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Response of heat tolerence genotypes/varieties on growth of wheat (*Triticum aestivum* L.) crop under timely and late shown condition

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Abstract
This experiment was carried out to determine the effects on growth of different heat tolerence genotypes of wheat (*Triticum aestivum* L.) under timely and late sown condition. The experiment was conducted at Nawabganj Research Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.) during *Rabi* season in year 2017-18, in randomized block design with two replications and twelve treatments. To assess the response of different genotypes on growth observations of wheat crop under timely and late sown conditions. The result shows that germination percentage of all the varieties was almost equal, in the range of 80-85% in both timely and late sown conditions, varieties like WH1218, PBW762 and DBW223 shows maximum productive tillers under timely sown condition. Under late sown condition there is reduction in number of productive tillers in all varieties except DBW150 and RW5 shows little reduction in number of productive tillers, under timely sown condition the number of leaves per plant is more than the late sown condition. Under late sown condition there is reduction in number of leaves per plant but some varieties like WH1218, DBW150 and RW5 shows no reduction, the data was taken after two months of sowing. Heading occurs earlier under late sown condition while it takes comparatively more days to heading under timely sown condition, days to anthesis under timely sown condition is more than the late sown condition DBW222 and K1601 shows maximum days to anthesis Under late sown condition varieties like DBW233, DBW150 and DBW233 shows minimum days to anthesis, under timely sown condition some varieties like K1601, DBW 223, DBW14, DBW222 and WH730 shows maximum days to maturity, under late sown condition some varieties like PBW762, DBW222, K1601 and DBW233 takes maximum days to maturity.

Keywords: *Triticum aestivum* L., growth, timely sown, late sown

Introduction
Wheat is the second most important staple food next to maize, consumed by nearly 35% of the world population and providing 20% of the total food calories. Wheat occupies about 32% of the total acreage under cereals in the world. The main wheat growing countries include China, India, USA, Russia, France, Canada, Germany, Turkey, Australia and Ukraine. In India, wheat is mainly grown in the states of Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan, Haryana, Bihar, Maharashtra, Karnataka and Gujarat. India accounts an area, production and a productivity of 30.37 million ha. 90.78 million metric tonnes and 2989 kg/ha., respectively. Globally, probable demand for wheat by the year 2020 is forecast at around 950 million tonnes per year. This target will be achieved only, if global wheat production is increased by 2.5% per annum.

The wheat belongs to the genus *Triticum* of the family *Poaceae* and its believed to be originated from South West Asia (Lupton, 1987). Three species of wheat *viz. T. aestivum* L. (Bread wheat), *T. durum* Desf. (Macaroni wheat) and *T. dicoccum* Schulb. (Emmer wheat) are presently grown as commercial crop in India, covering 86, 12 and 2 per cent of the total area, respectively. The bread wheat, a hexaploid with chromosome number 2n=6x=42 is cultivated in all the wheat growing areas of the country, the macaroni or durum wheat (tetraploid, 2n=28) is mostly grown in the northern (Punjab) and southern states, while, the emmer wheat (tetraploid, 2n=28) is confined to the southern states (mainly Karnataka) and some parts of Gujarat.

Wheat is a unique gift of nature to the mankind as it can be moulded into innumerable products like chapatis, breads, cakes, biscuits, pasta and many hot and ready-to-eat breakfast foods. Wheat is consumed by nearly 35% of the world population and contributes 20% food calories. Wheat grain contains starch (60-68%), protein (6-21%), fat (1.5-2.0%), cellulose (2.0-2.5%), minerals (1.8%) and vitamins.

The uniqueness of wheat in contrast to other cereals is that wheat contains gluten protein which enables leavened dough to rise by forming minute gas cells and this property enables bakers to produce light breads.

Availability of sufficient genetic variability is very important in a crop improvement programme. For successful breeding programme, amount of variability present in the experimental material is desirable characteristic.

All varieties do not maintain the same relationship under different temperatures with regards to yield, height, tillering, flowering etc. This indicates that some varieties would do better than others in yield and other agronomic characters when exposed to comparatively high temperatures. The proper screening of genotypes for temperature tolerance and their use in research programme will enable us to develop thermo-insensitive varieties which will boost up the wheat production especially in temperature prone areas of the country.

