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Jerusalem Artichoke Trials in Southern Oregon

Agricultural Experiment Station
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INTRODUCTION

The Jerusalem artichoke (Helianthus tuberosa L.) is a member of the sunflower family and a native American plant. It has long been a popular garden crop for its tubers, which can be eaten raw, sliced into salads, or boiled like potatoes. Farmers have used it as a livestock feed, sometimes making silage of the tops but more often feeding the harvested tubers to livestock or simply allowing hogs to root them out of the ground. The plant can easily become a weed, especially in gardens, and wild types are often called wild sunflowers.

From America, the crop was taken to Europe by early explorers, and its production spread throughout the continent. In Europe, its use for livestock feed and for human food began in the seventeenth century.

In the United States tubers served as a food source for the Huron Indians, and it was used in New England for pottage, a thick soup. Dried stalks were sometimes used for fuel in place of wood.

Recently, the Jerusalem artichoke has been mentioned as a promising source plant for the production of industrial alcohol, primarily for blending with gasoline to make gasohol. The tubers contain up to 18 percent sugar, mainly as levulose, and are a good source of inulin, an anhydride of levulose.

Trials were conducted in Oregon beginning in the early 1920's, although there was much interest and some production late in the nineteenth century (6). The United States Department of Agriculture conducted trials for several years beginning in 1931 in Illinois, Minnesota, Oregon, Wyoming, Maryland, and Virginia. One conclusion from that work was that western Oregon had very favorable growing conditions for the crop, resulting in high yields of tops and tubers (1).

To obtain information on some agronomic aspects of its production in southern Oregon, field experiments were conducted in 1980, 1981, and 1982. The effect of row and plant spacing, top growth removal, and volunteer stands were measured on fresh and dry weights of top growth, tuber yield, tuber specific gravity, and soluble solids. That information is presented in the first part of this report beginning on page 2. Herbicide tolerance information was obtained from trials conducted from 1982 through 1984. The second part of this report, beginning on page 13, presents data from the herbicide trials which were designed to find chemical means of eradiciating Jerusalem artichoke from a succeeding crop of barley.

Part 1: JERUSALEM ARTICHOKE PRODUCTION TRIALS

The trials were conducted on a deep, well-drained Central Point sandy loam soil, described as a coarse-loamy, mixed, mesic, Pachic Haploxerol by the Soil Conservation Service. Irrigation water was applied with high-rise, overhead sprinklers. The Jerusalem artichoke planting stock was the Mammoth French White selection. The design used in each experiment was a randomized complete block with four replications.

1980

Materials and Methods

The previous year's crop was spring barley. The experimental area was fertilized with 40 pounds of nitrogen (N), 40 pounds of phosphate (P_2O_5) and 40 pounds of potash (K_5O) per acre during seedbed preparation. Trifluralin (Treflan) and EPTC (Eptam) were applied at 0.75 and 2.0 pounds per acre, respectively, as preplant incorporated herbicide treatments on March 19. The two herbicides were registered for use on sunflower, but they were considered experimental for use on Jerusalem artichoke.

Small tubers and pieces of tubers averaging about two ounces were hand-planted March 21 at a depth of 3 inches. Planting variables included two row spacings, 20 and 40 inches, and spacings of 12, 18, and 24 inches within the rows. The amounts of planting stock used for the different spacings ranged from 800 to 3,260 pounds per acre.

The planting was fertilized with 80 pounds of nitrogen per acre as urea on May 21. Silage-stage sampling was done October 1, 194 days after planting, when the plants were in full bloom. Tuber harvest was done on November 18 from plants that had their tops removed for the silage-stage harvest. Tubers were harvested December 18 from plants whose tops were intact but killed by freezing weather.

The tubers were washed and fresh or green weights were recorded after each harvest. Specific gravity was determined on tubers after they were washed.

Results and Discussion

Excellent stands were obtained, and growth was vigorous throughout the season. By June 5, plants were 18 to 24 inches in height, and there were no weeds. Plants began flowering from buds at the terminals of the upper branches on September 22 (almost 90 days later than oilseed sunflowers growing nearby). Stalks were 10 to 14 feet, and the tallest growth occurred with the highest plant populations and with 20-inch row spacing. With the highest plant population, there was very little branching of the lower part of the plants, but there were many branches a few inches above the crown where plants were spaced 18 and 24 inches apart, especially in the 40-row spacing plantings.

The flowers resembled those of sunflowers, but they were numerous and smaller, averaging less than 2 inches in diameter. Fresh weights of top growth ranged from 29.7 to 33.8 tons per acre, and while yields were highest with the 12-inch plant spacing, the differences were not statistically significant (Table 1). Dry matter yields ranged from 7.51 to 9.50 tons per acre. The highest yields were with the 20-inch row spacing, and with the 12-inch hill spacing. Dry matter content averaged 26.9 percent; the 20-inch row spacing, 28.0 percent and the 40-inch row spacing 25.8 percent. The dry matter average yield of 8.56 tons per acre was 91 percent of the yield of 12 field corn hybrids grown on the station.

