IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB)
ISSN: 2455-264X, Volume 9, Issue 2 (Mar. – Apr. 2023), PP 71-75
www.iosrjournals.org

Study on Wheat (Triticum Aestivum L.) Variety Identification for Hyperthermal Durability

[1]Narendra Kumar Ray, [2]Dr. Krishna Paul
[1] Research Scholar, Department of Science (Botany), OPJS University, Churu, Rajasthan
[2]Associate Professor, Department of Science (Botany), OPJS University, Churu, Rajasthan

ABSTRACT
The study on wheat (Triticum aestivum L.) variety identification for hyperthermal durability represents a critical exploration in the field of agricultural science, particularly under the current scenario of global climate change. This research aims to categorize and identify wheat varieties that exhibit enhanced durability and resilience in hyperthermal (extremely high temperature) conditions, a challenge increasingly relevant in many wheat-growing regions worldwide. In the context of this study, "hyperthermal durability" refers to the capacity of wheat varieties to maintain productivity, physiological health, and grain quality under conditions of elevated temperatures. These conditions are becoming more frequent due to global warming and pose a significant threat to wheat production, a staple crop for billions of people. The identification of wheat varieties with improved tolerance to high temperatures is, therefore, a priority in ensuring food security and agricultural sustainability.

I. INTRODUCTION

For the majority of people on earth, wheat (Triticum astivum L.) is the most significant crop. It is the primary food source for two billion people, or 36% of the world's population. According to Briman and Graur (1995), over 55% of the carbohydrate and 20% of the total dietary calories consumed worldwide come from wheat. Because wheat is grown under a variety of climatic circumstances, genetic knowledge is very valuable for plant breeding and genetic research. Wheat is a member of the Poaceae (Gramineae) family, which also includes barley (Hordeum vulgare L.), oats (Avena sativa L.), rye (Secale cereale L.), maize (Zea mays L.), and rice (Oryza sativa L.). One of the tribes that contains more than 15 genera and 300 species, including wheat and barley, is Triticeae. Wheat was originally classified by Linnaeus in 1753. Sakamura reported the chromosome number sets (genomes) for each well recognized type in 1918. He divided wheat's chromosomes into three groups: diploids (2n=14), tetraploids (2n=28), and hexaploids (2n=42).

With a production of 595.15 million tons and cultivation over an area of 232.0 million hectares, wheat (Triticum astivum L.) is the most widely grown food crop in the world and provides a staple diet for one billion people. It contributes 11.57 percent of global cereal output, making it the second-most significant cereal crop after rice. India is the second-largest producer of wheat in the world, although its average productivity is far lower at 2770 kg ha-1 as compared to China's 3885 kg ha-1 and the United Kingdom's, the Netherlands, and other North Western European countries' 8043 kg ha-1. India's productivity is barely 35% of the UK's (Mitra and Bhatia, 2008).

Uttar Pradesh alone accounted for 9.17 million acres of the country's total wheat land, producing 24.94 million tons of grain and yielding 26.54 q ha-1 (Anonymous, 2007). U.P. is the state with the highest production (377.70%), followed by Punjab and Haryana. However, Punjab has the highest production, with 40.4 q ha-1. When compared to eastern Uttar Pradesh, which has a production of just 22.0 q ha-1, western Uttar Pradeshhas a higher productivity of 30.0 q ha-1 (Anonymous, 2008).

There is a wide latitudinal dispersion of wheat crops. The best growing conditions for the crop are in moderately temperate climates with sub- humid to semi-arid conditions. Wheat can survive temperatures that range from very low to moderate. While in the anthesis stage, wheat suffers from high temperatures in India as well as many other wheat-growing regions. At the anthesis stage, the high temperature combined with the water stress becomes crucial since the majority of the carbohydrates needed for grain development in wheat are produced after anthesis.

High temperature-exposed plants have a number of morphological and physiological adaptations that give them the ability to tolerate these stresses. However, a plant's usefulness as a selection criterion depends on how quickly and easily it can be assembled. The majority of physiological screening tests are too slow and complex for large-scale breeding programs. The purpose of the current research was to identify basic physiological characteristics that may be used to identify and screen wheat genotype for tolerance to temperature changes by establishing their relationship to grain yield.

