HEAT TOLERANCE IN WILD POTATO (*SOLANUM CHACOENSE*, SOLANACEAE)

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1- INTRODUCTION

Potato (*Solanum tuberosum,* Solanaceae) tuberization starts at 20°C and eventually any rise or fall in optimum temperature delays it by slowing metabolism and growth. Tubers development usually happens when temperature is below 15ºC, while 25 ºC or above temperatures results in increased growth of aerial parts and decreased development of the underground. Heat stress first of all affect leaves which impairs cell membrane integrity (BLUM; EBERCON, 1981). High temperature results in increased respiration, reduction in photosynthetic activity and leads to less byproducts essential for tuberization (LEVY; VEILLEUX, 2007). Heat tolerance is defined as the ability of the potato plant to develop and produce its potential yield under high temperatures (WAHID *et al.*, 2007). To access the potato genotypes which have ability to attain their potential tuber yield, they could be grown in specially designed chambers with controlled environmental factors (WAHID *et al.*, 2007).

Wild potatoes (*Solanum* sect. *Petota*) may have genes of interest for tolerance to heat stress (SMILLIE; HETHERINGTON, 1983), because their adaptation to wider and diverse climatic conditions (HAWKES, 1992). Many species have been reported to be tolerant such as *S. berthaultii*, *S. chacoense*, and *S. stoloniferum* (REYNOLDS; EWING, 1989) or somewhat tolerant such as *S. boliviense*, *S. chacoense*, *S. iopetalum*, *S. kurtzianum*, *S. polyadenium*, and *S. raphanifolium* (MACHIDA-HIRANO, 2015). Thus, this study aims to observe the best performing of two wild potato accessions of *S. chacoense* from Embrapa Clima Temperado Potato Genebank under heat stress.

2- MATERIAL AND METHODS

Two *S. chacoense* wild potato accessions BGB086, BGB444 and one commercial *S. tuberosum* cultivar BEL (PEREIRA *et al.*, 2015) were grown in factorial experimental design with two temperature treatments. Control with temperature range of 14-27ºC and heat treatment with temperature range of 24-34ºC, both with 12 h photoperiod. Tuber related traits such as number of big tubers (NBT), number of small tubers (NST), total number of tubers (NTT), weight of big tubers (WBT) (g), weight of small tubers (WST) (g), weight of total tubers (WTT) (g) were measured when plants were harvested 87 days after sowing (DAS). Cell membrane thermostability was measured by collecting samples after 60 days of treatment (KUO; CHEN; SUN, 1992). Observed data was analyzed with Genes (CRUZ, 2016) for significance analysis by considering the fixed effect for genotype and environment. The statistical model used was: $Y_{ijk}=m+G_i+A_j+B/A_{jk}+(GA)_{ij}+\varepsilon_{ijk}$. Correlation among traits in both environments were calculated by using “Corrplot” R package (WEI *et al.*, 2017) in R studio.

3- RESULT AND DISCUSSIONS

Under heat stress conditions the accession BGB444 performed better in all evaluated traits as compared to other genotypes. The genotype x environment interaction was significant ($F<0.01$) for fresh weight of big tubers and total tubers. BEL was top performer in control conditions, but BGB444 was top performer during stress conditions for both traits, WBT and WTT (Figure 1). So, this response shows that under normal conditions the commercial cultivar is outstanding but, as the temperature rises, commercial cultivar delayed the tuberization process and had a reduction in yield, while the wild genotype can adapt to wider environmental conditions and even can perform better in high temperature (LEVY; VEILLEUX, 2007).

