# Effect of Planting Date, Nitrogen Fertility and Postemergence Herbicides on Lesquerella Production

*J.M. Nelson, D.A. Dierig, and G.L. Hart*

## *Abstract*

*Lesquerella is a potential crop plant that produces seeds containing hydroxy fatty acids similar to those in castor beans. An important step in the commercialization of this plant for Arizona farms is the development of an efficient agronomic production system. Research on cultural practices for lesquerella was conducted during the 1991-92 and 1992-93 seasons. Results of planting date experiments indicate that early fall planting dates are superior to late fall or winter dates in terms of dry matter production and seed yield. Lesquerella produced a marked response to nitrogen (N) in tests comparing different N rates. In a postemergence weed control test, several herbicides gave good control of small winter weeds.*

## Introduction

Lesquerella has been determined to have potential as a crop plant that can provide U.S. industry with a domestic source of hydroxy fatty acids. Presently, imported castor oil and its derivatives are the only commercial source of these industrial fatty acids. Lesquerella produces a seed oil high in lesquerolic acid which is essentially identical to ricinoleic acid in castor beans. Consequently, lesquerella has potential for replacing castor as well as finding uses in other new industrial products. Lesquerella oil and its derivatives can be used in a wide range of products including resins, waxes, nylons, plastics, lubricants, cosmetics and coatings.

The species currently being domesticated, Lesquerella fendleri, occurs in the wild from Arizona to Texas and Oklahoma and it grows as a winter annual at elevations from 2000 to 5900 ft. in areas of annual rainfall ranging from 10 to 18 inches. Preliminary research indicates that lesquerella can be produced in Arizona in a cropping system similar to that of winter wheat or small grains. A key element in the commercialization of this plant is the development of an efficient agronomic production system. Needed immediately is information on when to plant the crop to obtain maximum yields. Also, the development of weed control strategies is critical to the successful cultivation of this plant.

Research reported here was conducted the past two seasons to evaluate fall and winter planting dates for lesquerella production in central Arizona. Nitrogen (N) fertility rates were included in these studies to determine the response of lesquerella to nitrogen. Also, a preliminary study of the use of postemergence herbicides for winter weed control in lesquerella was conducted in 1992-93.

## Materials and Methods

All cultural experiments were conducted at the University of Arizona Maricopa Agricultural Center, Maricopa, Az. The soil at this location is a Mohall sandy loam. Field preparations prior to planting included disking, land leveling and incorporating ON-45P-OK fertilizer at a rate of 200 lbs/acre.

Planting Date Experiment, 1991-92

Lesquerella was planted on five dates in 1991-92. The earliest planting, 26 Sept. 1991, was abandoned because of poor stands and weed problems. Other planting dates were 17 Oct., 6 Nov., 10 Dec. 1991, and 7 Feb. 1992. On all planting dates, seed was planted with a Brillion planter on raised beds with a 40-inch spacing between beds. The seeding rate was 4.5, 5.4, 6.0 and 6.0 lbs/acre for Oct., Nov., Dec. and Feb. plantings, respectively. Final plant populations were 215,000, 288,000, 547,000 and 506,000 plants/acre for the Oct., Nov., Dec. and Feb. plantings, respectively. Following planting, the field was flood irrigated three times to provide soil moisture for seed germination. Since the seeds are planted very shallow, the soil surface must be kept moist until seedling emergence occurs.

Nitrogen application rates of 0, 54 and 108 lbs/acre of N were established in each planting date plot. For the fall plantings, the N application rate was split with one-half applied preplant and one-half applied in Mar. The Feb. planting received all N fertilizer preplant. Soil samples collected in the field prior to planting contained 1.90 and 1.40 ppm of $NO_3$-N in the surface foot and second foot, respectively. The experimental design of this experiment was a split plot within a randomized complete block design with four replications. The larger main plots were planting dates and subplots were nitrogen rates. Planting date plots were six 40-inch rows wide by 150 ft. long and nitrogen fertility plots were six 40-inch rows wide by 50 ft. long.

Each planting was sampled on 20 Feb., 18 Mar., 22 Apr. and 22 May to determine above ground plant dry weight. On each date, one 10.75 sq.ft. area in each nitrogen fertility subplot was hand harvested. Plants within the harvested area were counted, clipped at the soil surface and dried at 150°F. On 22 May the average plant height was determined for all plots.

In this experiment, a final harvest to determine seed yield was planned for mid-Jun. However, on 28 May 1992 a heavy rain and hail storm caused a high percentage of the seed pods to open resulting in severe shattering. The Feb. planting had the lowest seed loss because fewer pods in this planting were mature when the rainstorm occurred. No seed yields are reported for this experiment.

Planting Date Experiment, 1992-93

Lesquerella was planted on 18 Sept., 16 Oct. and 16 Nov. 1992. The Oct. planting was eventually abandoned because of severe weed problems. In each planting, seed was planted on level land at a rate of 10 lbs/acre using a Brillion planter. Final plant populations were 635,000 and 809,000 plants/acre for the Sept. and Nov. plantings, respectively. Following sowing of seed, each planting was irrigated three to four times to germinate seed and obtain stands. The plantings were irrigated once a month in Jan. and Feb. and then every two weeks through mid-May.

