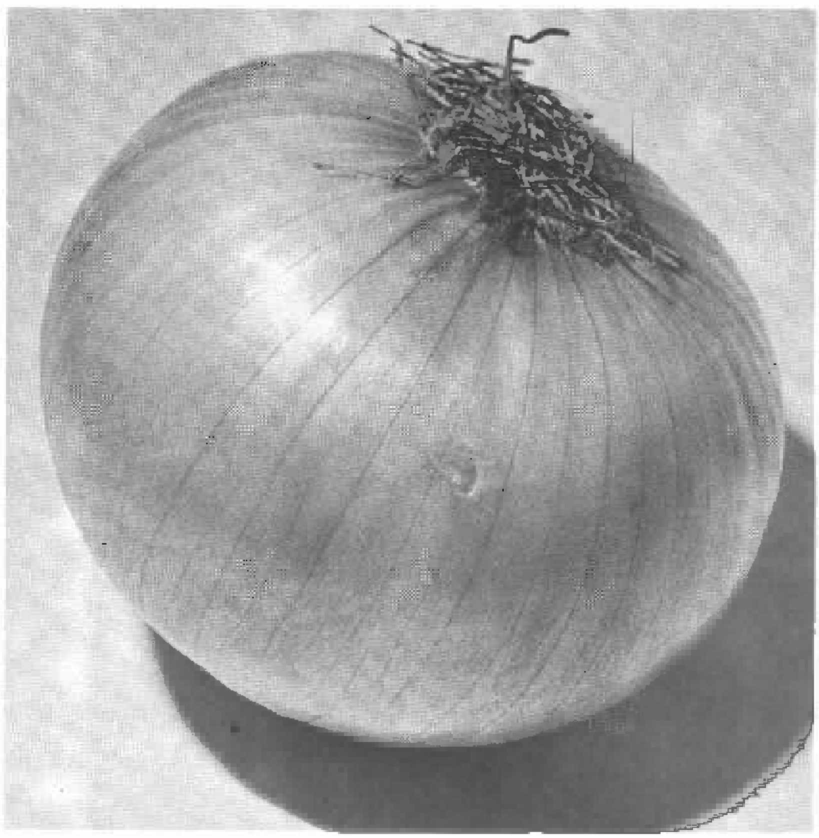
Overwintering Onions and Other Alliums in the Willamette Valley



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OVERWINTERING ONIONS AND OTHER ALLIUMS IN THE WILLAMETTE VALLEY

INTRODUCTION

Overwintered vegetable crops, planted in July through October and harvested the following spring, offer several advantages to both fresh market and traditional row crop growers.

The first is that these crops provide possible alternatives to winter grains and spring-seeded row crops. Market prices for vegetables are often higher in spring and early summer than later in the season. A second advantage is that these crops are often planted late enough and harvested sufficiently early to allow three crops in two growing seasons. A third advantage is the low irrigation requirement and the absence of foliar-feeding insects for much of the growing season.

Disadvantages include possibly increased costs for fertilizer and weed control, and the risk of crop failure caused by freezing or flooding.

We have accumulated seven years of experience growing overwintered onions at the North Willamette Station and also have looked at other possible crops, including cauliflower, shallots, leeks, cabbage, spinach, and Brussels sprouts. This report deals with our experiences with onions, shallots, and leeks. The approach has been to find varieties suitable for our climate and markets, then determine planting dates and probable harvest dates, and finally to work out cultural problems associated with each crop. The most common problems encountered are: 1) adequate plant growth in the spring, usually a soil fertility-temperature problem; 2) weed control; 3) diseases related to high moisture, low-temperature conditions; and 4) premature seed stalk formation (bolting).

A full-time program of vegetable crop research has been conducted at the North Willamette Experiment Station since 1976. The Station, a branch of the Oregon State University Agricultural Experiment Station, is just north of Aurora, a historic farming community 20 miles south of Portland, Oregon. The land is provided by Clackamas County, with facilities owned by the university. Major vegetable research emphasis is on the needs of fresh market growers in the Willamette River Valley, but research is also conducted on processed vegetable crops and home garden and small farm-intensive vegetable culture.

Many of the trials reported here involved cooperation with research and Extension Service colleagues in the Oregon State University system and with area vegetable growers. The contributions of Drs. T.L. Jackson and N.S. Mansour, in particular, are gratefully acknowledged. The financial support of the Northern Willamette Valley Horticultural Society and the Plant Food Association was essential to completing these projects and is greatly appreciated.

Overwintered Onion Variety Trial, 1977-1978

Methods

The trial was conducted on a Willamette silt loam, pH 5.8. Seed sources were Moran Seed Co. (Advance), Vilmorin (French lines), and Takii (all others). Plots were seeded on August 1, August 20, and September 20, 1977, with four replications of each variety at each planting date. Plots were a 10-foot section of a single row. Initial fertilizer application consisted of 1,700 pounds/acre of 10-20-10 incorporated into the seedbed along with 2 pounds/acre of diazinon. DCPA (Dacthal) at a rate of 9 pounds/acre was applied and irrigated in immediately after planting. An additional 300 pounds/acre of ammonium nitrate was applied on January 27 and again on March 8. All plots were harvested on June 30, 1978.

Results

Although there was considerable variability in rate and percent of emergence of the various lines, an acceptable initial stand was obtained in every case. However, the third planting was killed during the winter. Apparently the plants had not achieved sufficient size to overwinter successfully. Both the first and second plantings overwintered successfully but with considerable losses and damage from diseases and apparent fertilizer burn. Consequently, the yield data obtained did not include four replicates for each variety and were not subjected to statistical analysis. In contrast to a preliminary trial in 1976-1977, all varieties experienced a significant degree of seed-head formation in the spring. On April 21, Express Yellow, Kaizuka, Extra Early, and Advance had the highest percentage (over 30 percent) of bolters, while Mulhouse de Auxonne and Senshyu Yellow Globe had the smallest percentage (less than 10 percent).

Yield data for the best replicate for each variety in the first planting are shown in Table 1. Data for the second planting are in Table 2. The varieties Presto, Advance, and Senshyu Yellow Globe were the highest yielders at both planting dates. Yield was much smaller at the second planting date, except for the varieties Hatif de Paris and Keep Well. Largest bulb size was obtained with the varieties Senshyu Yellow Globe, Presto, Keep Well, and Express Yellow, but very acceptable size and quality were obtained with several other varieties. Bulb size was much smaller at the second planting, except for Hatif de Paris and Presto. All varieties had tops down at harvest except for those noted in Table 1 as having unusually large necks. Planting date did not greatly affect degree of bolting. The earlier planting data gave superior yields, at least for this season.

Table 1. Yield per plot and mean bulb weight of overwintered onions, first planting, 1977

Variety	Yield, (pounds/20 feet)	Rank	Mean bulb size,(pounds)	Rank	Comments
Advance	50.6	2	0.55	6	Med. large, yellow, globe
Dragon Eye	46.3	3(tie)	0.58	4(tie)	Med. large, yellow, flat
Express Yellow	23.2	10	0.58	4(tie)	Med. large yellow, flat to globe
Hatif de Paris	22.8	11	0.34	11	Med., very white, flat
Hatif de Vaugirard	30.3	9	0.47	7(tie)	Med. large, green-white, flat
Imai	16.1	13	0.67	3	Large, yellow, flat
Kaizuka Extra Early	31.8	8	0.47	9	Med. large, yellow, flat to globe
Keep Well	14.3	14	0.89	1	Very large, yellow, globe
Mulhouse de Auxonne	39.6	5	0.27	14	Small bulb, large neck, yellow, globe
Mulhouse de Selestat	35.2	6	0.42	10	Small bulb, large neck, yellow, globe
Paille des Vertes	20.8	12	0.33	12	Small bulb, large neck, yellow, globe
Presto	62.6	1	0.47	7(tie)	Med. large, yellow, flat
Printanier Parisien	34.6	7	0.27	13	Small, white, flat
Senshyu Yellow Globe	46.3	3(tie)	0.68	2	Large, yellow, flat to globe

Table 2. Yield per plot and mean bulb weight of overwintered onions, second planting, 1977

Variety	Yield, (pounds/20 feet)	Rank	Mean bulb size, (pounds)	Rank
Advance	34.0	2	0.28	6 (tie)
Dragon Eye	14.6	8	0.28	6 (tie)
Express Yellow	16.1	6	0.40	3
Hatif de Paris	21.6	4	0.32	5
Hatif de Vaugirard	15.6	7	0.20	11 (tie)
Imai	10.0	10	0.28	6 (tie)
Kaizuka Extra Early	4.4	14	0.22	10
Keep Well	19.4	5	0.37	4
Mulhouse de Auxonne	6.1	12	0.14	13
Mulhouse de Selestat	7.6	11	0.24	9
Paille des Vertes	5.5	13	0.12	14
Presto	41.0	1	0.46	1
Printanier Parisien	12.1	9	0.20	11 (tie)
Senshyu Yellow Globe	26.4	3	0.41	2

Overwintered Onion Variety Trial, 1978-1979

Methods

All varieties evaluated were from Takii & Co., Ltd., Kyoto, Japan. The plots were seeded on August 30, 1979, with a plant population of about 15/foot. Plot size was two rows x 12.5 feet with 1.5 feet between rows. The plot area was fertilized with 500 pounds/acre of 13-39-0 before planting and four pounds/acre of propachlor (Ramrod) herbicide was applied immediately after seeding. An early (1) and a late (2) spring nitrogen application was made as follows: (1) 300 pounds/acre of 34-0-0 on January 2, 1980, and again on February 15, 1980; (2) 300 pounds/acre of 34-0-0 on February 20, 1980, and March 20, 1980. The fertilizer treatments were applied in a randomized block design with four replications and with cultivars as subplots. All plots were harvested on June 10, 1980, after most tops had died back. Plant population at harvest was 10-13/foot.

Results

The timing of the spring N application did not significantly affect the yield of any onion cultivar (Table 3) but the later application slightly delayed maturity. The highest yielder, Keep Well, had elongated bulbs. Express Yellow and Dragon Eye had the most desirable characteristics of the higher yielding cultivars (Table 4).

Table 3. Effect of timing of N application on yield of onion cultivars, 1980

Cultivar	Yield, tons/acre		
	Early N application	Late N application	Mean, cultivar
Amber Express	13.7	13.6	13.7
Dragon Eye	14.3	14.7	14.5
Express Yellow	14.5	15.0	14.8
Imai Early Yellow	11.8	11.7	11.8
Kaizuka Extra Early	11.9	11.1	11.5
Keep Well	16.2	15.6	15.9
Senshyu Yellow	10.8	10.6	10.7
Mean, N application	13.3	13.2	LSD(0.05) 2.3

Table 4. Notes on onion quality characteristics two weeks before harvest, 1980

Cultivar	Maturity rank[a]	Mildew susceptibility[b]	Uniformity[c]	Percent bolte
Amber Express	1	2	3	0
Dragon Eye	5	4	3	2
Express Yellow	2	4	5	0
Imai Early Yellow	7	4	3	4
Kaizuka Extra Early	4	3	3	4
Keep Well	6	4	4	4
Senshyu Yellow	3	4	4	2

[a] 1 = most mature, 100% of tops down and dry; 7= least mature, 25% of tops down.
[b] 1 = most susceptible, 5 = least susceptible.
[c] 1 = least uniform bulb size and shape, 5 = most uniform.

