The potential of winter wheat cultivars and breeding lines for use in dual-purpose (grain and graze) systems

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Abstract

In the High Rainfall Zone of south-eastern Australia, winter wheat is used in a dual-purpose role, to provide grazing in autumn-winter when pasture growth is limiting, with additional return from harvesting the grain. There are few comparative studies on the dual-purpose potential of wheat cultivars and breeding lines. Forage dry matter (DM) yield, *in vitro* DM digestibility (IVDMD) at early stem elongation and grain yield were determined for 4 wheat cultivars and 8 breeding lines at a field site in southern NSW. In a separate area at the same site, the effect on grain yield of forage cuts at pre- and post-stem elongation phases were measured in the cultivar, Mackellar. Forage DM yield averaged 3.4?t/ha, with no significant differences (P?< 0.05) between entries. Grain yield differed significantly between entries, with mean yield of cultivars (8.0?t/ha) greater than that of the breeding lines (7.0?t/ha). IVDMD ranged from 74.3% to 82.5% among the entries. Forage harvest of Mackellar before stem apices had reached 5?cm height did not significantly reduce grain yield, whereas cutting at a later stage reduced grain yield by 42% compared with the uncut area. The reduction in grain yield following cutting after stem elongation had little effect on the number of fertile tillers measured at grain harvest, but was associated with a reduction in both kernel number per spike and single grain weight.

Key Words

Dual purpose crops, grazing wheat, IVDMD

Introduction

Commercial winter wheat cultivars used for dual purpose grazing and grain production (Freebairn *et?al.* 2002) were developed in breeding programs aimed at increased grain yield, adaptive phenology (maturity time) and disease resistance. To date there has been little assessment of genetic variation for aspects of the feeding value of winter wheat, such as forage productivity and nutritional quality. Moreover, there is little understanding of the effects of grazing at the time of stem elongation on crop responses, as reflected in components of grain yield. To explore the degree of variation in forage digestibility, biomass and grain yield potential, we compared a set of wheat cultivars and breeding lines. In a separate experiment, the cultivar Mackellar was measured for grain yield and components of grain yield following forage cuts at the pre- and post-stem elongation stages of development.

Methods

Cultivars and breeding lines

The winter wheat cultivars (Mackellar, Marombi, Rudd and Tennant) and 8 breeding lines were sown in 10-row plots (2?m ? 10?m) at 80?kg/ha in a randomized complete block design with 4 replications on 6th April 2004 at Ginninderra Experiment Station, Canberra, ACT. At pre-stem elongation stage, above ground biomass of each entry in 2 replicates was estimated from 0.06?m^2 cuts at 5?cm height. *In vitro* dry matter digestibility (IVDMD) analyses were conducted on pre-stem elongation samples from a separate trial by Feedtest ? (Department of Primary Industries, Victoria) using Near Infra-red Reflectance Spectroscopy. Grain yield was estimated from machine harvested samples of 8 rows per plot.

Cutting at pre and post stem elongation stages

A separate area of the same trial site was sown at 100?kg/ha to Mackellar on 14th April 2004. Six plots of 2 ? 9?m were marked within this area. Two plots were cut by sickle-bar mower to 7.5?cm height at pre-stem elongation stage, two were cut at post-stem elongation phase and two remained uncut. At grain harvest, the number of reproductive tillers, the number of grains per spike, and grain yield were determined from samples taken in each plot.

Results

Dry matter mass at late vegetative stage (DC stage 30) ranged from 2.9 to 4.2 t?DM/ha with no significant differences between cultivars or breeding lines and IVDMD was between 70-80% (Table 1). The mean grain yield of cultivars (8.0?t/ha) was significantly greater (P <0.001) than that of the breeding lines (7.0?t/ha).