Fresh weights of tubers from plants harvested for silage-stage determination ranged from 14.2 to 17.4 tons per acre (Table 2). Highest yields were obtained with the 12-inch spacing within the row, although differences were not statistically significant. When the tops were left on the plants until the December 18 harvest, tuber yields were more than double that of plants whose tops were removed October 1. The period of rapid tuber expansion of Jerusalem artichoke is after flowering, when sugars stored in the stalks are moved into the tubers. The highest yields were from plants spaced 12 inches apart in both row spacings.

Tubers of Jerusalem artichoke vary in shape and size. The type grown produced reasonably smooth tubers, although some knobbiness and pointed ends were present. Tuber weights varied widely, ranging from one half to over 10 ounces, although most were in the two to eight ounce range.

The specific gravities of the tubers, comparing tuber weights to that of water (1.000), averaged 1.037 when top growth was removed October 1 and 1.053 when tops were left on the plants until the December 18 harvest (Table 2). Tubers from plants spaced 12 inches apart had the highest specific gravities with both row spacings.

1981

Materials and Methods

The experimental area was fertilized with 70 pounds of nitrogen (N) and 80 pounds of sulfur (S) per acre during seedbed preparation. An additional 40 pounds of N was banded along one side of each row on May 27. Small and cut tubers were planted April 3 with 30-inch row spacing and 18-inch plant spacing within the row. Treflan was applied at 0.75 pound of active ingredient per acre as a preplant incorporated treatment.

The main variable imposed in 1981 was top growth removal from different plots on a monthly basis from June through October. All top growth was cut at or near ground level, weighed fresh and subsampled for dry matter content.

Table 1. Jerusalem artichoke top growth yields as affected by row and plant spacing variables, Medford, 1980 season

Spacing variables (inches)		Silage-stage yields (tons per acre)		Dry matter
Between rows	Within rows	Fresh wt	Dry wt	at harvest (%)
20	12	33.8	9.50	28.1
20	18	33.7	9.21	27.3
20	24	30.2	8.66	28.7
40	12	32.3	8.51	26.3
40	18	29.7	7.51	25.3
40	24	30.8	7.95	25.8
	Mean	31.8	8.56	26.9
	LSD, 5%	N.S.	1.19	
	C.V., %	7.6	9.1	

Notes:

1. The planting was made March 21.
2. Silage-stage sampling was done October 1 during the full-bloom stage of plant development.
3. Data are the means of four replications.

Table 2. Jerusalem artichoke tuber yield and specific gravity as affected by row and plant spacings and top growth removal, Medford, 1980 season

Spacing variables (inches)		Tuber yield, T/A		Tuber specific gravity	
Between rows	Within rows	Tops removed	Tops mature	Tops removed	Tops mature
20	12	16.1	35.1	1.046	1.066
20	18	16.2	33.9	1.039	1.059
20	24	15.9	32.6	1.042	1.050
40	12	17.4	35.7	1.052	1.056
40	18	16.6	30.9	1.032	1.045
40	24	14.2	29.2	1.028	1.040
	Mean	16.1	32.9	1.037	1.053
	LSD, 5%	N.S.	3.6	0.005	0.006
	C.V., %	14.3	7.3	0.34	0.39

Notes:

1. The planting was made March 21.
2. Tubers were harvested November 18 from plants that had top growth removed October 1.
3. Tubers were harvested December 18 from plants that had fully matured tops that had been frozen.
4. Data are the means of four replications.

The first top growth harvest was on June 17 when plants were 36 inches tall, 75 days after planting. The second set of plants was harvested July 20, 108 days after planting, when growth was 72 inches tall. Top growth harvests were made on other sets of plants August 19, September 24, and October 19. Some plants harvested on June 17 or July 20 were harvested a second time on October 19. The tubers were all harvested from December 11 to December 15. Tubers were washed, and fresh weight, specific gravity, and soluble solid contents determined. Soluable solids, measured in Brix units, is an approximation of the sugar percentage in plant parts.

Results and Discussion

The stand obtained was excellent, growth was vigorous throughout the season, and plant heights ranged to 10 feet. Flowering occurred late in September. Fresh weight yield from the June 17 harvest was 9.2 tons per acre, and dry weight was 1.27 tons per acre (Table 3). Regrowth was rapid, and the second harvest on October 19 yielded 15.1 tons of green material and 3.52 tons of dry matter per acre.

Plants harvested on July 20 showed a sizable increase in fresh and dry matter yields over the June-cut plants. Fresh weight yield was 21.5 and dry matter yield was 4.11 tons per acre. Some regrowth occurred, and the second harvest on October 19 yielded an additional 8.1 tons of green material and 1.70 tons of dry matter per acre.

The harvest of August 19 yielded 29.3 tons of green material and 6.71 tons of dry matter per acre. Regrowth was limited, so there was no second harvest.

