International Journal of Chemical and Biochemical Sciences
(ISSN 2226-9614)

Journal Home page: www.iscientific.org/Journal.html

Characterization of okra genotypes at reproductive stage under high temperature stress

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Abstract

Okra contains vitamin A, B, C as well as fat, carbohydrate fiber, iron, iodine and mainly protein. Its pods comprehend glycosides, a minor amount of Ca, P, Mg and K. A mucilaginous preparation from the fruit has set up an application as a plasma substitute or blood level expander. It is influenced by three most important factors like temperature, water and humidity, yet here in this examination we studied the harmful impacts of high temperature stress in okra plant. In the proposed study we assessed the different morphological, biochemical and physiological changes in okra under high temperature stress. Ten genotypes of okra were subjected to three separate condition of temperature i.e. 23°C (control), 40°C and 45°C (high temperature stress) at reproductive growth stage. The purpose of this study is to check the okra genotypes into heat tolerant and heat-sensitive group. The classification was made on the premise of different morphological, physiological and biochemical markers of high temperature resistance. Green wonder performed best under heat stress condition and Pen beauty, Rama krishna and MF.03 and shahzadi were heat sensitive cultivars.

Key words: Genotypes, Okra, Reproductive stage, Stress, Vegetable,

Full length article Received: 14-04-2016 Revised: 04-07-2016 Accepted: 15-07-2016 Available online: 31-07-2016

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Introduction

Okra (*Abelomuschus esculents* L.) belongs to family Malvaceae and is grown as summer vegetable all over the tropical and sub-tropical region of the world [1]. In Pakistan it is growing from March to July. Okra grows best in hot summer with minimum and maximum mean temperature of 18 ^{o}C (65^{o}F) and 35 ^{o}C (95^{o}F), respectively. If implanted in late spring may remain vegetative until late summer or early fall [2]. The soil temperature for okra seed germination is minimum about 15^{o}C, however the ideal germination temperature is 35^{o}C. Germination take 27 days, at soil temperature of around 15^{o}C while at around 24^{o}C germination may take just in 13 days and in a perfect condition it may take a week. The foreign literature indicates that the optimum temperature for okra seed germination is either 24- 32^{o}C or 30 -35 ^{o}C [3]; whereas, in the Japanese literature, the optimum germination temperature okra is reported to range from 25 to 30 ^{o}C [4, 5]. It is appropriately noticed that propagative tissues of crops have advanced vulnerability to heat stress in contrast with asexual organs [6]. Vegetable stress responses are very complex and many plant tissues in a certain hierarchy and contact with respectively are complicated in liable crop yield under stress [7].

Okra is sensitive to low temperatures and develop poorly below 15 ^{o}C [8]. Okra obliges high temperatures of around 70^{o}C and taking day length for ideal development and improvement. Studies on the ideal climate requirement for high return okra in the tropics demonstrate that okra perform best when the minimum and maximum temperatures are 18 ^{o}C and 35 ^{o}C respectively [9]. Grubben, [10] saw temperatures of between 25-40^{o}C for ideal development and yield of okra, while [11] recorded a basic day length of 12½ hours for blossom start and organic product yield. Welby and McGregor, [12] watched a change in the execution of okra when precipitation was around 750 mm, equally circulated and relative stickiness was between 90-95%. On the other hand, low temperatures of 28.9 ^{o}C - 29.2 ^{o}C and 17.9-19.8 ^{o}C (min) and short day-lengths of 5.2-5.7 hrs resulted in a higher number of blossoms [13]. The proposed study was to evaluate impact of heat stress on different okra genotype.

