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Research Article

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SCREENING OF HEAT TOLERANCE WHEAT GERMPLASM UNDER LATE SEEDED CONDITION

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Abstract

Climate change is not an issue it has become a challenge to deal with Agriculture and climate change are interrelated processes, both of which take place on a global scale. Temperature is increasing constantly and effect on productivity of major agriculture crops. The adverse effects of temperature on plants, higher than optimal temperature is considered as heat stress. In our experiment 10 wheat genotypes (AKW 1071, K9006, K0307, K 7903, RAJ 3765, LOK 1, V1, V2, V3, and K65) were grown at different sown dates during Rabi season 2014. The sowings were done on 20 November, 10th December and 30th December. Heat stress/ late sown had significant effect on all agronomic trait. In both treatment (T1 & T2) Raj 3765, Lok-1, K-7903 showed minimum reduction in all agronomic trait while maximum reduction were observed in V1, V2, AKW-1071, K0307. The chlorophyll content of normal sown is greater than the late sown condition. The maximum reduction in chlorophyll content was recorded in V1 under both T1 and T2 while minimum reduction was recorded in Raj 3765 followed by Lok 1 and K 7903. Three lines Raj-3765, K-7903 and Lok-1 showed maximum grain development and survival under heat stress condition. This study revealed that these genotypes (Raj-3765, K7903 and Lok-1) can be utilized in optimum as well as late sown condition.

Key word: Climate change, wheat, Chlorophyll content, agronomic trait

Introduction

In India Wheat (*Triticum aestivum L.*) is the second most important cereal crop after rice. It is the most important winter crop grown in India during Rabi season (November to April). It is grown over a large area and under a wide range of condition and, with about 697.8 million tons produced annually worldwide, it provides about one fifth of the calories consumed by humans. It is the major source of energy, protein and dietary fiber in human nutrition since decades. The productivity and yield of wheat is significantly influenced by selection of suitable varieties soil and environmental conditions as well as the management practices. The environmental factor like temperature is the major problems of wheat growing areas which substantially reduce the yield and quality of wheat (Singh and Purohit, 1995). High temperature is one of the most prominent among the chief ecological factors that determine crop growth and productivity (Al-Khatib and Paulsen 1999). High temperature in wheat becomes critical especially at anthesis stage because most of the carbohydrate used for grain growth is produced after anthesis. High temperature affect grain growth of wheat has been reported by researchers (Prakash et al., 2003, Stone and Nicholas 1995). Since wheat is a crop that is adapted to cool, moist growing for grain growth of approximately 15^{0}C (Paulsen 1994). It has been found to be one of the major environmental factors that limit both the quantity and quality of wheat production in India. Moreover, gradual rise in daily maximum temperature inflicts relatively less damage in comparisons to the server damage caused by sudden temperature build up. Such situations arise under India wheat growing environment due to the proximity to the desert and delayed planting.

Most of the world crops are exposed to heat stress during some stages of their life cycle (Stone, 2001). Exposure to higher than optimal temperature, or heat stress, reduces yield and decreases quality of cereals, furthermore, as the world population grows exponentially, there is a need to increase both agriculture productivity and to expand productivity areas of the world into warmer climate.

Heat stress due to global warming is a problem in 40% of the wheat growing areas of the world (Fisher and Byerlee, 1991), yield reduction in wheat under heat stress could be caused by accelerated phasic development, accelerated senescence (Kuroyanagi and Paulsen 1988), increase respiration (Berry and Bjorkman 1980), reduced photosynthesis (Conray et al., 1994) and inhibition of starch synthesis in developing kernels (jenner, 1994). The rise in daily average temperature, up to 30^{0}C, increases dough strength, while temperature above this threshold value (35^{0}C to 40^{0}C), even for periods of only few days tended to decreases dough strength (Randall and Moss, 1990).

Chlorophyll content is an important indicator for recognized plant stress response. It is an important chloroplast component for photosynthesis and it is positive relationship with photosynthetic rate. Both chlorophyll a and chlorophyll b are decline under stress condition (Farooq et al., 2009). Loss of chlorophyll content under stress condition can directly affect photosynthetic pigment and primary production of wheat.