The highest yields of green material and dry matter were obtained from the September 24 harvest. Yields were 31.2 and 7.26 tons per acre, respectively. There was not enough regrowth for a second harvest in October.

The October 19 harvest was lower than that of September for green and dry matter yields. Some moisture loss had occurred, as maturity was approaching, and food stored in leaves and stalks was being rapidly translocated to the tubers.

For treatments where tops were allowed to mature without being cut, tuber yields averaged 33.8 tons per acre, equal to the highest yield for 1980 (Table 4). When top growth was removed in October, tuber yield, specific gravity, and soluble solids were reduced by 20, 0.5, and 7 percent, respectively. Even though some light frosts had occurred by October 19, translocation of sugars to the tubers had not been completed.

Cutting top growth in September reduced tuber production nearly 62 percent compared to not topping. Specific gravity and soluble solids were also reduced.

Table 3. Top growth yields of Jerusalem artichoke as affected by cutting dates, Medford, 1981 season

Cutting date	Top growth yield, tons/acre Green	Dry	Dry matter at harvest (%)
June 17	9.2	1.27	18.3
2nd cut, October 19	15.1	3.52	23.3
Total, June and October	24.3	4.79	19.7
July 20	21.5	4.11	19.1
2nd cut, October 19	8.1	1.70	21.0
Total, July and October	29.6	5.81	19.6
August 19	29.3	6.71	22.9
September 24	31.2	7.26	23.3
October 19	21.3	6.04	28.4
Mean	27.1	6.12	
LSD, 5%	3.6	0.91	
C.V., %	9.1	10.0	

Table 4. The effects of the timing of top growth removal upon the yield, specific gravity, and soluble solids content of Jerusalem artichoke tubers, Medford, 1981 season

Cutting date	Tuber yield (tons/acre)	Tuber specific gravity	Soluble solids (Brix units)
June 17	23.4	1.076	21.1
June 17 and October 19	18.8	1.070	20.0
July 20	14.7	1.080	20.5
July 20 and October 19	11.1	1.070	19.1
August 19	5.9	1.071	19.4
September 24	13.0	1.064	19.1
October 19	27.1	1.064	19.6
Not topped	33.8	1.069	21.0
Mean	18.5	1.071	19.9
LSD, 5%	3.0	0.003	1.1
C.V., %	11.0	0.2	3.8

Notes:

1. The planting was made April 3; rows were spaced 30 inches apart, and plants were spaced 18 inches within the row.
2. The experimental area was fertilized with 70 pounds of N and 80 pounds of S per acre on May 27.
3. The tubers were harvested December 11 to 15.
4. Data are the means of four replications.

The greatest reduction in tuber yield, 83 percent, occurred when tops were removed in August. While top growth production was high in August, removal at that time did not allow adequate regrowth time to increase tuber production. A tuber yield reduction of 57 percent occurred when tops were cut in July, and a further reduction occurred when a second cutting was made in October. Removing topgrowth in June reduced tuber production 39 percent. When tops were removed again in October, the yield reduction was 44 percent, compared to not removing tops.

In the 1981 trial, no single or double harvest of tops approached the yield of tubers harvested from fully mature, untopped plants. Data from the University of California (5) showed that top growth harvested either once or twice during the season resulted in less fermentable sugar than that of tubers harvested from untopped, mature plants, agreeing with data from this trial.

While the Jerusalem artichoke is an annual crop, it acts as a perennial, because small and broken tubers escape harvest and leave a source of planting stock in the soil to emerge as new plants in the spring. A thick volunteer stand developed in 1981 where the crop was grown in 1980. Rows were formed in the stand May 14 using a rototiller to remove all but a 6-inch wide band of plants with a 30-inch row spacing. Sections of rows were cross-blocked to leave a plant or cluster of plants every 24 inches. A second rototilling was done later to remove new plants developing between the rows.

The tubers were harvested in December. Where rows were not cross-blocked, the tuber yield was 30.3 tons per acre. With cross-blocking, the yield was 27.3 tons, not a significant difference because of stand variability. The yields from the volunteer stand were only slightly less than from the planted trial alongside. It appears that satisfactory stands can be obtained with volunteer plants. Cultivation or the use of a herbicide as a directed spray could be used to form rows.

1982

Materials and Methods

The primary treatment variable imposed in 1982 was different dates of top growth removal, similar to the method used in 1981. Treflan was applied at 0.75 pound of active ingredient per acre and tilled into the seedbed. Small and cut tubers averaging 1.7 ounces were planted April 9 with a 30-inch row spacing and 18-inch spacing within the row, for a population of 11,616 seed pieces per acre. Ammonium sulfate was applied June 21 to supply 100 pounds of N and 114 pounds of S per acre. About 26 inches of irrigation water was applied during the season.