Material and Methods

The research was conceded out in the growth chamber of, Department of Horticulture, University College of Agriculture, University of Sargodha. Planned study was done to check out the conclusion of Characterization of okra genotype at reproductive stage under temperature stress. Seeds of ten okra varieties were obtained from Ayub

Agricultural Research Institute Faisalabad. The seeds were clean with 5% sodium hypochlorite solution. After surface decontamination the seeds were sown in plastic pots of nine inch in length. The pots were filled with peat mass, vermiculite as the rooting medium. Five seeds were sown in a pot. After development the number of plants were be thinned, by removing the weak and less vigorous saplings. The plants was allowed to grow under controlled environmental conditions at 23 ^{o}C (i.e. control) from seedling to fruit formation. After the floral bud initiation plants were be exposed to first temperature stress and after ten days of heat stress application data was collected. One week after data collection the plants was again exposed to second range of temperature and again data was collection after 10 days. After the appearance of flowers the plants was be exposed to different temperature i.e. one week after initiation of heat stress the data concerning various morphological and physiological features was recorded. Data regarding various morphological, physiological and nutritional parameters were collected and analyzed using the software statistx. 8.1.

Results and Discussion

Data regarding number of leaves per plant revealed that by increasing temperature number of leaves per plant decreased as compare to control (T_0). Maximum number of leaves per plant (6.53) were observed in treatment T_0 followed by T_1 (5.73) T_2 (3.00) respectively, while treatment T_2 exhibit minimum number of leaves per plant (3.00). Due to temperature stress all variety of okra showed significant difference in plant growth. But performance regarding mean value of number of leaves per plant showed that Green wonder exhibited maximum number of leaves (7.00) that significantly differ from Anar kali, Desi okra, Sar sabz, F.Click 5769, Sbaz pari. While cultivar shahzadi exhibited minimum number of leaves (3.22) per plant at higher temperature level. Interaction of treatments and variety also exhibit variations. Green wonder showed minimum decreases in number of leaves per plant at all temperature levels but in all other cultivars of okra by increasing temperature number of leaves were decreased (Figure 1).

Data regarding number of flower per plant revealed that by increasing temperature levels on flower per plant decreased as compare to control (T_0). Maximum on flower per plant (8.83) were observed in treatment T_0 followed by T_1 (4.60) T_2 (0.93) respectively, while treatment T_2 exhibit minimum flower per plant (0.93). Due to temperature stress all variety of okra show significant difference in plant growth. But performance regarding mean value of flower per plant showed that Green wonder exhibited maximum flower (6.11) that significantly differ from Anar kali, Desi okra, Sar sabz, F.click 5769, Sbaz pari. While cultivar shahzadi exhibited minimum flower (3.33) per plant at higher temperature level. Interaction of treatments and variety also exhibit variations. Green wonder showed minimum decreases flower per plant at all temperature levels but in all other cultivars of okra by increasing temperature number of flower were decreased (Figure 2).

Data regarding number of fruit per plant revealed that by increasing temperature levels on fruitper plant decreased as compare to control. Maximum on fruit per plant (1.30) were observed in treatment T_0 followed by T_1 (0.70) T_2 (0.20) respectively, while treatment T_2 exhibit minimum fruit per plant (0.20). Due to temperature stress all variety of okra show significant difference in plant growth. But performance regarding mean value of fruit per plant showed that Green wonder exhibited maximum fruit (1.33) that significantly differ from Anar kali, Desi okra, Sar sabz, F.Click 5769, Sbaz pari. While cultivar shahzadi exhibited minimum fruit (0.33) per plant at higher temperature level. Interaction of treatments and variety also exhibit variations. Green wonder showed minimum decreases fruit per plant at all temperature levels but in all other cultivars of okra by increasing temperature number of fruit were decreased (Figure 3).

Data regarding rate of photosynthesis per plant revealed that by increasing temperature levels decreased the rate of photosynthesis per plant as compare to control as shown in figure 4. Maximum on rate of photosynthesis per plant (7.35 μmol CO_2 m^{-2} s^{-1}) were observed in treatment T_0 followed by T_1 (6.71 μmol CO_2 m^{-2} s^{-1}) T_2 (3.88 μmol CO_2 m^{-2} s^{-1}) respectively, while treatment T_2 exhibit minimum rate of photosynthesis per plant (3.88 μmol CO_2 m^{-2} s^{-1}). Due to temperature stress all variety of okra show significant difference in plant growth. But performance regarding mean value for rate of photosynthesis per plant showed that Green wonder exhibited maximum photosynthesis (7.20 μmol CO_2 m^{-2} s^{-1}) that significantly differ from Anar kali, Desi okra, Sar Sabz, F.Click 5769, Sbaz pari. While cultivar shahzadi exhibited minimum photosynthesis (3.90 μmol CO_2 m^{-2} s^{-1}) at higher temperature level (T_3). Interaction of treatments and variety also exhibit variations. Green wonder showed minimum decreases photosynthesis per plant at all temperature levels but in all other cultivars of okra by increasing temperature photosynthesis were decreased (Figure 4).

