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EVALUATION OF YIELD ATTRIBUTES OF FINGER MILLET (*ELEUCINE CORACONA*. L.) AT HIGH TEMPERATURE STRESS

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ABSTRACT

A field investigation was carried out during summer 2024 at the wetland farm of S.V. Agricultural College, Tirupati, Acharya N.G. Ranga Agricultural University, Andhra Pradesh, to assess the yield performance and yield-related traits of finger millet (*Eleusine coracana* L.) genotypes screened for high temperature tolerance. The experiment was conducted on red soils using a randomized block design (RBD) with three replications. A total of 14 diverse finger millet genotypes were initially screened for thermotolerance employing the standardized Thermo-Induced Response (TIR) protocol. Based on TIR screening, eight genotypes were identified as thermotolerant and subsequently evaluated under field conditions for their yield potential and associated attributes under high-temperature stress. The evaluated yield parameters included number of tillers per plant, number of fingers per ear, 1000-grain weight, straw yield, and grain yield. Results indicated that thermotolerant genotypes exhibited significantly superior performance in all measured yield components compared to moderately tolerant and susceptible genotypes. Among the evaluated entries, the genotypes 'Tirumala' and 'VR 1099' consistently recorded higher values for yield and associated traits. Notably, the genotype PPR 1160 recorded the highest grain yield (2496 kg/ha), followed by PPR 1272 (2382 kg/ha). The genotype VR 1099 demonstrated superior yield attributes, including number of tillers per plant (10.63), number of fingers per plant (9.26), test weight (3.76 g), and harvest index (36.46%), comparable to PPR 1160. Conversely, the lowest grain yield was observed in PPR 1216 (1099 kg/ha). The findings underscore the critical sensitivity of finger millet to high temperature stress during the panicle initiation stage. Genotypes such as 'Tirumala' and 'VR 1099' were identified as promising for cultivation under high temperature conditions due to their superior thermotolerance and yield performance. Additionally, genotypes like PPR 1216 and PPR 1094 may be suitable for both irrigated and rainfed environments.
***Keywords*:** Finger millet, Temperature stress, Grain yield, Straw yield and Harvest index.

Introduction

Millets are nutritious than major cereals and hence called as "Miracle Nutri-cereals." With the aim of creating awareness and increasing the production and consumption of millets, the United Nations, at the request of the Government of India, declared 2023 as the International Year of Millets (IYoM). This initiative has led to a significant boost in millet production and consumption across the globe. Specifically, in India, the production of millets, including finger millet (Eleusine coracana), documented a significant increase. According to recent reports, the production of finger millet increased by 15% in 2023 compared to the previous year (Krishna *et al*., 2021; Kastury *et al*., 2024). Finger millet is grown in an area of 11.14 lakh hectares in India, with a productivity level of 1,497 kg/ha and a yield of 16.69 lakh tonnes. (Ministry of Agriculture & Farmers Welfare, Govt of India, 2023). In Andhra Pradesh, it is grown in an area of 0.30 lakh hectares yielding 0.35

lakh tonnes with productivity of 1,167 kg/ha (Ministry of Agriculture & Farmers Welfare, Govt of India, 2023).

Apart from various abiotic stresses worldwide, heat stress is the major limiting constraint for crop yield and the loss of crop yield due to heat stress is increasing every year. Hence, to generate better heat tolerant crop plants. Finger millet varieties grown by farmers can grow and sustain well up to a temperature maximum of 36°C. However, increase in temperature above these limits has a drastic effect on production and leads to crop failure. Under changing climatic conditions, high temperature stress is the most severe problem for the whole agriculture. Identification and utilization of crop plants which can sustain and yield better under high temperature conditions is need of the day. In this study, we established finger millet as thermotolerant crop.