Therefore, the aim of this research was to see the performance of wheat genotype under high temperature stress condition and find out the reduction in yield due to temperature stress condition. We also identified temperature tolerance genotypes with lower rate of reduction in yield.

MATERIAL AND METHODS:-

The study was carried out during 2014-15 Rabi season in the research field of Swami Vivekanand Subharti University, Meerut. The agro ecological zone of this area is between $28^0$57’ to 28^0 02’ North latitude and 77^0 40’ to 77^0 45’ East longitude in the Indo-Gangetic Plains of India. Treatments were ten genotypes (AKW 1071, K9006, K0307, K 7903, RAJ 3765, LOK 1, V1, V2, V3 and K65) sown on optimum (20 November) and late sown (10 December and 30 December) condition in randomized complete block design with three replication. For both normal and late sowing condition, management of sown are same accept the date. The sowing was done manually at proper depth (5 cm) and spacing (20 cm). The recommended dose of fertilizer was given. Irrigation was done from time to time as per need and recommendation. Uniform spacing was maintained by thinning after complete germination. data on wheat plants i.e., plant height, number of spikelets, number of grain per spike, Test weight, Days to maturity and spike length were determined from randomly selected 10 tillers.

Chlorophyll is the major chloroplast component for photosynthesis. It is highly correlated with photosynthetic rate. The Decrease amount of chlorophyll under temperature stress condition has been considered a typical symptom of oxidative stress and may be the result of chlorophyll degradation. Both chlorophyll a and chlorophyll b are minimum due to soil dehydration (Farooq et al., 2009). Most of the researches have been done that under stress condition chlorophyll content decreased under stress condition (Kpyoarissis et al., 1995; zhang and Kirkham., 1996). The Chlorophyll pigment viz., Chlorophyll “a”, Chlorophyll “b” and total Chlorophyll content in leaf was estimated by the method as described Hisox and Israelstam (1971). In this method fully opened top leaves were brought in polyethylene bags and were cut into small pieces. Known weight of leaves (100 mg)) was homogenized with 7 ml Dimethyl sulfoxide (DMSO) in test tube. The test tubes were kept for incubation at 65^0C for 50 minutes. At the end of the incubation period, supernatant liquid was decanted and the volume was made upto 10 ml with DMSO. The absorbance of the extract was read at 645 and 663 nm in spectrophotometer using Dimethyl sulfoxide as blank.

The Chlorophyll content was calculated by using the formula and expressed in mg/g fresh weight.

$$\text{Chlorophyll "a"} = 12.7\ (A663) - 269\ (A645) \times \frac{V}{1000 \times W \times A}$$

$$\text{Chlorophyll "b"} = 22.9\ (A645) - 4.68\ (A663) \times \frac{V}{1000 \times W \times A}$$

$$\text{Total Chlorophyll} = 20.2\ (A645) + 8.02\ (A663) \times \frac{V}{1000 \times W \times A}$$

Where,

A645 = Absorbance of the extract at 645 nm
A663 = Absorbance of the extract at 663 nm
a = Path length of the cuvette (1 cm)
v = Volume of the extract
w = Fresh weight of the sample (g)

RESULTS AND DISCUSSION

Table 1: Agronomic data (Days to maturity, Spike length and spikelet/spike) of 10 wheat genotypes under control and stress condition