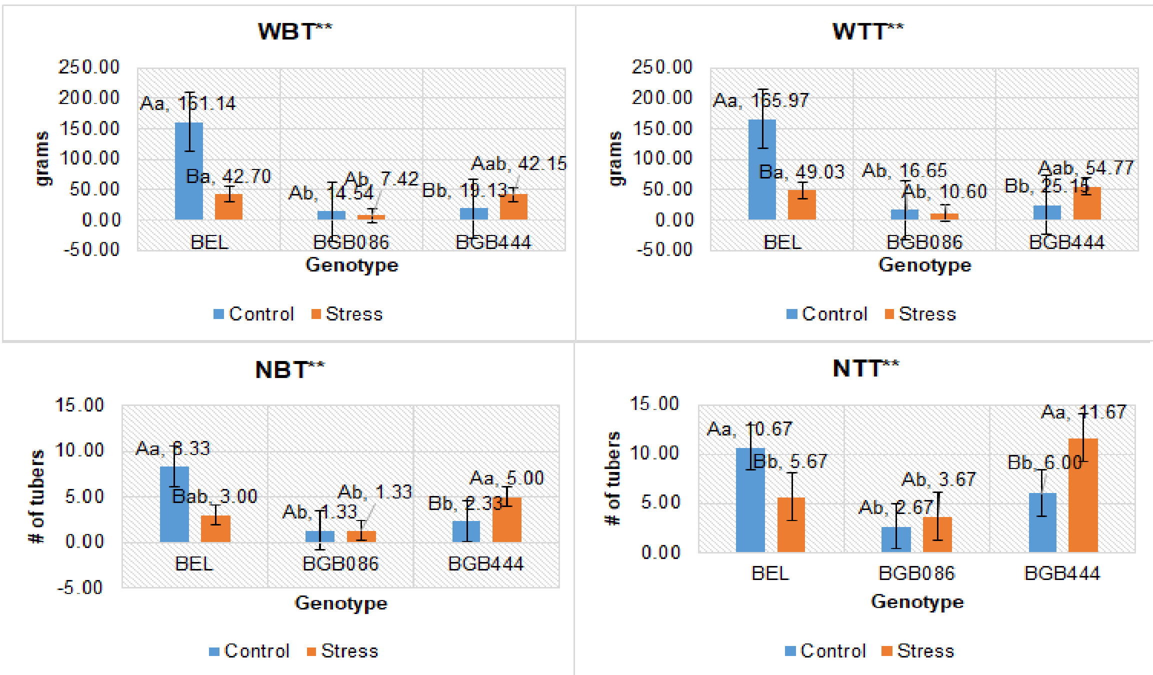

FIGURE 1: Average weight of big tubers (**WBT**), weight of total tubers (**WTT**), average number of big tubers (**NBT**), number of total tubers (**NTT**) of cultivated potato BEL (*Solanum tuberosum*) and wild potatoes BGB086 and BGB444 (*S. chacoense*) in control and stress condition. Averages followed by the same capital and lowercase letter are not significantly different at the 5% probability level by the Tukey test. "**" highly significant to 1% probability of error.

For both traits NBT and NTT, BGB444 was the best performer with average of 5 and 11.67 respectively and found highly significant ($F<0.01$) (Figure 1). The results also indicate that BGB444 may possess genes tolerant to heat stress.

