Growth and yield of durum and bread wheat

by

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Dedicated
to my mother and late father,
my wife and children,
whom I love.

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Summary

Durum wheat is a relatively new crop in South Australia and many of the current varieties yield poorly compared with adapted bread wheats. A series of experiments was conducted to examine the growth and nutrient uptake of durum and bread wheat at a number of sites in South Australia. The experiments examined the response to water stress, the pattern of root and shoot growth, soil water extraction and nutrient uptake among a range of adapted bread wheat and durum wheat cultivars. Seasonal conditions varied considerably over the 3 years, with severe drought occurring in 2 years. Consequently growth and yield varied greatly between experiments.

Durum wheat cultivars had a high grain yield, similar to or higher than bread wheat, when grown in favourable conditions. However, when water stress was induced, the reduction of grain yield in durum wheat cultivars was higher than that of the bread wheat cultivars. Calculation of a drought susceptibility index (S) showed that durum wheat cultivars were more susceptible to drought than bread wheat. The yield components of durum wheats were all more sensitive than those of bread wheat showing that the greater sensitivity of durum wheat was evident throughout its growth cycle.

Durum wheat cultivars generally had a higher kernel weight than bread wheat cultivars, although they tended to produce fewer kernels/m^2. This appeared to be related to durum wheat tillering less and producing fewer ears/m^2. Where durum wheat produced a similar number of ears/m^2 to bread wheat, grain yield was higher because of its

kernel weight. Therefore, although most yield components of durum wheat were more sensitive than those of bread wheat, the ability to produce larger number of fertile tillers/m^2 appears to be important in affecting the yield of durum wheat relative to bread wheat.

The early vigour of durum wheat was less than that of bread wheat. Durum wheat cultivars consistently produced fewer tiller/m^2 and less dry matter than bread wheat. This may result in low water use efficiency (WUE) in durum wheat because the loss of water ~~from~~ by evaporation from the soil surface early in the growing season maybe high.

Specific root length for both durum and bread wheat at all sites was generally lower than published values for wheat from Australian sites. Root growth of durum was not less than that of bread wheat when grown in a fertile soil, however durum's root growth was less than that of bread wheat when compared at a site with poorer fertility. Although there were differences in root growth between genotypes, ~~it~~ they were not highly correlated with water use or yield. It is suggested that other factors may be more important than total root length in determining water use and grain yield.

The concentration of nutrients were found to be deficient for nitrogen, phosphorus, potassium, and zinc while boron concentration was found to be high. These nutritional problems are often found to inhibit plant growth and yield in South Australian wheat growing areas, but ~~at~~ in the present experiments, the concentrations of nutrients were not significantly different between durum and bread wheat. However, there were large differences in the sodium concentration and uptake between durum and bread wheat, with the concentrations of sodium being much

important nutritional constraint for durum wheat in South Australia. However, some genotypes were able to maintain growth and yield despite high sodium concentrations, suggesting it is feasible to breed for greater salinity tolerance.

Despite the limited range of genotypes used in the study, a number of conclusions can be drawn from this study:

(1) Under glasshouse and field conditions, it was found that durum wheat has a potential to produce a comparable yield to bread wheat when soil moisture deficits do not limit growth, or when foliar disease is severe. However, when growing under water deficits or nutritional stress, the yield of durum wheat was reduced more than bread wheat;

(2) The greater sensitivity of durum wheat to water stress compared to bread wheat occurred in most yield components;

(3) The early vigour of durum wheat was poor which may affected its ability to use water efficiently, especially in low rainfall areas;

(4) Root growth in the subsoil of durum wheat was less than that of bread wheat when grown in a nutritional poor soil, but not a more fertile soil, suggesting that sensitivity to nutrient stress may be an important factor in root growth and use of subsoil moisture reserves.

(5) High sodium concentrations were measured in durum wheat shoots and this may be a potential constraint of durum wheat production in the sodic soils of South Australia.

Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

SIGNED:__ DATE: 22/01/96

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cv.	cultivar
das	days after sowing
DM	dry matter
HI	harvest index
ICP	Inductively Coupled Plasma Spectometry
L_a	root length per unit ground area (cm/cm^2)
LAI	leaf area index
L_v	root length per unit soil volume (specific root length) (cm/cm^3)
ϑg	gravimetric soil moisture content (g/g)
ϑv	volumetric soil moisture content (g/cm^3)
RDM	root dry matter weight
s.d. (sd)	standard deviation of data
s.e. (se)	standard error of means
v/v	volume/volume
WUE	water use efficiency

cm	centimeter
g	grams
ha	hectares
Kg	kilograms
L	liters
m	meter
mequiv.	milliequivalent
mg	milligrams
MJ	megajoule
m m	millimeter
^oC	degrees Celcius
t	tonnes
µg	micrograms