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Research Article

Study on Cultivation of Wheat by Temperature Control with Adequate Irrigation in the Fields of South India

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Abstract

This investigation was conducted during the Zaid season of 2023 to evaluate the performance of four wheat variants was conducted in the agricultural plots of Nindra Mandal, Chittoor District, Andhra Pradesh, India. (13.3831°N 79.6963°E). The experimental plots were laid out in open farming design with adjacent block design with for variants of wheat: Chhoti Lerma, Kalyan sona, Sharbati Sonora and Sonalika with control being GW173. Growth and yield were found to be good in open farming comprising the nutrient rich red soil with pH 5.6. Growth parameters viz. plant height, diameter and crown width were observed. Grain yield attributes like wheat germination count, leaf area index and plant height were found higher in Kalyan sona. Harvest Index and Nutrients in each variety have been recorded in which the grains of Kalyan sona and Sonalika showed to be compatible to be cultivated in summer.

Keywords: Wheat varieties, Heat stress, Kalyan Sona, Sonalika, Durum Wheat, Zaid cultivation, Chittoor District.

Introduction

Temperature is the major ecological factors that determines the cultivation of plants in the terrestrial environment. The atmospheric changes is mainly affected due to the accumulation of carbon dioxide and others gases which can retain the high temperatures resulting in diurnal temperatures (Barnaby & Ziska, 2012). Photosynthesis takes place in the thylakoids of chloroplast converting the light energy to chemical energy releasing water, carbon dioxide and oxygen. The light and dark reactions are governed by the integral membrane proteins which affect the light harvesting and light depending reactions (Horvath *et al*., 2008). Heat stress is when there is irreversible damage occurs to the plant that effects the physiological development in the plant. High temperatures affect the yield of the crops due to the disturbance in the thylakoid membranes to carry out photosynthesis effectively (Mahdavi *et al*., 2022). There will be a decline in the thylakoid membrane integrity which affects the growth and yield of the plant (Chakraborty *et al*., 2008). The physical state

and structure of the thylakoid membrane is important. The ideal temperatures for wheat plant to grow and yield better crop is 10℃ to 24℃. At temperatures over 28℃ to 34℃. There is 17% decrease in growth for each degree (Yadav *et al*., 2022). The enzymes responsible for the accumulation of the starch in the grains becomes inactive at the grain filling stage. Changes in the photosynthesis are reversible between 10℃ and 35℃. High temperature stress mainly targets the oxygen evolving complex resulting in loss of manganese ions and extrinsic polypeptides. High temperature stress also results in the changes in membrane viscosity due to the increase in the grana of thylakoids when exposed to damaging temperatures (Chauhan *et al*., 2011). As the composition of wheat mainly contains 60% of starch, the overall quality of the grains will be affected. Heat stress effects the pollination, seed germination and seedling growth and at the cellular level it causes the oxidative stress causing deactivation of photosynthetic enzymes (Deryng *et al*., 2024). However, the air temperature can be combatted with the chaperones in the wheat plant. Therefore, drought temperatures are considered to be taken care of by irrigation at regular intervals to enable the wheat plants to produce quality grain even in the high temperature zones. Wheat plants reduce their temperature by 3℃ when supplied with water. The structural rearrangements allow photosynthesis to tolerate moderate heat stress and reverse the damage when the leaves cool back to normal non-stressful temperatures (Farooq *et al*., 2011).

Material and Methods

Five acres of land was chosen to grow the wheat variants using open farming method with adjacent block designing of the field comprising half acre for each variant to be grown. The area is located in the agricultural plots of Nindra Mandal, Chittoor District, Andhra Pradesh, India. (13.3831○N 79.6963○E). Durum wheat variant GW173 was taken as controlled as it is known to be productive under heat stress pertaining to 40℃. The other variants being Kalyan sona, Sonalika, chhoti Lerma and Sharbati sona were cultivated in half acre each respectively under controlled conditions with proper irrigation preventing the drought stress. The quality of wheat production showed to meet the good quality conditions after the harvest. And the parameters were measured. Harvesting was done at an ideal time period for each variant after 130 days. The grain yield in heat stress helps in selecting genotypes for cultivation and rate of yield. The integration of physiological and biotechnological tools with conventional breeding techniques will help to develop wheat varieties with better grain yield under heat stress during reproductive and grain-filling phases. This paper discusses the impact of heat stress during reproductive and grain-filling stages of wheat on grain yield and suggests a possible cultivation in the chapter of agriculture to improve wheat cultrivation in the high temperature zones of South India.