S.NO.	variety	Pedigree	Days to maturity			Spike length (Cm)			Spikelet per spike		
			control	T-1	T-2	control	T-1	T-2	control	T-1	T-2
1	**AKW 1071**	**VEE'S'/ 3FLN/ACC// ANA**	93.66	90.30	84.60	10.66	9.66	8.60	20.60	19.33	16.60
2	**K 9006**	**CPAN 1687 /HD 2204**	96.33	95.66	79.66	12.33	11.33	10.00	21.30	20.00	17.60
3	**K 0307**	**K 8321/UP 2003**	98.33	97.66	91.00	12.00	11.00	9.30	20.30	18.66	15.60
4	**K 7903**	**HD 1982/K816**	89.00	86.66	82.66	9.33	9.00	8.30	18.60	18.30	16.30
5	**RAJ 3765**	**HD 2402/VL639**	96.66	96.33	87.66	10.30	9.66	9.30	18.30	18.00	17.30
6	**LOK 1**	**S308 / S331**	96.33	96.00	91.00	11.60	10.66	10.30	20.30	20.33	19.60
7	**V1**	**BL 1724/BL1887//BL2031**	116	113.3	106.6	11.16	10.66	8.6	15.60	15.00	12.30
8	**V2**	**BL 1724/BL1887//BL2031**	115.33	110.6	102.66	11.33	10.50	9.30	13.60	13.60	12.30
9	**V3**	**BL 1724/BL1887//BL2031**	107	106	101.66	11.66	11.30	9.60	12.33	12.30	10.30
10	**K 65**	**C591/NP773**	104	102.6	96.00	10.00	9.66	9.30	18.00	17.30	16.30
		CD	**2.2**	**2.3**	**2.0**	**1.09**	**0.8**	**0.94**	**0.97**	**1.29**	**1.21**
		SE(d)	**1.0**	**1.11**	**0.95**	**0.51**	**0.4**	**0.44**	**0.46**	**0.611**	**0.57**
		SE(m)	**0.76**	**0.79**	**0.67**	**0.36**	**0.28**	**3.1**	**0.32**	**0.43**	**0.4**
		CV	**1.3**	**1.37**	**1.26**	**5.76**	**4.84**	**5.8**	**3.14**	**4.32**	**4.5**

Table-2 Agronomic data (Plant height, No. of grain/spike and Test weight) of 10 wheat genotypes under control and stress condition

S.NO.	variety	Pedigree	plant height			No. of grain/spike			Test weight (1000 grain) gm		
			control	T-1	T-2	control	T-1	T-2	control	T-1	T-2
1	AKW 1071	VEE'S'/ 3FLN/ACC// ANA	88.00	86	75	53	46.66	32	42.22	34.40	34.40
2	K 9006	CPAN 1687 /HD 2204	113.0	110.0	95.00	44.66	41.00	32.33	42.71	35.80	35.80
3	K 0307	K 8321/UP 2003	99.66	97.66	89.00	52.66	45.00	31.33	38.13	31.40	31.40
4	K 7903	HD 1982/K816	89.00	84.66	81.33	47.00	43.00	39.66	33.50	31.10	31.10
5	RAJ 3765	HD 2402/VL639	96.30	93.33	89.00	35.66	32.00	30.33	39.26	36.90	36.90
6	LOK 1	S308 / S331	103.0	100.33	96.33	34.33	30.00	27.66	44.95	40.90	40.00
7	V1	BL 1724/BL 1887//BL2031	99.33	97.66	71.33	28.33	27.33	26.33	38.73	31.70	31.70
8	V2	BL 1724/BL 1887//BL2031	102.0	99.00	81.00	28.33	27.66	25.66	37.83	31.60	31.60
9	V3	BL 1724/BL 1887//BL2031	115.0	110.66	80.66	33.66	32.66	30.66	40.46	35.33	35.30
10	K 65	C591/NP773	119.0	114.33	103.66	41.00	34.00	30.66	43.93	40.10	39.10
		CD	2.97	2.026	4.01	2.25	1.8	1.8	0.9	1.7	1.7
		SE(d)	1.4	0.95	1.8	1.06	0.85	0.8	0.42	0.8	0.83
		SE(m)	0.99	0.67	1.3	0.75	0.6	0.6	0.3	0.5	0.5
		CV	1.6	1.17	2.69	3.21	2.9	3.5	1.307	2.9	2.9

As shown in **table 1 and 2** for optimum and stress treatment of wheat, significant differences were found for plant height, spike length, number of grain per spike, days to maturity, number of spikelets and test weight. Heat stress had significant effect on all the parameter. In optimum condition, maximum test weight (gm) was recorded in Lok 1 (44.95) and minimum test weight was recorded in K-7903 (33.5). Heat stress markedly reduced test weight in all the varieties. Maximum reduction in test weight was recorded in V1 (18.16) while minimum reduction was recorded in Raj-3765, similar result was also reported by Rajender et al., (1998) and Kumar et al., (2013).

