05)	=0.719	CV (%)	=0.45	

Legend: D = *Date of sowing*, D_1 = 30 Nov, D_2 = 15 Dec, D_3 = 30 Dec, D_4 = 14 Jan

V = *Genotpe*: V_1 = BARI Gom 26, V_2 = BAW 1051, V_3 = BAW 1120, V_4= BAW 1141

LSD = Least significance difference, CV = Coefficient of varience.

Table 3. Effect of terminal high temperature on days to anthesis of wheat genotype (V) imposed by late sowing times (D).

D × V	D_1	D_2	D_3	D_4
V_1	81	79	67	58
V_2	80	75	65	59
V_3	80	74	58	58
V_4	71	72	67	59
LSD(0.05)	=0.719	CV (%)	=0.45	

Legend: D = *Date of sowing*, D_1 = 30 Nov, D_2 = 15 Dec, D_3 = 30 Dec, D_4 = 14 Jan

V = *Genotpe*: V_1 = BARI Gom 26, V_2 = BAW 1051, V_3 = BAW 1120, V_4= BAW 1141

LSD = Least significance difference, CV = Coefficient of varience.

Physiological maturity

It is generally known that the duration of maturity of any crop is reduced by stress condition. High temperature in the post anthesis period shortens the duration of grain filling (Wiegand and Cuellar, 1981). In our study, high air temperature imposed by late sowings had also a considerable influence on days to physiological maturity of tested wheat genotypes. There was also a significant variation among the genotypes to attain maturity. In ITS condition, BARI Gom 26 took significantly the second highest days for physiological maturation (113 days) which was followed by V_3 (115 days) & V_2 (108 days). V_4 also took the lowest days (106 days) among other two advanced genotypes (Table 4). After ITS condition, days required to maturity of all the genotypes decreased drastically but gradual trend was observed in V_4 (Fig. 5). In ILS conditions, V_4 required the shortest duration and other two advanced genotypes needed longer duration to attain physiological maturity. In this experiment, in respect of sowing times and genotypes, the temperature during the physiological maturity was 21.9-24.8°C mean air temperature in ITS condition and was 24.5-26.8°C in ILS conditions. In late sowings, temperatures prevailed higher during physiological maturity stage of wheat than those of ITS seeding. Due to higher temperature, all the tested genotypes matured earlier in ILS conditions as compared to ITS condition. There is a similarity between the result of the present study and that of Ubaidullah *et al.*, (2006) and Nahar *et al.,* (2010). These results implied that in case of maturity, the performance in respect of heat tolerance of tested genotypes were as in order of $V_4 > V_2 > V_1 > V_3$ since less day required compared to ITS seeding.

Table 4. Effect of terminal high temperature on days to physiological maturity of wheat genotype (V) imposed by late sowing times (D).

D × V	D_1	D_2	D_3	D_4
V_1	113	103	91	85
V_2	108	101	89	86
V_3	115	100	83	83
V_4	106	104	93	86
LSD(0.05)	=2.679	CV (%)	=0.58	

Legend: D = *Date of sowing*, D_1 = 30 Nov, D_2 = 15 Dec, D_3 = 30 Dec, D_4 = 14 Jan

V = *Genotpe*: V_1 = BARI Gom 26, V_2 = BAW 1051, V_3 = BAW 1120, V_4= BAW 1141

LSD = Least significance difference, CV = Coefficient of varience.

Table 5. Effect of terminal high temperature on grain yield (t ha^{-1}) of wheat genotypes (V) imposed by late sowing (D).

D×V	D_1	D_2	D_3	D_4
V_1	4.96	3.82	3.20	2.52
V_2	4.92	3.71	3.26	2.57
V_3	4.67	3.92	3.11	2.69
V_4	4.89	4.08	3.41	3.35
LSD(0.05)	=0.879	CV (%)	=0.07	

Legend: D = *Date of sowing*, D_1 = 30 Nov, D_2 = 15 Dec, D_3 = 30 Dec, D_4 = 14 Jan

V = *Genotpe*: V_1 = BARI Gom 26, V_2 = BAW 1051, V_3 = BAW 1120, V_4= BAW 1141

LSD = Least significance difference, CV = Coefficient of varience.

