Short Communation

THE EFFECTS OF WATER AND HEAT STRESS ON WHEAT

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Abstract

The study was evaluated the effects of drought and heat stress on spring wheat (Triticum aestivum, C.V. Chablis) at the flowering phase. The potted plants of wheat at the flowering stage was exposed to drought stress during five days under high temperature during day/ night temperature of 26/13°C, and low temperature at 15/10°C. After stress period wheat plants were tested for water potential, and after harvesting for number of ear per pot, grain per year, harvest index, number of grains per spikelet, weight grains per spikelet and mean weight grain per spikelet. Exposure of plants to drought stress under high temperature had significantly decreased leaf water potential. Drought in combination with high temperature reduced significantly the number of ear per pot, grain per year, harvest index, and reduced significantly the number of grains per spikelet, grains weight per spikelet and mean grain weight per spikelet. The study showed that water stress with high temperature at 26°C accelerates plant growth and flowering, but reduces yield components.

Key words: water stress, water potential, grain weight, grain number and yield

INTRODUCTION

Water stress is one of the main a biotic stress and an important factor for reducing yield of cultivated plants in semi arid agricultural land (Koneke et al., 2007). Water stress in wheat changes patterns of plant growth and development, depressed water potential , cell division, organ growth , net photosynthesis, protein synthesis and alter hormonal balances of major plant tissues (Guttieri et al., 2001). Water stress is an important factor affecting the phasic development of wheat, and the level of stress regulate the time of anthesis and senescence in the plant (Angus and Mocur,1977).

Leaf water potential is considered to be a reliable parameter for quantifying plant water stress response (Sddique and Hamid, 2000), and it does mean, it is depending on the level of water stress.

Water deficits around anthesis may lead to a loss in yield by reducing spike number, spikelet number and the fertility of surviving spikelets (Royo and Blanco, 1998). The role of temperature on plant growth and yields and it effects have been recorded in cereals in many experimental studies (Fischer, 1973). High temperature during maturation and ripening is a major stress in many wheat production areas (Gibson and Paulsen, 1999).

Heat stress/high temperature drastically reduces kernels per plant as a result of lower number of spikelet per plant (Gibson and Paulsen, 1999). High sensitively of kernels per spikelet to heat stress documented also by Gibson and Paulsen (1999). Many investigations were observed significant differences in water potential among wheat genotypes under drought stress (Siddique and Hamid, 2000). Drought during grain filling especially if it accompanied by high temperature hastens leaf senescence, reduce the duration of grain filling and reduce grain weight (Austin, 1989). This study was conducted to investigate the effects of water stress on wheat under greenhouse condition to realize the effects of drought and heat stress on water potential, number of grains per spikelet, weight of grains per spikelet and mean weight grain per spikelet and harvest index.

MATERIAL AND METHODS

An experiment was conducted at the research site. Haajbakkegaard, Taastrup, of the Danish Royal Veterinary and Agriculture University in Copenhagen. The experiment was carried out during one vegetation period. Soil rich in PK was homogenized with K_2SO_4. Before planting, the soil was added with three grams N per pot. The research started by putting 22 kg fertilized soil in 32 pots , and in April 7th , seeds of spring wheat (*Triticum aestivum*, cv. Chablis) were sown in 32 pots as a

Tab. 1: Water potential (mean ± S.E., n =) of flag leaves in (LW, LD, HW and HD) after five days under stress

Treatment/measurement	Water potential (MPa)
LW	^{a}–1.15 ± 0.21
LD	^{b}–2.5 ± 0.56
HW	^{a}–1.9 ± 0.014
HD	^{b}–1.65 ± 0.28
LSD	0.91

Only two values which a column is significantly different at 5% level if they have no letter in common; a^{NS};. b*

population of 25 seeds per pot and plants harvested in September 14th. The pots were left in open area with facility for irrigation, and the plants were grown there until maturity and harvest except where they were under experimental treatment. After 40 days of vegetation, the pots were transferred from out door to two different temperature regimes (16 pots per each temperature regime) in climate chambers namely: For high (1) temperature 26°C as maximum during day (HT treatment) and 13°C during night, (2) other 16 pots, the day temperature was 15°C (LT treatment) and night temperature was 10°C. The light intensity for both treatments was 700µ mol $m^{-2}s^{-1}$. The relative humidity was 90% during night and 70% during the day. And all pots were watered equally in two days. After 50 day of vegetation, eight pots of each treatment were exposed to water stress namely: Low temperature dried soil plants (LD) and high temperature dried soil plants (HD) by withholding irrigation in five days. The other eight pots for each temperature regime were watered as usual namely: Low temperature watered plants (LW) and high temperature watered plants (HW). After five days exposing to water stresses used pressure chamber technique to measure water potential of flag leaves. And then all pots were transferred again to outdoor until harvesting.

RESULTS

Water potential

Table 1 shows that after five days of soil drying at (anthesis) flag leaf water potential significantly decreased in drought (LD) plants for both law and high light intensities.

Which dose means that water potential has proportional relation with duration of drought, the more droughts the less water potential?

Yield components

Table 2 shows that there is non-significant treatment on the weight of grain per pot except HD. All treatments had significant affect at 5% level on the weight of straw per pot except that of HW. There is non-significant effect of LW and LD treatments on the seed number per pot, but HW and HD had significant effect at 5% level. All treatments had significant effect on harvest index at 5% level.