All top growth was removed from different plots each month beginning June 15 and continuing through October 15. Some plants harvested in June were harvested a second time in August. Green weights were recorded, and dry weights were determined for each sampling. Tubers were harvested December 1 after top growth had been killed by frosts. Tuber yield, specific gravity, and soluble solids were determined. Soluble solids were also determined in leaves and stalks August 25.

Results and Discussion

The plants cut June 15 averaged 34 inches in height 77 days after planting. Green weight yield was 7.9 tons and dry weight yield was 1.00 ton per acre (Table 5). Dry matter content was 12.7 percent. Plants averaged 74 inches in height at the July 15 harvest, 97 days after planting. The green weight yield was 35.2 tons per acre, the highest of the season, while dry weight yield was 3.81 tons per acre. Moisture content of the green material was slightly over 89 percent.

The August 16 green weight yield was 31.5 tons per acre, while the dry matter yield increased 86 percent over the July harvest to 7.10 tons per acre, with a dry matter content of 22.5 percent. Regrowth from plants harvested in June yielded 17.7 tons of green material and 2.27 tons of dry matter per acre. The green material had only 13 percent dry matter. Combining the June yields with the regrowth harvested in August resulted in 25.6 and 3.27 tons per acre, respectively, for the green and dry yields, far short of the single harvest made in August.

Plants harvested September 15 had the highest dry matter yield of the season at 7.72 tons per acre, while green weight was 28.5 tons. The dry matter content was 27 percent.

October top growth yields were lower than in August and September even though the dry matter content of the green material had reached 31 percent. Translocation of sugars was occurring from leaves and stems into the tubers, which began to increase in size rapidly after the plants flowered about September 25.

Top growth removal greatly affected tuber yields, depending upon when it was done. The highest tuber yield of 22.2 tons per acre was obtained when tops were not removed before harvest December 1 (Table 6). Removing tops in June reduced the tuber yield 21 percent, but July top growth removal caused a 61 percent reduction.

The greatest reduction in tuber yield occurred from the August top growth removal. The yield was only 15 percent that of untopped plants. There was very little tuber development by August 16, and there was insufficient regrowth to contribute to substantial tuber size increase. September top growth removal also resulted in arrested tuber development and a low yield.

Table 5. Top growth yields of Jerusalem artichoke as affected by cutting dates, Medford, 1982 season

Cutting date	Top growth, T/A green	Top growth, T/A dry	Dry matter at harvest (%)
June 15	7.7	1.00	12.72
July 15	35.2	3.81	10.89
August 16	31.5	7.10	22.54
September 15	28.5	7.72	27.14
October 15	18.5	5.68	31.00
August 16 (June regrowth)	17.7	2.27	13.00
June 15 plus August 16	25.6	3.27	
Mean	23.6	4.41	
LSD, 5%	5.28	1.15	
C.V., %	15.1	17.6	

Notes:

1. Top growth was cut at or near ground level.
2. Harvest data are the means of four replications.

Table 6. The effect of the timing of top growth removal upon the yield, specific gravity, and soluble solids content of Jerusalem artichoke tubers, Medford, 1982 season

Cutting date	Tons/acre	Specific gravity	Soluble solids (Brix units)
June 15	18.4	1.044	18.7
July 15	8.6	1.053	18.5
August 16	3.3	1.048	17.9
September 15	5.9	1.044	17.8
October 15	18.3	1.049	18.4
June 15 and August 16	5.1	1.045	17.1
Not topped	22.2	1.053	19.8
Mean	11.7	1.048	18.3
LSD, 5%	4.5	0.0038	0.74
C.V., %	25.7	0.2	2.7

Notes:

1. The tuber seed pieces, averaging 1.7 ounces each, were planted April 9 with a 30-inch row spacing and 18-inch spacing within the rows.
2. The experimental area was fertilized June 21 with 100 pounds of N and 114 pounds of S per acre as ammonium sulfate.
3. A total of 26 inches of irrigation water was applied during the season.
4. The tubers were harvested December 1.
5. Data are the means of four replications.

Removing top growth as late as October 15 reduced the tuber yield somewhat compared to uncut plants. Much tuber development had occurred, but translocation of leaf and stem sugars to the tubers was not yet complete. The first light frost of the season did not occur until October 18.

It appears that if top growth is to be removed for silage, green chop, or for fermentation into alcohol, removal as late as October 15 would be advisable, if near maximum tuber yield is the objective. However, top growth removal in August and September should result in maximum green and dry matter yields, with adequate tuber development for volunteer plants for the next year's crop.

Tuber specific gravity was highest when top growth was not removed until harvest or when it was removed in July. Soluble solids values were highest when top growth was not removed and lowest when it was removed in both June and August.

The concentration of sugars is usually higher in stalks than in leaves (5). The partitioning of sugars in leaf and stalk samples taken August 25 followed that trend when top growth had not been removed. However, soluble solids were higher in leaves than in stalks regrowing after top growth removal on June 15 and July 15. Data are shown in Table 7.