Data regarding stomatal conductance of okra genotypes revealed that by increasing temperature levels on stomata conductance of okra plant decreased as compare to control. Maximum on stomata conductance (3.54 mmol m^{-2} s^{-1}) was observed in treatment T_0 followed by T_1 (3.28 mmol m^{-2} s^{-1}) T_2 (1.56 mmol m^{-2} s^{-1}) respectively, while treatment T_2 exhibit minimum stomata conductance (1.56 mmol m^{-2} s^{-1}). Due to temperature stress all variety of okra show significant difference in plant growth. But performance regarding mean value of stomata conductance showed that Green wonder exhibited maximum stomata conductance (3.59 mmol m^{-2} s^{-1}) that significantly differ from Anar kali, Desi okra, Sar sabz, F.Click 5769, Sbaz pari. While cultivar shahzadi exhibited minimum stomata conductance (2.10 mmol m^{-2} s^{-1}) at higher temperature level. Interaction of treatments and variety also exhibit variations. Green wonder showed minimum decreases stomata conductance at all temperature levels but in all other cultivars of okra by increasing temperature stomatal conductance were decreased (Figure 5).

The present experiment demonstrate that the number of leaves, shoot and root length was decreased with increase in temperature. Though the variety green wonder was not affected by high temperature when its revenue maximum level and displayed the maximum no of leaves at higher temperature. These results are in accordance with Amooaghaie and Moghym, [14] who reported that heat shock stress caused decrease in root and shoot length of soybean seedlings.

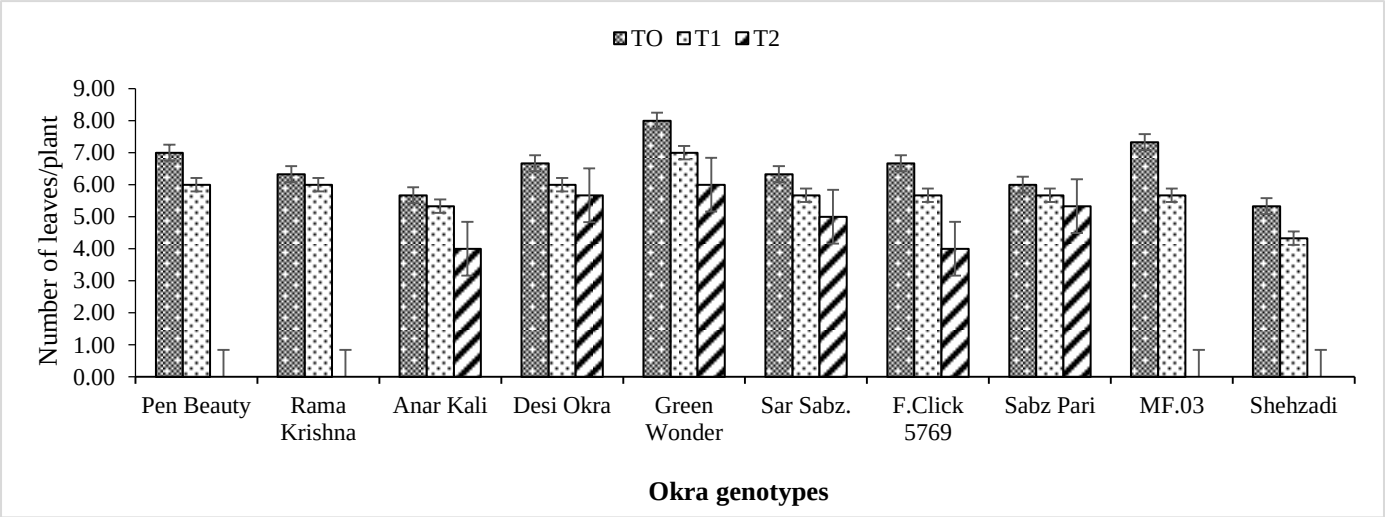

Figure 1: Effect of high temperature stress (T_0: 23 °C, T_1: 40 °C, T_2: 45 °C) on number of leaves/plant of different okra genotypes

