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Developing Practices for Optimum Canola Production In Southwestern North Dakota

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Research Summary

Practices which optimize canola production generally have been developed outside of southwestern North Dakota. These practices may not be suited to local conditions, unless they first are modified. The objectives of this study are to develop seeding and tillage strategies for optimum economic returns of canola produced in southwestern North Dakota. This research began in 2001 and will be fully implemented in 2002.

Introduction

Timely seeding is important for growing canola successfully. Research at Carrington, Langdon, and Prosper indicated that fewer pods formed on canola plants when seeding was delayed, thereby lowering yield (Johnson et al., 1995). Out of this study evolved the general recommendation that canola should be sown as early in the spring as possible, thereby minimizing exposure to heat and moisture stress during anthesis and seed filling. Early-spring seeding is not always possible, however, particularly when cool, wet conditions develop.

Frost- or dormant-seeding is an alternative to early-spring seeding. Yield advantages have been demonstrated when canola was dormant-seeded rather than spring-seeded in Canada (Kirkland and Johnson, 1998). Dormant-seeding can be a risky practice, however, if bare seed is sown in moist soil and warm fall temperatures subsequently develop. Canola seed which germinates in the fall will die during winter months.

A polymer seed-coating has been developed to reduce the risk of dormant-seeding canola and other summer annual crops. The seed-coating induces a dormancy period lasting approximately 21 days that protects the seed from fall germination, thereby providing some flexibility in timing the seeding operation. Unpublished data indicate that coating canola seed increased winter survival of fall-sown seed compared to sowing bare seed in Canada (K. Zaychuk, per. comm.).

Attempts at dormant-seeding canola generally were unsuccessful in southwestern North Dakota in 2000, whether polymer-coated or bare seed was sown. Environmental factors partially explain why dormant-seeding failed, but lack of knowledge about this practice also was a contributing factor. Research on dormant-seeding canola is limited and has been confined primarily to Canada. More importantly, research that identifies the environmental conditions determining the success or failure of dormant-seeding is virtually non-existent. Dormant-seeding probably will continue to be a poorly understood practice as long as simultaneous analyses of environmental and agronomic data are not done.

Tillage regimes affect canola performance, whether the canola is dormant- or spring-seeded. Seed yield generally increased as tillage was reduced in a Canadian study (Wright, 1989). Similar results have been generated in an ongoing tillage study at Dickinson (unpub. data). Yield increases resulting from reductions in tillage often are attributed to soil moisture considerations, but phenotypic response of plants to changes in tillage implicate other edaphic factors as well. Research is needed which identifies the specific environmental changes resulting from reductions in tillage and how seed yield of canola is affected.

The importance of rotation in cropping systems is again being emphasized (Beck, 1998). The enhancement in wheat yield when canola is incorporated into wheat-based cropping systems is recognized, but the mechanisms responsible for this enhancement remain poorly understood. Research is needed which identifies how the soil environment is modified when canola is inserted into a wheat-base cropping system, and why yield and quality of a subsequent wheat crop are affected.

The objectives of this project are to: (i) develop seeding strategies for optimum economic returns of canola produced in southwestern North Dakota; (ii) develop tillage strategies for optimum economic returns of canola produced in southwestern North Dakota; and (iii) determine the impact of canola on wheat in a wheat-canola rotation compared with continuous wheat.

Materials and Methods

Develop seeding strategies for optimum economic returns of canola produced in southwestern North Dakota.

Plots will be arranged in a randomized and replicated study (i.e. treatments will be arranged in a randomized complete block with 5 replications). Transgenic (RR) canola will be sown in 10 x 100 ft NT plots using the following strategies: (i) dormant-seeding polymer-coated seed by 15 November or when the soil temperature at a 1-in (2.5-cm) depth remains 40^{o}F over a 5-d period preceding sowing, whichever is first; (ii) dormant-seeding bare seed when the soil temperature remains 36^{o}F over a 5-d period preceding sowing; and (iii) seeding bare seed at spring warm-up (soil temperature at a 1-in depth remains 40^{o}F over a 3-d period preceding sowing). A lowdisturbance JD-750 planter with a grass-seed box will be used to sow all plots. Accepted agronomic procedure will be used to seed and manage the study.

Soil samples will be extracted from each plot and analyzed for organic matter, N, P, K, Zn, Fe, Mn, Cu, S, and B prior to establishing the dormant-seeding treatments. Soil samples also will be collected and analyzed for N (total, ammonium, and nitrate) periodically during the growing season so that soil-N flux when canola plants are growing can be determined. Canola plants will be harvested at physiological maturity and analyzed for nutrient concentration (N, P, K, C, Mg, Zn, Fe, Mn, Cu, S, and B). A balance-sheet approach will be used to account for soil-nutrient uptake by canola across treatments.

