OILSEED PRODUCTIVITY UNDER VARYING WATER AVAILABILITY

D.C. Nielsen
Research Agronomist
USDA-ARS
Central Great Plains Research Station
Akron, CO
Voice: 970-345-0507 Fax: 970-345-2088
Email: David.Nielsen@ars.usda.gov

INTRODUCTION

Meeting the growing demands for fuel in the United States will require a variety of alternative energy strategies and technologies. One of the emerging sources of alternative energy is biofuels, and one of those biofuels is biodiesel. Biodiesel can be produced from oil extracted from a number of oilseed crops, including canola (*Brassica napus* L.), mustard (*Brassica juncea* L.), camelina (*Camelina sativa* L.), sunflower (*Helianthus annuus* L.), safflower (*Carthamus tinctorius* L.), and soybean (*Glycine max* L.). This paper discusses basic agronomic differences between these crops, their responses to varying water supply, and expected dryland and irrigated yields for northeastern Colorado.

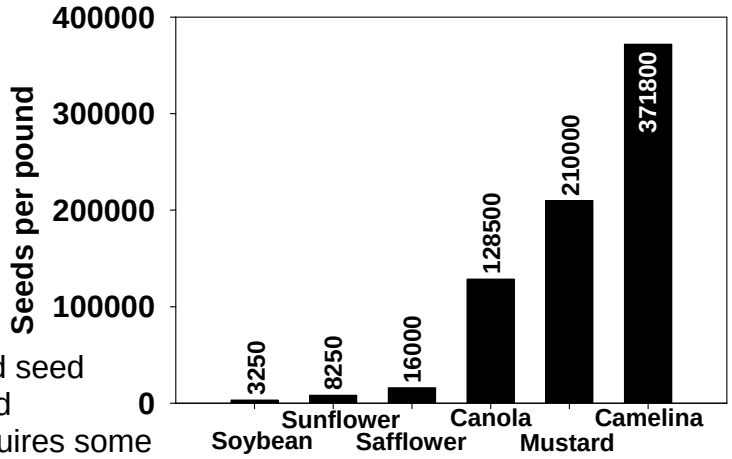
BASIC CROP DESCRIPTIONS

Canola, mustard, and camelina are Brassica crops, among the oldest cultivated plants known to humans (Raymer, 2002). The term “canola” is a registered trademark of the Canadian Canola Association and refers to cultivars of oilseed rape that produce edible seed oils with less than 2% erucic acid (22:1) and meals with less than 30 mmol of aliphatic glucosinolates per gram (Raymer, 2002). In northeastern Colorado all three are generally planted in the early April and harvested in late July. Seed oil contents for these species generally run between 37 and 45%.

Sunflower and safflower are both deep-rooted species. Sunflower is native to the Americas while safflower is believed to have originated in southern Asia. Oil content generally runs from 40 to 47% for both species. Sunflower is generally planted in late May and matures by the end of September, while safflower is planted at the beginning of May and harvested at the end of August.

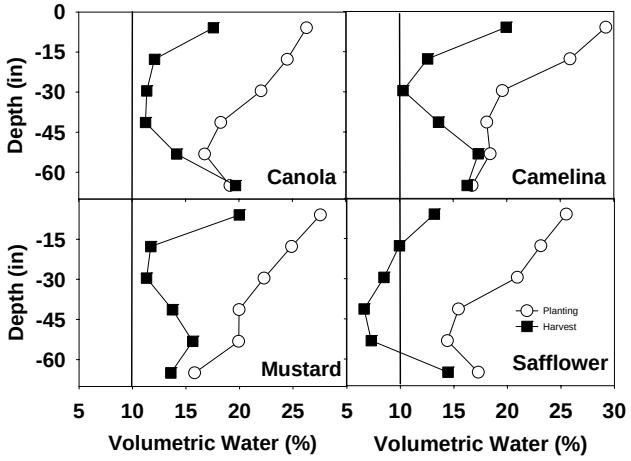
Soybean is a legume native to east Asia. It is generally planted in mid-May and harvested at the end of September. Oil content generally runs 18 to 20%.

SEED SIZE



There is wide variation in the seed size of the six oilseed crops. The figure shows that the number of seeds per pound ranges from 3250 seeds per pound for soybean to 371,800 seeds per pound for camelina. The small seed size for canola, mustard, and camelina generally requires that a good seed bed be formed to ensure good germination. That usually requires some tillage operations and a rolling operation to pack and firm the seed bed. Accurate depth control on the seeding drill is also essential for proper placement of these small seeds. On the other hand, the larger seeds of sunflower and soybean, while easier to plant, require more water for imbibition and germination to occur.

SOIL WATER EXTRACTION



In the figure at the right the open circles are soil water content at planting, and the filled squares are water content at harvest. The space between the two lines is an indication of the amount of soil water extracted. Canola, mustard, and camelina extract soil water mostly from the top four feet of the soil profile. More water is extracted by safflower (and sunflower, not shown) in the fifth foot. Safflower and sunflower can extract soil water to lower water contents (less than 10% volumetric water content) than canola, mustard, and camelina. Other data (not shown) indicates that safflower and sunflower can extract soil water to less than 10% water content in the sixth foot as well.