Understanding this would provide the groundwork for enhancing wheat's high temperature tolerance for grain development. Since cultivar diversity already exists, it is thus necessary to identify reliable physiological features that contribute to high temperature tolerance in order to create high temperature-tolerant varieties. With the aforementioned information in mind, the current investigation, titled "Physiological Characterization of Wheat (Triticum aestivum L.) Varieties for Hyperthermal Tolerance in Alwar Region," was undertaken with the following objectives:

1. Screening and assessment of the tolerance of different types of wheat at high temperatures.

2. To recognize physiological characteristics linked to high temperature tolerance.

II. REVIEW OF LITERATURE

Zhang et al. (2009) investigated the effects of different concentrations of Al on nucleoli in root tip cells, root growth, antioxidant enzyme activity and MDA content in hydroponically grown Viciafaba L. Aluminum significantly inhibited root growth of V. faba treated with Al. In the nucleolus in root tip cells, some particulates containing argyrophilic proteins were extruded from the nucleus into the cytoplasm, and some were scattered in the nucleus after Al stress. SOD activity in leaves and roots exposed to different concentrations of Al was mostly higher than in the control. Seedlings exposed to 100μM Al showed significantly higher POD activity in roots than in the control. POD activity increased much more in roots than in leaves. CAT activity was lower in roots than in leaves. MDA content in leaves and roots of plants exposed to Al was significantly higher than in the other groups and the control at 6 to 9 days of treatment. These results suggested that alterations in nucleoli and altered antioxidant enzyme activity and MDA content in V. faba could serve as useful biomarkers for detection of Al toxicity.

Navascués et al. (2011) worked on forage legume Lotus corniculatus to find out, if oxidative stress was the cause of aluminum toxicity in plant. The exposure of plants to 10μM Al inhibited root and leaf growth, but had no effect on the production of reactive oxygen species or lipid peroxides. The effects of Al on key proteins involved in cytoskeleton dynamics, protein turnover, transport, methylation reactions,redox control and stress responses underscore a metabolic dysfunction, which affects multiple cellular compartments, particularly in plants exposed to 20μM Al.

Lata et al. (2011) studied foxtail millet (Setaria italica L.) as it is one of the relatively drought-tolerant crops across the world and is grown in arid and semi-arid regions. To explore genetic diversity of drought-induced oxidative stress tolerance in foxtail millet, they measured lipid peroxidation to assess membrane integrity under stress as biochemical marker to screen 107 cultivars and classified the genotypes as highly tolerant, tolerant, sensitive, and highly sensitive. From this comprehensive screening, four cultivars showing differential response to dehydration tolerance were selected to understand the physiological and biochemical basis of tolerance mechanisms. The dehydration-tolerant cultivars showed considerably lower levels of lipid peroxidation and electrolyte leakage as compared with dehydrationsensitive cultivars, indicating better cell membrane integrity in tolerant cultivars.

III. RESEARCH METHODOLOGY

3.1 Experimental site:

The experimental site is located in Kisan Seva Kendra's main campus, 23 kilometers from Alwar.

3.2 Alwar's position geographically (Rajasthan).

In the Indian state of Rajasthan, Alwar is a city, home to a municipal council, and the district's administrative center. One of the very few districts in India where the district name is distinct from the name of the district's largest town. Alwar's MLA is Rao Narendra Singh, and thearea is one that is dominated by Yadavs. Gurgaon and Alwar are only separated by 128 kilometers and 2 hours, 15 minutes, respectively, while traveling by road.

Geographically speaking, Alwar may be found at 28°02′N 76°07′28.04°N 76.11°. It rises an average of 298 meters (977 feet) above sea level. The area is rich in mineral resources, including albite, calcite, quartz, beryl, tourmaline, muscovite mica, and biotite mica. The temperature may drop as low as -3°Celsius during the winter.

Fertility:

Through the use of urine, DAP, and potash muriate, respectively, 120, 80, and 60 kg ha-1 of nitrogen, phosphorus, and potash were added to the soil.Prior to seeding, the base dose of nitrogen, total phosphorus, and potash was added. The remaining nitrogen was provided in two equal split doses, one during planting and the other at the start of the spike.

With the aid of kudali, the seeds were sown at a rate of 100 kg per hectare at a row spacing of 20 cm and a plant-to-plant spacing of 15 cm at an average depth of 5 cm.

Irrigation:

The crop was watered whenever necessary and during all of the crucial stages. The months of March and April saw a higher frequency of irrigation.