Overwintered Onion Variety Trial, 1980-1981 and 1981-1982

Methods

Plots were seeded on September 3, 1980, and September 15, 1981, in randomized complete block design with three (1980) or four (1981) replications. The plant stands were thinned to no more than 8/foot. Plot size was 1 row x 20 feet with 20 inches between rows. The plot area was fertilized with 700 pounds/acre (1980) or 1,000 pounds/acre (1981) of 10-20-10 before planting. Four pounds/acre of propachlor herbicide was applied immediately after seeding. Additional N was applied as follows: 35 pounds N/acre as ammonium nitrate in January 1981 and 100 pounds N/acre in April 1981. In 1982, additional N was applied at 50 pounds/acre in January, March, and April; 4.0 pounds/acre of propachlor was applied in November, January, and March of each crop year. Plots were hand-weeded as necessary. All plots were harvested on July 16, 1981, and July 8, 1982. Plant population at harvest was 7-8/foot for most cultivars. Several cultivars were selected for storage tests. A sample of bulbs was held at 20°C mean temperature and 70 percent mean relative humidity in mesh bags. Rot and sprouting were evaluated in late October of each year.

Results and Discussion

1980-81

The 1980-81 winter was exceptionally mild, particularly in January. Most cultivars exhibited significant bolting. Since all cultivars were harvested on the same day, a few were overmature and suffered some sunscald. However, very little regreening occurred. Some cultivars exhibited a small percentage of split bulb basal plates. This may have been caused by exposure to moisture after tops died down, or by onion maggot damage.

In 1981, the highest-yielding cultivars in gross weight were Sweet Winter, Red Cross, Keep Well, Senshyu Yellow Globe, OWY 100, and Willamette Sweet (Table 5). Largest mean bulb size was obtained with Sweet Winter, Senshyu Yellow, Red Cross, Keep Well, and OWY 100. When the bulbs which had bolted were subtracted from the total yield, the rankings changed significantly. Highest estimated usable yield was obtained with Red Cross, followed by Keep Well, Dragon Eye, Senshyu Yellow 7991, Sweet Winter, Willamette Sweet, OWY 42, and OWY 100. Border rows of Imai also yielded very well, but the stand was not thinned and Imai plots were not randomized.

Cultivars with particularly high quality in color, lack of bolting and splits, and small neck size included Keep Well, Imai, Senshyu Yellow, and Red Cross (Table 6). Sweet Winter and Willamette Sweet were also impressive but had a high percentage of bolters. Red Cross was particularly mild-flavored. Cultivars considered overmature at harvest were Amber Express, Red Cross, Express Yellow, and Dragon Eye.

At the end of three-month storage, Keep Well and OWY 100 had exhibited the smallest degree of sprouting, while 100 percent of the Red Cross bulbs had sprouted (Table 7). Storage rots, molds, and maggot damage were low for all cultivars.

1981-82

The weather pattern in the 1981-82 winter was normal and no winterkill was observed. The only cultivars exhibiting any bolting were Cima (45 percent) and Walla Walla Sweet Super Early Strain (1 percent). The percentage of tops down at harvest ranged from 8 percent for Walla Walla Sweet Early Arbini strain to 95 percent for Top Keeper and Red Cross. However, no cultivar was considered overmature at harvest and there was very little sunscald or regreening.

Highest yielding cultivars were Walla Walla Sweet (Super Early strain), Red Cross, and Top Keeper (Table 8). Largest bulb size (mean weight of all bulbs) was obtained with the same three varieties. When ranked by yield of No. 1 bulbs (more than 3.0 inch diameter) only, the same three varieties had the highest yield (Table 8). Highest quality cultivars were Walla Walla Sweet Super Early, Top Keeper, Keep Well, Red Cross, OWY 100, and Willamette Sweet (Table 9).

Yields were down somewhat from 1980-81 for cultivars tested both years. The reduction was caused mostly by smaller plant populations but bulb size did decline for a few cultivars.

One hundred bulbs of seven cultivars were placed in storage immediately after harvest. Bulbs were examined at approximately monthly intervals and graded for firmness, rot, and sprouting (Table 10). Willamette Sweet, Top Keeper, and Keep Well had the lowest degree of storage rots and sprouting.

Table 5. Yield and mean bulb weight of overwinter onions, 1980-81

Variety	Mean bulb wt. (ounces)	Total yield (tons/acre)	Rank	Estimated usable yield[b] (tons/acre)	Rank
Sweet Winter	6.3	40.2	1	20[c]	5
Senshyu Yellow 7985	6.0	42.6	4	17[c]	10
Senshyu Yellow 7991	5.7	30.5	7	23	4
Red Cross	5.5	35.2	2	32	1
Keep Well	4.6	34.1	3	29	2
OWY 100	4.6	32.6	5	19	8
Dragon Eye	4.3	24.5	9	25	3*
Willamette Sweet	4.2	30.7	6	20	6
OWY 50	4.1	29.3	8	13[c]	13*
AC 7952	4.0	19.6	13	16	11*
AC 7949	4.0	17.3[a]	14	9[c]	16
AC 7948	3.9	22.8	10	11[c]	15
Express Yellow	3.6	17.2	15	17	9*
AC 7950	3.5	20.5	11	9[c]	16
Gladalan Brown	3.1	13.7[a]	18	7[c]	18
Early Golden Globe	3.1	10.3[a]	19	5[c]	19*
Amber Express	3.0	16.0	16	16	11
Braeside	2.8	15.1	17	12	14
Pukukohe	2.7	5.6[a]	26	1[c]	22*
OWY 42	2.6	19.7	12	20	6
Kitami Ki	2.4	8.2[a]	23	0[d]	--
Creamgold	2.3	9.6	20	0[d]	--
Sapporo Yellow	2.2	8.6[a]	22	0[d]	--
Sapporo Ki	2.1	9.1[a]	21	0[d]	--*
Creamgold Early	2.0	6.3[a]	24	3[c]	20*
Early Locker Brown	1.7	5.9[a]	25	3[c]	20
Imai[e]	3.8	39.3	--	35	--
LSD (0.05)	1.4	7.0			

[a]Poor stand, less than 5/foot.
[b]Total yield less yield of bolters.
[c]50% or more bolters.
[d]100% bolters.
[e]Not included in replicated planting. Excess stand of approx. 12 foot.
*Indicates a tie.

Table 6. Sources and quality characteristics of overwintered onions, 1980-81

Variety	Source[a]	Maturity[b]	Bulb shape[c]	Scale color[d]	Percent bolted	Neck size[e]	Split bulbs[f]	Overall rating[g]
AC 7948	1	2	f-t	2	50	M	1	2
AC 7949	1	1	t	2	50	M	2	2
AC 7950	1	2	f-t	2	50-60	S	2	2
AC 7952	1	3	fg-g	2	20	S	2	2
Amber Express	2	1	f-t	1	0	S	3	2
Braeside	1	2	g-s	1.5	20	M	1	1.5
Creamgold	1	2	dg	1	100	M	1	1
Creamgold Early	1	2	g	1	50	M	1	1
Dragon Eye	2	1	f-g	2	0	S	2	3
Early Golden Globe	1	3	dg	2	50	M	1	2
Early Locker Brown	1	2	dg	1	50	M	1	1
Express Yellow	1	1	f-t	1.5	5-10	S	1	2
Gladalan Brown	1	2	dg	2	50	S	1.5	2
Imai	2	2	t	2.5	10	M	1.5	3
Keep Well	2	2	t-v	2.5	15	S	1.5	3
Kitami Ki	3	3	f-g	1.5	100	L	1	1
OWY 42	4	1	f	1	0	S	2.5	2
OWY 50	4	3	t-v	1.5	55	M	2	3
OWY 100	4	2	fg-t	2	40	M	2	3
Pukukohe	3	3	g	2	80	L	1	1
Red Cross	2	2	f	red	10	S	1.5	3
Sapporo Ki	3	3	s	3	100	L	1	1
Sapporo Yellow Globe	3	1	s	3	100	L	1	1
Senshyu Yellow 7985	1	3	t	2.5	50	S	2	3.5
Senshyu Yellow 7991	1	2	g-t	2	25	M	1.5	3.5
Sweet Winter	4	2	ft	2	50	S	1.5	4
Willamette Sweet	4	2	fg	1.5	35	S	1.5	4

[a] 1 = International Plant Breeders, 2 = Takii Seeds, 3 = N.S. Mansour, Oregon State University, 4 = ARCO Seed Co.
[b] 1 = early, nearly all tops down at harvest; 3 = late, over 50% of tops standing.
[c] f = flat, fg = flat globe, g = globe, dg = deep globe (elongated), t = top, s = spindle, v = variable.
[d] 1 = pale, 3 = dark yellow brown, uniform.
[e] S = small, M = medium, L = large.
[f] 1 = over 5%, 3 = less than 1%.
[g] 1 = poor, 5 = excellent.

Table 7. Storage ratings of overwinter onions, 1980-81

Varieties	Percent Sprouted	Percent Rotted (10-27-81)
Dragon Eye	60	4 (very firm)
Keep Well	8	60 (maggot infested)
OWY 50	21	4
OWY 100	11	0
Red Cross	100	15
Sweet Winter 1909	45	25 (soft)
Willamette Sweet	30	4

Table 8. Yield and mean bulb weight of overwinter onions, 1981-82

Variety	Yield of all bulbs (tons/acre)	Rank	Mean bulb wt. all bulbs (ounces)	Rank	Yield of No. 1 bulbs (ounces)[a]	Rank
Avanti	17.0	6	4.6	6	10.2	5
Cima	7.0	12	2.1	12	0.2	12
Imai	11.1	10	3.4	10	3.9	11
Keep Well	18.2	5	5.1	4	10.1	6
OWY 100	17.0	6	4.4	7	8.3	8
Red Cross	24.4	2	5.7	2	19.0	2
Senshyu Yellow	13.9	9	3.8	9	5.1	9
Sweet Winter 1909	16.2	8	4.9	5	11.0	4
Top Keeper	22.4	3	5.5	3	12.1	3
Walla Walla Early Arbini	10.7	11	2.9	11	4.0	10
Walla Walla Super Early	28.0	1	7.2	1	24.1	1
Willamette Sweet	18.6	4	4.0	8	14.1	7
LSD (0.05)	7.1		2.1		6.0	

[a]No. 1 bulbs have minimum diameter of 3 inches.

