Fiber and Oilseed Flax Performance

Brian A. Charlton[1] and Daryl Ehrensing[2]

Abstract

Two market classes of flax (*Linum usitatissimum*) were planted in an observational trial at the U.S. Timberlands Tree Nursery, Yonna Valley, Oregon in 2001 to determine whether this crop could be grown to maturity in the cool, short-season climate of the Klamath Basin. Both fiber and oilseed market classes were evaluated. Slight differences in oilseed yield were observed for Omega and Neche, while differences in oil content were negligible. Minor differences in fiber yield were observed between Argos, Elise, and Viola, while yields of Viking were considerably lower. Although oil content was low, yields of both oilseed and fiber flax are comparable to yields observed in production areas of Canada. Newly emerged flax plants are sensitive to frost damage while older plants can withstand temperatures to 24°F.

Introduction

Flax (*Linum usitatissimum*) production dates back to ancient history. Flax remnants have been recovered from Stone Age dwellings in Switzerland and ancient Egyptians made fine linens from the fiber. Flax was probably first cultivated in areas of southern Asia and the Mediterranean. Early cultivated varieties likely originated from wild flax (*Linum angustifolium*) that readily crosses with domesticated flax (Martin *et al*, 1976). Cultivation of flax began in America during the colonial period and moved westward across the northern United States and Canada during the 1800's. Demand for flax products increased during World War I and II. Flax oil and fiber were used for industrial and textile purposes, respectively. During this time, the Willamette Valley of Oregon was a major supplier of high-quality flax fiber. Development of synthetic fibers during the early 1960's reduced demand for flax fiber and eventually displaced the entire industry.

The development of synthetic alternatives has displaced many traditional markets for flax products. Synthetic fibers and petrochemical-based products have replaced flax in both textile and industrial uses. Consumer demand for biodegradable and environment-safe products is leading to a resurgence of flax usage.

Seeds from flax are crushed to produce linseed oil and linseed meal. Linseed oil is a major ingredient in many fine paints, varnishes, and stains that are used to preserve, protect, and beautify wooden surfaces. Linseed oil is also used to preserve concrete surfaces by preventing damage from water and salts. Linoleum is a flooring manufactured by oxidizing linseed oil to form a thick mixture called linoleum cement. The cement is cooled and mixed with pine resin, and wood flour to form sheets on jute backings. Linoleum is often used to describe many types of flooring, although most products are actually

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[1] Faculty Research Assistant, Klamath Experiment Station, Klamath Falls, OR.
[2] Senior Faculty Research Assistant, Department of Crop and Soil Science, Oregon State University, Corvallis, OR.

derived from polyvinyl chloride components. Vintage linoleum is making a major comeback because it is completely biodegradable, environmentally safe, non-allergenic, and very durable.

Linseed oil used for industrial purposes has approximately 50 percent linolenic acid. Industrial linseed oil turns rancid quickly and is not well suited for human consumption. New varieties of flax have been developed which contain approximately 5 percent linolenic acid. Seeds and oil with low levels of linolenic acid are suitable for human consumption. Edible flaxseed oil contains high levels of Omega-3 fatty acids. Omega-3 fatty acids, mostly found in fish, have been shown to modify several risk factors for heart disease, strokes, and certain types of cancer by interfering with the effects of estrogen (Flax Council of Canada). Currently, consumers are using flax in their diets because of its many health benefits and pleasant flavor. The pet food and poultry industries are using flax in various feeds and rations. Poultry fed rations with flax have elevated Omega-3 fatty acid levels in egg production. As nutritional research continues to unveil health benefits associated with flax, usage in the food and feed sectors should continue to increase.

Fiber from flax is used in making high-grade paper, upholstery tow, insulating materials, rugs, yarn, linen, and other textiles. As happened with linseed oil, flax fiber in many products was replaced by cotton and other synthetic fibers. Currently, fabrics using cotton and linen blends are gaining popularity. Flax fiber is also being used to produce other fibrous products such as car-door panels, planting pots, and retaining mats. Flax fiber is being blended with certain types of plastic resins to produce automotive components. Europe produces most of the high-quality long-fiber flax used for linens, rugs, and other textiles. Canada produces most of the short-fiber flax used for paper, planting pots, and other fibrous products such as car-door panels. As new markets develop, increased demand for high-quality flax fiber will continue.

Crop options for the Klamath Basin are limited by climatic conditions, a lack of processing facilities, and distance to markets. Low commodity prices for several crops grown in the region have heightened interest in finding alternative crops that offer profit potential. Flax was chosen for evaluation because market outlets for industrial and edible flax oil may be readily accessible, variable production costs are probably similar to those for cereal crops grown in the region, and value of flax for fiber and oilseed may exceed value of cereals for feed or food uses.

Procedures

Four fiber-type and two oil-type flax varieties were planted on Fordney loamy fine sand at the U.S. Timberlands Tree Nursery in Yonna Valley, Oregon. Preceding crops at the site were coniferous tree seedlings in 1999 and 2000. The site was treated in the spring of 1999 with 235 + 115 gal/acre of methyl bromide and chloropicrin, respectively. The soil has an organic matter content of about 1.0 percent in the plow layer and a pH of about 7.0. Varieties were arranged in a randomized complete block design with four replications. Seed for both types of flax was drilled to a depth of 0.75 in using a modified Kincaid (Kincaid Equipment Manufacturing) planter on May 8.