Conditions of the Field

The field is located in Nindra Mandal, Chittoor District, Andhra Pradesh, India. The geographical location between13.3831○N and 79.6963○E. The field is composed of red soil with a pH of 6.8, specific gravity 2.46, sand 0.02mm – 3mm (70%), gravel 2%, clay 22.7% and the composition including organic carbon, sulphates, Iron and Aluminium Oxalates, Calcium, Magnesium, Sodium and Phosphorous.

Climatic Conditions

The climate is hot ranging from the lowest being at 22℃ and the highest above 35℃. The experiment was chosen to be done taking advantage of red soil and proper irrigation facilities in the field.

Design

Five acres of land was chosen for the experiment. The plot of designed to be a split plot; with each plot measuring half acre and the control GW173 sown in 1 acre of land. Each of the variant was sown in half acre of field.

Land Preparation

The land is prepared by harrowing three times and removing the weeds. Dry land is good for better germination and growth of the crop. The soil is tilled for conserving moisture.

Sowing

Seeds should be sown 6cm deeper in the soil. The seed rate being 60kg/ha. Seeds should be sown in rows that are 30cm apart.

Seed Treatment

All varieties were treated with fungicides before sowing. Each variant is specific for its resistance. Chhoti Lerma is resistant to yellow rust and black rust, Kalyan Sona has wider ad to all conditions. Adaptability and resistance to smut, Sharbati Sonora is Amber grained and Sonalika has wider adaptability.

Fertilizers and Pesticides

NPK fertilizers were given at the doses of 50:25:12 and urea used was 60kg/acre. Saaf, Geolife No virus, Alika and Multiplex Kranthi and other locally available Bio Agricultural Pesticides were given to the plants.

Weeding

Interculturing should be done at 30 day interval to keep the crop free of weeds. Weeding should be done whenever required manually.

Irrigation

The crop requires 12 I to 14 irrigations having red soil each of 50mm. After that it should be 12 irrigations for 3 days interval. The irrigations should be given at CRI, tilling, jointing, flowering and milking stages.

Harvesting

The crop is harvested when the grains become hard and the straw becomes golden yellow and dry. The plants are harvested early in the morning with help of the sickle and tied into bundles and then carried to the threshing floor for heaping. The grain is then thrashed on the threshing floor. Clean grains are dried for about 7 days under open sunlight to be devoid of moisture for storage.

Results and Discussion

The data shows that the crop sown during the first month had a minimum temperature of 21 and maximum temperature 31. The grain filling stage had a minimum temperature of 22 and maximum temperature of 38. Studies have shown that the ideal temperature for quality yield is 15 to 25 by the heat variants yielded good crop in a controlled weather by proper irrigation and prevention of drought stress. The life cycle of the plant completes quickly than normal under heat stress which can be controlled by proper irrigation measures. The grain yield meets the normal yield just as in rabi season. Effective farming can produce good quality crop even under heat stress when supplied with frequent irrigation preventing the drought stress. Data shows similarity with the previous findings of Dias *et al*. (2008) and Farooq *et al*. (2011). Table 1 shows various parameters of all variants considered during the investigation. Chen et al. (2007) worked on effects of straw mulching on soil temperature, evaporation and yield of winter wheat in North China, our results show agreement with the previous reports (Dhanda *et al*., 2012)

Growth

After germination and at maturity the crop is 7cm – 8cmThe minimal plant height was seen during the first month and a 60% height growth was seen during the third month. The colour of the crop differs as per the characteristics of the variant.

Calculations

The parameters were calculated according to the following formulae and data are shown in Fig. 1, Fig 2 and Fig. 3.