Grain Yield

In ITS condition, all the genotypes resulted in significantly higher grain yield and thereafter yield decreased with the delay of sowing times. The yield recorded from ITS condition was significantly higher than that of all ILS conditions. Under ITS condition, the advanced genotype V_1 produced significantly the highest grain yield (4.96 t ha^{-1}). This yield was statistically identical to the yield noted from other genotypes. This finding indicated that in ITS condition, the advanced or promising genotypes were not inferior to recently released variety, V_1. Just after 15 days i.e. in D_2 seeding, the significant yield reduction was found in V_1 (3.82 t ha^{-1}), V_2 (3.71 t ha^{-1}) and V_3 (3.92 t ha^{-1}) due to higher temperature and low humidity prevailed in their heading, flowering and grain filling stages (Fig.1, Table 5) D_2 sowing. In this sowing, yield reduction of the genotypes V_1, V_4, V_3 and V_2 was 23.0%, 16.6%, 16.1% and 24.6%, respectively compared to ITS condition.

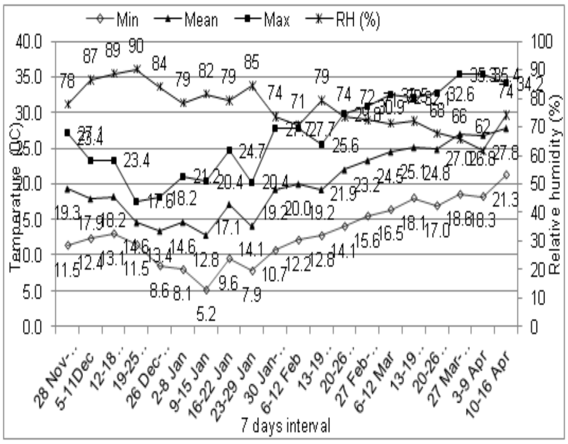

Fig. 1. 7 days interval average minimum, maximum & their mean temperature and relative humidity (% RH) during the growing period of wheat from 28 November, 2012 to 10 April, 2013 at WRC, Dinajpur.

In the late sowing (D_3), V_4 gave significantly the highest yield (3.41 t ha^{-1}) and other genotypes statistically produced similar yields (3.11 -3.26 t ha^{-1}). In this sowing, yield reduction of the genotypes V_4, V_1, V_2 and V_3 was 30.3%, %, 35.5%, 33.7% and 33.4%, respectively compared to ITS condition. In the very late sowing (D_4), V_4 also produced significantly the highest yield (3.35 t ha^{-1}). On the contrary, the recently released variety (V_1) gave the lowest yield (2.52 t ha^{-1}) in this seeding. Other two advanced genotypes performed identically resulting in a yield more than 2 t ha^{-1}.

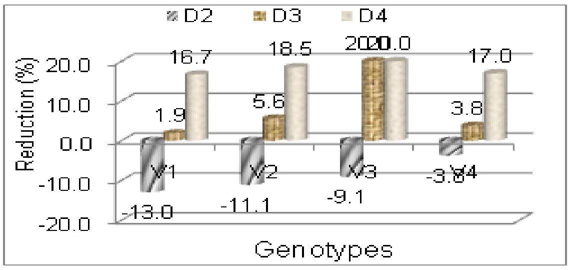

Fig. 2. Reduction percentage (%) of days to heading at different irrigated late sowing conditions (D_2, D_3 and D_4) comapered to irrigated timely sowing (D_1)

Legend: D_2 = 15 December, D_3 = 30 December, D_4 = 14 January.

V_1 = BARI Gom 26, V_2 = BAW 1051, V_3 = BAW 1120, V_4= BAW 1141.

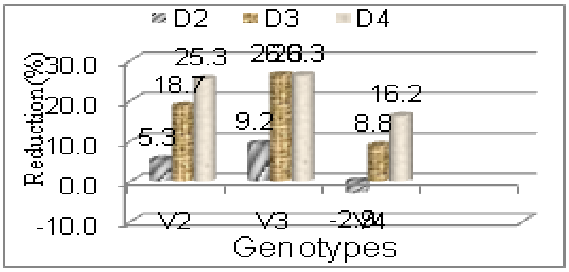

Fig. 3. Reduction percentage (%) of days to heading at different irrigated late sowing conditions (D_2, D_3 and D_4) comapered to irrigated timely sowing (D_1)

Legend: D_2 = 15 December, D_3 = 30 December, D_4 = 14 January.