It is essential for a plant physiologist to measure the variability with the help of parameters like phenotypic coefficient of variation, genotypic coefficient of variation, heritability and genetic advance. The wheat crop requires favourable winter for about 100-110 days for producing its potential yield. Therefore, the heat tolerant wheat variety is still one of the priorities of agricultural research, because above the optimum temperature (22-24 ^{0}C) wheat yield is drastically affected. wheat crops can be injured at seedling emergence, reproductive stage, stem elongation, heading and maturity stage by high temperature. Even 1 ^{0}C increment in temperature reduce 8 to 10% grain yield. Wheat is especially sensitive to temperature exceeds 32 ^{0}C for any significant period. This occurs at the grain filling stage in wheat resulting in the development of shrivelled grain which reduces yield and decreases quality. Many studies have shown that genetic variability for heat tolerance exists in germplasm lines and varieties.

Fast exploding population pressures combined with limited availability of cultivable land area leaves us with no recourse but to attempt at increasing productivity per unit area of land Asana, (1968) [1] and this can possibly be accomplished by narrowing down the gaps between the actualities and the potentialities.

Blackman's (1919) [2] concept of growth as a compound interest process may be considered to be the first step in developing procedure for analysing growth in terms of dry weight change.

Growth analysis of field crop attempted by Corley *et al.* (1981) [5] and Buttery & Buzzel (1982) indicates that growth analysis is useful criteria for selection of high yield.

The extensive growth studies made at the international rice research institute on wheat, Asana (1968) [1] and Donald (1968) [6], have not only emphasized the signification of sink capacity and the morphological components of yield but also the important contribution of the area above the flag leaf node towards the development and growth of sink.

Date of sowing significantly influenced the plant height, number of tillers and dry matter accumulation (Singh *et al*., 1992) [10].

It has been reported from Odisha that the higher plant height was achieved when wheat was sown on 21st November and 1stDecember than the preceding and succeeding dates of sowing and recorded higher number of effective tillers when wheat was shown on 21st of November and 1st of December (Rout and Satapathy, 1994) [9].

In another experiment the plant height at maturity stage was significantly influenced by sowing dates. Significantly the tallest and shortest plants were observed under 14 November and 24 December sown crops respectively (Hem Chandra 2003) [7]. On December 10 sown crops attained more plant height at all the stages of growth compared to January 5 sown crop (Choudhary 2004) [4].

An experiment was conducted by Pandey *et al.,* (2010) [8] found that plant height differ significantly among wheat varieties and crop sown earlier on 23 November except for seeding emergence and tiller initiation took maximum days for node initiation, boot stage, ear emergence, milk stage, dough stage and maturity which decreased significantly under delayed sowing except node initiation at 7 December sown crop.

Materials and methods

The experiment was conducted on wheat during *Rabi* season of 2017-18 under natural condition at Nawabganj research farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. The soil of the experimental field was alluvial in origin. Soil sample (0-15cm) depths were initially drawn from randomly selected parts of the field before sowing. The quantity of soil sample was reduced to about one kilogram through quartering technique. The soil sample was then subjected to mechanical and chemical analysis in order to determine the textural class and fertility status the soils were sampled to a depth of 0-30 cm of the soil, air-dried and sieved (2 mm) for soil analyses. Some physical and chemical properties of soils are given in Table 1.

Table 1: Some properties of the <2mm fraction of the top 30 cm of soil used for the site.

S.No.	Particulars	Values
1.	Sand (%)	43.05
2.	Silt (%)	33.73
3.	Clay (%)	23.00
4.	Textural Class	Loam
5.	pH (1:2.5)	7.70
6.	EC (1:2.5) (ds/m at 25 ^{0}C)	0.60
7.	Organic Carbon (%)	0.45
8.	Available Nitrogen (kg/ha)	185.00
9.	Available Phosphorus (kg/ha)	12.80
10.	Available Potassium (kg/ha)	175.00
11.	Particle Density (Mg/m^3)	2.54
12.	Bulk Density (Mg/m^3)	1.32
13.	Pore Space (%)	46.50

Twelve promising varieties of wheat, DBW150, PBW762, WH1218, DBW222, K1601, DBW223, DBW14, RW5, RAJ3765, DBW233, WH730, DBW71 were obtained from section of Rabi cereals. The experiment was layout in randomised block design. The treatment comprised of above twelve wheat varieties. Sowing of each wheat variety was done in line and each were replicated twice. In twelve treatment with having plot size 3 x 6 meter square. Doses of fertilizers are normally applied @ 120 Kg N, 60 Kg P_2O_5, 40 Kg K_2O/ha through Urea, D.A.P and Murate of Potash. Seed were sown in furrow placing the seed at 5 cm. depth as practicable, on 15th of Nov. 2017 (Timely sowing) and 20th of December 2017 (Late sowing).