Number of grain per spikelet

Number of grain as it is seen in Figure 1 clearly shows that the number of grains per spikelet was position depended. The figure also shows clearly that the number of grains per spikelet is most decreased by HD treatment and it dose mean that the plants had most abortion in HD situations.

The weight of grain per spikelet as it is shown in Figure 2 is position depended.

LW and HD treatment seems to have the highest level of weight grain per spikelet.

LD treatment has medium weight of grain per spikelet. HD plants have the lowest weight of grain per spikelet. DH plants have the lowest weight of grain per spikelet.

What is concern, the *mean weight* of grain per spikelet, HW and LW plants have the highest mean weight grain

Tab. 2: Ear per pot, the weight of grain and straw per pot, seed number per pot as well as harvest index per pot (mean ± S.E., n = 8)

Treatment/ measurement	Eears/pot	Grain (g/pot)	Straw (g/pot)	No (seed/pot)	Harvest index
LW	^{b}52.37 ± 4.4	^{a}73.95 ± 11.5	^{b}78.53 ± 8	^{a}2169.37 ± 15	^{b}0.47 ± 0.019
LD	^{b}62.12 ± 9	^{a}71.47 ± 6	^{b}73.25 ± 8	^{a}2271.25 ± 247	^{b}0.49 ± 0.015
HW	^{b}53.62 ± 8.8	^{a}73.62 ± 16	^{a}76.57 ± 16	^{b}1961.25 ± 510	^{b}0.42 ± 0.049
HD	^{b}52.37 ± 14	^{c}38.37 ± 16.5	^{b}70.78 ±12	^{c}977.37 ± 76	^{c}0.35 ± 0.081
LSD	4. 32	5.9	5.31	154.9	0.02

Only two values within a column are significantly different at the 5% level if they have not letter in common; a^{NS}, b*, c**

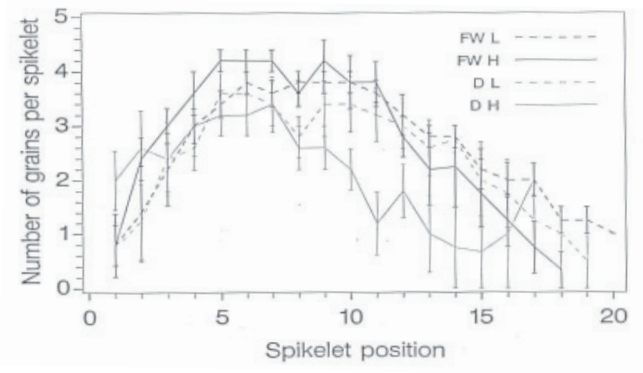

Figure 1: No of grain per spikelet of final harvest (n = 4 ± S.E)

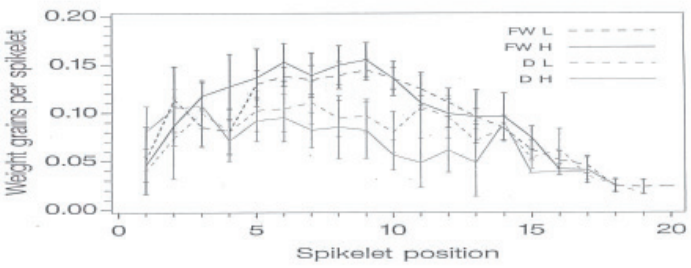

Figure 2: Weight of grain per spikelet (g/spikelet, n = 4 ± S.E)

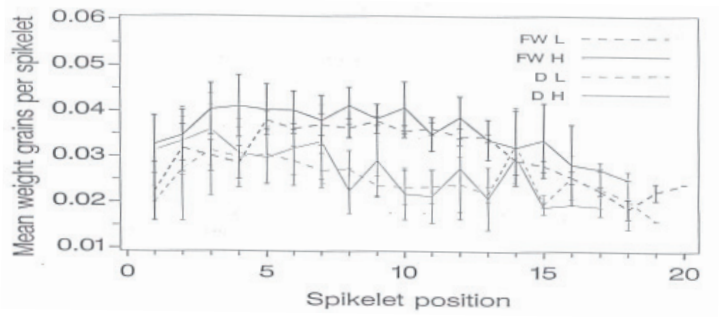

Figure 3: Mean weight grain per spikelet (g/spikelet, n = 4 ± S.E)

per spikelet. Plants from LD and HD have the lowest mean weight per spikelet as it is seen in Figure 3.

DISCUSSION

As it was expected, high temperature had an effect on water potential, it dose mean that the higher the temperature, the lower the water potential. According to Friend, 1965, ear length and spikelet number if wheat growth at different temperatures of 30/10°C and 20/15°C were highest at lower temperate. It had been observed also the same result in these experiments which were registered the high number at low temperature of 13/10°C.

Our results have shown the significant effect of water stress at high temperature and drought at 26°C on ear number/pot, the same result has been confirmed by Rawson and Bagga (1979), whom found progressive reduction in grain number per year for wheat plants that remained at temperature > 15°C. At low temperature stressed plants there were shown no significant reduction in grain number and weight, in contrast to this results Wardlaw, 2002 recorded a significant reduction of grain number and weight at temperature of 18/13°C. It dose show that grain number and weight can be affected by three degree of temperature.

CONCLUSIONS

Results obtained in this experiment indicated that drought stress combined with heat significantly decrease yield water potential, grain number, weight and yield. In order to have an optimal yield to wheat we may ensure an environment with day temperature under 26°C and night temperature 13°C.

After five days of soil drying at anthesis stage flag leaf water potential significantly reduced by drought.

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