Table 7. Soluble solids contents of Jerusalem artichoke stalks and leaves on August 25 as affected by top growth removal, at Medford, 1982 season.

	Soluble solids (Brix units)	
Top growth removal date	Stalks	Leaves
June 15	5.7	7.2
July 15	4.9	7.5
Not removed	15.5	9.5

Tubers can be stored for a period up to 5 months without serious loss of quality when kept at a temperature from 31° to 35°F and a relative humidity of 90 to 95 percent. Tubers from the 1980 crop were stored outside on a flatbed trailer over winter. Tubers on the outside of the pile showed browning and some dehydration. Those inside the pile showed very little spoilage until March 25, when sprouting began.

Tubers can be left in the ground until late March, if the soil is well drained. They can be dug anytime during the winter when soil conditions permit their removal. In southern Oregon, sprouting in the field begins about March 25 to April 1.

Findings from the southern Oregon production trials are in good agreement with data from Prosser, Washington (2). Topgrowth removal before full maturity was found to reduce tuber yield, and plants cut in July or later made very little regrowth. Maximum fresh weight in Washington was measured August 22, 120 days after planting, quite similar to findings in southern Oregon.

Jerusalem artichoke tops have less protein content than field corn when fed as silage. When tubers are fed to livestock or hogs, they should be supplemented with grain (4, 6). The maximum feed value of tops are obtained when plants are in the bud stage through early bloom while most of the sugars are still in the stalks.

The relationships between top growth fresh weight, dry matter production, and the fresh weight of tubers, as affected by dates of top growth removal, are shown in figures 1 and 2 for the 1981 and 1982 seasons. Of particular interest is the high yield of top growth green weight in the July 15, 1982 harvest. The moisture content was 89 percent, resulting in a dry matter yield of only 3.81 tons per acre. The data for both years show the decline in top growth dry matter as sugars are being translocated from leaves and stems to the tubers late in the growing season.

The uses of Jerusalem artichoke tubers includes feeding to livestock, human consumption, and the fermentation into alcohol. Estimates of the yield of alcohol are at least 20 gallons per ton of tubers. If tuber yields range from 20 to 30 tons per acre, the theoretical production of alcohol would be from 400 to more than 600 gallons per acre. This is higher than for such crops as corn and potatoes, and approximately equal to sugar beets (3).

The carbohydrates in the tubers can be hydrolyzed to yield fructose, a liquid sweetener extensively used in soft drinks and confections. Currently the primary source of fructose for making the liquid sweetener is field corn.

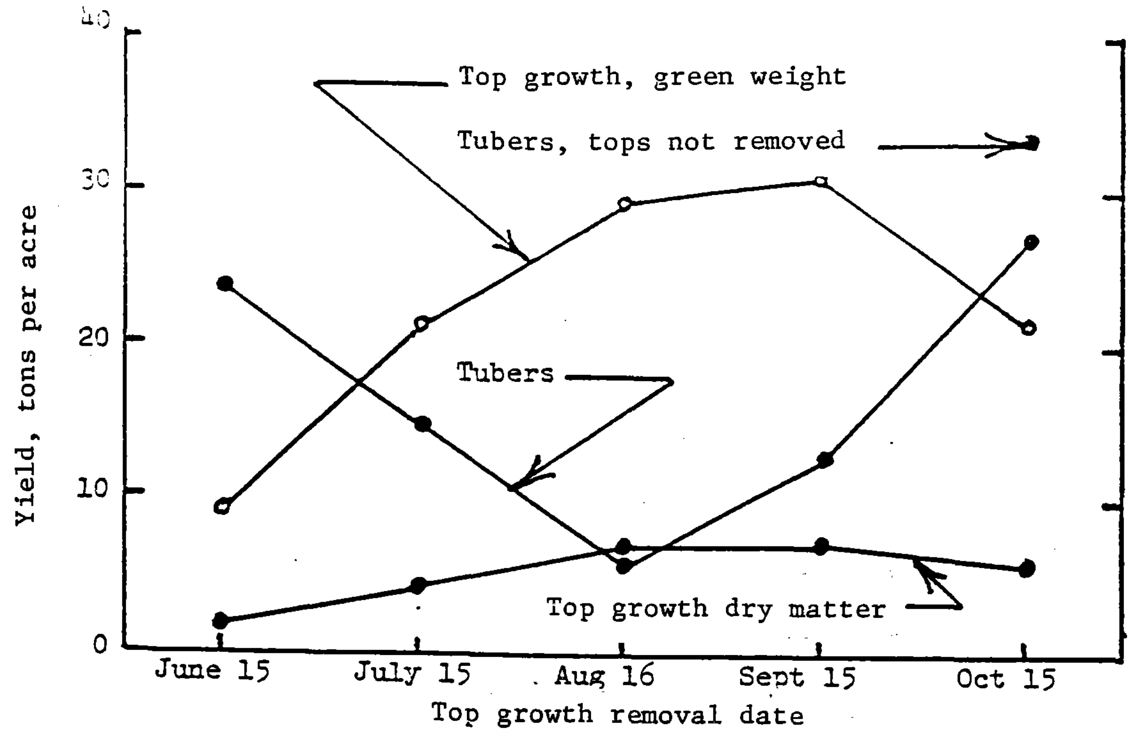

Figure 1. The effect of top growth removal upon Jerusalem artichoke top growth and tuber yields, 1981 season.