Nitrogen application rates of 0, 54, and 108 lbs/acre of N were established in each planting date plot as in the 1991-92 experiment. Experimental design and plot size was the same as in the 1991-92 experiment.

Harvest was on 7 Jun. 1993. On each date, two 10.75 sq.ft. areas in each nitrogen fertility subplot were hand harvested. Plants within the harvested area were counted, clipped and dried at 150°F. The above-ground plant dry weights were measured before hand threshing to obtain seed. The seed was cleaned and weighed and the seed oil content was determined.

Postemergence Weed Control Experiment

Lesquerella was planted on level land using a Brillion seeder at a rate of 9.5 lbs/acre of seed on 1 Dec. 1992. The planting was irrigated three times to obtain stands. Additional irrigations were applied on 15 Jan., 15 Feb. and then bi-weekly in Mar., Apr. and May. In early Mar. , 54 lbs/acre of N was broadcast on the planting and activated by an irrigation.

Herbicide treatments were applied on 6 Feb. 1993 when lesquerella plants were one to two inches in height and weeds were small. Treatments were: oxyfluorfen (Goal) at 0.3 and 0.5 lb a.i./acre, cyanazine (Bladex) at 0.5 and 0.75 lb a.i./acre, simazine (Princep) at 0.5 and 0.75 lb a.i./acre, and an untreated check. Each treatment was replicated four times in a randomized complete block design. Treatments were applied at a total volume of 20 GPA using a spray boom with nozzles spaced 20 inches apart. The plots were evaluated for weed control three weeks after application of treatments. Weeds present in the planting were London Rocket (Sisymbrium irio), Sowthistle (Sonchus asper), Prickly Lettuce (Lactuca serriola), Malva (Malva parviflora) and volunteer small grains. A 21.5 sq.ft. area was harvested in each plot on 4 Jun. 1993 to determine lesquerella dry matter and seed yield and weed dry matter production.

## Results

Planting Date Experiment, 1991-92

There were large differences among planting dates in above ground dry matter production (Table 1). The results of the experiment indicate that the earlier the planting date, the higher the dry matter yield will be in March, April and May. Dry matter yield has been shown to be positively correlated with seed yield, so the earliest plantings would also be expected to produce the highest seed yield. Planting lesquerella in Feb. at this location resulted in greatly reduced dry matter yields. The Oct. planting produced nearly six times more dry matter yield than the February planting for a 20 May harvest. Extending the growing season past June to allow late plantings time to produce higher yields does not appear to be feasible at Maricopa, since the probability of rain increases in late June and July and rainstorms can cause a high percentage of mature seed pods to shatter.

The period of greatest growth of full planted lesquerella was Mar. through May. In the Oct. planting, 92 percent of dry matter yield was produced after the 20 Feb. sampling date.

The N fertility rate had a marked effect on lesquerella dry matter production (Table 2). The highest N rate resulted in significantly higher dry matter yields than the lowest rate at the end of the season. Nitrogen treatments appeared to influence the N content of lesquerella plant tissue. Leaf blades collected from Oct. and Dec. plantings in April averaged 2.2, 2.6 and 3.0% total N in the 0, 54 and 108 lbs/acre N treatments, respectively. More research is needed to determine if a relationship exists between leaf blade N content and seed yield.

Planting Date Experiment, 1992-93

The Sept. planting produced significantly greater dry matter and seed yields than a Nov. planting (Table 3). The highest seed yield obtained in this experiment was 1120 lbs/acre in the Sept. planting at the highest N rate. There were no differences between planting dates in oil content of seeds or seed weight.

As in the 1991-92 experiment, lesquerella responded to N fertilizer. In both the Sept. and Nov. plantings the highest N rate resulted in significantly higher dry matter and seed yields than when no N fertilizer was applied. Nitrogen rate had no significant effect on seed oil content or seed weight.

Plant populations in the 1992-93 experiment were higher than those now considered optimum for seed production. Research indicates that optimum plant populations for lesquerella range from 284,000 to 405,000 plants/acre (Kebe et al, 1993).

The major weed problem in lesquerella in central Arizona is winter weeds that emerge with lesquerella at planting time or in established stands in the fall and winter following irrigations or rain. During the winter

many weeds grow more rapidly than lesquerella and if not controlled, can eventually overshadow smaller lesquerella plants. Summer weeds can be a problem in early fall plantings and in mature plantings in May and Jun. Late-season weeds can make combine harvesting more difficult and less efficient.

Postemergence Weed Control Experiment

Results of the test are shown in Table 4. All of the herbicides tested gave good control of the weeds present. Simazine was effective against weeds but resulted in stunting of lesquerella at the low rate and severe stunting and death of plants at the higher rate. Oxyfluorfen gave good control of most broadleaf weeds present and also killed or injured volunteer small grain plants. Cyanazine was nearly as effective as oxyfluorfen for broadleaf weed control but was not as effective in controlling volunteer grain. Some of the larger weeds were injured but not killed by the oxyfluorfen and cyanazine treatments and some of these weeds recovered and produced growth.