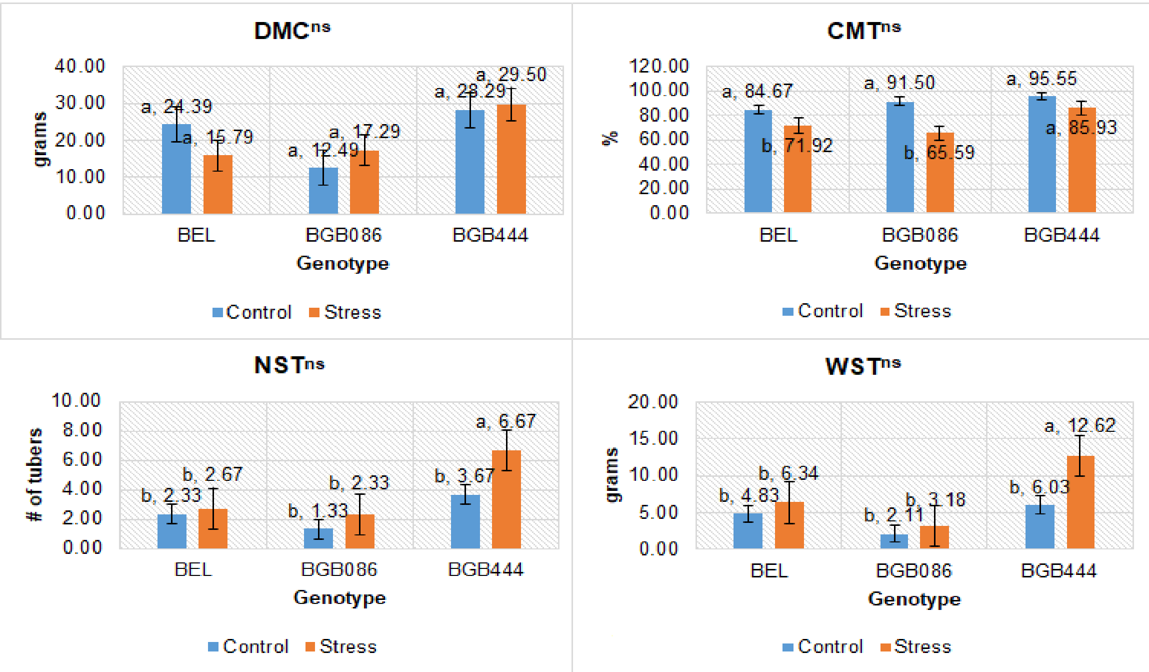

FIGURE 2 Average dry matter content (**DMC**), cell membrane thermostability (**CMT**), Average number of small tubers (**NST**), weight of small tubers (**WST**) of cultivated potato BEL (*Solanum tuberosum*) and wild potatoes BGB086 and BGB444 (*S. chacoense*) in control and stress condition. Averages followed by the same lowercase letter belong to the same group at the level of 5% probability by the Scott-Knott test. "ns" indicates non-significance of the trait.

Heat stress is known to disrupt the plasma membrane structure and composition, which consist of lipid and protein (ASTHIR, 2015). Electrolyte leakage measured from the membrane injuries caused by abiotic stress reflects the level of stability of membrane under heat stress (ARVIN; DONNELLY, 2008). In this case, BGB444 is more stable under heat stress since it has a small decrease in CMT. But the DMC and CMT were found non-significant (Figure 2). As well as number of small tubers (NST) and fresh weight of small tubers (WST) were non-significant (Figure 2).

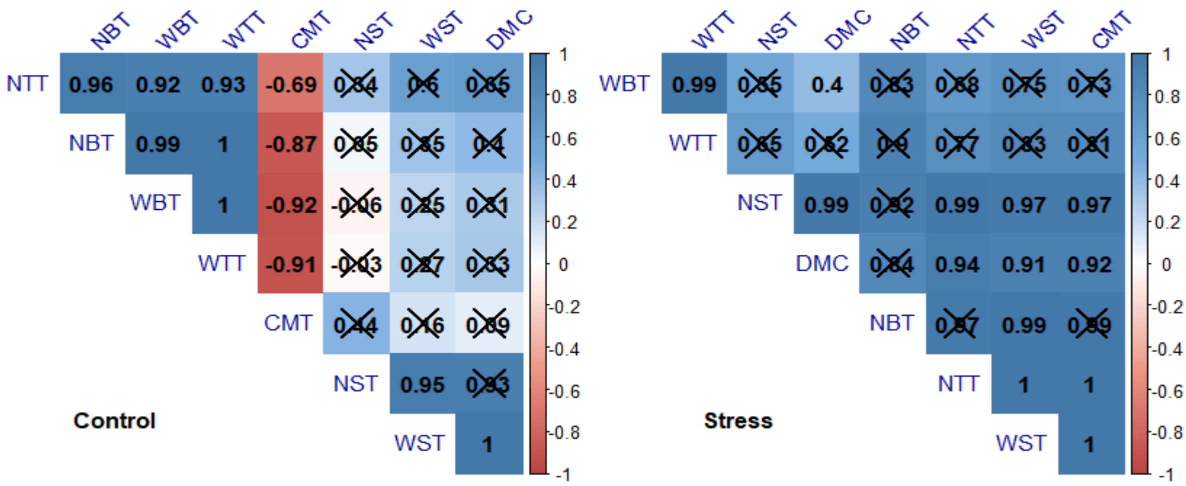

FIGURE 3: Correlations between the variables evaluated in control condition and stress condition. Color bar indicates the magnitude of the correlation. "X" indicates the non-significance at 5% CI.

Correlation analysis (Figure 3) among observed traits in both control and stress conditions shows that CMT was found significantly correlated with NBT, NST and NTT but positively correlated under stress conditions and negatively correlated under control conditions. Dry matter (DMC) was highly positive correlated with NST and WST which explains the role of small tubers in dry matter content but also these three traits were found non-significant due to their relation (Figure 2). WTT and WST were also found highly positive correlated in both environmental conditions which proves the relation of contribution in each other performance.

4- CONCLUSION

BGB444 presents better yields of tubers under high temperature conditions. This genotype could be a potential source of genes required to be incorporated into potato breeding program for heat tolerant cultivar development.

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