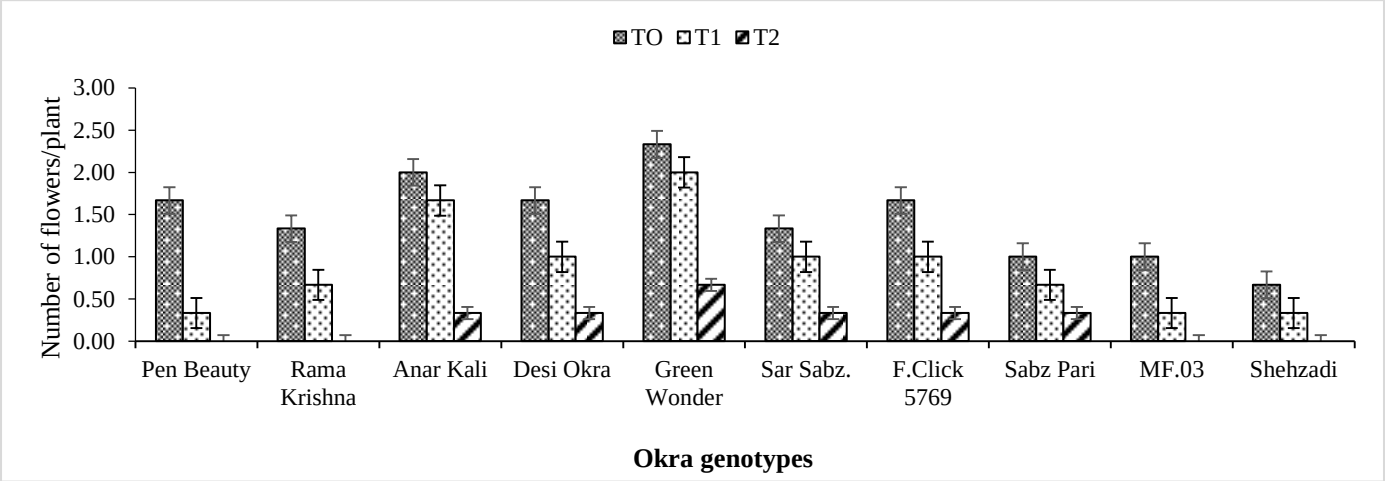

Figure 2: Effect of high temperature stress (T_0: 23 °C, T_1: 40 °C, T_2: 45 °C) on number of flowers/plant of different okra genotypes