Table 9. Sources and quality characteristics of overwintered onions, 1981-1982

Variety	Source[a]	Maturity[b]	Bulb shape[c]	Scale color[d]	Percent bolted	Neck size[e]	Split bulbs[f]	Diameter (inches)	Overall rating[g]
Avanti	4	2	fg	1.5	0	S	3	2-3	2
Cima	4	3	fg	1.5	45	S	3	2	1
Imai	1	2	f	2	0	S	3	2-3	2
Keep Well	1	2	fg	2	0	M	3	3	4
OWY 100	3	2	fg	2	0	M	3	3	3
Red Cross	1	1	f	red, fair	0	M	3	3-4	4
Senshyu Yellow	1	2	fg	2	0	M	3	2-3	3
Sweet Winter	3	2	fg	1.5	0	M	3	2-4	3
Top Keeper	1	1	fg	some green 3	0	S	3	3	4
Walla Walla Early Arbini	2	3	g	1	0	L	3	2-3	1
Walla Waller, Super Early	2	2	g	1.5	1	M	3	3-4	3-5
Willamette Sweet	3	2	fg	1.5	0	M	3	2-4	3-5

[a] 1 = Takii Seeds, 2 = N.S. Mansour, Oregon State University, 3 = ARCO Seed Co., 4 = Keystone Seed Co.
[b] 1 = early, nearly all tops down at harvest, 3 = late, over 50% tops standing at harvest.
[c] f = flat; fg = flat globe; g = globe.
[d] 1 = pale, 3 = dark yellow brown, uniform.
[e] S = small, M = medium, L = large.
[f] 1 = over 5%, 3 = less than 1%.
[g] 1 = poor, 5 = excellent.

Table 10. Storage ratings of overwinter onions, 1981-82

Cultivar	Date 8/11	9/20	10/21	Comments (8/11)
	% soft or rotten			
Keep Well	0	18	20	Firm
OWY 100	17	19	27	½ slightly soft
Red Cross	20	29	34	Most firm, some sprouting
Sweet Winter 1909	50	68	75	Very soft, some rot
Top Keeper	11	14	14	Slightly soft
Walla Walla Super Early	19	22	48	Soft, some sprouting
Willamette Sweet	4	6	7	Slightly soft

Lime and Fertilizer Effects on Overwintered Onions, 1982-1983 and 1983-1984

Introduction

Obtaining vigorous and early growth in the spring is essential to achieve large bulb size and profitable yields of overwintered onions. However, soil and air temperatures are usually less than optimal during the spring growth period, possibly limiting response to fertilizers.

Highest yields have been obtained with a total N application of 200 or more pounds/acre, with the majority of the N applied in the spring. No information is available on potential differences in overwintered onion response to type of spring-applied N; e.g., NO_3- vs. NH_4-N. On cold soils with limited conversion of other forms of N to plant available NO_3, applying a NO_3-N fertilizer might improve N use efficiency. However, NO_3 is also not tightly bound to soil particles and may be quickly leached through the root zone by heavy spring rains.

Since P availability is limited on cold soils, overwinter onions might also respond to banded application of P fertilizers or to lime, which increases P availability. Onions also have a high S requirement, but overwinter onion response to a fertilizer S source has not been studied in the Willamette Valley.

The following experiments were designed to evaluate the effects of lime, spring-applied P, spring-applied $CaSO_4$ (gypsum), and two N sources on yield and elemental concentrations of overwintered onions.

Methods

1982-1983

Agricultural limestone (95% $CaCO_3$ equivalent) at 0, 2, 4, and 6 tons/acre was applied in 1979 to 2,300 square feet plots of Willamette silt loam with four replications of each treatment in randomized block design. Resulting soil pH at planting in 1982 averaged 5.5, 6.0, 6.2, and 6.6, respectively. Raised beds (8 inches high, 5.5 feet wide) were formed in early September, 1982 following a broadcast application of 800 pounds/acre of 10-20-10 and seeded with 3 rows/bed of OWY 100 (ARCO Seed Co.) onion on September 15.

Propachlor herbicide was applied at 4 pounds/acre on September 16, and again on October 20 and December 10. Many weed species escaped the propachlor treatment. Linuron (Lorox) at 1.0 pound/acre was applied on February 2, 1983 and chloroxuron (Tenoran) at 3.0 pounds/acre was applied on March 21. These treatments eliminated most established weeds; large grasses and plantain were pulled by hand in late April. No further herbicides were applied and plots were hand-weeded in May, primarily to control vetch and groundsel.

On February 15, 1983, the lime main plots were split into six subplots (one bed x 24 feet) by random application of the following: 1) ammonium nitrate at 50 pounds N/acre; 2) ammonium nitrate as above plus 100 pounds gypsum/acre; 3) ammonium nitrate as above plus 100 pounds 0-45-0/acre; 4) ammonium nitrate, gypsum, and 0-45-0, as above; 5) ammonium sulfate at 50 pounds N/acre; 6) check (no spring fertilizer). The N materials were reapplied at 50 pounds N/acre on March 28 and May 13, 1983; concentrated superphosphate (0-45-0) and gypsum were not reapplied. Leaf samples were collected for plant tissue analysis on April 26 from plots representing three replications of the zero and 4 tons/acre lime rates and all subplot treatments. On April 27, stand counts were made for all treatment combinations. Onions were topped and harvested from the center row of each plot on July 5, 1983. Bulbs were graded into #1 (more than 3 inch diameter) and #2 categories before weighing.

1984.

Methods were as above for 1983, except as follows. Seeding date was September 13, 1983; variety was ARCO Sweet Winter. Propachlor was applied four times in the fall and winter and only chloroxuron was applied in the spring. Metalaxyl (Ridomil) was applied twice for mildew control. Subplot treatments were applied on February 17, 1984, when half of each main plot was sidedressed with 0-45-0 at 150 pounds/acre. Ammonium nitrate was applied to all plots at 50 pounds N/acre on February 17, March 26, and May 3. Harvest was on July 24, 1984.

Results and Discussion

1983.

Application of lime significantly increased onion stands, total onion yield, yield of grade #1 bulbs, mean bulb weight, and number of bulbs harvested (Table 11). Stand counts were made in April 1983, too late to determine whether the lime application enhanced onion germination and emergence or enhanced survival by increasing the growth rate of seedlings. Previous experiments on Willamette soil indicated that liming increases seedling emergence of onions and several other small seeded vegetable crops. Since the application of lime also visibly stimulated early plant growth (no measurements recorded), enhanced winter survival of larger seedlings also may have contributed to the effect of lime on onion stands.

Of the subplot treatments, only N application affected stands, with a small, but statistically significant, increase in stand on plots which received no spring fertilizer. Since no stand counts were made before application of the first subplot treatments, it cannot be determined whether spring fertilizer application actually caused some stand reduction or the stand differences reflected existing variability within main plots.

Most of the stand and yield response to lime occurred with application of only 2 tons/acre; however, further significant increases in yield and number of grade #1 bulbs were obtained at 4 tons/acre (Table 11). Leaf tissue of plants grown on limed soil contained significantly higher concentrations of P, K, and Ca, and significantly lower concentrations of Zn and Mn than did leaf tissue grown on unlimed soil (Table 12). Since P levels were quite low compared to reported values and were increased 24 percent with application of 4 tons/acre of lime, much of the yield response to lime might be ascribed to increased P availability. However, increased K and Ca uptake or reduction of Mn toxicity may also have been involved in the lime response.

Application of spring N fertilizer, when averaged across lime, P, gypsum, and form of N, significantly increased total and #1 yields and bulb weight (Table 11). There were no significant N x lime interactions, and highest overall yields (30-33 tons/acre) were obtained with combinations of the highest rate of lime and spring application of either ammonium nitrate or ammonium sulfate.

Application of spring N increased leaf tissue N, Zn, and Mn concentrations (Table 12). The yield response to N was primarily attributable to increased soil N supply. The increase in tissue Zn concentration may also have played a role since Zn concentration of plants which received no spring fertilizer application was low compared to values reported in the literature. The increase in leaf tissue Zn and Mn concentrations with spring N application may have been caused by a temporary localized decrease in soil pH after application of the acidifying N fertilizers.

Within the subset of plots receiving a spring application of fertilizer, there was a trend toward higher yields and mean bulb weights with ammonium sulfate as N source (Table 11). These differences were never significant at the 5 percent level; however, the increase in total yield was significant at the 10 percent level. Leaf tissue N levels were slightly higher with ammonium sulfate as N source, and leaf S levels were increased by more than 50 percent with $(NH_4)_2SO_4$. Other tissue elemental concentrations were not significantly affected by N source (Table 12). Based on results of this trial, it would not appear necessary to provide NO_3-N to assure good onion yields.

Within the subset of treatments receiving a spring application of ammonium nitrate, application of concentrated superphosphate did not affect overall yields but did slightly increase mean bulb weight (Table 11). There were no significant P x lime interactions. Application of P had no effect on leaf elemental concentrations (Table 12). Since P had no effect on tissue P levels, it is evident that the surface application did not bring the relatively insoluble P into sufficient contact with the root mass, or that some other factor prevented effective uptake. Lack of P uptake from the fertilizer probably precluded any yield response. However, since the winter and spring were unusually mild, any P effect on yield may have been masked by better than normal spring growth on all plots.

Also within the subset of plots fertilized with ammonium nitrate, application of gypsum increased total and grade #1 yields. Some of this increase was caused by slightly higher (the increase was not statistically significant) stands on subplots fertilized with gypsum. Mean bulb weight, however, also increased with gypsum application and was the major component of the yield increase (Table 11). Leaf S levels increased by more than 50 percent on soils fertilized with gypsum, caused by increased S availability. Sulfur availability also may have been involved in the nearly significant yield increase with ammonium sulfate compared to ammonium nitrate.

There were no significant P x gypsum interactions affecting yield or leaf elemental concentrations, but lime and gypsum interacted strongly in increasing yield of grade #1 onions (Table 13). The greater response to gypsum at higher rates than at lower rates of lime indicates that S uptake may be a limiting factor in onion production at near-neutral soil pH. There were no significant lime x gypsum interactions affecting leaf elemental concentrations.