Global climate change events such as higher surface temperatures, changes in precipitation pattern, increased intensity, frequency and duration of drought periods, growing scarcity of water for irrigation are affecting agricultural productivity worldwide. In arid and semi-arid regions, drought is the major abiotic stress factor that seriously affects crop productivity. Millets perform better than cereals in semiarid and arid environments due to their climate resilient features such as tolerance to environmental stresses, a minimum requirement for irrigation water, superior growth and productivity. Tolerance to high temperature stress conditions, particularly those that mimic the field environment, should be the focus of future research programmes aimed to select genotypes with enhanced tolerance to naturally occurring environmental conditions. The simultaneous occurrence of multiple abiotic stresses rather than one stress is commonly noticed under field conditions. However, relatively little information is available with reference to physiological, biochemical, and molecular responses of finger millet to high temperature stress. Hence the present investigation was carried out with an objective to evaluate the yield and yield components of finger millet genotypes for high temperature stress under field conditions.

Material and Methods

The field experiment was conducted during summer, 2024 to expose the crop to the high temperature stress in Field No. 23 of wetland farm, S.V. Agricultural College, Tirupati campus of Acharya N.G. Ranga Agricultural University which is geographically at 79°E longitude and 13°N latitude was used for each treatment. The data on yield and yield components was taken as given below

Number of Fingers per Plant: Five plants were randomly selected from each net plot area at harvest. The number of fingers on each plant was counted, and the average number of fingers per plant was calculated.

Test Weight (1000 grain weight in g): Five composite samples, each consisting of 1000 grains, were collected from the net plot yield of each treatment. The weight of these samples was recorded, averaged, and expressed as the test weight (1000-grain weight) in grams.

Grain Yield (kg ha^{-1}): The grains obtained from the net plot area, including those from sampled plants, were thoroughly sun-dried to a safe moisture level of 14%. The dried grains were then weighed and expressed in kg ha^{-1}.

Straw Yield (kg ha^{-1}): The straw obtained from the net plot area, including that from sampled plants, was thoroughly sun-dried to a constant weight, weighed, and expressed in kg ha^{-1}.

Harvest Index (%): The harvest index is the ratio of economic yield to total biological yield, expressed as a percentage, as suggested by Donald and Hamblin (1976).

Results and Discussion

The evaluation of finger millet genotypes under high-temperature field conditions revealed significant variability in yield parameters such as number of tillers per plant, number of fingers per ear head, ear head length, test weight, grain yield, straw yield, and harvest index. These findings underscore the importance of selecting genotypes with robust yield traits and efficient biomass-to-grain conversion for cultivation under thermal stress conditions.

The data presented in Table.1 represents the comparative performance of eight TIR screened genotypes of finger millet. Each of these genotypes exhibited distinct characteristics across the evaluated parameters, which are crucial for understanding their agricultural potential and overall performance.

Number of tillers per plant

The number of tillers per plant is an important trait for determining the potential yield of a crop. In this study, genotype VR 1099 showed significantly highest number of tillers per plant at 10.63, outperforming the others which is followed by genotypes PPR 1160 and PPR 1272 with 9.36 and 8.56 tillers per plant, respectively (Table.1). Cultivar Tirumala, genotypes VR 1192 and VR 1188 have moderate tiller numbers, while genotypes PPR 1094 and PPR 1216 exhibited the lowest, with values of 5.3 and 5.13 tillers per plant, respectively.

Number of fingers: Number of fingers, another critical yield component, varied significantly among the genotypes. Genotype VR 1099 recorded 9.26 fingers, followed by genotypes PPR 1272 (8.63 fingers) and PPR 1160 (8.53 fingers). The genotypes VR 1192 and VR 1188 showed lower numbers of fingers, 6.36 and 6.6 respectively, whereas genotypes PPR 1094 and PPR 1216 recorded the least number of fingers, indicating potentially lower grain production.