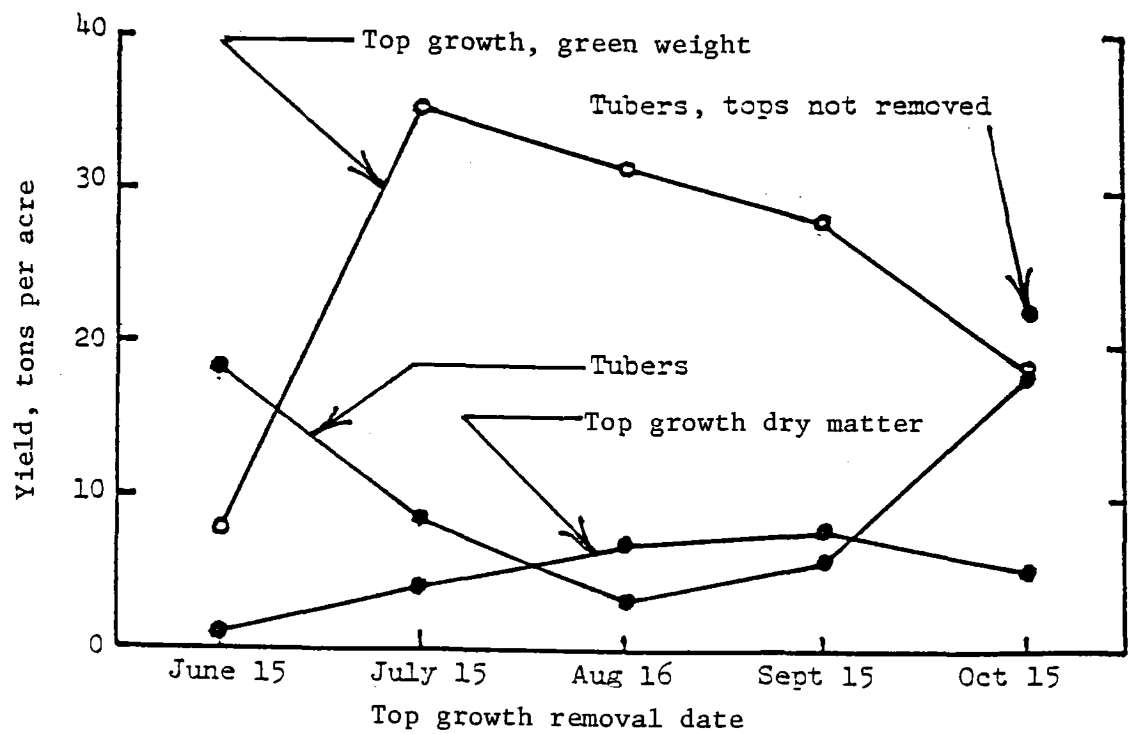

Figure 2. The effect of top growth removal upon Jerusalem artichoke top growth and tuber yields, 1982 season.

Part 2: CONTROL OF JERUSALEM ARTICHOKE WITH HERBICIDES

Jerusalem artichoke has tolerance to Treflan and Eptam, two herbicides often used for weed control in sunflower, although neither material is registered for use on Jerusalem artichoke. Roundup (glyphosate) is registered for use before the crop emerges.

Chemical control of Jerusalem artichoke in a succeeding crop was studied in 1982, 1983, and 1984, since the crop can become a very competitive weed. The herbicides used in the trials were all applied as post-emergence treatments in Steptoe spring barley seedings.

1982 TEST

Materials and Methods

Barley was seeded April 9 in a seedbed that had been prepared by disking and rototilling. The planting area had many tubers left in the soil from the 1981 crop. One half of the area was irrigated, while the other half was dependent on rainfall and moisture stored in the soil.

The 10 herbicide treatments were applied June 10 when the barley was heading and the Jerusalem artichokes ranged from 12 to 28 inches in height, depending upon irrigation status. Treatments included 2,4-D, Banvel (dicamba), Brominal or Buctril (bromoxynil), Lexone or Sencor (metribuzin), Glean (chlorsulfuron), Ally (metsulfuron methyl), and mixtures of 2,4-D with Banvel, and Banvel with MCPA (MonDak). Final weed control observations were made just before barley harvest (Table 8).

Results and Discussion

Twenty hours after application, 2,4-D, Banvel, and the mixture of 2,4-D and Banvel, and Banvel plus MCPA resulted in severe leaf curling of the artichokes. The other materials had shown no immediate effect.