Table 11. Main effects of lime, spring-applied N, form of N, spring-applied P, and gypsum on yield components of overwinter onion, 1983

	Stand onions/ plot	Total yield	Yield of #1 onions	#1 bulbs harvested/ plot	Mean bulb wt., all onions	Mean bulb wt., #1's
		---tons/acre----			---------ounces---------	
Lime (tons/acre)						
0	92	7.6	3.1	17	2.7	8.0
2	127	22.3	13.7	66	5.6	8.9
4	129	25.1	16.7	82	6.0	8.9
6	129	26.5	18.6	89	6.2	9.1
LSD(0.05)	19	3.1	3.6	9	0.8	0.5
Ammonium nitrate	117	21.0	14.1	45	5.4	8.9
Ammonium sulfate	125	23.3	15.4	49	5.6	8.9
	NS[a]	NS	NS	NS	NS	NS
+P	116	20.8	14.2	45	5.4	9.2
-P	118	21.2	13.9	46	5.2	8.7
	NS	NS	NS	NS	*	*
+Gypsum	123	22.3	15.4	48	5.6	9.0
-Gypsum	112	19.8	12.8	42	5.1	8.8
	NS	*	**	*	*	*
+N	119	21.5	14.4	46	5.4	8.9
-N	125	14.9	6.5	24	3.8	8.0
	**	**	**	*	**	**

[a] **,*,NS: significant at 1% and 5% levels, and non-significant respectively.

Table 12. Main effects of lime, spring-applied N, form of N, spring-applied P, and gypsum on onion leaf tissue elemental concentrations, 1983

Treatment	N	P	K	Ca	Mg	S	Zn	Mn	Cu
	- - - - - - -	- -	% - -	- -	- - - - -	- -	- -	ppm	- -
Lime, 0 tons/acre	2.87	0.136	2.00	0.59	0.148	0.29	15.4	93	3.9
4 tons/acre	2.87	0.168	2.38	0.69	0.157	0.35	14.0	52	3.7
	NS[a]	*	*	*	NS	*	*	*	NS
+N	2.97	0.150	2.22	0.64	0.153	0.32	15.3	77	3.8
-N	2.37	0.160	2.05	0.63	0.148	0.32	11.8	48	3.5
	**	NS	NS	NS	NS	NS	**	**	NS
Ammonium nitrate	2.94	0.152	2.20	0.64	0.153	0.28	15.3	74	3.8
Ammonium sulfate	3.09	0.143	2.30	0.64	0.157	0.47	15.2	91	3.8
	*	NS	NS	NS	NS	**	NS	NS	NS
+Gypsum	2.97	0.151	2.24	0.65	0.153	0.33	15.3	76	3.8
-Gypsum	2.91	0.153	2.16	0.64	0.153	0.22	15.2	71	3.8
	NS	NS	NS	NS	NS	**	NS	NS	NS
+P	2.94	0.153	2.22	0.64	0.152	0.29	15.4	78	3.8
-P	2.94	0.151	2.18	0.64	0.154	0.27	15.2	70	3.8
	NS	NS	NS	NS	NS	NS	NS	NS	NS

[a]**,*,NS: significant at 1% and 5% levels, and non-significant, respectively.

Table 13. Interaction of lime and gypsum on yield of overwinter onion, 1983

Lime rate	Gypsum	Total yield	Grade #1 yield
tons/acre	pounds/acre	- - - - - - tons/acre	- - - - - - -
0	0	6.4	2.9
	100	6.9	2.4
2	0	22.7	14.3
	100	24.8	15.7
4	0	25.3	17.5
	100	27.5	20.1
6	0	24.5	16.5
	100	30.1	23.1
	LSD(0.05)	5.2	4.6

1984

Onion yields obtained from all treatments were very low compared to those recorded in previous years. For example, the highest yielding lime treatment produced only 3.6 tons/acre (Table 4) compared to 26.5 tons/acre in 1983. This was due primarily to losses in plant stand which occurred during the severe freeze of December 23-24, 1983. Temperatures as low as 6°F were accompanied by 20 to 40 mph winds, resulting in plant breakage and desiccation.

Nevertheless, the surviving plants responded to treatment much as they did in 1982-83. Highest total yields, and by far the highest weight of #1 bulbs, were obtained with the 6 tons/acre lime treatment. More bulbs were harvested from limed plots, perhaps because of better plant survival or better initial stands. Mean bulb weight also increased markedly with increasing rate of lime. Sidedressing concentrated superphosphate on the soil surface in early spring tended to increase total and #1 yield and mean bulb weight, but these differences were not statistically significant. Mean weight of #1 bulbs did increase significantly with P application, as in 1983. Also as in 1983, there were no significant P x lime interactions.

Because of reduced stands, the gypsum and N source portions of the 1983 experiment were not repeated.

Table 14. Mean effects of lime and spring-applied P on yield of overwintered onions, 1984

Treatment	# bulbs harvested/plot	Total yield	Yield of #1 bulbs	Mean bulb wt., all onions	Mean bulb wt #1's
Lime (T/A)		- - - tons/acre - - -		- - - - - ounces - - - - -	
0	22	0.4	0.0	1.2	-
2	55	1.6	0.4	2.6	6.8
4	41	1.5	0.6	3.1	6.4
6	56	3.6	2.3	5.6	8.4
LSD(0.05)	15	2.3	0.9	1.7	1.8
+P	43	1.8	0.9	3.4	7.6
-P	44	1.6	0.8	2.9	6.9
	NS[a]	NS	NS	NS	**

[a]**, NS: significant at 1% level and non-significant, respectively.

Lime, Banded P, and Gypsum Effects on Overwintered Onions, 1984-1985

Introduction

This trial was the third in a series commencing in 1982/83. Onion yields increased markedly with liming in 1982/83 and 1983/84, both due to increased stands and to increased bulb size. Onion yield did not vary significantly with a broadcast application of superphosphate in the spring in either year, except for a very small increase in mean bulb size. Yields increased slightly with spring-applied gypsum ($CaSO_4$) in 1982/83, indicating a possible S response.

The purpose of the 1984/85 trial was to further evaluate the response of overwintered onions to lime, to gypsum, and to banded application of superphosphate at planting.

Methods

Methods were the same as for the two previous years except as follows. Raised beds (8 inches high, 5 feet wide) were formed in early September, 1984, following a broadcast application of 700 pounds/acre of 10-20-10 fertilizer, and were seeded with three rows/bed of Sweet Winter (ARCO Seed Co.) onion on September 12. The lime plots were split by application of superphosphate at 0 or 90 pounds/acre in a band 2 inches to the side and 2 inches beneath the seed row.

Propachlor herbicide was applied at 4 pounds/acre at planting, and again on October 17, December 6, February 22, and May 7. Metalaxyl fungicide was applied at 8 ounces/acre on October 17 and April 4. Chloroxuron herbicide was applied on February 22. Plots were also hand-weeded twice to control grasses, vetch, and late-germinating groundsel. On February 18, gypsum was broadcast on the appropriate plots at 150 pounds/acre. Ammonium nitrate was applied at 50 pounds N/acre to all plots on February 18, March 25, and May 7. Leaf samples were collected for tissue analysis on May 1. Plants were topped and harvested on July 16. Soil samples were collected for pH determination following harvest.

Results

As in the preceding years, onion stands increased with increasing soil pH (lime application), and this is reflected in the greater number of bulbs harvested at the higher rates of lime (Table 15). In the previous trials, most of the stand increase with lime occurred with application of only 2 tons/acre. In 1984/85, however, the stand was significantly higher at the 4 tons/acre than at the 2 tons/acre rate. This may have been due to the general decline in soil pH of the lime-treated soil over the intervening years (Table 16). The sharp decline in soil pH between 1982 and 1985 may be partially explained by the heavy applications of acid-forming N fertilizers during this time. Another contributing factor is that the sampling in 1982 occurred in the spring with saturated, well-leached soil. The 1985 sampling was on dry soil with high residual fertilizer content, which would tend to produce lower readings. Overall stands and yields were lower in 1984/85 than in 1982/83, due primarily to reduced seeding rather than to reduced emergence.

Liming also greatly increased the mean bulb size and percentage of large (grade #1) bulbs (Table 15). The combination of increased stands and greater bulb size contributed to a nearly 8-fold increase in total yield between the lowest and highest rates of lime. This confirms the 4- to 9-fold yield increases with lime in the previous years.

Lime had no effect on leaf tissue concentration of K, Ca, and Cu, but reduced concentrations of N, Mg, Zn, and Mn and increased leaf S concentration (Table 17). The reduced Mg content may be a dilution effect of increased leaf growth or may reflect competition for uptake between Mg and Ca. The large reduction in Mn concentration on limed soil and the high level in tissue grown on unlimed soil indicate that Mn toxicity may play a role in poor onion growth at low pH.

Banding P at planting had no effect on plant stands (Table 15), but increased the mean bulb weight, reflected in an increase in yield of grade #1 bulbs and the percentage of #1 bulbs. Total yield also tended to be increased with banded P, but the difference was not significant. This was in contrast to the previous trials, in which the response to broadcast P was very small and usually not statistically significant. Banded P reduced leaf tissue concentrations of N, S, Mn and Cu, but the differences were small (Table 17).

Gypsum application slightly increased the percentage of #1 bulbs and mean bulb weight, but the increases were not significant. The number of bulbs harvested and total yield tended to decrease with gypsum. These results are in contrast to 1982/83, when all components of #1 and total yield were increased with gypsum application and the gypsum response was greatest at higher soil pH. Gypsum application increased leaf tissue N and S concentrations.

There were no significant 2- or 3-way interactions of lime, gypsum, and P affecting any yield component or leaf tissue elemental concentration, thus only main effects are reported in the Tables.

Table 15. Main effects of lime, banded P, and gypsum on yield components of overwintered onion, 1984/85

Treatment	Stand, seedlings/plot	Total bulbs harvested/plot	#1 bulbs harvested/plot	Total yield	#1 yield	Mean wt., all bulbs	Mean wt., #1 bulbs	Percentage #1's
Lime (tons/acre)	----------------	No./24 ft	----------------	--tons/	acre-	-------	ounces------	%
0	22	18	0.5	1.6	0.1	1.9	-	2
2	41	35	3.8	5.6	1.4	4.3	9.8	11
4	62	55	10.0	11.1	3.8	5.9	10.7	19
6	63	57	13.2	12.3	5.2	6.3	10.7	26
LSD (0.05)	9	15	5.1	2.9	0.8	0.6	0.5	9
+ P	46.0	41.7	8.4	8.4	3.2	5.0	10.7	18
- P	48.0	40.7	5.3	6.9	1.9	4.2	10.1	11
	NS[a]	NS	**	*	**	*	NS	**
+ Gypsum	46.6[b]	39.6	6.9	7.5	2.8	4.8	10.5	15.3
- Gypsum	47.4	42.8	6.8	7.9	2.5	4.5	10.3	13.6
	NS	NS	NS	NS	NS	NS	NS	NS

[a]**, *, NS: significant differences among means at 1% and 5% levels, and non-significant, respectively.
[b]Stand recorded before gypsum was applied.