Ear head length: Ear head length, which contributes to the final grain yield, showed that genotype VR 1099 had the longest ear heads (10.63 cm). Genotypes PPR 1160 and PPR 1272 followed with ear head lengths of 9.36 cm and 8.56 cm, respectively (Table.1). Cultivar Tirumala, genotypes VR 1192 and VR 1188 have shorter ear heads, while genotypes PPR 1094 and PPR 1216 showed the shortest ear heads, which may contribute to their lower yields.

Test weight: Test weight, an indicator of grain size and quality, was highest in genotype VR 1099 at 3.76 g, indicating potentially heavier and more marketable grains. Genotype PPR 1160 and cultivar Tirumala have intermediate test weights, while genotypes VR 1192, VR 1188, PPR 1094 and PPR 1216 have significantly lower test weights, suggesting lighter grains.

Grain yield: Grain yield is a critical measure of productivity. Genotype PPR 1160 recorded the highest grain yield at 2496.86 kg/ha, suggesting its superior performance under the given conditions. Genotype VR 1099, despite having the highest tillers and ear head length, had a slightly lower yield at 2292.33 kg/ha. Cultivar Tirumala, genotypes VR 1192, VR 1188, PPR 1094 and PPR 1216 exhibited progressively lower yields, genotype PPR 1216 having the lowest grain yield at 1099.5 kg/ha.

Straw yield: Straw yield, representing the non-grain biomass, was highest in genotype VR 1099 at 4941.67 kg/ha, followed by genotypes PPR 1160 and PPR 1272 with 4763 kg/ha and 4685 kg/ha, respectively. Cultivars Tirumala showed a moderate straw yield, while genotypes VR 1192, VR 1188, PPR 1094 and PPR 1216 had lower straw yields, with genotype PPR 1216 being the lowest at 3146 kg/ha.

Harvest index: Harvest index, which is the ratio of grain yield to total biomass, provides an indication of the efficiency with which the plant converts its biomass into grain. Genotypes VR 1099, PPR 1160 and PPR 1272 exhibited high harvest indices of 36.46 per cent, 36.41 per cent and 32.54 per cent, respectively, indicating efficient biomass utilization. Cultivar Tirumala also showed a relatively high harvest index, while genotypes VR 1192 and VR 1188 have moderate values. Genotypes PPR 1094 and PPR 1216 have the lowest harvest indices, indicating less efficient biomass conversion.

Overall, genotypes VR 1099 and PPR 1160 emerged as superior genotypes with high yields and efficient biomass conversion, making them promising candidates for cultivation. Genotypes like PPR 1272 and cultivar Tirumala also showed potential, though with some limitations in specific traits. The lower-performing genotypes such as VR 1192, VR 1188, PPR 1094 and PPR 1216 may require further improvement or specific management practices to enhance their productivity.

These findings align with studies emphasizing the importance of reproductive traits and biomass-to-grain conversion in enhancing yield under stress conditions (Gayathri *et al*., 2022).

In terms of the number of tillers per plant, the genotype VR 1099 demonstrated the highest tiller production. This aligns with the findings of Rajaneesh *et al.,* (2019), who emphasized the importance of tillers as a yield component in wheat improvement programs. The high number of tillers in genotype VR 1099 suggests a healthy vegetative growth which is often associated with higher grain yields due to increased photosynthetic area and resource allocation (Rajaneesh *et al*., 2019).

The number of fingers per plant is another crucial yield determinant. Genotypes VR 1099 and PPR 1160 showed superior performance in this trait. Ear head length, which significantly affects grain yield, was longest in VR 1099. This trait has been highlighted by Huel and Hucl (1996) as vital for competitive ability and overall yield in wheat genotypes. The extended ear head length in VR 1099 suggests a higher number of grains per head, contributing to increased yield potential (Huel and Hucl, 1996).

The test weight, reflecting grain quality and marketability, was highest in genotype VR 1099. Mengesha *et al*., (2022) found that higher test weights are often correlated with better grain filling and overall yield performance in maize hybrids. The superior test weight in genotype VR 1099 indicates not only high yield potential but also better grain quality (Mengesha *et al*., 2022).

