Dryland Canola Production: Variety Selection, Nitrogen Response, and Water Use in the Central Great Plains

Merle F. Vigil, David C. Nielsen, Ardell Halvorson, and Bill Beard

Abstract

Canola has been identified as a potential dryland oilseed crop for the Central Great Plains. Much of the basic agronomic knowledge required to make canola a successful dryland option in this region is uncertain. The objectives of this research are to determine the nitrogen response, yield potential, water use efficiency, and economic feasibility of spring and winter canola in the Central Great Plains. Nine spring varieties (Westar, Alto, Parkland, Tobin, Global, Cyclone, Excalibur, IMC01 and IMC129) and two winter varieties (Glacier, Crystal) were evaluated over a two-year period in a split-block designed field experiment, with varieties as main plots and nitrogen rates (0, 40 and 80 lb nitrogen/acre top dressed as ammonium nitrate) as subplots. Using a rain out shelter, and line source sprinkler we evaluated water stress and water use at various developmental stages of canola in 1993. Dryland yields of 1,400 to 1,600 lb/acre were harvested in 1992. The highest yields were always from the *Brasica Napus* types at the 80 lb nitrogen rate with Alto, Westar, and Cyclone as the best performers in 1992 and in 1993. Total nitrogen uptake was between 100–150 lbs of nitrogen for the higher yielding varieties at both the 40 and 80 lb nitrogen rates. Hail damage in 1993 precluded a good evaluation of 1993 yield potential. Observation of water stress in 1992 and 1993 suggests that water stress during pod filling is more critical than water stress at flowering and during vegetative development.

Introduction—A Need For The Research

The United States currently imports over 600 million lb of canola annually. This represents a potential production acreage in the United States of 250–350 thousand acres. Increased use of conservation tillage in our region has increased precipitation storage efficiency and made more soil moisture available for crop production, thereby providing greater opportunities for more intensive crop production as compared with conventional wheat-fallow. Canola has potential as a new alternative that may fit into current production systems. Much of the basic agronomic knowledge required to make canola a successful option in the Central Great Plains is unknown. Basic management information such as variety selection, nutrient and water use requirements, heat unit requirements, planting date, planting depth, and seeding rates have not been established for canola in our region and soils. Knowledge regarding the sensitivity to water stress at various growth stages, soil water extraction pattern, nutrient requirement, heat unit requirement, and varietal response can help to determine whether canola is suited to our region. This study will help to determine which canola varieties are adapted to our region, the nitrogen needs of the varieties tested, water use/yield relationships, and critical growth stages with respect to water stress. This study will provide general management recommendations for canola and help to determine whether canola is a viable option for our region of the Great Plains.

Materials and Methods

Variety by Nitrogen Rate Study

In 1992, a split-block experiment (4 replications) with the spring varieties: Westar, Alto, Parkland, Tobin, Global, and the winter varieties Glacier and Crystal was established under 3 different nitrogen regimes (0, 40, and 80 lb nitrogen/acre). Varieties were arranged as main plots and nitrogen regime as subplots (strip-plots). All

USDA-ARS. Central Great Plains Research Station. Akron. Colorado 80720.

nitrogen was topdressed preplant as NH_4NO_3. Individual experimental units are 30–50 ft in size. The experiment is established on a Platner silt loam under two different previous crop-management histories. Site one is established in wheat stubble, site two is established in fallow ground previously planted to dryland corn.

In 1993 the spring varieties: Excalibur, Cyclone, IMC01 and IMC129 were added and the variety Tobin was dropped from the study. The same winter canola was evaluated both years. Spring canola was planted when the average soil temperatures reached 40°F (the last week of March), 1 in. deep, using a Tye no-till-disk drill at a seeding rate of 900,000 seeds/acre. Depending on the variety this is between 4 and 11 lbs of seed/acre. Winter varieties were planted in late August in the same manner as spring varieties. Canola was swathed when 25% of the seeds from the main stem had turned from green to brown in mid to late July. Canola was combined using a John Deere 45 with a pickup head 3–7 days after swathing depending on the weather.

In 1992 in the fallow plots one application of Prowl at 1.5 lb ai/acre applied preplant was sufficient to control weeds. However, in the stubble plots serious problems with volunteer wheat and downy brome may have partially reduced grain yields and grain quality. We suspect that the poor weed control in the stubble plots is the result of poor herbicide incorporation. Canola planted in the fall of 1992 and the spring of 1993 was treated with Treflan granules at the 1.0 lb ai/acre rate with a sweep blade applicator preplant. Treflan applied in the fall gave good control of most broadleaf and grassy weeds. Spring application of Treflan at the 1 lb rate did not control russian thistle, kochia, fall germinated downy brome and volunteer wheat.

Water Use Study

Twelve small plots (8–8 ft) covered by an automatic rain out shelter (planted April 20, 1993) were divided into four water treatments with three replications (Table 1). All plots receive the same amount of water over the growing season, but at different times. The 15 week growing season was divided into a 5-week vegetative period, a 5-week reproductive period, and a 5-week grain-filling period. Long term average precipitation during the 15 week growing season is 9.2 in. This amount of water was applied in equal weekly amounts as designated in Table 1. For example the No stress treatment received 15 equal weekly applications of 0.61 in., while the other treatments received 10 equal weekly applications of 0.92 in. These other three treatments had water withheld during one of the 5-week periods. All treatments began with a 36 in. soil profile near field capacity. Soil water content was incrementally measured to 5 ft with neutron probe and Time-domain reflectometry.