Table 16. Effect of liming on soil pH for samples taken in 1982 and 1985

Lime rate (tons/acre)	Soil pH, 1982	Soil pH, 1985
0	5.5	4.5
2	6.0	4.7
4	6.2	5.0
6	6.6	5.2

Table 17. Effects of lime, banded P, and gypsum on onion leaf tissue elemental concentrations

Treatment	N	P	K	Ca	Mg	S	Zn	Mn	Cu
Lime (tons/acre)	%						ppm		
0	3.8	0.16	2.04	0.90	0.169[a]	0.22	24	323[a]	4.0
2	3.6	0.17	2.06	0.81	0.138	0.26	20	126	4.0
4	3.6	0.18	2.27	0.85	0.134	0.28	18	79	4.2
6	3.3	0.15	2.16	0.81	0.127	0.27	17	61	3.9
LSD(0.05)	0.4	NS	NS	NS	0.017	0.03	5	87	NS
+ P	3.4	0.16	2.09	0.83	0.141	0.24	20	140	3.7
- P	3.6	0.16	2.17	0.85	0.143	0.27	20	154	4.4
	*[a]	NS	NS	NS	NS	*	NS	*	*
+ Gypsum	3.6	0.16	2.15	0.85	0.142	0.30	20	145	4.1
- Gypsum	3.4	0.17	2.12	0.83	0.142	0.22	20	149	3.9
	*	NS	NS	NS	NS	**	NS	NS	NS

[a]**, *, NS: significant differences at 1% and 5% levels, and no significant differences, respectively.

Effect of N Source on Yield of Overwintered Onions, 1984-1985

Introduction

No information has been available on potential differences in overwintered onion response to form of spring-applied N, ie. ammonium-N vs. nitrate-N. On cold soils with limited conversion of other forms of N to plant-available nitrate, applying a nitrate fertilizer might improve N use efficiency. However, NO_3 is not bound to soil particles and may be quickly leached through the root zone by heavy spring rains. The other elements contained in some nitrogen fertilizers, e.g. sulfate, potassium, or calcium, are themselves fertilizer elements and complicate the yield response of crops to form of applied N.

An earlier trial in 1982/83 resulted in slightly higher yields of overwintered onion with ammonium sulfate (21-0-0-24) rather than ammonium nitrate (34-0-0) as N source. It was not possible to determine whether this was a response to the sulfur in the ammonium sulfate or indicated an advantage for 100 percent NH_4-N.

This trial was undertaken to further explore the relative advantages of various sources of N for overwintered onions.

Methods

Raised beds of pH 6.0 soil were formed in early September, 1984, following a broadcast application of 700 pounds/acre of 10-20-10 fertilizer, and were seeded with three rows/bed of Sweet Winter (ARCO Seed Co.) onion on September 11. Propachlor herbicide was applied at 4 pounds/acre at planting, and again on October 17, December 6, February 22, and May 7. Metalaxyl fungicide was applied at 8 ounces/acre on Oct. 17 and on April 4. Chloroxuron herbicide was applied on February 22 and the plots were also hand-hoed twice in late spring. On February 18, the appropriate plots were treated with a broadcast application of 50 pounds N/acre as calcium nitrate (15.5-0-0), ammonium nitrate, ammonium sulfate, urea (46-0-0), ammonium chloride (38-0-0), or ammonium nitrate plus 150 pounds gypsum/acre. The N treatments were re-applied on March 25 and May 7. Leaf samples were collected for tissue analysis on May 1. Plants were topped and harvested on July 16.

Results

The number of bulbs harvested per plot varied significantly with treatment, but the stands may have varied before the treatments were applied (Table 18). Total yield varied with N source, but the differences were not directly proportional to stand differences. Mean bulb weight and percent #1 bulbs was highest with ammonium sulfate, in spite of a greater than average stand. They were lowest with ammonium chloride, in spite of a low stand. The high percentage of #1 bulbs and high mean bulb weight with ammonium sulfate confirms the efficacy of this fertilizer observed in 1982/83. Among the other fertilizers, there was no clear advantage for ammonium-N over nitrate-N sources. Adding the sulfur source, gypsum, to ammonium nitrate did not improve yields. Although the amount of S provided by the gypsum (36 pounds/acre) was much lower than that provided by the three ammonium sulfate applications (171 pounds/acre), it should have been sufficient to cause a yield response if S were deficient in the soil. Gypsum at this rate also did not increase yields in a parallel study of the effects of lime, P, and gypsum on overwintered onions in 1984/85. However, in a study of the effects of lime and gypsum on spring-seeded onions in 1985, this rate of gypsum increased yields significantly.

Source of N had no effect on leaf tissue concentrations of N, P, K, Ca, Mg, Zn, and Cu (Table 19). Leaf Mn concentration was highest with the acid-forming ammonium chloride and ammonium sulfate. These levels of Mn are all in the normal range and should not have affected yield. Leaf S concentration was highest with ammonium sulfate or with ammonium nitrate plus gypsum, indicating plant availability and uptake of the fertilizer sulfate. Although leaf S levels were low with the other N sources, there was no correlations between leaf S levels and yield, due to the low yields with ammonium nitrate plus gypsum.

While confirming that ammonium sulfate is a good spring N source for overwintered onions, this trial provided no new information on the relative importance of the ammonium or sulfate ions in providing the yield response. The increase in leaf Mn with ammonium sulfate, and tendency toward increased leaf Zn content with this fertilizer, may indicate that ammonium sulfate, through its acidifying effect on the soil, is increasing availability of micronutrients which were limited in availability on this well-limed soil.

Table 18. Effect of N source on yield of overwintered onions, 1985

N source	Total bulbs harvested/plot	#1 bulbs harvested/plot	Total yield	#1 yield	Mean wt., all bulbs	Mean wt., #1 bulbs	Percentage # 1's
	----------No./24 ft.-----------		---tons/acre--		------ ounces ------		
Amm. nit.	54	12	10.9	4.6	5.9	10.4	23
Amm. sul.	68	19	15.0	6.7	6.5	10.0	28
Cal. nit.	59	15	12.2	5.3	6.2	10.4	26
Amm. chl.	55	3	7.4	1.1	3.9	9.7	6
Urea	74	15	12.8	4.8	5.1	9.5	19
Amm. nit. + gyp.	56	11	11.1	3.8	5.8	10.0	20
LSD(0.05)	10	3	4.0	2.8	1.4	NS	14

Table 19. Effect of N source on onion leaf tissue elemental concentrations, 1985

N Source	N	P	K	Ca	Mg	S	Zn	Mn	Cu
	- - - - - - - - - - - % - - - - - - - - - - -						- - - ppm - - - -		
Amm. nit.	3.9	0.20	2.34	0.82	0.13	0.22	21	47	4.6
Amm. sul.	3.5	0.19	2.25	0.80	0.12	0.37	21	61	4.3
Cal. nit.	4.0	0.22	2.39	0.82	0.13	0.21	19	47	4.1
Amm. chl.	3.3	0.20	2.23	0.82	0.12	0.18	20	86	4.1
Urea	3.4	0.19	2.17	0.88	0.12	0.22	18	51	3.9
Amm. nit. + gyp.	3.7	0.19	2.15	0.76	0.12	0.34	18	41	4.3
LSD(0.05)	NS	NS	NS	NS	NS	0.05	NS	8	NS

Overwintered Onion Weed Control Trial, 1985-1986

Introduction

The major cultural problem in overwintered onion production is weed control. Onions are a slow-growing crop which competes poorly with weeds. Since the crop is in the ground for eight or nine months, and cultivation is nearly impossible during the winter rainy season, both good weed control at planting and good postemergence control are necessary. The weed control task has been made more difficult by the loss of registration of effective preemergence herbicides such as propachlor. The purpose of this trial was to compare the effectiveness of two preemergence herbicides in combination with several alternatives for fall and spring postemergence herbicides. In addition to weed control rating, observations were made on onion injury and stand reduction by the herbicides and onion yield data was obtained.

Methods

'Sweet Winter' onions (ARCO Seed Co.) were seeded in 3 rows on 5-foot beds at about 20/foot on August 28, 1985. The seedbed was prepared by rotary tillage following a broadcast application of 10-20-10 fertilizer at 800 pounds/acre, and gypsum at 100 pounds/acre. Either Dacthal at 10 pounds active/acre or Ramrod at 4 pounds active/acre was applied on August 29 and irrigated in. These main plots consisted of 3 beds x 80 feet and were replicated four times in randomized block design.

On October 11 the plots were split by four postemergence ("fall application") treatments. These were oxyfluorfen (Goal) at 0.125 pounds/acre, oxyfluorfen plus cultivation between rows on October 2, pendimethalin (Prowl) at 0.5 pounds/acre, or pendimethalin plus cultivation. The resulting subplots consisted of 3 beds x 20 feet. All plots received an application of oxyfluorfen at 0.125 pounds/acre on January 6, 1986.

The "fall application" subplots were split by "spring" application of oxyfluorfen at 0.125 pounds/acre, chloroxuron (Tenoran) at 3.0 pounds/acre, or ureasulfuric acid (N-Tac) at 15 gallons/acre (30 gallons/acre total volume) on February 21, 1986. The resulting sub/subplots consisted of a 20-foot section of a single bed. On April 8, 1986, all plots received an application of metolachlor (Dual) at 2.25 pounds/acre. All herbicide applications were followed by rainfall or at least 0.5 inch irrigation. An additional 100 pounds N/acre was applied as ammonium nitrate in February and March. Weed control and crop injury ratings were made after each treatment. Bulbs were topped and harvested on July 16, 1986.

Results and Discussion

The preemergence herbicides had no effect on seedling stand (Table 20). Weed control ratings were first made on October 1, 1985. Each bed was scored separately within each main plot. Weed control was clearly far superior with Ramrod as compared to Dacthal (Table 20). Dacthal provided good control of chickweed but little control of *Poa annua*, groundsel, dog fennel, shepherdspurse, and mustards. Ramrod also provided inadequate control of knotweed and the larger grasses, but these were not a problem in most of the plot area. Ramrod provided very little chickweed control.

Weed control ratings were made again two weeks after the "fall application" of herbicides and cultivation of appropriate plots. For the main effect of the preemergence application, Ramrod was again clearly superior (Table 21). Goal provided superior burn down of escaped weeds, especially shepherdspurse and groundsel, but had no effect on grasses or chickweed. Cultivation had no effect on weed control ratings as the soil moisture was too high to get good weedkill from the cultivation alone. Some plots receiving Ramrod and Goal were essentially weed-free at this point. There were no significant interactions affecting weed control between preemergence and fall herbicide treatments or between the fall-applied herbicides and cultivation. Only main effects are given in Table 21.

Dacthal and Ramrod had no significant effect on onion injury rating, but Goal injured the onions more than did Prowl. The Goal stunted and twisted the onion leaves. Cultivation tended to reduce Goal and Prowl injury slightly, probably by shielding the onion leaves from the herbicide spray or by providing more cover for the roots. There were no significant interactions and only main effects are given in Table 21.