Yields of grain were low because of the relatively late seeding date, and the artichokes had competed strongly with the barley before the treatments were applied (Table 8).

In the check treatment, artichoke height averaged 48 inches with irrigation and 29 inches without. With 2,4-D amine at 1.0 pound per acre, partial control (52%), was achieved under irrigation while 82% control was achieved under dryland conditions. There was more regrowth after the initial leaf curling in the irrigated section than under dryland conditions.

Brominal/Buctril was less effective than 2,4-D, not surprising because the artichokes were well beyond the seedling stage when it was applied. Lexone/Sencor resulted in poor control of Jerusalem artichoke. Glean did not result in effective control, while Ally, a related compound, provided excellent control.

Table 8. The effects of herbicide treatments for the control of Jerusalem artichoke in spring barley at Medford, 1982 season

Herbicide applied	Rate/acre (a.i.)	Grain yield (g/plot) Irrigated	Grain yield (g/plot) Dryland	Jerusalem artichoke control (%) Irrigated	Jerusalem artichoke control (%) Dryland	Jerusalem artichoke height (inches) Irrigated	Jerusalem artichoke height (inches) Dryland
Check	none	874	601	0	0	48	29
2,4-D	1.0 lb	1,279	421	52	82	27	18
Brominal/Buctril	0.5 lb	1,525	758	40	27	25	22
Lexone/Sencor	0.5 lb	795	925	25	17	32	27
MonDak	0.12 +0.25 lb	1,403	481	87	87	19	15
Banvel	0.25 lb	864	900	60	90	17	15
Banvel	0.5 lb	953	487	90	95	17	15
Ally	0.5 oz	977	533	100	100	0	0
Glean	0.5 oz	1,168	787	25	35	36	24
2,4-D + Banvel	0.5 + 0.12 lb	960	1,007	65	92	26	13
Mean	1,080	690					
LSD, 5%	N.S.	375					
C.V., %	35.3	24.1					

Notes:

1. Steptoe spring barley was seeded April 9.
2. The seedbed was disked and rototilled; Jerusalem artichoke tubers left in the ground overwinter provided the planting stock for the dense, volunteer stand.
3. The herbicides were applied June 10 when the maximum temperature was 90°. The barley was heading and the Jerusalem artichoke plant ranged to 28 inches in height.
4. The Mondak treatment was a mixture of Banvel and MCPA.
5. Data are averages of two replications for the irrigated barley and two replications for the dryland barley.

Banvel and Banvel plus MCPA resulted in greater control than 2,4-D. It appeared that earlier application of the treatments was needed. That was done in the 1983 and 1984 experiments.

1983 SEASON

Materials and Methods

The experimental area was plowed in January. Many tubers had been left in the ground, assuring a plentiful supply of volunteer plants for 1983. Final seedbed preparation was done April 5, and Steptoe barley was seeded April 6, dates corresponding to sprouting of tubers in the soil.

Early postemergence treatments were applied April 21 when the barley was at the 2-leaf stage and the Jerusalem artichoke plants ranged to four inches in leaf spread. The herbicides applied were Brominal/Buctril, Glean, and Ally. Late post-emergence treatments were applied May 11 when the barley was jointed, and the artichokes ranged to 12 inches in height. Herbicides included were Banvel, Igran (terbutryn), MonDak (Banvel plus MCPA), Lexone/Sencor, 2,4-D, and 2,4-D plus Banvel.

Results and Discussion

In the check treatment, the stand of artichoke was dense and tall, suppressing the barley. Brominal/Buctril resulted in poor control, Glean resulted in partial control, while Ally gave fairly good artichoke control, but it was less effective than in 1982 (Table 9).

Among the late postemergemce treatments, Banvel was very effective, although both rates resulted in some barley injury, mainly shortening the straw and causing twisting of awns. Banvel is not used on spring barleys in Oregon. MonDak, 2,4-D, and 2,4-D plus Banvel resulted in good control of Jerusalem artichoke. Lexone/Sencor and Igran resulted in poor control, and the Ingran severely injured the barley.

Sweet corn was grown in an unrelated test adjacent to the herbicide test on land which had produced Jerusalem artichoke in 1982. AAtrex (atrazine) applied pre-emergence at 1.6 pounds of active ingredient per acre did not control the artichoke or greatly reduce the competitive effect on the corn. Cultivation was used to suppress the artichokes.

1984 TRIAL

Materials and Methods

The plot area was plowed February 8, and final seedbed preparation was done just before Steptoe spring barley was seeded March 5. Jerusalem artichokes had been grown in 1983, and a sufficient number of tubers had been left in the ground to assure there would be a volunteer stand in 1984.