Grain yield is the ultimate measure of genotype performance. Genotype PPR 1160 recorded the highest yield, followed closely by genotype VR 1099. This is consistent with findings by Khan *et al*., (2015) who demonstrated that certain wheat genotypes under rainfed conditions yielded significantly higher than others, emphasizing the role of genotype in yield optimization (Khan *et al*., 2015). The high yields of genotypes PPR 1160 and VR 1099 underline their potential for cultivation in similar environments.

Straw yield, an indicator of biomass production was also highest in genotype VR 1099. This is in agreement with the study by Abinasa *et al.* (2011) who noted that biomass production is a critical trait for determining the overall productivity of durum wheat genotypes. The high straw yield in VR 1099 suggests efficient biomass accumulation which can be beneficial for both grain and fodder production (Abinasa *et al*., 2011).

The harvest index, which measures the efficiency of biomass conversion to grain was highest in genotypes VR 1099 and PPR 1160. According to Muluneh Mekasha *et al*., (2020), a high harvest index indicates effective resource use and partitioning of biomass towards grain production. The high harvest indices of genotypes VR 1099 and PPR 1160 reflect their superior genetic potential for high yield under the given conditions (Pradhan *et al*., 2019 and Muluneh Mekasha *et al*., 2020).

Conclusion

These findings offer valuable insights for selecting finger millet genotypes that can maintain productivity under thermal stress, essential for developing resilient crop varieties. The obtained results can be supported by research-based claims that high-temperature stress adversely affects the growth, yield and harvest index of finger millet (Pradhan *et al*., 2019). Future research should focus on elucidating the molecular mechanisms underlying heat tolerance and developing climate-resilient finger millet varieties. Identifying the key genetic and physiological factors that contribute to high harvest index and efficient resource allocation under high-temperature conditions will be crucial for breeding and cultivating finger millet genotypes that can thrive in the face of thermal stress.

Table 1 : Effect of high temperature stress on yield and yield attributes of TIR screened finger millet genotypes under field conditions during summer 2024

Genotypes	Number of tillers per plant	Number of fingers	Ear head length	Test weight	Grain Yield (Kg ha^{-1})	Straw Yield (Kg ha^{-1})	Harvest index
VR 1099	10.63^{a}	9.26^{a}	10.63^{a}	3.76^{a}	2292.33^{ab}	4941.67a	36.46^{a}
PPR 1160	9.36^{b}	8.53^{b}	9.36^{b}	3.4^{ab}	2496.86^{a}	4763^{ab}	36.41^{a}
PPR 1272	8.56^{b}	8.63^{ab}	8.56^{b}	3.16^{bc}	2382.23^{a}	4685^{b}	32.54^{a}
Tirumala	7.2^{c}	7.23^{c}	7.2^{c}	3.36^{ab}	2282.2^{ab}	4121^{c}	34.22^{a}
VR 1192	7.33^{c}	6.36^{de}	7.33^{c}	2.8^{cd}	1724.5^{bc}	3762.67^{d}	26.61^{b}
VR 1188	6.4^{c}	6.6^{cd}	6.4^{c}	2.7^{d}	1277^{cd}	3567^{e}	25.05^{b}
PPR 1094	5.3^{d}	5.76^{ef}	5.3^{d}	2.2^{e}	1107.86^{d}	3360^{f}	17.72^{c}
PPR 1216	5.13^{d}	5.3^{f}	5.13^{d}	2.13^{e}	1099.5^{d}	3146^{g}	15.76^{c}
SE (m) ±	**0.1036**	**0.2164**	**0.1439**	**0.0930**	**122.5565**	**39.1560**	**1.0972**
CD 5%	**0.3142**	**0.6565**	**0.4366**	**0.2821**	**371.7368**	**118.7674**	**3.3280**

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