Table 1. Treatments for effect of timing of water stress on canola production.

Treatment stress period	Vegetative	Reproductive	Grain filling
	Fraction of Total Water Applied		
No stress	1/3	1/3	1/3
Grain filling	1/2	1/2	0
Reproductive	1/2	0	1/2
Vegetative	0	1/2	1/2

Results and Discussion

In 1992, Alto and Westar performed the best in both fallow and stubble (Table 2). The largest yields were found generally at the 80 lb nitrogen rate. Oil yields tend to follow grain yields with Alto and Westar as top performers in this test. These data suggest that for the yield potential we have measured the nitrogen requirement is near 100 lb/acre or between 6 and 11 lb of nitrogen/100 lb of grain for the varieties Westar and Alto. In 1993 hail damage precluded any useful measurement of grain yield (data not shown). The decrease in yield potential observed between fallow and stubble is primarily a function of grassy weed pressure (downey brome and volunteer wheat). Preplant available soil water in the soil profiles of each site were about the same. We have had little success with winter varieties. In 1992 we experienced 100% winter kill. In 1993 we observed 100% winter kill in stubble. In fallow plots in 1993 we observed 100% winter kill in reps 1 and 4. In reps 2 and 3 we observed only 10–15% winter kill.

In the rain out shelter experiment the highest water use occurred where all of the water was applied during the first 10 weeks (Table 3). This seems reasonable in light of the higher leaf area development for this treatment during vegetative and reproductive periods (data not shown). The lowest water use occurred where no water was applied during the reproductive period of growth (second 5 weeks of growth) (Table 3). Seed yield was not significantly different among water stress timing treatments, although the trend appears to be for a large reduction in yield when water stress occurs during grain filling. Yields in this treatment were 62% lower than yields where water stress occurred during the vegetative growth. The overall low yields for all treatments may partially be the result of the later planting date. The low yields when water was withheld during grain filing are a result of significantly lower numbers of branches/plant and pods/branch. Seed weight was not significantly affected by water stress timing treatments.

Concluding Remarks

From this limited data set we anticipate that canola has potential in our region. Water stress during grain filling appears to be most critical. On average 3 in. of rain is received in May and 2.7 in. in June. In 1992 we received 3 in. in May and 3.9 in. in June which appears to be what canola needs for good seed yield. In 1993 only 1 in. of rain was received in May and 1.7 in. in June. Hail eliminated a fair measure of yield potential in 1993. However, we suspect that yields would have been less. Of the varieties tested the Napus types outperformed the Campestris types with Westar and Alto as the best performers.

Acknowledgments

The authors would like to thank the following for their help with these experiments: InterMountain Canola, Canbra Foods, Spectrum Crop Development, our technicians and summertime help: Carolyn Brandon, Curt Ruele, Bob Florian, Arnold page, Kyle Lambrecht, Michaela Witcher, Matthew Perry, Hubert Lagae, Mike Perry, Sharel Franke, and Kris Lindhal.

Table 2. Spring canola as affected by variety nitrogen rate in fallow and stubble plots in 1992.

		Fallow				Stubble			
Nitrogen rate (lb/acre)	Variety	Grain yield (lb/acre)	Oil yield (lb/acre)	Nitrogen uptake (lb/acre)	Total biomass (lb/acre)	Grain yield (lb/acre)	Oil yield (lb/acre)	Nitrogen uptake (lb/acre)	Total biomass (lb/acre)
0	Alto	767	339	71	4230	615	273	63	3241
0	Global	479	206	50	3315	339	147	55	3420
0	Parkland	321	138	60	3368	461	202	59	3655
0	Tobin	387	159	50	3306	410	169	53	3422
0	Westar	773	337	53	4053	445	196	32	1967
40	Alto	1108	484	95	4743	776	336	93	4832
40	Global	815	341	100	5131	493	213	85	4578
40	Parkland	701	301	79	4263	462	198	46	3346
40	Tobin	664	267	81	3955	647	263	63	3795
40	Westar	1195	520	97	5614	680	294	75	3931
80	Alto	1202	505	104	5332	775	321	78	3651
80	Global	887	355	111	4675	539	219	102	4659
80	Parkland	670	288	96	4433	485	209	55	3108
80	Tobin	691	273	113	4928	753	301	83	4767
80	Westar	1408	585	82	4458	904	378	55	2790
	LSD(0.05)	204	92	22	1147	176	79	28	1122
Source	df			P>F				P>F	
Nitrogen rate	2	0.021	0.003	0.002	0.027	0.000	0.000	0.096	0.057
Variety	4	0.046	0.041	0.733	0.697	0.079	0.065	0.315	0.350

Table 3. Yield, yield components, evapotranspiration (ET), and water use efficiency (WUE) of canola as affected by timing of water stress.

	Treatment stress period				
Quantity measured	No stress	Grain fill	Reproductive	Vegetative	P>F
Branches/plant	4.55	3.51	4.61	4.69	0.058
Pods/branch	6.65	5.61	6.01	8.68	0.009
Seeds/pod	10.0	10.6	8.90	7.70	0.374
Pods/plant	30.4	19.7	27.8	48.8	0.018
Seeds/plant	305	206	241	316	0.121
1000 Seed Wt (g)	3.19	2.70	3.44	2.90	0.145
Seed Yield (lb/a)	841	562	830	909	0.343
ET (cm)	35.8	40.0	30.1	33.3	0.001
WUE (lb/acre/in)	60.6	35.6	70.2	69.7	0.179

This research was funded in part by InterMountain Canola Company