Table 9. Jerusalem artichoke control in spring barley at Medford, 1983 season

Herbicide applied	Rate/acre (a.i.)	Barley		Jerusalem artichoke		Comments
		Height (in)	Injury (%)	Height (in)	Control (%)	
Check	none	31	0	51	0	much J. artichoke
Post-emergence, April 21						
Buctril/Brominal	0.5 lb	31	0	47	9	poor control
Glean	0.5 oz	20	0	41	45	partial control
Ally	0.5 oz	30	0	40	72	fairly food control
Post-emergence, May 11						
Banvel	0.25 lb	26	11	31	86	good control
Banvel	0.5 lb	25	20	29	89	good control
Igran	2.0 lbs	23	92	44	7	poor control, crop injury
Lexone/Sencor	0.5 lb	30	0	45	17	poor control
Banvel + MCPA (Mondak)	0.12 + 0.25 lb	25	4	33	85	good control
2,4-D	0.5 lb	28	0	33	79	fairly good control
2,4-D	1.0 lb	28	0	33	89	good control
2,4-D + Banvel	0.75 + 0.12 lb	26	9	32	85	good control

Notes:

1. Barley injury refers to that caused by the herbicide; where Jerusalem artichoke control was poor the barley was suppressed, and its stand was usually thin because of the competition.
2. Harvest of the barley with a combine could not have been done efficiently with less than 70% control of the Jerusalem artichokes.

The first post-emergence herbicide treatments were applied April 13 when the barley was tillering and the Jerusalem artichoke plants were from three to six inches across but were still prostrate. The herbicides were Brominal/Buctril at 0.5 pound per acre, and Glean and Ally at 0.25 and 0.5 ounce per acre. A non-ionic surfactant (Aide) was added to each treatment at 0.3 percent of the spray volume of 41.7 gallons per acre.

Late post-emergence treatments were applied May 4 when the barley was from 12 to 16 inches tall, and the Jerusalem artichokes were from 6 to 12 inches tall and very leafy. Materials used were 2,4-D at 0.5 and 1.0 pound per acre amd Banvel at 0.12 pound per acre.

Results and Discussion

The stand of barley was satisfactory, and the stand of Jerusalem artichoke was uniform enough for evaluating the effects of the herbicide treatments. In the check treatment, artichokes competed strongly with the barley and resulted in much green material that caused a problem at harvest. The green material had to be separated from the barley to prevent molds from damaging the grain. The minimum degree of control necessary for the efficient use of a combine for barley harvest was 70 percent.

Excellent control of Jerusalem artichoke was obtained with 2,4-D at both rates (Table 10). The very few plants were small, spindly, and not of sufficient size to cause harvesting problems.

Banvel also effectively controlled Jerusalem artichoke. It did, however, act as a plant growth regulator by restricting the barley's height. Steptoe barley has shown sensitivity to Banvel in previous tests.

Ally was effective in controlling weedy growth, while Glean was much less effective, Brominal/Buctril treatment resulted in poor control of Jerusalem artichoke, and the mass of green material made grain harvest difficult.

Summary

For practical chemical control of Jerusalem artichoke in a barley crop, 2,4-D is a good choice. Another effective material is MCPA. Banvel could be used as a spring application to winter barley or wheat. In three years of trials, there were few weeds other than Jerusalem artichoke since it is a vigorous, competitive grower that suppressed most other weeds.

Mechanical control of Jerusalem artichoke is possible. In earlier trials conducted by the USDA (1), from 6 to 8 cultivations at 10 to 14-day intervals were necessary to approach eradication in a single growing season. Topgrowth removal in July or early August followed by tillage should be effective, since almost no tubers would be formed to provide planting stock for the next year.

Table 10. Jerusalem artichoke control in spring barley with herbicides at Medford, 1984 season

Herbicide applied	Rate/acre (a.i.)	Grain yield (Bu/A)	Test wt (lbs/bu)	Height/i barley	Height/i J. art.	J. artichoke control (%)
Check	none	59.6	51.2	43	39	0
2,4-D	0.5 lb	63.3	53.2	40	23	93
2,4-D	1.0 lb	77.9	51.1	43	24	94
Banvel	0.12 lb	62.3	50.9	31	24	90
Brominal/Buctril	0.5 lb	62.5	51.1	43	37	46
Glean	0.25 lb	67.8	51.2	43	37	60
Glean	0.5 oz	74.4	50.4	42	39	66
Ally	0.25 oz	76.3	51.8	40	30	82
Ally	0.5 oz	74.5	50.8	41	26	86
	Mean	61.2	51.1	41	32	
	LSD, 5%	N.S.	N.S.	1.9	5.7	
	C.V., %	20.6	2.5	3.2	12.4	

Notes:

1. Steptoe barley was seeded March 5 in a soil containing Jerusalem artichoke tubers from the previous year's crop.
2. Early post-emergence treatments applied April 13 were Brominal/Buctril, Glean, and Ally when the barley was tillering and the Jerusalem artichokes had emerged but were till prostrate.
3. Late post-emergence treatments applied May 4 were 2,4-D and Banvel when the barley was 1 to 16 inches tall and the Jerusalem artichokes were 6 to 12 inches tall.

REFERENCES

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