Reduced germination and survival of wheat seed exposed to high (35-40?c) temperatures

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Adverse effects of high temperature on germination, survival and emergence of wheat is important in tropical areas where wheat may be sown as a crop following rice. Six spring wheat cultivars were examined using a thermogradient plate to determine their temperature response curves over a range of 15-40?C. Physiological mechanisms involved with intolerance to germination at high temperatures (35-40?C) were investigated.

Methods

Wheat cultivars were exposed to high temperatures using a large thermogradient plate (temperature change of 0.3?C/cm) with a temperature range from 15-40?C. Treatments were imposed for 3-5 d. Survival of non germinated seeds was determined by (i) germination following return to 20?C optimum temperature and/or (ii) tetrazolium staining. Solute leakage was determined over 30 min using a conductivity meter. Conductivity data was expressed as % of total conductivity/seed : this total conductivity was the conductivity measured in extracts after grinding the seeds and extraction of solutes by boiling.

Results and discussion

A preliminary experiment showed that the cultivar Eradu was more tolerant than Gutha during germination at high temperatures: Gutha had 55% reduction in germination at 35?C while there was little reduction in germination of Eradu relative to plants at 20?C (Fig.1). Germination of Gutha at 40?C was reduced to zero. The remainder of experiments were on Gutha, the heat intolerant cultivar. During the first 4 h at 40?C there was no large decrease in % survival or differences in imbibition relative 20?C. By 18 h at 40?C the % survival of seeds decreased to 20% (determined by recovery at 20?C), but there were no significant differences in solute leakage from intact seeds or excised embryos relative to seeds at 20?C (Fig. 2, and one other experiment). The 80% death of seeds at 18 h was confirmed using tetrazolium dye. Between 18-72 h solute leakage from seeds at high temperature increased to 50% of the total conductivity of seeds (Fig.2).

Figure 1. Germination of spring wheat cultivars during 5 d at 35?C. Data are expressed as percent germination at 20?C. Cultivars arc: 1. Gutha, 2. Concord, 3. Gamenya, 4. Sonora, 5. Eradu, 6. Japateca.

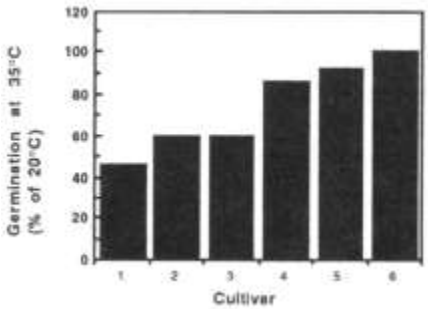
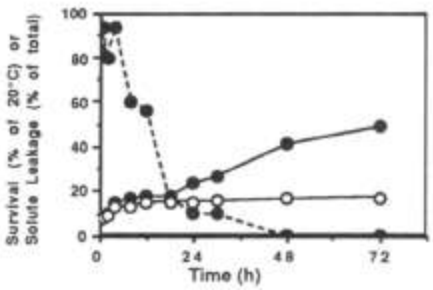


Figure 2. Percent survival after 1-72 h treatment at 40?C (dashed line); and changes in solute leakage at 20? C(0, solid line) and 40?C (•, solid line). Data are for the heat intolerant wheat cultivar, Gutha.



The above data suggest that loss of membrane integrity was not the cause of adverse effects of high temperature because a substancial decrease in germination occurred before solute leakage (over control) could be detected. This conclusion conflicts with other work at high temperatures (30-50?C) where it is suggested that reduced germination in wintercress and lettuce occurs because of "membrane transitions" and solute leakage(1).

1. Hendricks, S.B. and Taylorson, R.B. (1979). Proc. Natl. Acad. Sci., USA 76: 778-781.