Heat stress effect on the plant height, maximum percent reduction was found in V1 (28.1) while minimum reduction was observed in Raj-3765 (7.5). Therefore, maximum percent reduction in spike length was observed in V1 (22.09) while minimum reduction was recorded in Raj 3765 (10) followed by Lok-1(11.20) and K-7903(10.77).Therefore, spikelet per spike was effected by heat stress, minimum reduction were recorded in Lok-1 (3.44) followed by Raj-3765 (5.46) and maximum reduction was recorded in V1 (21.16). Furthermore, temperature stress affect number of grain per spike, days to maturity Ali *et al.* (1982), Melladoze (1980), Waraich *et al.* (1981), Amit kumar et al., (2013).

Chlorophyll is one of the major chloroplast components for photosynthesis, and relative chlorophyll content has a positive relationship with photosynthetic rate. The decrease in chlorophyll content under climate change has been considered a typical symptom of oxidative stress and may be the result of pigment photo-oxidation and chlorophyll degradation. Decreased chlorophyll level during drought stress has been reported in many species, depending on the duration (Kpyoarissis et al., 1995; Zhang and Kirkham, 1996). Loss of chlorophyll contents under heat stress is considered a main cause of inactivation of photosynthesis. Chlorophyll content was measure at different date from the sown then we observed that the chlorophyll content of normal sowing is greater than the late sowing treatment shown in **table-3**. Heat stress significantly reduced the chlorophyll content of all the wheat varieties. The maximum chlorophyll a (mg/g) content was observed in Raj 3765 (1.719) in controlled as well as in treatment than the other varieties. While minimum chlorophyll a (mg/g) content was recorded in V1 (1.434) under controlled as well as in treatment. Furthermore, maximum chlorophyll b and total chlorophyll content was observed in Raj 3765 (0.577, 2.327), while minimum chlorophyll b and total chlorophyll content was recorded in V1 (0.358, 0.1.880) under controlled as well as treatment.

Table-3 significant effect of late sowing on chlorophyll content of different wheat cultivars

Variety	CONTROL			TREATMENT (T1)			TREATMENT (T2)		
	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Total Chlorophyll (mg/g)	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Total chlorophyll (mg/g)	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Total chlorophyll (mg/g)
AKW-1071	1.432	0.445	1.943	1.449	0.430	1.930	1.481	0.397	1.880
K-9006	1.549	0.347	1.945	1.538	0.349	1.880	1.486	0.321	1.830
K-0307	1.448	0.423	1.923	1.477	0.381	1.850	1.502	0.347	1.830
K- 7903	1.550	0.553	2.157	1.515	0.566	2.093	1.615	0.423	2.060
Raj 3765	1.719	0.577	2.327	1.660	0.523	2.237	1.616	0.454	2.083
LOK 1	1.526	0.504	2.080	1.551	0.426	1.993	1.625	0.357	1.970
V1	1.434	0.368	1.880	1.459	0.358	1.833	1.589	0.347	1.823
V2	1.483	0.463	1.973	1.618	0.358	1.850	1.607	0.383	1.973
V3	1.526	0.371	1.993	1.515	0.485	1.943	1.596	0.362	1.927
K-65	1.543	0.450	2.063	1.545	0.462	1.913	1.539	0.427	1.920
CD	**0.035**	**0.015**	**0.05**	**0.02**	**0.006**	**0.038**	**0.008**	**0.006**	**0.22**
SE(d)	**0.017**	**0.007**	**0.024**	**0.01**	**0.003**	**0.018**	**0.004**	**0.003**	**0.011**
SE(m)	**0.012**	**0.005**	**0.017**	**0.007**	**0.002**	**0.013**	**0.003**	**0.002**	**0.007**
CV	**1.34**	**1.915**	**1.43**	**0.764**	**0.755**	**1.119**	**0.296**	**0.884**	**0.667**

Conclusion

Heat stress is one of the major environmental factors which effect on wheat productivity at each stage of wheat growth. So researchers need to take responsibility to develop or screen new varieties which can adapt to heat stress or climate change. This study concluded that most of the wheat germplasm were affected from heat stress but some genotypes had the capability to tolerate heat stress. We observed that Raj-3765, Lok-1 and K-7903 are highly tolerant varieties under terminal heat stress condition. Although, varieties V1, V2, AKW 1071 and K-0307 showed susceptible under heat stress condition. This study revealed that these genotypes (Raj-3765, K-7903 and Lok-1) can be utilized in optimum as well as in late sown condition.

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