Grain Yield

GRAIN YIELD = (GRAIN YIELD / SUBPLOT) ÷ (AREA / SUBPLOT) x 10000

Biological Yield

BIOLOGICAL YIELD = (BIOLOGICAL YIELD / SUBPLOT) ÷ (AREA / SUBPLOT) x 10000

Straw Yield:

STRAW YIELD = (BIOLOGICAL YIELD – GRAIN YIELD)

Harvest Index:

HI = (GRAIN YIELD ÷ BIOLOGICAL YIELD) X 100

Growth of all Variants

Data shown in Fig. 1 shows that GW173 & Sonalika wheat showed high growth in respect to others.

Table 1: Parameters of all variants

Wheat Variants	PLANT HEIGHT (cm)	BIOLOGICAL YIELD (kg/ha)	GRAIN YIELD (kg/ha)	STRAW YIELD (kg/ha)	HARVEST INDEX (%)
GW173	99.48	8.99	5.79	3.20	64.40
CHHOTI LERMA	90.7	7.85	5.02	2.83	63.9
KALYAN SONA	92.6	8.65	5.49	3.16	63.46
SHARBATI SONORA	97.5	8.02	5.10	2.92	63.27
SONALIKA	96.8	8.06	5.08	2.98	63.02

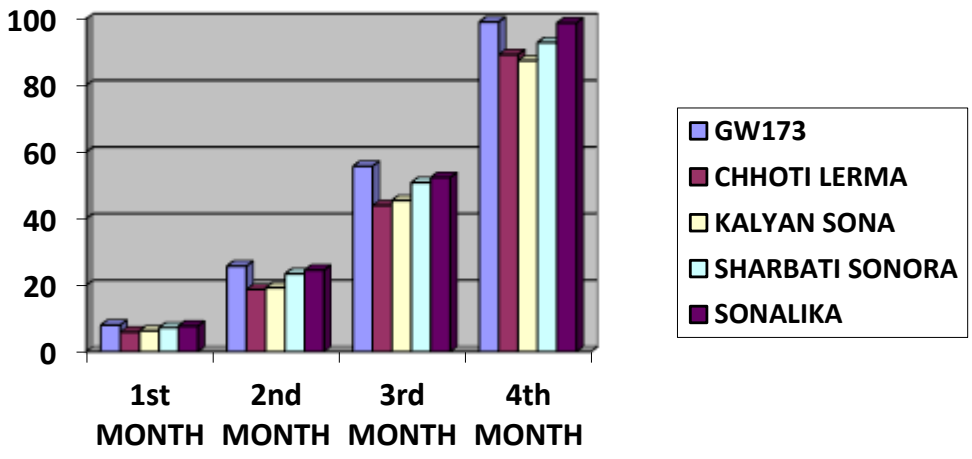

Fig. 1: Growth data of wheat varieties under certain intervals

Yields of all parameters

Straw yield, grain yield and biological yield were recorded for all varieties used and data is presented in Table 1 & Fig. 2.

Harvest Index of all Variants

Table 1 & Fig. 3 shows the harvest index of all variants. It is evident with the data that maximum harvest was recorded in GW173 and minimum in Sonalika.