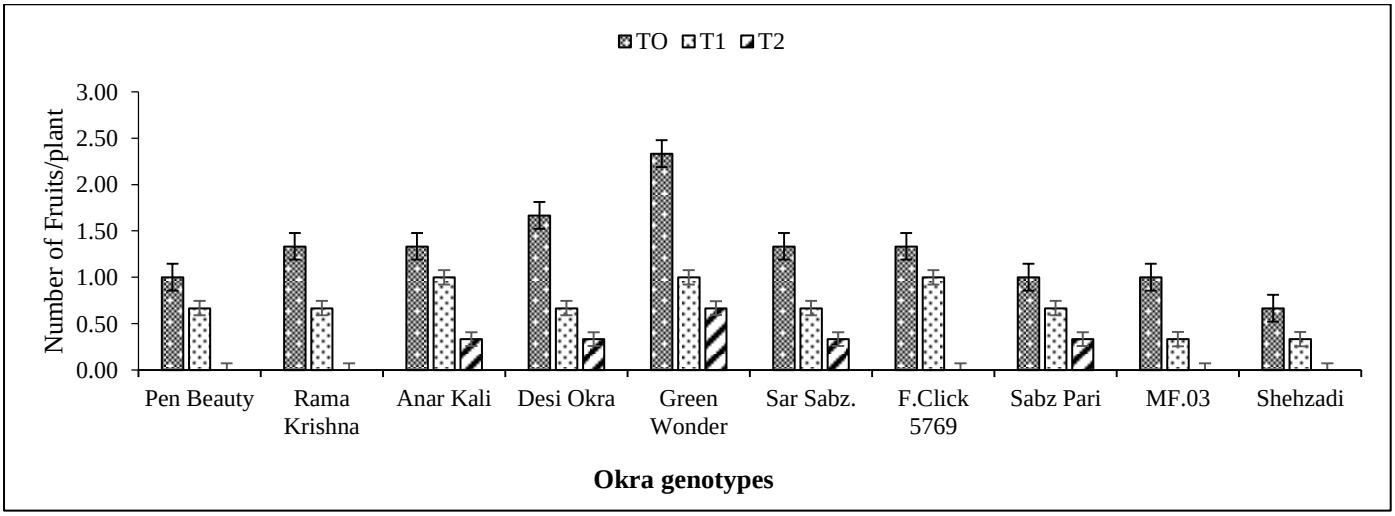

Figure 3: Effect of high temperature stress (T_0: 23 °C, T_1: 40 °C, T_2: 45 °C) on number of fruits/plant of different okra genotypes

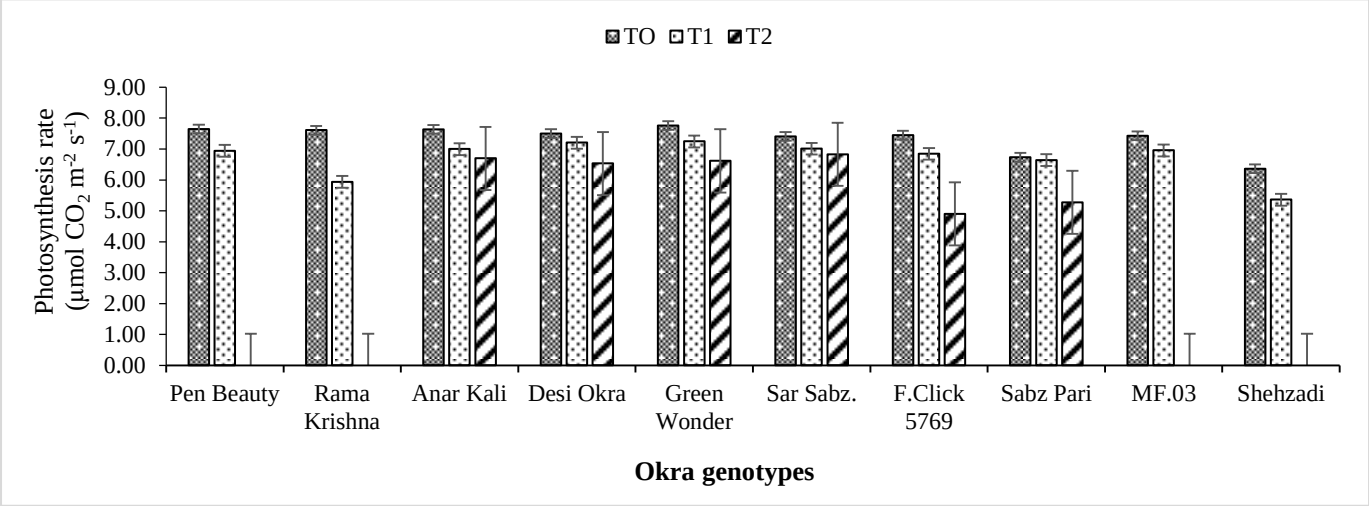

Figure 4: Effect of high temperature stress (T_0: 23 °C, T_1: 40 °C, T_2: 45 °C) on photosynthesis rate of different okra genotypes