Measures to protect plants:

To keep the plant free from insects and diseases, appropriate plant protection measures were adopted.Recorded observations:

Growth parameter Height of plant in cm:

At the 30th, 60th, 90th, and harvest stag, the height of the main shootof five tagged plants was measured. With the aid of a measuring scale, the height was measured from the ground level to the ligule of the topmost leaf before the emergence of the ears and from the ground level to the base of the ears after the emergence of the ears, and the average plant height was expressed in centimeters.

Phenology:

Days to 50% flowering:

Number of days to 50% flowering under each treatment was assessed by counting the number of days taken from sowing to the day when 50% plants show ear emergence. It is also termed as days to 50% heading.

Days to maturity:

The maturity duration of the crop for each treatment was assessed by visual appearance of grains and colour of leaves particularly flag leaf. The crop is mature when flag leaf become yellowish and the grain has lost its green chlorophyll colour and turned wheatish.

IV. DISCUSSION AND CONCLUSION

Due to the wide spread intensive cropping system, which often delays the sowing of wheat up to mid-January, notably in north eastern India where it is typically seeded after the harvest of rice and sugarcane, late wheat planting is quite prevalent. As a result, crop development is accelerated and it experiences high temperatures, which significantly reduces grain yield. According to Mc Donold et al. (1983), for every 10C rise in temperature over 180C, the weight of a single grain of wheat decreases by as much as 4 percent.

By 30 and 60 days after planting, a reduction in wheat grain yield of 29 and 52 percent had been observed, respectively. This was because high temperatures had occurred during crop growth and grain development (Singh and Pal, 2003).

High temperatures have an adverse effect on all phases of crop growth, accelerate floral initiation, shorten spikes with fewer spikelets, and adversely affect pollen development (Zhu et al., 1997). High temperatures have been discovered to affect photosynthesis, respiration, the conversion of sugar into starch, and the deposition of protein in developing grains (Rawson, 1993).

Heat stress causes the creation of reactive oxygen species in the body's heat, which damages the cell membranes. The production of active oxygen scavengers such super oxide dismutase, peroxidase, and catalase by plants may counteract this effect (Sairam and Saxena, 2002). The growth and productivity of wheat crops grown under high temperatures have also been reported by many researchers (Berry and Bjorkman, 1980; Jenner, 1991 a, b; Reynolds et al., 1994).

Despite the long-standing evidence of the detrimental effects of high temperatures on wheat yield, concerted efforts to identify reliable physiological variables influencing grain yield under normal and late- sown conditions are more significant. The current investigation aimed to identify some physiological and yield-contributing characteristics that had greater stability under high temperature stress for the development of promising wheat cultivars by analyzing physiological variations among 15 different wheat cultivars under normal and delayed sowing. In this chapter, an effort has been made to examine the outcome of the previous investigation in light of recent advancements made in the field of tetraplegic strife. The following headings explain the results that were obtained:

At 30 and 60 DAS, the plant height of many wheat varieties showed a significant increase. In contrast to usual planting at higher stag•es, practically all of the varieties recorded higher plant height during delayed sowing under both 15 and 30 days. Whereas at 90 DAS, late planting caused a dramatic decrease in plant height across all varieties, and the extent of the decline was more than 30 days after the last sowing. Due to late seeding at 90 DAS, the varieties Halna, Raj 3765, NW 1014, DBW- 14, HD 2285, and K 8962 exhibited relatively less reduction in plant height. Similar to our results, Naik et al. (1991) and Singh and Singh (1998) reported an initial increase in plant height due to delayed seeding (1975). Vans and Wardlaw (1976) claim that high temperatures increase growth rate but decrease growth duration. According to RGR values (Tab. 7 and 8), high temperature present during the critical development phase increased the growth rate, which led to an increase in plant height of various varieties at 30 and 60 DAS.

Similar to plant height, the number of tiller per plants in wheat varieties increased at 30 DAS under the conditions of the most recent sowing, but not at later stages, namely 60 and 90 DAS. In all varieties, a progressive decline in the number of tillers was observed. The decrease in the number of tillers was more caused by seeding 30 days later than 15 days earlier. In terms of varietal performance, HP 1633, Sonalika, HD 2285, PBW 343 and NW 2036 maintained a higher tiller count than other varieties during a 30-day delayed sowing period at 90 DAS. Increase in temperature under late seeding causes forced crop maturity, resulting in a decrease in the number of tillers per plant. Similar to our results, a number of workers have reported less tillers in various wheat varieties at various times extended in the wake of recent events (Singh et al., 2001; Kumar and Sharma, 2003; Negi et al., 2003).