Since this test did not contain a weed-free check, we could not determine if oxyfluorfen or cyanazine resulted in injury to lesquerella plants. However, visual evaluation of plants after treatment indicated that if damage occurred it was minimal. Cyanazine did cause some leaf burn at the highest application rate. Data from this test indicate there is a strong relationship ($r^2$= 0.90) between dry matter production and seed yield. Apparently, cultural factors that result in reduced lesquerella growth will also reduce seed yield. None of the herbicides used in this test are currently registered for use on lesquerella in Arizona. An effort is being made to obtain registration for the use of oxyfluorfen on lesquerella.

## References

Kebe, B., D.T. Ray, and D.A. Dierig. 1993. Performance characteristics of Lesquerella fendleri as influenced by plant density. Abstract. AAIC Annual Meeting. New Orleans, LA. Sept. 25-30, 1993.

## Table 1. Effect of planting date and sampling date on lesquerella dry matter yield and plant height in 1991-92.

| Planting date | Sampling date | | | | Plant height [2] |
|---|---|---|---|---|---|
| | 20 Feb. | 18 Mar. | 22 Apr. | 22 May | |
| | (lbs/acre) | | | | (inches) |
| 17 Oct. | 330 a[1] | 928 a | 2016 a | 4219 a | 10.6 a |
| 6 Nov. | 71 b | 508 b | 1704 ab | 2881 b | 9.8 b |
| 10 Dec. | 36 b | 330 b | 1035 b | 2132 b | 8.9 c |
| 7 Feb. | -- | 18 c | 250 c | 714 c | 5.5 d |

[1] Means in columns followed by the same letter are not significantly different at the 0.05 probability level.
[2] Plant height was measured on 22 May 1992.

**Table 2. Effect of nitrogen application rate and sampling date on lesquerella dry matter yield and plant height in 1992-93 season.**

| Nitrogen rate | Sampling date | | | | Plant height [3] |
|---|---|---|---|---|---|
| | 20 Feb.[1] | 18 Mar. | 22 Apr. | 22 May | |
| (lbs./acre) | ----------(lbs/acre)---------- | | | | (inches) |
| 0 | 95 b[2] | 299 a | 809 b | 1833 b | 7.2 a |
| 54 | 167 a | 513 a | 1291 ab | 2578 ab | 9.1 b |
| 108 | 184 a | 526 a | 1648 a | 3051 a | 9.8 c |

[1] Does not include data from the 7 Feb. planting date.
[2] Means in columns followed by the same letter are not significantly different at the 0.05 probability level.
[3] Plant height was measured on 22 May 1992.

**Table 3. Effect of planting date and nitrogen application rate on lesquerella seed yield, dry matter yield, seed oil content, and seed weight in 1992-93.**

| Planting date | N fertility rate | Seed yield | Dry matter yield | Oil | Weight/ 100 seeds |
|---|---|---|---|---|---|
| | (lbs N/acre) | (lbs/acre) | (lbs/acre) | (%) | (g) |
| 18 Sept. | 0 | 710 | 4920 | 22.3 | .057 |
| | 54 | 1010 | 6960 | 23.6 | .057 |
| | 108 | 1120 | 7670 | 22.6 | .056 |
| | Mean | 950 | 6520 | 22.8 | .057 |
| 16 Nov. | 0 | 580 | 3750 | 25.1 | .057 |
| | 54 | 740 | 4830 | 25.0 | .056 |
| | 108 | 890 | 5800 | 23.2 | .058 |
| | Mean | 740 | 4790 | 24.4 | .057 |
| | LSD (.05)[1] | 260 | 1640 | NS[3] | NS |
| | LSD (.05)[2] | 190 | 1360 | NS | NS |

[1] For comparison of nitrogen treatments within a planting date.
[2] For comparison of planting date means.
[3] Means not significantly different.

**Table 4. Effect of postemergence herbicides on winter weed control and lesquerella production.**

| Herbicide treatment | Application rate | Weed control | Lesq. seed yield | Lesq. dry matter yield | Weed dry matter yield |
|---|---|---|---|---|---|
| | (lb. a.i./acre) | (%) | (lbs/acre) | (lbs/acre) | (lbs/acre) |
| Oxyfluorfen | 0.30 | 87. bc[1] | 522 ab | 5320 a | 220 b |
| Oxyfluorfen | 0.50 | 95 ab | 467 ab | 4530 ab | 60 b |
| Cyanazine | 0.50 | 85 c | 540 a | 5080 ab | 380 b |
| Cyanazine | 0.75 | 92 abc | 467 ab | 4720 ab | 120 b |
| Simazine | 0.50 | 98 a | 383 ab | 4100 bc | 10 b |
| Simazine | 0.75 | 99 a | 257 c | 3240 c | 5 b |
| Untreated check[2] | -- | 0 d | 253 c | 3220 c | 2190 a |

[1] Means in columns followed by the same letter are not significantly different at the 0.05 probability level.
[2] Weeds were not controlled in this treatment.