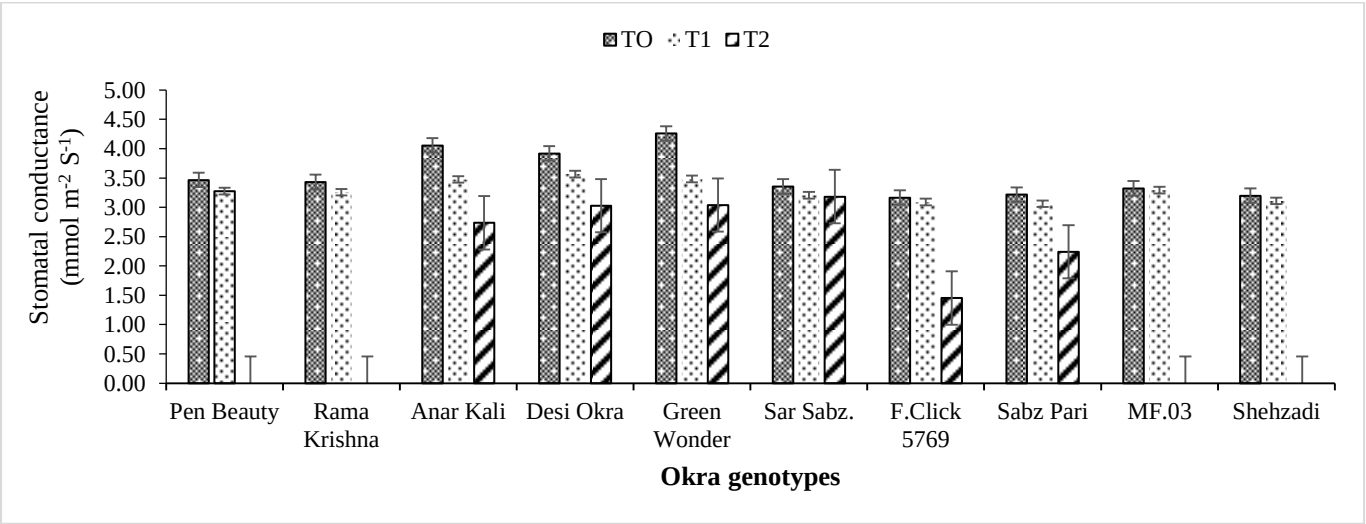

Figure 5: Effect of high temperature stress (T_0: 23 °C, T_1: 40 °C, T_2: 45 °C) on stomatal conductance of different okra genotypes

Pollen development, fertilization, and asynchrony of stamen and gynoecium's development are sensitive to temperatures during flowering [15]. The loss of pollen or stigma viability under high temperatures stress might be the primary reason for the lowered number of seeds produce in the legume [16, 17]. The effects of current study exposed that when temperature was continuously increased then flower setting decreased. The cultivars Green wonder showed least decrease in chlorophyll contents because it obstructed the process associated with necessary protein degradation as compared to other variety especially Shahzadi. Reduced fruit- set at higher heat was mostly outstanding to poor pollen viability, diminish pollen production and poor pollen tube growth, altogether of which lead to poor fertilization of flowers [18]. Flower abortion also has been attributable to the reduced seeds per plant and seed yield in other crops such as *Brassica napus* [19] *Brapa* [20] and B. Juncea [21]. The outcome of our finding is that the green wonder variety of okra is better performance as compared other varieties particularly the shahzadi variety.

High temperature influence rubisco, which disturbed photosynthesis of plant. Since high temperature deactivates of the rubisco and which is one of the reasons that causes the turn down in photosynthesis [22]. The significances of current study revealed that when constant temperature was expanded then rate of photosynthesis reduced. However, the cultivar Green wonder was very little influenced by the heat push and keeps up its definition of rubisco on high heat condition and the variety Shahzadi failed and to withstand high temperature condition.

The impact of high temperature on the mesophyll cell, which exasperates the stomatal conductance of plants [23]. Through this created an incompletely vascular group and organelle structure got to be unsteady because of high temperature. Our outcomes likewise identified with above discoveries that by rising the temperature the stomatal conductance influenced which greatly impact the development of plants. Yet, the cultivar of Green wonder was not an incredibly influenced by the heat stress while the

variety shahzadi neglected to remain healthy in high heat condition.

Conclusions

Green wonder genotypes of okra produced maximum results in case of morphological, physiological and biochemical characteristics. Thus Green wonder is considered as the best genotype of okra under high temperature stress conditions.

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