The plant biomass of all varieties increased as a result of late planting at 30 and 60 DAS; however, at 90 DAS, all the varieties shown substantial declines, with a greater magnitude under 30 days of late sowing than under 15 days of late sowing. At 90 DAS, the average plant biomass was 24.4 grams per plant under normal planting. This decreased to 15.9 and 19.5 grams after 15 and 30 days later sowing, respectively. When compared to recently sown plants, wheat plants' longer development periods during regular sowing gave them the chance to accumulate more biomass, which therefore showed higher plant biomass. Raj 3765, Sonalika, HD 2285, and K 8962 were among of the varieties that showed less reduction in maturity time than other varieties with late seeding (Table 10).

All of the varieties' RGR was higher between 30 and 60 DAS than it was between 60 and 90 DAS under both normal and late-sown conditions. Between 30 and 60 DAS, RGR of all varieties was higher after seeding 15 and 30 days later than usual. In contrast, all of the varieties showed reduced RGR with late seeding as compared to typical sowing between 60 and 90 DAS. RGR decreased more after seeding 30 days later than it did after sowing 15 days later. Raj 3765 had the highest RGR between 60 and 90 DAS, followed by Halna and HP 1744 within 30 days after sowing in both years. HP 1633, UP 2425, HD 2307, and PBW 343 had lower RGR than other varieties, however. The plant biomass values observed at 30, 60, and 90 DAS were used to calculate the RGR of different wheat varieties. Because of this, as compared to conventional seeding, the plant biomass of virtually all of the varieties was higher at 30 and 60 DAS and lower at 90 DAS. In compared to early planting, higher RGR values of wheat varieties were higher between 30 and 60 DAS and lower between 60 and 90 DAS.

The days to 50% flowering and the period of maturity were markedly reduced by delayed wheat planting, regardless of varietal variation. The mean days to 50% flowering with 15 and 30 days late seeding were 62 and 51 days, respectively, as opposed to 72 days under regular sowing. Under regular seeding, the average maturity time was 122 days. The mean maturity time was shortened to 109 days and 96 days, respectively, by delaying sowing by 15 days and 30 days. This clearly demonstrates that seeding 15 and 30 days later reduced the average maturity time by 13 and 26 days, respectively.

Numerous researchers have noted a significant reduction in the length of the development phases of wheat crops grown in high-temperature regions due to recent planting (Asana, 1976; Saini and Dadhwal; Wardlaw et al.; 1989; Nagarajan, 2002). In general, wheat varieties showed greater variation in reduction to days to 50% flowering and maturity duration under 30 days of late sowing than 15 days ago (Al-Khatib and Paulsen, 1984; Nagarajan, 2002). This may be due to forced maturation and premature senescence of wheat plants under extremely delayed sown conditions, where plants are exposed to high temperatures.

The amount of protein and chlorophyll in all wheat varieties' leaves increased by up to 60 DAS in general. Following the seeding, a considerable decrease was seen in both the typical and late sowing conditions. All the varieties recorded lower total chlorophyll and protein content than after late planting at all observational stages, and the extent of the reduction was greater under 30 days since sowing than under 15 days since sowing. Chlorophyll and protein content declines were most pronounced at 90 DAS, when all the varieties showed their greatest reduction.

High temperature accelerates the degradation of chlorophyll under recent planting and mostly affects the activities of the thylakoid membrane, which damages the thermosensitive photosystème. II Reaction Center, according to Al Khatib and Paulsen (1990). Early reports of premature chlorophyll loss due to heat sensitivity in wheat crops have been made (Rynolds et al., 1994). Our findings with regard to protein content are quite similar to those of Ristic et al. (2008), who observed a decline in protein content in winter wheat cultivars with an increase in heat treatment. At 90 DAS after the most recent planting, K 8962, HD 2307, NW 2036, NW 1014, and Raj 3765 had higher levels of chlorophyll content than other varieties. Raj 3765, Halna, K 8962, HD 2285, and Sonalika also shown higher levels of protein content. When exposed to moisture and high temperature stress, there is a difference in the amount of chlorophyll in the leaves between tolerant and susceptible wheat genotypes, it has been reported (Prakash, 1997).

