EFFECT OF AGRONOMIC PRACTICES ON THE OVERWINTERING OF WINTER CANOLA IN SOUTHERN ALBERTA

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INTRODUCTION

Winter rapeseed was first tested in southern Alberta in 1983. As 70% of the crop survived the winter, research was expanded to determine the potential of the crop for the area. Ensuring a consistent level of winter survival was the first major goal; to achieve this a diverse collection of germplasm, including canola quality lines were tested for winter hardiness over the next years. However, the effects of agronomic practices including planting date, seeding rate and presence of standing stubble were found to have much greater effects on winter survival than varietal differences. Field studies that relate these factors to fall growth and winter survival are presented here.

Winters in southern Alberta are characterized by fluctuating temperatures from +15°C to -35°C, strong winds, inconsistent snow cover and low soil moisture. This environment stresses overwintering plants such that fall growth must be optimal for their survival.

MATERIALS AND METHODS

Two field experiments examined growth and survival of winter canola Brassica napus cv. Crystal. All plants were grown in the field at Lethbridge, Alberta, Canada under irrigated conditions to ensure adequate moisture for emergence and growth. Nitrogen levels were 58 kg/ha in the top 15 cm, and 180 kg/ha from 15 to 60 cm.

1) 1990/91 Planting Date test.

The experiment consisted of five planting dates: August 1,10, 20, 28, and September 11, 1990. A randomized complete block design of 4 replicates was used, with plot sizes of 6 m x 1.8 m. A double-disk drill with 18 cm row spacing was used to plant 130 seeds/m^2. Emerged seedlings were subsequently thinned to 40/m^2.

On January 18/91 with +5°C weather, 10 or more plants were removed from each plot. Root neck diameter, measured under the cotyledon scars, and stem elongation, measured from the cotyledon scars to the crown base, was recorded for each plant. Plants were transplanted into 15 cm pots with the same field soil and kept in a 15°C greenhouse for 30 days. Plants were then rated as dead, healthy (live with a healthy apical meristem), or live with a dead apical meristem ("damaged"). In this last category, new growth commenced from side shoots. Each of the three plant health categories were divided into a matrix of frequencies of individual root neck diameters and elongation measurements to examine the survival of plants with specific dimensions.

2) Seeding rate x date experiment 1990/91.

A 4 replicate split plot design experiment, with 3 seeding dates: July 30, August 15 and 28 as main plots was established in the field. Four plant densities: 25, 64, 160 and 400 m^2 were established as sub-plots by thinning after emergence. These densities equalled plant spacings of 20, 12.5, 8, and 5 cm, respectively. Row spacings were the same as plant spacings. Sub-plot size was 1.2 x 1.2 m. Plant dimensions were measured on 5 plants per plot on October 25, after fall growth had ceased.

RESULTS

1) Planting date experiment

Survival to January 18 was strongly affected by planting date (Table 1). The August 20 planting date had 94% survival, while the earliest and latest dates were reduced to 28 and 3% survival. Survival included both healthy and damaged live plants. Damaged plants, those with a dead apical meristem and side shoot production, had decreased vigor and were slower to flower. The overall proportion of dead vs. healthy vs. damaged plants was 3:2:1 (n=228).

Root neck diameter, which has good correlation with plant biomass, and stem elongation were unique to each seeding date (Table 1).

Observations of root diameters and stem elongation recorded on January 18, 1991 showed that plants with a root diameter of 4 mm or less had 98% mortality (Table 2). Survival was highest when plants had a root diameter of 5-16 mm and a stem elongation in the 0-3 cm range. The damaged plants were most frequently those with larger root diameters.

2) Seeding rate x date experiment.

Both root diameter and stem elongation were affected by seeding date and rate (Figure 1 a,b). The differences in plant

Table 1. Percent survival and mean plant dimensions of overwintering plants sown at 5 dates in 1990.

Characteristic measured	Planting date Aug. 1	Aug.10	Aug.20	Aug.28	Sep. 11
Survival %	28	72	94	44	3
S.E.	18	7	4	16	3
Root neck diameter(cm)	16.8	12.7	10.1	8.4	2.9
S.E. 0.7	0.6	0.6	1.1	0.2	
Stem elongation (mm)	5.1	3.1	1.9	0.6	0
S.E. 0.2	0.2	0.1	0.3	0	

Table 2. Percent and number of surviving plants on January 18/91 grouped by root diameter and stem elongation.