Individual plots measured 4.5 by 20 ft, with a 4.5- by 14.5-ft area harvested. Seeding rates were 150 and 40 lb/acre and drill rows measured 6 and 18 in for fiber and oil types, respectively. All plots were fertilized with 50 lb N/acre, 63 lb P_2O_5/acre, and 41 lb S/acre banded at planting. All plots received 50 lb N/acre applied during an irrigation set on June 19.

Irrigation was applied with solid-set sprinklers arranged on a 30- by 40-ft spacing. Total crop water, including irrigation and rainfall, was approximately 16 in. Previous fumigation treatments and weed control efforts provided a relatively weed-free environment. Therefore, herbicide applications were not required. Minimal hand weeding was necessary to eliminate border weed infestations. No insecticide or fungicide applications were made. Irrigation ceased on August 6 to provide adequate time for seed and stem drying.

Poor germination occurred in the center drill-row of both oilseed types. Compaction from the planter drive-wheel may have caused this effect. Yield data was collected from an outer drill-row from each plot. Seed was harvested with a Hege (Hans-Ulrich Hege) plot combine on August 21. Seeds from each plot were cleaned to remove chaff and broken kernels using a series of screens and modified air blowers. Given small sample size and non-uniform row emergence, statistical analysis was not performed.

Plots containing fiber-type varieties were hand-pulled on August 21. Morning dew and one supplemental micro-irrigation were used to promote field retting (microbial breakdown of plant pectin, which binds fiber bundles together). Stems were partially retted when field-dry straw yield was collected on September 20. Pertinent data were analyzed using MSTAT (Michigan State University) software. Least significant differences (LSD) are based on Student’s *t* at the 5 percent probability level.

Results and Discussion

Yields did not significantly differ between fiber-type varieties (Table 1). Averaged across varieties and replications, yields were relatively high. Similar performance was observed for Viola, Argos, and Elise while Viking produced the lowest yield. Scutching, the method used to process flax straw, entails mechanically bending and abrading the retted straw to separate shives (woody core of the stem) and fiber. Yield of scutched fiber was estimated to be 20 percent of field-dry straw weight (Table 1). Plant height did not significantly differ between fiber-type varieties.

Plant stands in the center row of three-row plots were not uniform for oil-type varieties, probably due to excessive compaction from the planter drive-wheel. Yield data were therefore taken from the outer drill-rows. Statistical analyses were not performed on yield data due to potential effects of poor stands in the center row. Omega produced slightly higher yields of seed and oil per acre than Neche (Table 2). Oven-dry oil content did not significantly differ between Omega and Neche (Table 2). Optimum oil content will range from 40 to 48 percent under ideal conditions. Oil content averaged 30 percent for both varieties, which is well below the optimum range, suggesting oil production may not be feasible in the short-season climate of the Klamath Basin. Excessive heat during late July and early August may have contributed to the low oil content. However, the 2001 season was not uncommonly warm overall. Fall establishment of cold hardy varieties would likely facilitate early harvest and could provide conditions for greater oil production.

Summary

The main objective of the study was to determine if flax could reach physiological maturity in the cool, short-season climate of the Klamath Basin. Length of growing season in the Klamath Basin appears to be adequate for flax production although late summer heat may reduce oil content. Frequent frosts during the growing season are common occurrences. Flax plants can withstand temperatures to 24^{o}F. Most areas in the region would be conducive for flax production although cold pocket areas such as Lower Klamath and Copic Bay may experience temperatures below 24°F. Additional research to evaluate fall establishment is needed to adequately assess effects of frost on fiber and oil production.

A wide array of products made from flax includes linseed oil, car-door panels, edible oil and grains, pet and animal food supplements, linen, paper, linoleum, and automotive components. This indicates many marketing opportunities may exist for local production. A good example may be as a ration supplement for a large poultry industry in California. Additional research is needed to further define yield, economic potential, and determine optimum cultural practices for flax production in the Klamath Basin.

References

Martin, J.H., W.H. Leonard, and D.L. Stamp. 1976. Principles of Field Crop Production. Third Edition, Macmillan Publishing Co., Inc., New York, NY.

Flax Council of Canada. www.flaxcouncil.ca/flaxnut9.htm.

Table 1. Field-dry fiber yield and plant height of four flax varieties planted May 8, 2001 at U.S. Timberlands Tree Nursery, Yonna Valley, OR.

Variety	Field-dry straw yield (lb/acre)	Extractable fiber yield (lb/acre)[1]	Plant height (75% boll formation)[2]
Argos	8600	1720	37
Viking	6975	1395	32
Elise	8050	1610	35
Viola	8650	1730	38
Mean	8067	1614	35
CV (%)	15.4	15.4	9.4
LSD (0.05)	NS	NS	NS

[1] Estimated as 20.0% of field-dry weight (includes long and short fiber).

[2] Height expressed in inches.

Table 2. Field-dry seed yield and percent oil content of two flax varieties planted May 8, 2001 at U.S. Timberlands Tree Nursery, Yonna Valley, OR.

Variety	Field-dry seed yield (lb/acre)	Field-dry oil yield (lb/acre)[1]	% Oil content[2]	
			Field-dry	Oven-dry
Neche	1185	382	32.2	30.1
Omega	1410	480	34.1	30.3
Mean	1298	431	33.2	30.2

[1] Field-dry oil yield calculated from field-dry seed yield and field-dry oil content -- 10% moisture.

[2] Oil content = field-dry approximately 10% moisture; oven-dry near 0% moisture (50°C for 48 hours).