Growth observations were taken after germination to the end of vegetative state. Germination percentage: Germination percentage was recorded after 15- 20 days of sowing of each plots of both timely and late sown conditions. Number of productive tillers/full 3m row length: It is the total number of productive tillers recorded from full 3m length of row for each variety.Number of leaves/plant: It is the total number of leaves of a plant. It was recoded after 3months ofsowing Days to heading: The data of days to heading was recorded after two months of sowing. Days to anthesis: Days to anthesis was recorded after the heading of the crop separately for timely and late sown condition. Days to maturity: It was recorded after four months of sowing. Statistical analyses of the data were carried out according to Randomized block design. All the parameters were subjected to analysis of variance (ANOVA), using RBD procedure.

Results

The effect of timely and late sown wheat genotypes on growth of crop these are specified that

Germination percentage: The observation of germination percentage was recorded after 15 days of sowing during timely sown condition. The data collected shows that the germination percentage of all the varieties was almost equal, in the range of 80-85% in both timely and late sown conditions. Table 1 contains the data of germination percentage of 12 varieties under timely sown condition and Table 2 shows the germination percentage under late sown condition.

Number of productive tillers: The data presented in Table1 and Table 2 shows that the number of productive tillers were more during timely sown condition as compared to late sown condition. The observation of number of productive tillers were taken after four months of sowing during timely sown condition. Some varieties like WH1218, PBW762 and DBW223 shows maximum numbers of productive tillers under timely sown condition. Under late sown condition there is reduction in number of productive tillers in all varieties but some varieties such as DBW150 and RW5 shows little reduction in number of productive tillers.

Number of leaves per plant: The data presented in above two tables shows that the genotypes differed widely in their capacity of having number of leaves per plant. Under timely sown condition the number of leaves per plant is more than the late sown condition. Under late sown condition there is reduction in number of leaves per plant but some varieties like WH1218, DBW150 and RW5 shows no reduction in number of leaves per plant.

Table 2: Observations of germination percentage, number of productive tillers and number of leaves per plant under timely sown condition**.**

Genotypes	Germination percentage (%)	Productive Tillers per Full 3 M Row length	No. of Leaves Per plant
DBW 150	85	365	23
PBW 762	85	451	25
WH 1218	85	481	27
DBW 222	85	457	30
K 1601	85	473	29
DBW 223	82	450	25
DBW 14	82	422	22
RW 5	80	412	24
RAJ 3765	80	422	22
DBW 233	82	441	23
WH 730	82	442	26
DBW 71	85	420	21
S.E. (Diff.) =	1.01	26.52	1.59
C.D. (0.05) =	2.10	55.01	3.30

Table 2: Observations of germination percentage, number of productive tillers and number of number of leaves per plant under late sown condition**.**

Genotypes	Germination percentage (%)	Productive Tillers / Full 3 M Row length	No. of Leaves / Plant
DBW 150	82	370	23
PBW 762	85	371	16
WH 1218	82	418	22
DBW 222	82	432	23
K 1601	80	425	22
DBW 223	82	388	23
DBW 14	85	372	21
RW 5	85	394	27
RAJ 3765	85	380	20
DBW 233	85	322	14
WH 730	85	361	22
DBW 71	85	342	15
S.E. (Diff.) =	1.01	26.71	2.29
C.D. (0.05) =	2.10	NS	NS

Days to heading: The data presented in table 3 shows the days to heading of 12 genotypes under timely sown condition which is more than that of late sown condition as presented in table 4. The data was taken after two months of sowing. Heading occurs earlier under late sown condition while it takes comparatively more days to heading under timely sown condition. Under timely sown condition some varieties like DBW22 and K1601 takes maximum days to heading whereas some varieties like DBW223 and DBW71 takes minimum days to heading. Under late sown condition some varieties like K1601, DBW223, DBW222, DBW150 and WH730 takes minimum days to heading.