V_1 = BARI Gom 26, V_2 = BAW 1051, V_3 = BAW 1120, V_4= BAW 1141.

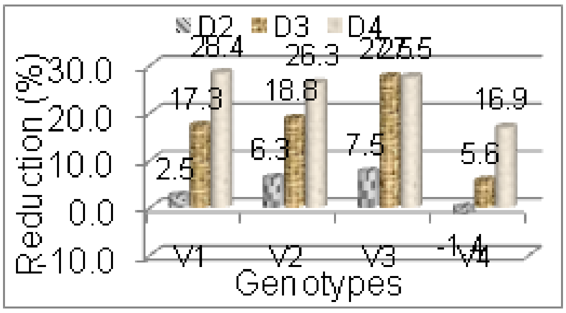

Fig. 4. Reduction percentage (%) of days to anthesis at different irrigated late sowing conditions (D_2, D_3 and D_4) comapered to irrigated timely sowing (D_1 = 30 November).

Legend: D_2 = 15 December, D_3 = 30 December, D_4 = 14 January.

V_1 = BARI Gom 26, V_2 = BAW 1051, V_3 = BAW 1120, V_4= BAW 1141.

At that time, the percent of yield reduction was remarkable and it was 31.5%%, 42.4 %, 47.8% and 49.2% in V_4, V_3, V_2 and V_1, respectively compared to ITS condition. Considering the performance of yield production, the advanced line V_4 performed better than other genotypes in all sowing times though there was significant yield reduction over ITS condition. This line produced more than 3 t ha^{-1} grain yield up to D_3 sowing and it also produced 3.35 t ha^{-1} grain yields in 14 January sowing (D_4). This indicates that among the tested genotypes, BAW 1141 (V_4) is better in heat stress condition.

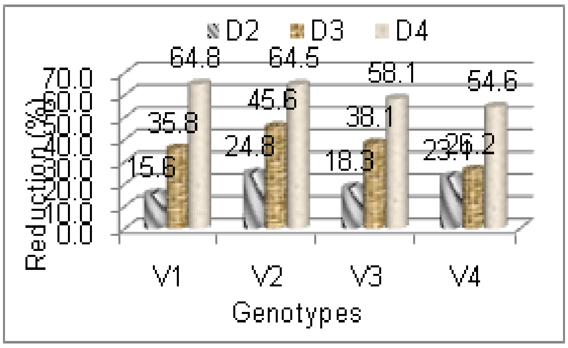

Fig. 5. Reduction percentage (%) of days to physiological maturity at different irrigated late sowing conditions (D_2, D_3 and D_4) comapered to irrigated timely sowing (D_1)

Legend: D_2 = 15 December, D_3 = 30 December, D_4 = 14 January

V_1 = BARI Gom 26, V_2 = BAW 1051, V_3 = BAW 1120, V_4= BAW 1141.

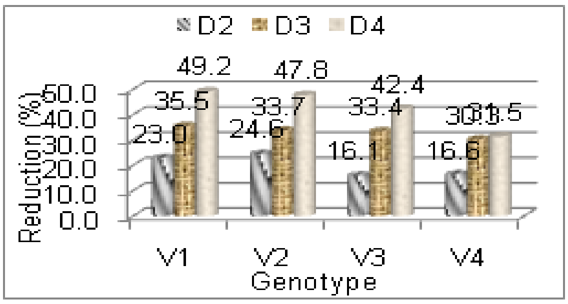

Fig. 6. Reduction percentage (%) of yield at different irrigated late sowing conditions conditions (D_2, D_3 and D_4) comapered to irrigated timely sowing (D_1)

Legend: D_2 = 15 December, D_3 = 30 December, D_4 = 14 January.

V_1 = BARI Gom 26, V_2 = BAW 1051, V_3 = BAW 1120, V_4= BAW 1141.

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