Sowing depth effects on emergence of wheat: the importance of coleoptile length

S. Hines, M. Andrews, W. R. Scott and D. W. Jack

Department of Plant Science, Lincoln University, P.O. Box 84, Canterbury, New Zealand.

Introduction

Increased sowing depth can result in decreased emergence percentage of a range of wheat (*Triticum aestivum* L.) cultivars (Sunderman, 1964; Whan, 1976; Radford *et al.*, 1989). Three reasons have been proposed for poor emergence with increased sowing depth. Firstly, decreased aeration with increased soil depth results in decreased germination (Bremner *et al.*, 1963). Secondly, seed reserves become depleted before the shoot reaches the soil surface (Wibberley, 1989). Thirdly, the first leaf emerges from the coleoptile underground and although the leaf continues to extend, it is less rigid than the coleoptile and hence folds more easily and often is unable to push up through the soil (Sunderman, 1964). Several workers, using a wide range of wheat genotypes have found a strong positive correlation between final coleoptile length and emergence percentage from deep sowings (Sunderman, 1964; Whan, 1976).

In the study described here, six New Zealand wheat cultivars were compared with respect to emergence percentage from different sowing depths. The correlation between emergence percentage and coleoptile length was examined.

Methods

In experiment 1, seed of wheat cvs. Sapphire (mean seed weight = 57 mg), Bounty (54 mg) and Brock (52 mg) were obtained from Challenge Seeds Ltd, Christchurch, New Zealand. Seed of cvs. Otane (53 mg) and Pernel (48 mg) were obtained from Elders Pastoral, Christchurch, New Zealand while cv. Batten (44 mg) was obtained from Crop Research Division, Department of Science and Industrial Research (now Crop and Food Research), Lincoln, Canterbury, New Zealand. In experiment 2, Otane was obtained from Pyne Gould Guiness, Christchurch, New Zealand. Batten and Otane are milling wheats, Bounty and Brock are biscuit wheats while Pernel and Sapphire are feed wheats. Seed from all sources showed >95% germination. Seed used in experiments was of mean seed weight ± 5%.

In experiment 1, seed of all cultivars were sown at either 30 or 90 mm depth in 100 mm diameter, 200 mm tall pots (5 per pot) containing a vermiculite/perlite (1:1) mixture soaked with basal nutrient solution (Andrews *et al.*, 1989) containing 5 mol m^{-3} potassium nitrate. Plants were grown in the dark in a controlled environment chamber. The temperature ranged from 5 -10°C during each 24 h period. All pots were flushed twice weekly with the appropriate nutrient solution. Emerged plants were counted each week after planting. Emergence from each pot was taken as complete either when all plants had emerged or when no further plants emerged during a 3 wk period after emergence of at least thirteen plants from that particular sowing depth. On completion of the experiment, seed which failed to produce emerged seedlings were examined to determine if germination had occurred and coleoptile length of all seedlings was measured. In experiment 2, Otane sown at 60 mm depth was supplied 10 mol m^{-3} NO_3^- under the conditions of experiment 1. At harvest, coleoptile length of all seedlings was determined.

The experiments were of completely randomised design with six replicates per treatment, each replicate comprising one pot of five plants. Analysis of variance was carried out on all data. The experiments were repeated. Effects discussed have an F ratio with a probability of $P < 0.01$ and were obtained in repeat experiments.

Results and Discussion

In experiment 1, all cultivars showed 96% or greater emergence from a sowing depth of 30 mm (Table 1). This value was similar to germination percentage. For all cultivars, germination percentage was not affected by sowing depth but emergence percentage decreased with increased sowing depth. At 90 mm sowing depth, emergence percentage decreased with cultivar in the

order Batten = Sapphire > Otane > Bounty = Brock > Pernel. Emergence percentage was positively correlated (correlation coefficient = 95%) with coleoptile length (Table 1).

In experiment 2, Otane showed 66% emergence from a sowing depth of 60 mm. Mean coleoptile length for plants which emerged was 46 ± 1 mm. The value for plants which did not emerge was 31 ± 1 clearly showing that it is seedlings with short coleoptiles which are vulnerable to deep sowings.

Table 1. Effect of sowing depth (30 and 90 mm) on emergence percentage of six New Zealand wheat cultivars and mean coleoptile length of these cultivars at 90 mm sowing depth.

Cultivars	Emergence (%) (from two sowing depths) 30 mm	90 mm	Coleoptile length (mm)
Sapphire	100	77	67
Batten	97	76	60
Otane	96	58	53
Bounty	100	33	49
Brock	98	31	48
Pernel	99	22	40
s.e.m,	6.0		2.1

It is proposed that decreased emergence percentage with increased sowing depth was due to emergence of leaf 1 within the substrate. Leaf 1 is less rigid than the coleoptile and hence folds more easily and is unable to push up through the substrate. Decreased emergence percentage with decreased coleoptile length is likely to have been due to the increased distance the shoot had to extend before it could emerge from the substrate.

References

Andrews, M., Love, B.G. and Sprent, J.I. 1989. The effects of different external nitrate concentrations on growth of *Phaseolus vulgaris* cv. Seafarer at chilling temperatures. *Annals of Applied Biology* ***114***, 195-204.

Bremner, P.M., Eckersall, R.N. and Scott, R.K. 1963. The relative importance of embryo size and endosperm size in causing the effects associated with seed size in wheat. *Journal of Agricultural Science, Cambridge* ***61***, 139-45.

Radford, B.J., Strong, W.M. and Wilderminth, G.B. 1989. Effects of urea and flutriapol on germination, coleoptile length and establishment of wheat and barley. *Australian Journal of Experimental Agriculture* ***29***, 551-7.

Sunderman, D.W. 1964. Seedling emergence of winter wheats and its association with depth of sowing, coleoptile length under various conditions and plant height. *Agronomy Journal* ***56***, 23-25.

Whan, B.R. 1976. The emergence of semi-dwarf and standard wheats and its association with coleoptile lengths. *Australian Journal of Experimental Agriculture and Animal Husbandry* ***16***, 411-16.

Wibberley, E.J. 1989. Cereal Husbandry. Farming Press Books, Ipswich, UK.