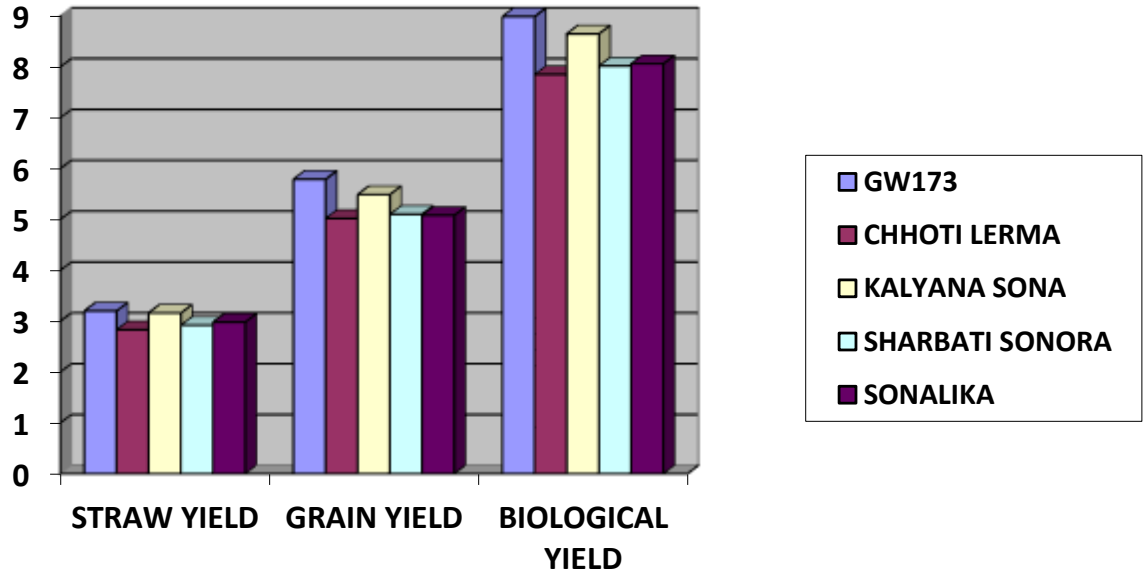

Fig. 2: Yields of wheat varieties.

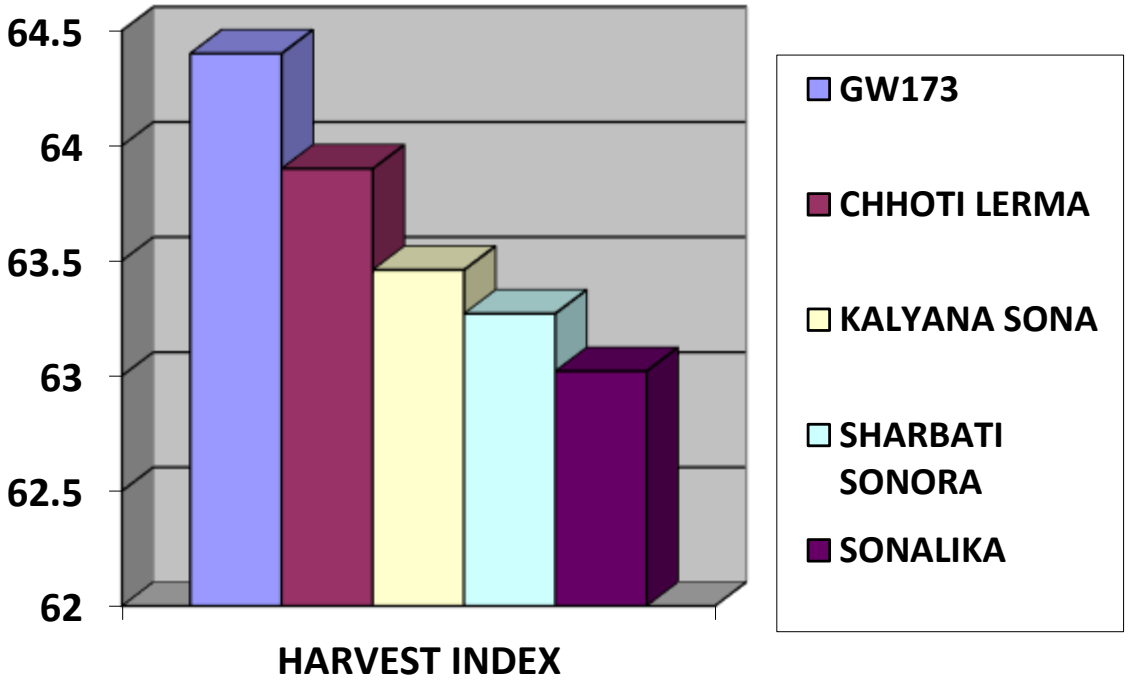

Fig. 3: Harvest index of all variants

Conflict of Interest

The authors declare that there is no conflict of interest with present publication.

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