Table 1. Grain yield, biomass at pre-stem elongation stage (Pre-SE) and *in vitro* dry matter digestibility (IVDMD) of wheat cultivars and breeding lines grown at Ginninderra Experiment Station, Canberra, ACT

Entry	Grain yield (t/ha)	Pre-SE Biomass (t?DM/ha)	IVDMD (%)
Cultivars			
Mackellar	7.7	2.9	82.5
Marombi	8.6	3.2	81.8
Rudd	8.6	4.2	-
Tennant	7.3	3.0	-
Mean	8.0	3.3	82.2
Breeding lines			
Mean	7.0	3.5	78.8
LSD(P=0.05)			
Between means	0.5	ns	-

Grain yield of Mackellar was not reduced by cutting at pre-stem elongation stage, compared with that of the uncut treatment, but was reduced by 42% by cutting at the post stem elongation stage (Figure?1a). The reduction in grain yield following cutting at post-stem elongation stage was not associated with a

reduction in the number of fertile tillers at harvest (Figure?1a) but was associated with reduction in the number of kernels per spike (Figure?1b).

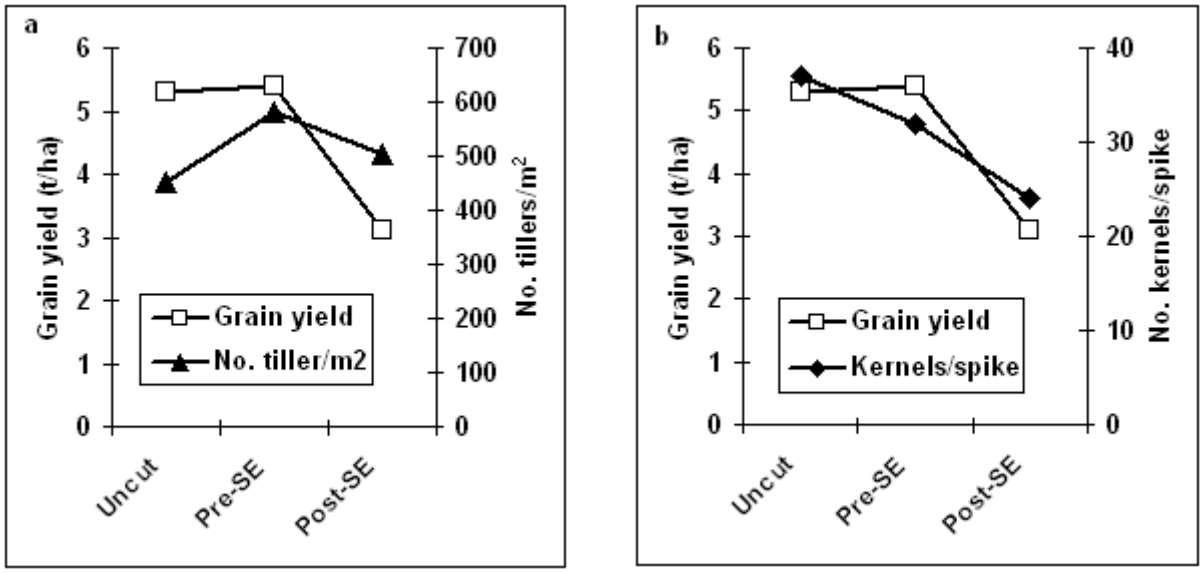

Figure 1. The effects of pre-stem elongation (Pre-SE) and post-stem elongation (Post-SE) cutting treatments on grain yield and the number of tillers/m^2 (a) and the number of kernels per spike (b) at grain harvest.

Conclusion

The winter wheat cultivars examined combined high forage yield and digestibility with high potential grain yield. The breeding lines produced as much forage at the late vegetative stage as the cultivars, but had significantly lower grain yield potential. Cutting of cv. Mackellar before stem elongation was associated with increased tiller survival and did not significantly reduce grain yield compared with an uncut treatment. On the other hand, cutting after stem elongation significantly reduced grain yield through a reduction in kernel number per spike.

References

Freebairn B, Ayres L, Kleven S, McRae F and Ellison F (2002). Productive dual purpose winter wheats. New South Wales Department of Primary Industries