Table 20. Effects of Dacthal and Ramrod at planting on weed control rating on October 1, 1985 and on onion seedling stands

	Seedlings/foot	Weed control rating[a]
Dacthal	10.6	2.7
Ramrod	10.9	7.2
Significance[b]	NS	**

[a]Ten point scale, 9 = no weeds, 0 = no control.
[b]NS = no significant difference, ** = difference significant at 1% level.

Table 21. Main effects of preemergence and "fall" herbicide applications and cultivation on weed control and onion injury on October 25, 1985

	Weed control	Onion injury[a]
Dacthal	3.0	2.1
Ramrod	5.4	1.8
	**	NS
Goal	5.6	2.8
Prowl	2.7	1.1
	**	**
Cultivated	4.1	1.8
Non-cultivated	4.2	2.1
	NS	*

[a]Five point scale with 0 = no injury, 4 = seedling destroyed.

The "spring" herbicide applications were made between February 21 and 26, 1986. There were no interactions between preemergence, fall and spring applications, so means given in Table 22 are main effects only. Weed control was rated on a 0-9 scale with 9 being weed free. Onion stands and vigor were rated on a 0-5 scale, with 5 the most desirable rating. Notes were also taken on weed species in each plot.

Goal spotted grass leaves but did not kill the grasses. Tenoran was ineffective on grasses but controlled chickweed. N-Tac provided no control of established weeds. Ramrod controlled most grasses and Dacthal plots were still free of chickweed. No difference was expected at this time between the fall treatments (Goal vs. Prowl) since all plots had a Goal treatment in January.

Looking at simple effects, the highest mean weed control ratings were obtained with Ramrod + Goal (no cultivation) + Tenoran (8.25), followed by Ramrod + Goal + cultivation + Tenoran (7.6), followed by Ramrod + Prowl + cultivation + Tenoran (7.25), followed by Ramrod + Prowl (no cult.) + N-Tac (7.0). The lowest mean rating was for Dacthal + Goal (no cult.) + N-Tac (1.5), followed by Dacthal + Prowl + cultivation + Tenoran (2.5). The best combinations using Dacthal at planting were Dacthal + Goal (no cult.) + Tenoran (5.5), and two with a score of 5.0: Dacthal + Goal + cultivation + Goal and Dacthal + Prowl + cultivation + Tenoran.

Ramrod and Goal both reduced the stand rating and reduced onion vigor. Lowest vigor was on plots receiving Ramrod and two or three applications of Goal. There was a strong negative correlation between weed control rating and onion vigor rating (R_{xy} = -0.638, p=0.001). However, the very best vigor ratings did not coincide with the worst weed control. Vigor was usually highest on plots with high populations of low growing *Poa annua* or chickweed, but few large weeds.

Table 22. Weed control, stand, and vigor ratings on 17 March, 1986

Herbicide	Weed control	Onion stand	Onion vigor	Major weeds present
Dacthal	3.8	3.1	3.0	*Poa*, grasses, groundsel
Ramrod	6.6	2.6	2.4	chickweed, groundsel, *Poa*
	**	**	**	
Goal	5.2	2.0	2.1	*Poa*, grasses, chickweed
Goal+Cult.	5.6	2.3	2.5	*Poa*, grasses, chickweed
Prowl	4.7	3.4	2.9	*Poa*, grasses, groundsel, chickweed
Prowl+Cult.	5.3	3.7	3.3	*Poa*, grasses, groundsel, chickweed
	NS	**	**	
Goal	5.2	2.6	2.4	*Poa*, grasses, chickweed
Tenoran	5.6	2.9	2.7	*Poa*, grasses, groundsel
N-Tac	4.9	3.0	3.0	*Poa*, chickweed, grasses, groundsel
	NS	NS	*	

The reduced stand ratings with Ramrod at planting (Table 22) or Goal applied in the fall were reflected in lower numbers of bulbs present at harvest (Table 23).

The main effect of Ramrod at planting, when averaged over the other herbicide treatments, was to slightly reduce the total number of bulbs, increase the number of large bulbs, and increase mean bulb weight, grade 1 yield and total yield as compared to Dacthal (Table 23). Since the stand reduction with Ramrod was very small, the yield increase can be attributed to improved weed control.

Goal, when compared to Prowl, reduced stands by more than 50 percent, and decreased both total and grade 1 yield. Mean bulb weights were greater with Goal. This increased bulb weight could be due either to reduced competition among onion plants or to the superior weed control.

Cultivation in the fall prevented stand reduction and tended to increase bulb weight, resulting in highly significant increases in total and grade 1 yield. Cultivation may have shielded the onion plants from spray damage. Prowl produced a higher number of grade 1 bulbs/plot than did Goal when following Ramrod, but not when following Dacthal (Table 24). This can be attributed to the relatively greater impact on weed control of Goal following Dacthal than Goal following Ramrod.

Main effects of the spring-applied herbicides on yield were not significant (Table 23), but the trend was toward greatest yields with Tenoran. There were interactions of herbicides at planting with spring-applied herbicide affecting several components of yield (Table 25). Total yield and number of grade 1 bulbs/plot were highest with Tenoran following Ramrod but not following Dacthal. Since the major effect of Tenoran was to burn down chickweed and Ramrod-treated plots contained more chickweed than did Dacthal-treated plots, the greater effect of Tenoran following Ramrod was to be expected.

The highest yielding treatments were Ramrod + Prowl + cultivation + Tenoran, Ramrod + Prowl + cultivation + Goal, Ramrod + Prowl + Tenoran, and Dacthal + Prowl + cultivation + Goal. Each of these except the last produced much better than average weed control. The correlation of total yield and weed control rating made in March was not strong, however (R_{xy}=0.291, p=0.085). This is to be expected since stands were often reduced with those treatments producing excellent weed control. The yield of grade 1 bulbs (R_{xy}=0.35, p=0.005) and mean bulb weight (R_{xy}=0.63, p=0.001) both correlated strongly with weed control rating. The major weeds present at harvest were grasses, dog fennel, and chickweed (except on Tenoran-treated plots).

In summary, these results confirm that loss of use of Ramrod and Tenoran as onion herbicides greatly increases the difficulty of growing a successful crop of overwintered onions. Goal is promising as a postemergence burn down treatment but may injure the crop. N-Tac provided little weed control in this trial, but its contribution to the N needs of the crop must be considered. The Prowl used in this trial was old, with crystals precipitating out. This material deserves further investigation.

Table 23. Main effects of weed control programs on yield and bulb size of overwintered onions, July 16, 1986

Treatment		Yield		Mean bulb wt.		No. of bulbs/plot	
		Grade 1 bulbs[a]	All bulbs	Grade 1	All	Grade 1	All
		--------tons/acre--------		----ounces---			
Planting:	Dacthal	1.5	9.6	19.5	2.9	3.4	89.4
	Ramrod	4.5	14.9	10.0	4.7	11.2	81.2
		**[b]	**	NS	**	**	NS
Fall:	Goal	2.4	8.4	10.6	4.1	5.7	55.5
	Prowl	3.5	16.1	9.6	3.5	8.9	115.1
		*	**	*	*	*	**
	Cultivated	3.9	15.0	10.2	3.9	9.7	96.8
	Non-cultivated	2.0	9.6	10.0	3.6	4.9	73.9
		**	**	NS	NS	**	*
Spring:	Goal	3.0	12.1	10.4	3.9	7.2	82.5
	Tenoran	3.6	13.6	9.9	3.8	8.8	89.2
	N-Tac	2.4	11.7	9.9	3.6	5.8	88.2
		NS	NS	NS	NS	NS	NS

[a]Over 3 inch diameter.
[b]**, *, NS: Means differ significantly at 1% and 5% levels, and no significant differences, respectively.

Table 24. Interaction of herbicides at planting and fall herbicide applications on number of grade 1 bulbs/plot, July 16, 1986

Treatment			No. of grade
Planting	Fall		1 bulbs/plot
Dacthal	Goal		2.0
	Goal + cult.		5.1
	Prowl		2.6
	Prowl + cult.		4.0
Ramrod	Goal		4.6
	Goal + cult.		11.0
	Prowl		10.4
	Prowl + cult.		18.8
		LSD (0.05)	5.6

Table 25. Interaction of herbicides at planting and spring herbicide applications on total onions yield, mean weight of grade 1 bulbs, and number of grade 1 bulbs/plot, July 16, 1986

Treatment: Planting	Treatment: Spring	Total yield (tons/acre)	Mean wt. of grade 1 bulbs (ounces)	No. of grade 1 bulbs/plot
Dacthal	Goal	11.0	10.6	4.8
	Tenoran	8.1	10.4	2.5
	N Tac	10.4	9.3	3.0
Ramrod	Goal	13.1	10.1	9.6
	Tenoran	19.1	9.4	16.0
	N Tac	13.0	10.5	8.4
	LSD (0.05)	4.0	1.0	4.9

Table 26. Simple effects of all treatment combinations on yield of grade 1 bulbs, total yiel and mean bulb weight, July 16, 1986

Treatment: Plant	Treatment: Fall	Treatment: Spring	Total yield	Grade #1 yield	Mean bulb wt.
			tons/acre	tons/acre	ounces
Dacthal	Goal	Goal	4.7	1.3	2.6
		Tenoran	1.5	0.3	2.3
		N-Tac	4.7	0.5	2.0
	Goal + Cult.	Goal	2.8	1.4	6.5
		Tenoran	6.7	1.2	2.2
		N-Tac	9.1	2.7	3.1
	Prowl	Goal	12.6	1.6	2.6
		Tenoran	6.7	0.7	3.4
		N-Tac	11.7	0.3	2.0
	Prowl + Cult.	Goal	16.6	2.6	3.2
		Tenoran	12.0	1.2	2.3
		N-Tac	9.0	0.5	2.6
Ramrod	Goal	Goal	6.6	2.9	5.1
		Tenoran	4.3	2.8	5.6
		N-Tac	6.7	3.1	4.0
	Goal + Cult.	Goal	9.0	4.7	4.4
		Tenoran	15.3	5.8	5.8
		N-Tac	14.5	3.8	4.8
	Prowl	Goal	9.9	1.5	3.3
		Tenoran	17.2	5.0	3.9
		N-Tac	13.9	4.1	4.5
	Prowl + Cult.	Goal	24.5	8.3	4.6
		Tenoran	25.8	6.6	4.6
		N-Tac	9.4	2.1	3.8
		LSD (0.05)	8.0	4.0	2.7

Summary of Onion Trials and Recommendations

1. Varieties. Overwintered varieties must be winter-hardy and resistant to bolting after exposure to cold weather. The varieties should be able to stand several months of light frosts and short periods as low as 0°F. Bulb formation must start when daylengths are between 10 and 13 hours. Storage quality is not of great importance since the crop should be marketed before the spring-seeded crop matures in September. Varieties maturing in May or early June have not been particularly successful in the Willamette Valley as they do not have sufficient time to achieve large bulb size. The best varieties mature in late June or July from an early September planting. A list of recommended varieties is found in Table 27. The markets prefer red and yellow globe types.