Soil temperature at a 1-in depth will be recorded at 6-h intervals from the date of dormant-seeding until 30 d after spring-seeding in polymer-coated seed treatments in two replications (Hobo® H8 Pro Series, Onset Computer Corp., Bourne, MA). Additional climatic data will be recorded by a North Dakota Automated Weather Network (NDAWN) station located within 0.10 mi of the study.

Canola plant population will be determined by counting emerged canola plants at 4 locations in a 5.4-ft^2 (0.5-m^2) area in each plot at 10, 20, 30, and 40 days after spring warmup. Crop development stages will be determined for 10 plants randomly selected in each plot when plant populations are determined and periodically during the growing season using a revision of the Harper-Berkenkamp scale (Harper and Berkenkamp, 1975). Plants will be evaluated for evidence of root-pathogen infection at these times. Plant-water stress will be indicated by drying excavated plants at 122^oF (50^oC), calculating plant-water concentration, and comparing calculated to expected plant-water values.

Plant water use will be determined by measuring soil-water content between a 6- to 48-in (15- to 122-cm) depth in each plot in 2 replications at spring seeding and thereafter at 10- to 14-d intervals until seed harvest using a neutron probe (Troxler Labs., Triangle Park, NC). Soil water in the 0- to 6-in (0- to 15-cm) depth will be determined gravimetrically and multiplied by soil bulk density to convert to a volumetric basis. Evapo-transpiration will be expressed as precipitation plus soil water use between sampling dates.

Seed yield, moisture content, and test weight will be determined by swathing and then harvesting the entire plot. Seed weight will be determined by measuring the weight of 1000 seeds per plot. Oil concentration will be determined for a sub-sample of seed from each plot using the near infrared method.

A simple budgeting approach will be used to compare net income produced by contrasting seeding treatments. This approach will enable treatments to be ranked from most to least profitable.

A different study from the study described under Objective (i) will be used to achieve Objectives (ii) and (iii)

Develop tillage strategies for optimum economic returns of canola produced in southwestern North Dakota.

Treatments will be established in 30 x 40 ft plots arranged in a randomized and replicated design (i.e., treatments will be arranged in a randomized complete block with four replications). Tillage systems (CT, RT, NT) will comprise treatments: (i) CT plots will be worked until

< 30% residue cover remains prior to sowing; (ii) RT plots will be worked so that > 30% residue cover remains after sowing; and (iii) no tillage will occur in NT plots. Crop residue cover (%) for each tillage treatment will be determined using crop residue frame estimators (KCS Enterprises, Gurley, NE). Canola will be sown as described under Objective (i) for the spring-sown treatment.

Soil and plant nutrient concentration, soil temperature, plant moisture use, crop growth, seed production and seed quality will be determined for each tillage treatment as described for the seeding treatments in the study described under Objective (i). A simple budgeting approach will be used to compare net income produced by contrasting tillage treatments.

Determine the impact of canola on wheat in a wheat-canola rotation compared with continuous wheat.

Treatments are arranged in a randomized and replicated design (i.e., treatments are arranged in a split plot with four replications; tillage treatments comprise whole plots and crop rotation [wheat-canola, continuous wheat]) comprises subplots.

Soil-nutrient and -moisture status will be determined in each crop rotation subplot prior to sowing wheat. Wheat plant stand will be determined in crop rotation subplots as described for canola in seeding treatment plots under Objectives (i). Wheat plant growth (tiller development, plant-water concentration, spikes/plant, kernels/spike) will be determined following the procedure used in similar studies located at Dickinson (Carr et al., 2000). Grain yield, protein concentration, test weight, and kernel weight will be determined when wheat plants reach physiological maturity.

Data in each study will be analyzed using PROC MIXED available from SAS. Seeding, tillage, and crop rotation treatments will be considered fixed effects. Replications and years will be considered random effects. Where F tests indicate significant differences between treatments, means will be separated using Fischer's protected LSD at $P < .05$.

Time-frame for Project

Soil sampling and analyses will be completed and tillage treatments will be imposed prior to dormant-seeding canola in both 2001 and 2002. Climatic, plant growth, soil water, and other data will be collected by 31 August in 2002 and 2003. Grain and seed will be processed during September. Data analyses will be completed by 15 October and interim and final reports will be completed by 31 December in 2002 and 2003.

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