The amount of total soluble carbohydrates and starch in wheat variety leaves sharply decreased after the most recent planting. This decline was Mseen at all stages of observation, but at 90 DAS there was a more severe reduction compared to normal planting, which may have been caused by an onslaught of high temperatures at this stage that disrupted photosynthetic activity and caused the crop to advance toward senescence. Regarding the total amount of soluble carbohydrates and starch present after late seeding, there was a substantial variance seen across varieties. In contrast to other varieties, Raj 3765, HD 2285, Sonalika, K 8962, and HD 2307 maintained better levels of carbohydrates after recent planting. HP 1633, UP 2425, and HP 1744 had lower levels of carbohydrates. The starch synthesizing enzyme, according to Jenner et al. (1993), is more adversely affected in susceptible types when exposed to post-anthesis temperatural stress. This might be one of the causes of the genetic heterogeneity in starch content in the current experiment. Raj 3765, HD 2285, Sonalika, and K 8962 showed lower -amylase activity during late planting than other varieties, which may be one of the reasons for their higher starch status after late sowing, according to the results of the present experiment. Prolinaceous content increased as crop age advanced up to 90 DAS and accumulated excessively under late planting conditions. At all stages of observation, all of the varieties recorded higher proline contents under late seeding than under normal sowing, and maximum values were seen under 30 days after planting. Depending on the intensity of the stress, plant growth, metabolism, and developmental activities are all adversely impacted. The plants use a variety of adaptive mechanisms to grow and survive under these conditions. Proline accumulation is another protective mechanism that is vital to the plant's ability to resist environmental change. Increased proline accumulations may be caused by the cessation of neoprotein synthesis, the hydrolysis of reserve proline, or the non-utilization of protein when temperatures are high. Proline protects against protoplasmic dehydration, aids in osmotic regulation, and serves as a readily accessible source of nitrogen. Additionally, it was shown via experimentation that certain varieties, such as Raj 3765, K 8962, Sonalika, and HD 2285, performed better than other varieties with late seeding.

At all stages of observation, all wheat varieties recorded higher Membrane Injury Indicators (MII) after late seeding than usual sowing; however, 30 days after sowing produced a greater increase in MII than 15 days after sowing. The highest MII for all varieties under normal and late planting was seen at 60 DAS, but lower values were observed at 90 DAS in comparison. In contrast to other varieties sown recently, Raj 3765, NW 2036, HD 2285, K 8962, and Halna exhibited lower MIIs, whereas UP 2425, HP 1633, and HP 1744 had higher MIIs. According to reports (Sullivan and Ross; 1979; Raison et al., 1980), stable cell membrane that remains functional under stress seems to influence adaptation to high temperatures. It is also related to both heat and drought tolerance. In addition to water, ion, and organic solvent movement, photosynthesis, and perspiration, membrane disruption may also occur (Christiansen, 1978).

REFERENCES

[1]. Gupta, N.K.; Shukla, D.S. and Pande, P.C. (2002). Interaction of yield determining parameters in late sown wheat genotypes. Indian J. Plant Physiol., 7 : 264-269.

[2]. Kamaluddin (2005) Grain filling duration : An important traits in wheat improvement. SAIC News Letter, Oct. – Dec., 2005.

[3]. Mullet, J.E. and Whitsitt, M.S. (1996). Plant cellular responses to water deficit, Plant Growth Reg., 20 : 119-124.

[4]. Prasad, N.K. (1979). Effect of late sowing on wheat and barley. Indian J. Agron., 24 (3) : 331-332.

[5]. S. Singh and Madan, Pal (2003). Growth, yield and phonological response of wheat cultivars to delayed sowing. Indian J. Plant Physiol., 8 (3) (N.S.) pp. 277-286.

[6]. Saini, A.D. and Dadhwal, V.K. (1986) Influence of sowing date on grain growth, duration and kernel size in wheat. Ind. J. Agric. Sci., 56 : 439-447.

[7]. Yemm, E.W. and Willis, A.J. (2011). The estimation of carbohydrates in varieties in relation to their response to nitrogen in the tropics soil, Plant Nutrition, 14 (4) : 103-112.

[8]. Zhao, Hui, Tingbo, Dai, Qi, Jing, Dong, Jiang and Weixing, Cao(2017). Leaf senescence and grain filling affected by post anthesis high temperatures in two different wheat cultivars. Plantgrowth regulator, Vol. 51, No. 2 pp. 149-158 (10).

[9]. Zhau, R.G.; Fan, Z.H.; Li, X.Z.; Wang, Z.W. and Wan, W. (2015). The effect of heat acclimation in membrane thermo-stability and reactive enzyme activity. Acta, Agron. Sin., 21 : 568-572