This more aggressive soil water extraction by safflower and sunflower compared with the other oilseed species means that subsequent crop yields will be adversely affected by safflower and sunflower as the previous crops in a cropping system, and that dryland farmers will likely need to incorporate a year of fallow into the system before another crop is planted. Irrigated producers will need to perform some off-season irrigations to restore soil water contents to near field capacity in the lower half of the soil profile prior to planting the next crop.

PRODUCTION FUNCTIONS

The seed yield response of five of the six oilseed crops to water use is shown in the figure to the right and the regression equations for the production functions are given in Table 1. The regression slopes (determined at Akron, CO) range from 110.5 lb/a per inch of water use for camelina to 175.2 lb/a per inch of water use for canola. Soybean shows the highest seed yield for any given amount of water use. The production functions estimate that canola, camelina, safflower, and sunflower will all yield about the same for water use in the 15 to 20 inch range (approximately 1470 to 2170 lb/a).

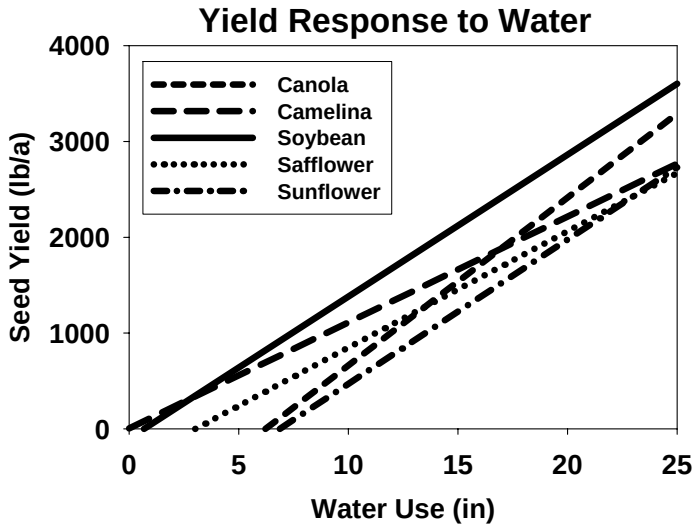


Table 1. Linear regression production functions for five oilseed crops grown at Akron, Colorado.

Crop	Production function (seed yield [lb/a] vs. water use [inches])
Canola	lb/acre = 175.2*(in – 6.2)
Camelina	lb/acre = 110.5*(in – 0.0)
Soybean	lb/acre = 148.1*(in – 0.7)
Safflower	lb/acre = 121.4*(in – 3.0)
Sunflower	lb/acre = 150.6*(in – 6.9)

ESTIMATING YIELDS UNDER A RANGE OF WATER AVAILABILITY

Table 2 shows seed yields predicted using the production functions given in Table 1 (assuming average growing season precipitation and six inches of soil water extraction) at three Great Plains locations. The production functions indicate that soybean would produce the largest yields at all of the locations under all of the water availability conditions. However, soybean yields would likely be lower than shown due to seed loss from not being able to effectively harvest the lowest node of pods (podding to close to soil surface) and seed shatter as pods spontaneously open due to very low afternoon humidity and high winds at harvest time in the Great Plains . Also it should be remembered that the oil content of soybean seed is lower than that of the other oilseed crops. For the

other four crops grown at Briggsdale, camelina would yield highest under rainfed conditions and with three inches of irrigation, but canola would yield highest with six inches of irrigation (2093 lb/a). At all three locations and all three water availability conditions sunflower yields the least of all of the oilseed crops.

Table 2. Estimated seed yields of sunflower, safflower, camelina, canola, and soybean at three Great Plains locations assuming six inches of soil water use and average precipitation, average precipitation plus three inches of irrigation, and average precipitation plus six inches of irrigation.

Location	Crop	Rainfed	3" Irrigation	6" Irrigation
		---------- lb/a ----------		
Briggsdale, CO	Sunflower	863	1315	1767
	Safflower	1306	1670	2034
	Camelina	1350	1681	2013
	Canola	1042	1568	2093
	Soybean	2087	2531	2975
Wray, CO	Sunflower	1056	1508	1959
	Safflower	1570	1935	2299
	Camelina	1604	1935	2267
	Canola	1445	1971	2496
	Soybean	2365	2809	3254
McCook, NE	Sunflower	1285	1737	2188
	Safflower	1802	2166	2531
	Camelina	1805	2136	2468
	Canola	1764	2290	2815
	Soybean	2636	3080	3525

REFERENCES

Raymer, P.L. 2002. Canola: An emerging oilseed crop. p. 122–126. In: J. Janick and A. Whipkey (eds.), Trends in new crops and new uses. ASHS Press, Alexandria, VA.