Days to anthesis: The observation of days to anthesis was taken after the heading of the crop. The table 3 shows the data of days to anthesis under timely sown condition which is more than the late sown condition which is presented in table 4. DBW222 and K1601 shows maximum days to anthesis whereas some varieties like DBW233 and DBW71 shows minimum days to anthesis. Under timely sown condition among 12 varieties some varieties like. Under late sown condition among all the varieties some varieties like DBW233, DBW150 and DBW233 shows minimum days to anthesis.

Days to maturity: The data presented in table 3 and table 4 shows the days to maturity under timely and late sown condition respectively. The observation was taken after four months of sowing. The varieties grown under late sown condition matures earlier as compared to the timely sown condition. Under timely sown condition some varieties like K1601, DBW 223, DBW14, DBW222 and WH730 shows maximum days to maturity whereas some varieties like DBW150, RW5, WH1218 and RAJ3765 takes minimum days to maturity. Under late sown condition some varieties like PBW762, DBW222, K1601 and DBW233 takes maximum days to maturity whereas others take less days to maturity.

Table 3: Observations of days to heading, days to anthesis, days to maturity and number plants under timely sown condition**.**

Genotypes	Days to Heading	Days to Anthesis	Days To Maturity
DBW 150	82	88	125
PBW 762	82	88	127
WH 1218	85	91	125
DBW 222	90	97	130
K 1601	91	98	135
DBW 223	73	80	130
DBW 14	85	91	130
RW 5	82	90	124
RAJ 3765	85	91	125
DBW 233	84	90	125
WH 730	83	90	130
DBW 71	79	86	128
S.E. (Diff.) =	1.17	0.32	2.90
C.D. (0.05) =	2.49	0.66	5.50

Table 4: Observations of days to heading, days to anthesis, Days to maturity and number of plants under late sown condition.

Genotypes	Days to Heading	Days to Anthesis	Days to Maturity
DBW 150	72	78	110
PBW 762	74	81	115
WH 1218	74	80	112
DBW 222	72	78	115
K 1601	72	80	115
DBW 223	71	79	115
DBW 14	74	80	110
RW 5	75	81	115
RAJ 3765	74	81	112
DBW 233	73	79	110
WH 730	72	80	110
DBW 71	74	84	110
S.E. (Diff.) =	1.03	0.29	2.05
C.D. (0.05) =	2.15	0.61	4.01

Discussion

The investigation was carried out to screen out the varieties suitable for better growth under timely sown and late sown condition. It has been observed that all the varieties show almost equal germination percentage in both timely and late sown condition. But on comparing timely sown to late sown we get that there is some reduction in germination percentage from timely sown to late sown condition, but some varieties are there which do not show any reduction in germination percentage under late sown condition such as PBW762, WH1218, DBW223 and DBW71 and some varieties are there which give more germination percentage under late sown condition such as RW5, RAJ3765, DBW233 and WH730.The observation of number of productive tillers and number of leaves also show some reduction under late sown condition, but some varieties like DBW150, DBW222, K1601 and RW5 shows little reduction in number of productive tillers. In case of number of leaves varieties like DBW222, K1601, WH1218, DBW150 and RW5 shows no reduction in comparison to timely sown condition, which shows that these varieties can withstand high temperature.

Coming to days to heading, days to anthesis and days to maturity we can see that there is reduction in all these days, heading occurs earlier in case of late sown condition due to high temperature, similarly days to anthesis shows reduction under late sown condition. Days to maturity also reduced during late sown condition because of high temperature which shortens the vegetative period as tested by Stratonovitch and Semenov (2015) according to them, because of high temperature plant flowers much earlier so the risk of heat stress affecting yield of the crop is much higher in sensitive genotypes. Under timely sown condition varieties like DBW222 and K1601 takes maximum days to heading whereas varieties like DBW223 and DBW71 takes minimum days to heading. Under late sown condition some varieties like K1601, DBW222, DBW223, DBW150 and WH730 takes minimum days to heading.

In case of days to anthesis varieties like DBW222 and K1601 shows maximum days whereas as varieties like DBW233 and DBW71 shows minimum days to anthesis under late sown condition. Similarly, in case of days to maturity these varieties show reduction.

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