Table 27. Recommended overwintered onion varieties for trial in the Willamette Valley

Variety	Maturity	Shape	Comments
Imai	early June	flat globe	pale color
Red Cross	early June	flat	good red
Keep Well	early June	globe	fair keeper
Senshyu	mid-June	globe	yellow
Top Keeper	late June	globe	small neck, good color
Sweet Winter	early July	flat globe	pale, mild
Willamette Sweet	mid-July	globe	good keeper, large neck
Walla Walla	late July	globe	large neck, very mild

2. Planting window. Planting date has little effect on maturity. Planting too early will cause premature flowering or bolting to seed and usable bulbs will not be formed. Planting too late will result in poor winter survival, particularly in soils prone to frost heave. The goal is to have plants six inches tall, and with two or three true leaves, by the end of October. Planting in the last week of August through September 5 should accomplish this in most years.

3. Planting site. The soil type must be a well-drained sandy or silt loam without low spots which collect standing water in the winter. The site should be sheltered from the cold, desiccating winds which occasionally invade the Valley from the north and east. Frost pockets should be avoided. Winterkill temperatures are from 0° to 15°F, depending on duration of the low temperature, soil moisture, wind velocity, relative humidity, variety, and stage of growth. Some loss of yield can be expected when the temperature reaches the low teens, particularly if accompanied by frost heave.

4. Fertilization. Soil pH should be adjusted to at least 6.2 with a mixture of calcitic and dolomitic limes. The initial fertilizer application should include 70 to 80 pounds N/acre unless the onions follow a heavily fertilized crop with high residual soil nitrogen. Phosphorus and potassium should be applied in accordance with soil test. Ranges for application of these nutrients are given in Table 28. Onions have a high sulfur requirement and Willamette Valley soils are often S deficient. Sulfur should be applied before planting. A spring sidedressed application may be desirable after a very wet winter.

The key to a successful crop is ample N availability throughout the winter. The bulk of the N application should be made in late winter and spring, 150 to 200 pounds N/acre, split between applications in late January, early March, and mid-April. Nitrogen source trials indicated a possible advantage to applying N in the NH_4 form; however, acid-forming fertilizers such as ammonium sulfate and ammonium nitrate should not be used if soil pH is below 6.0.

Magnesium, calcium, boron, copper, and zinc are other elements likely to be limiting for onion production. Rates of up to 30 pounds Mg/acre should be based on soil test. Calcium is not likely to be deficient on properly limed soils. Boron is often deficient in Willamette Valley soils. Up to 3 pounds B/acre may be applied before planting or as a spring foliar spray, based on soil test. Copper and Zn should be applied only if a soil test indicates a deficiency.

Table 28. Overwintered onion fertilizer requirements (pounds/acre)

	N	P_2O_5	K_2O	S	minor elements
At planting:	80	90-150[a]	0-80	30	--[b]
In spring:	150-200	0	0	30	--

[a]Band up to 90 pounds P_2O_5/acre two inches to the side and two inches below the seed line.
[b]May need Cu, B, Zn, Mg.

5. Cultural practices. Seedbed preparation is the same as for the spring-seeded crop. About three pounds of seed/acre are necessary to achieve a seedling density of 6-7/foot. Seed should be planted ½ inch deep with a precision seeder. Thinning, if necessary, should be delayed until spring to allow for winterkill. The crop requires irrigation until the start of the fall rains and again in late spring.

6. Pest control. The major pests include onion maggot, thrips, slugs, birds, cruciferous weeds, chickweed, and grasses. Local Cooperative Extension offices or licensed pesticide consultants should be contacted for current pesticide registrations. Good weed control is essential. This is an area of active research. The best current program is DCPA at planting, followed by several applications of oxyfluorfen. Diseases commonly encountered include downy mildew, pink root, neck rot, and smut. Control methods are the same as for the spring-seeded crop.

7. Rotations. Overwintered onions can follow any crop which matures sufficiently early and which does not result in residues of herbicides or other pesticides not registered for onions. Ideal candidates include peas, early beans, early cole crops, leafy greens, early root crops, and winter wheat. Overwintered onions should not follow a badly shattered grain crop, as thick stands of volunteer grain will seriously compete with the crop. Fields should not be in onions in successive years. Several row crops, including leaf lettuce, spinach, radish, turnip, and cauliflower, can easily follow overwintered onions because of the early-summer harvest season. Fertilizer needs may be reduced, as residual N should be available to the following crop.

8. Risks and rewards. The greatest risk is the possibility of losing the crop to a severe freeze, accompanied by desiccating winds and frost heave. The recommended varieties have all survived temperatures as low as 10°F, but stands can be reduced at this temperature. Marketable crops should be produced in most years.

Markets are hard to predict. During June and July the major competition is from Southern California, Texas, and Georgia growing areas as well as the Walla-Walla district.

Fertilizer requirements are higher for overwintered onions than for the spring-planted crop, since N and other elements leached by winter rainfall must be replaced in the spring. However, application of much of the N can be delayed until the extent of winterkill has been determined.

Among the advantages to the crop are reduced costs for irrigation, a cash flow during a period when onions are not usually harvested, and the potential for three crops in two years. Marketable yields of 500 hundredweight/acre are not uncommon.

Overwinter Leek Variety Trial, 1984-1985

Introduction

Extremely high quality leeks are being produced on a small scale in the Willamette Valley with good yields. The crop is usually seeded in early spring, matures in autumn, and can be held through the winter for harvest the following spring. Very few varieties are grown commercially and the highest quality plants have been transplanted and grown in trench culture. The most lucrative market is the restaurant trade, which demands long, thick, blanched stems. Healthy foliage can also be used decoratively in presentation of restaurant dishes. This trial had two purposes, to evaluate a number of cultivars in a late spring planting for overwinter harvest, and to evaluate several winter hardy cultivars in a late planting for overwinter harvest. Growers would benefit if planting of the overwinter crop could be delayed, allowing the possibility of double cropping with a short season crop and reduced weed control problems. This report includes data from two harvests each of spring and summer plantings made in 1984 and harvested in the spring of 1985.

Methods

Nine leek varieties were seeded in flats on a greenhouse bench on March 23, 1984, and seven were seeded on June 6. The plot area received a broadcast application of 1000 pounds/acre of 10-20-10, followed by formation of raised beds with 18 inch tops, 40 inches furrow to furrow, and about 7-inch height. Seedlings were transplanted on May 31 and July 31, respectively, into holes dibbled approximately 4 inches deep on 6-inch spacing, with two rows/bed. A single plot consisted of 20 feet of bed (80 plants). Treatment (cultivars) were replicated 3 times in randomized complete block design. Propachlor herbicide was applied at 4 pounds/acre after planting and was reapplied on June 29, July 31, and October 8. The plots were also hand-hoed twice during the summer. An additional 25 pounds N/acre as nitroform was applied on July 6 and again on August 31. Twenty plants were harvested from each plot of the early planting on August 24 and on October 8. Harvested plants were topped 2 inches above the growing point (base of leaves).

An addition 50 pounds N/acre as nitroform was applied on February 13, 1985, along with propachlor, chlorpropham and fluazifop-butyl herbicides. Both plantings were harvested on March 8, 1985. The late planting was harvested a second time on May 7.

Results

At the first harvest in August, 1984, all cultivars were somewhat immature and did not differ significantly in weight/plant, blanched stem length, or stem width (Table 29). Often there appeared to be more variation between blocks than between varieties. Stem length did vary significantly with cultivar, with Conqueror and Acadia the shortest and Tivi the longest. All stems were slightly bulbed at the root end; color was light blue-green for all cultivars.

At the second harvest of the early planting, all cultivars had produced mature, marketable plants. Mean leek weight did not vary greatly with cultivar, except that Conqueror was lighter and Argenta heavier than most other cultivars (Table 30). Stem length varied considerably among cultivars, with Tivi, Bluvetia, and Kilima producing longer stems and Conqueror and Electra shorter stems. Blanch length did not vary significantly with cultivar and appeared to be mostly controlled by transplanting depth. Stem width also varied little with cultivar, with great variability within a cultivar.

Differences in growth habit and foliage color were very evident by the second harvest. Acadia and Conqueror had the darkest blue foliage; Argenta, Bluvetia, Kilima, and Tivi had pale, green foliage, with the other three cultivars intermediate in color. Tivi plants were tall and upright; Electra and Kilima plants were taller than average but with less upright foliage. Alaska and Conqueror had the shortest leaves. All cultivars were judged of acceptable quality, with the blue-foliage plants more attractive.

Table 29. Leek size on Aug. 24, 1984, 85 days after transplanting, early planting

Cultivar	Stem wt.	Stem length[a]	Blanched length[b]	Stem width[c]
	ounces	inches		
Acadia	4.3	3.3	2.2	1.2
Alaska	3.6	3.5	2.3	1.0
Alberta	4.4	4.0	2.8	1.2
Argenta	4.7	3.8	2.8	1.2
Bluvetia	4.6	4.0	2.2	1.2
Conqueror	4.0	3.2	2.0	1.0
Electra	4.9	3.5	2.0	1.3
Kilima	4.8	3.7	2.1	1.3
Tivi	5.1	4.3	2.5	1.3
LSD(0.05)	NS	0.7	NS	NS

[a]Measured from base of bulb to point of leaf branching.
[b]Measured from base of bulb to mean extent of white area.
[c]Measured just above the bulb.

Table 30. Leek size on Oct. 8, 1984, 130 days after transplanting, early planting.