Stem elongation	Root diameter (mm) 2-4	5-7	8-10	11-13	14-16	17-28
0 cm	2%[a] (44)[b]	18% (11)	50% (6)	50% (4)	-% (0)	-% (0)
1 cm	-% (0)	29% (7)	72% (18)	60% (5)	-% (0)	-% (0)
2 cm	-% (0)	83% (6)	100% (16)	100% (16)	100% (6)	-% (0)
3 cm	-% (1)[c]	-% (0)	78% (9)	64% (14)	90% (10)	40% (5)
4-5 cm	-% (0)	-% (0)	-% (2)	25% (12)	22% (9)	33% (12)
6-9 cm	-% (0)	% (0)	-% (1)	20% (5)	25% (4)	40% (5)

a percent survival of healthy+ damaged plants.

b number of plants at that intersection

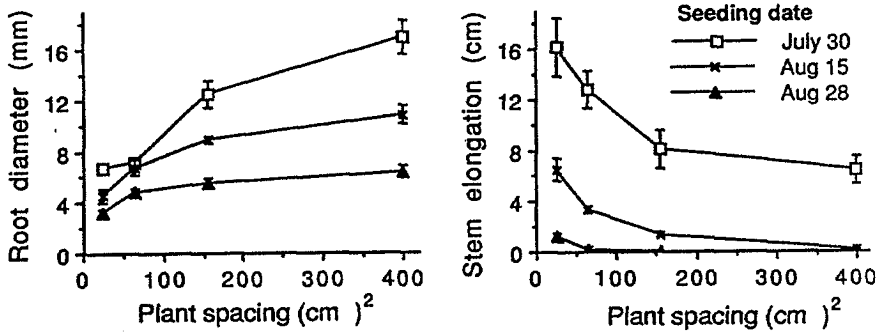
c a minimum of 3 plants was required for a % calculation.

dimensions increased the earlier the crop was seeded. Root diameter was inversely related to stem elongation for any given seeding date. Both dimensions increased with earlier seeding.

DISCUSSION

1) Planting date test

Maximum survival in 1990 was attained in mid-August within a window for seeding date of less than 3 weeks. The window size and date has fluctuated in the past, depending on growing conditions. For example, in 1989 a similar experiment had poor survival on August 19, and no survival in later dates, due in part to an early September killing frost. In 2 other years, August 30 plantings had the best survival. While the optimal date cannot be predicted with any more success than the weather that determines it, the explanation of why a particular planting date was best appears to be related to the size of plants that enter the winter. Stem elongation and root neck diameter are two measurements that correlate well with plant survival.



1a) Effect of plant spacing on root diameter

1b) Effect of plant spacing on stem elongation

Figure 1 a,b. Planting rate x date experiment. Error bars are S.E.

Root neck diameter has good correlation with plant biomass.

The importance of stem elongation on survival is attributed to two factors. First, the crown is exposed to colder temperatures the more it is raised above the soil surface. Secondly, an elongated stem that supports the crown is susceptible to frost kill. In previous experiments, some live crowns were observed to re-commence growth in the spring, but soon died as the tissue connecting the crown to the root was dead.

Crown temperatures, measured with thermocouples, and snow depth were recorded for each planting date to examine the relationships of these factors with plant sizes. Snow depth increased as the seeding date became earlier, as plots with more leaves trapped more snow. Under typical strong windy conditions, all snow could be blown off the September 11 seeded plots. Crown temperature was warmest in the middle dates, as snow capture was adequate, yet the crowns were closer to the ground than in the earliest date. For example, with an air temperature of -32°C, the crown temperatures were: -19°, -13°, -13°, -18°, and -25°C for dates 1-5. Increased winterkill could be expected, and was observed for the earliest and latest seedings with these colder temperatures.

Similarly, plots seeded into standing stubble have had much greater survival than those on fallow land (Topinka, unpublished data). The moderation of plant micro-climate by snow capture permits the survival of a wider range of plant sizes.

Plants with side shoots were agronomically unsuitable because of delayed maturity, and stems which tended to break off at ground level in the wind.

2) Planting rate x date experiment

Root diameter and stem elongation increased as date of seeding became earlier, as in the planting date test. The relationship between these dimensions and planting date was simply due to increased overall plant size resulting from earlier seedings and a longer growing season prior to a killing frost.

The inverse relationships between plant spacing, root diameter and stem elongation appeared to be due to competition. As plant competition increased with density, biomass decreased, and plants became etiolated. This interaction was increased by early seeding date, due to the greater plant size and duration of competition.

CONCLUSION

Survival of a winter canola plant in western Canada largely depends upon it entering the winter with a certain size range. These plant dimensions are affected by factors such as planting date and seeding rate. For survival to at least mid-January, the root diameter may be 5 to 16 mm, while stem elongation should not exceed 2 cm. Such plants occurred in the August 15 seeding date with a minimum spacing of 150 cm^2/plant (max.64 plants/m^2), to as late as August 28 date with a plant spacing of 64 cm^2 or more (max. 160 plants/m^2).

As the winter survival may be decreased by subsequent cold, exacerbated by loss of hardening and alternating warm/cold weather, the optimal dimensions for a surviving plant may become more restricted. There is limited room for alternate plant types; for example if the root diameter requirement were raised one mm to 6 mm, only the August 15 date at the 2 lowest densities would have any survival. Survival from an initial stand of 25-64 plants/m2 may produce acceptable yields as in Idaho (A. Thostenson, personal communication) although competition by weeds may be a problem. A greater range in plant size could be tolerated in winter canola seeded into standing stubble, as it was not exposed to the extremes of temperature.