Cultivar	Stem wt.	Stem length	Blanched length	Stem width
	ounces	inches		
Acadia	7.9	4.7	2.5	1.5
Alaska	7.4	3.9	2.4	1.4
Alberta	8.4	3.9	2.6	1.4
Argenta	9.9	4.5	2.9	1.6
Bluvetia	8.2	5.2	2.1	1.4
Conqueror	6.4	3.3	2.5	1.4
Electra	7.6	3.5	2.5	1.5
Kilima	9.0	5.1	2.1	1.6
Tivi	8.4	5.2	2.6	1.4
LSD (0.05)	2.5	0.6	NS	NS

Table 31. Leek size on March 28, 1985

Cultivar	Early planting			Late planting		
	Stem wt.	Stem length	Stem width	Stem wt.	Stem length	Stem width
	ounces	-------- inches -------		ounces	--------inches---------	
Acadia	12.2	4.2	2.0	3.2	3.7	1.0
Alaska	11.7	4.3	1.8	3.2	3.3	1.0
Alberta	12.5	4.6	1.9	2.7	3.7	0.9
Argenta	14.0	5.0	1.9	4.2	4.0	1.1
Bluvetia	13.0	5.3	1.9	-	-	-
Conqueror	11.9	4.0	1.8	3.5	3.0	1.1
Electra	14.7	5.2	1.9	3.8	2.8	1.1
Kilima	15.0	7.3	1.9	-	-	-
Tivi	14.2	7.2	1.8	-	-	-
LSD(0.05)	NS	1.2	NS	NS	0.8	NS

Table 32. Leek size on May 7, 1985, late planting

Cultivar	Stem wt.	Stem length	Stem width	Comments
	ounces	-------- inches -------		
Acadia	5.1	4.2	1.3	bulbed, bolting
Alaska	4.7	3.8	1.3	pronounced bulb, bolting
Alberta	4.8	3.7	1.2	bulbed, bolting
Argenta	5.3	4.7	1.3	slightly bulbed, bolting
Conqueror	4.8	3.7	1.2	bulbed, bolting
Electra	5.4	3.7	1.3	slightly bulbed, bolting
LSD(0.05)	NS	0.3	NS	

The early planting overwintered nicely. All varieties had excellent size when evaluated on March 28, had not yet bolted, and the stems were not woody. Mean stem weight increased by 50 percent or more, due both to increased diameter and length (Table 31). Kilima and Tivi had the longest stems, but were not significantly heavier than the other varieties. These two varieties also had a less desirable light blue-green color.

Only varieties suggested by the seed companies to be very winter hardy and bolting-resistant were included in the late planting. At first harvest on March 28, 1985, most varieties had longer stems than the industry standard, Electra, but were not heavier or thicker. All varieties were somewhat immature at this harvest.

At the May harvest of the late planting, all varieties had bolted, even though the stems were still somewhat small. This indicates that the July 31 transplanting date was too late. To successfully overwinter, plants must be set out early enough that mature stems are formed in the fall.

This trial indicates that of the several varieties available, none significantly out performs the popular variety Electra. Transplanting should probably occur no later than June for either fall or overwintered harvest. The dibble planting method was acceptable, but did not produce blanch length equal to that of trench culture.

Shallot Planting Density Trial

Introduction

Shallots may be grown as an overwinter or spring-planted crop in the Willamette Valley. Major cultural problems in this crop include weed and disease control, effect of planting dates on yield, maturity, and degree of bolting, and the effects of size of planting stock and planting density on yield and bulb size at harvest. This study was designed to investigate the effects of three planting densities and two bulb sizes on the total yield and mean bulb weight at harvest and on the number of bulbs produced per bulb planted.

Methods

"French red" shallot bulbs of two sizes (small, mean weight of 0.43 ounce; large, mean weight of 1.0 ounce) were planted at three densities (low, 6 inches x 24 inches; medium, 6 inches x 12 inches; high, 6 inches x 6 inches) on September 16, 1981 in a factorial experiment with six treatment combinations. Plots were arranged in randomized block design with three replications. Individual plots consisted of four 10 foot rows. Records were taken from the two middle rows of each plot. The fertilizer program included 1000 pounds/acre of 10-20-10 broadcast and incorporated before planting, and 50 pounds/acre of N as ammonium nitrate applied on January 20, March 11, and April 14, 1982, for a total N application of 250 pounds/acre. DCPA herbicide at 9 pounds/acre was applied immediately after planting. Propachlor at 4.0 pounds/acre was applied on January 20 and March 19, 1982, following cultivation. Plots were harvested on July 29, 1982.

Results

Total yield on an area basis was significantly affected by both bulb size at planting ($P \le 0.05$) and by spacing or density ($P \le 0.01$). Planting larger bulbs produced about a 12 percent yield increase when compared with smaller planting stock (Table 33). A fourfold increase in planting density produced a doubling of yield. Yield per unit area did not increase proportionally to the increase in planting density since both bulb weight and the number of bulbs produced/bulb planted decreased at higher densities. Planting large bulbs increased the number of bulbs produced per unit area, since the number of bulbs produced/bulb planted was greater with the larger planting stock. However, mean bulb weight tended to decrease slightly (difference not significant at 5 percent level) with the larger planting stock.

For production of planting stock, high planting densities would be preferable to achieve maximum yields. Low planting density and small planting stock size should favor production of large bulbs required for some markets, but with greatly reduced total yield.

Table 33. Yield of overwintered shallots in response to bulb size and planting density

Treatment	Total bulb yield (lb/ft^2)	Mean bulb weight (ounces)	No. of bulbs produced per square yard	No. of bulbs produced per bulb planted
low density, small bulbs	0.67	0.65	167	16.6
low density, large bulbs	0.77	0.61	186	20.6
medium density small bulbs	0.85	0.50	248	13.7
medium density, large bulbs	1.09	0.46	342	18.9
high density, small bulbs	1.39	0.48	428	11.9
high density, large bulbs	1.56	0.40	534	14.8
LSD (0.05)	0.24	0.10	69	3.5
Mean, small bulbs	0.96	0.54	276	14.1
Mean, large bulbs	1.09	0.49	354	18.1
LSD (0.05)	0.13	NS[a]	39	2.0
Mean, low density	0.71	0.63	168	18.6
Mean, medium density	0.97	0.49	295	16.3
Mean, high density	1.43	0.44	482	13.3
LSD (0.05)	0.17	0.07	49	2.5

[a]NS: no significant difference at 5% level. Difference significant at 10% level

Weed Control in Overwintered Shallots

Methods

In both 1982 and 1983, "French red" shallots were planted on 0.5 foot x 2.0 foot spacing. Plots were 4 rows wide x 10 feet long with 4-foot borders. Six treatments were applied in completely random design with three replications of each treatment. The plot area received a broadcast application of 500 pounds/acre of 10-20-10 which was incorporated by rotary tilling. Shallot bulbs were set on October 14, 1982, and October 10, 1983. Herbicides were applied immediately after planting followed by an irrigation of 0.6 inches. All herbicides were applied with a hand-held sprayer in 50 gallons/acre of water. Treatments were: 1. Non-weeded check; 2. hand-weeded (1983 only); 3. propachlor (Ramrod) at 4.0 pounds/acre; 4. linuron (Lorox), 1.0 pound/acre; 5. napropamide (Devrinol) at 4.0 pounds/acre in 1982 and 3.0 pounds/acre in 1983; 6. clorpropham (Furloe) at 4.0 pounds/acre. Herbicide-treated plots were not cultivated and no further herbicide applications were made. Plots were rated for weed control in February and May 1983, and in May 1984. Shallots were harvested July 21, 1983, and July 17, 1984.

Results and Discussion

1982-83

Propachlor controlled all weeds for approximately five weeks after planting. By February, control was ineffective, with chickweed, several grasses, many mustard species, dog fennel, and groundsel present on propachlor-treated plots. No injury to the shallots was observed. Linuron and chlorpropham provided much more effective and lasting weed control, although linuron did not control grasses. No crop injury was observed with either material. Napropamide provided nearly complete weed control. The only weed present at harvest was miner's lettuce, and at less than 0.1 plant/ft^2. However, crop injury was severe. Severe shallot root dieback was evident by the May rating period.

Gross yields were highest with linuron and chlorpropham, lowest with napromide and the non-weeded check (Table 34). The number of shallots harvested/plot was significantly lower on napropamide-treated and non-weeded plots than for the other treatments. Moreover, mean bulb weight was also lowest on non-weeded and napropamide-treated plots.

Table 34. Effect of herbicides on shallot yield, 1983

Treatment	Yield	No. of shallots/plot	Mean bulb wt.
	tons/acre		ounces
check	1.4	266	0.28
hand-weeded	5.6	450	0.69
clorpropham	7.3	496	0.87
linuron	8.5	495	1.01
napropamide	3.1	281	0.64
propachlor	5.0	399	0.74
LSD(0.05)	3.5	101	0.28

1983-84

All herbicides provided effective weed control for about five weeks after planting, and all herbicides except propachlor continued to provide effective control until early December. A severe freeze in late December (5°F) killed most emerged weeds. Most herbicides continued to provide some control until early May (Table 35), when napropamide-treated plots had the smallest weed mass present. By harvest in July, all plots except the hand-weeded had extensive weed infestation.

No treatment completely controlled false dandelion and groundsel, but napropamide effectively controlled all grasses, chickweed, miner's lettuce, and shepherdspurse (Table 35). Weed control by linuron and chlorpropham was not as effective as in 1983, when these two herbicides were clearly superior to propachlor. The apparently improved performance of propachlor relative to linuron and chlorpropham in 1984 may have been from the winterkill of emerged weeds on propachlor-treated plots.

All herbicides increased yield and mean bulb weight when compared to non-weeded check plots, but yields for all herbicide treatments were lower than those on hand-weeded plots (Table 36). Unlike 1983, there was no severe crop injury with napropamide, which was applied at a lower rate in 1984 than in 1983.

The importance of effective weed control in shallots is seen in the six-fold yield increase on hand-weeded compared to non-weeded plots. Effective early weed control can be obtained with several herbicides. However, complete reliance on chemical weed control will only be feasible if an effective burn-down herbicide can be applied in late winter without undue crop injury, followed by reapplication of a germination inhibitor such as propachlor.

The fact that these herbicides were included in this trial should not be taken to mean that the materials have been registered for shallots or other members of the onion family.

Table 35. Effect of herbicides on fresh weight of weeds present on May 9, 1984

Treatment	Weed fresh wt.(lb/ft^2)	Weed species present in descending order by number
check	0.74	groundsel, fescue, orchard grass, annual bluegrass, false dandelion, chickweed, miner's lettuce, shepherdspurse.
chlorpropham	0.09	groundsel, false dandelion, annual bluegrass, chickweed, shepherdspurse.
linuron	0.05	groundsel, chickweed, false dandelion, annual bluegrass, shepherdspurse.
napropamide	0.01	false dandelion, groundsel.
propachlor	0.10	groundsel, false dandelion, chickweed, fescue, annual bluegrass.
LSD(0.05)	0.06	

Table 36. Effect of herbicides on shallot yield, 1984

Treatment	Total yield	No. of bulbs harvested/plot	Mean bulb wt.
	tons/acre		ounces
check	0.6	139	0.27
hand-weeded	3.8	244	0.90
chlorpropham	1.1	136	0.49
linuron	1.6	149	0.41
napropamide	1.1	132	0.50
propachlor	1.6	187	0.51
LSD(0.05)	0.8	67	0.18

Conclusion

Overwintered onions and shallots offer an opportunity for expanded production without increased acreage and can generate income when few other crops are being harvested. At the North Willamette Experiment Station research continues on overwintered production of cauliflower and other cole crops. Floating row covers will be evaluated for protection of overwintered cauliflower, spinach, and onions. Weed control research in overwintered onions will be continued.