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Nontillage Weed Control for Beans Tested

Hugh E. Morrison Passes Away November 13 at Corvallis

On November 13, 1967, Hugh E. Morrison passed away following a major operation. He had not been in good health for nearly two years.

Morry studied the biology and control of the symphylan for three decades. With a bachelor's degree from Franklin and Marshall College (Pennsylvania) and a M.S. from Ohio State University, he joined the Entomology Department staff in 1937. Morry specialized in soil arthropods and was largely responsible for the development of the highly successful soil treatments of aldrin and similar materials for control of a multitude of pests attacking vegetable and specialty crops. The results of his practical studies on soil fumigants, particularly for symphylan control, are well known to his colleagues and to the growers and field men of Oregon. He will be missed around the Department of Entomology at OSU.

—H. H. CROWELL
Department of Entomology

In This Issue . . .

With current interest in optimum plant densities and spacing of vegetable crops there is also an interest in nontillage weed control programs for these crops. Economics and lack of available selective herbicides or available herbicides with proper label registrations may dictate that less than total weed control must be accepted under these circumstances.

The study reported here was carried out in 1967 with bush snap beans (Tendercrop). Conventional row spacings were used; however, relative competitive effects of weeds could be expected to be similar with equi-distant type spacings. The most prevalent weed in these plots was redroot pigweed, with groundsel and mustard present to a lesser degree. Preplant treatments were applied and mixed into the soil to a depth of 2 inches with a powered rotary tiller just prior to planting. Pre-emergence treatments were applied the day following planting. Periodic applications of overhead irrigation were made for herbicide activation and maximum crop growth.

Plots of the various herbicide treatments were split; one half received periodic cultivation and hand weeding so that weed competition would not be a factor in crop growth and the other half received no cultivation or weeding. Visual evaluation of the degree of weed control obtained in the noncultivated plots was made by rating (0 = no control, 10 = complete control) about one month after the plots were established. Yields were obtained by a single hand picking at time of optimum maturity. This information is summarized in the accompanying table.

Analysis of the data indicates that significant reductions in yield resulted from noncultivated plots that

(*Continued next page*)

Weed Control . . . (*Continued from page 1*)

Summary of results of weed control experiment in beans

Herbicide	Application: Rate	Application: Timing	Weed control rating[a]	Plot yield: Weeded	Plot yield: Not weeded
	Lbs. ai/A			*Lbs.*	*Lbs.*
EPTC	3	Preplant	6	44.9	33.2
Trifluralin	¾	Preplant	7	47.8	37.3
Nitralin	¾	Preplant	6	46.4	24.5
DNBP amine	4½	Pre-emergence	5	49.2	23.9
OCS 21799	2	Pre-emergence	8	45.1	42.7
C 6989	4	Pre-emergence	9	48.4	46.1
EPTC plus Trifluralin	3 + ¾	Preplant	8	46.8	37.0
EPTC plus DNBP amine	3 + 4½	Preplant plus pre-emergence	8	50.7	34.4
Trifluralin plus DNBP amine	¾ + 4½	Preplant plus pre-emergence	9	41.3	36.4
Trifluralin plus OCS 21799	¾ + 2	Preplant plus pre-emergence	9	46.2	40.1
EPTC plus OCS 21799	3 + 2	Preplant plus pre-emergence	9	42.2	44.5
Untreated check		....	3	43.9	24.3

[a] 0 equals no control; 10 equals complete control. Ratings are for noncultivated plots.

received no herbicide and from plots treated with EPTC, Nitralin, or DNBP amine. Since comparable treatments that were weeded yielded well, this yield reduction is apparently due to poor weed control in these plots and the resultant weed competition with the crop. In most instances weed control and yields of beans in noncultivated plots were improved by using combinations of herbicides. It is recognized that the usefulness of a specific herbicide program will vary with the kind and relative abundance of weed species present and that under other circumstances other herbicide programs may be of greater value than those showing the most promise in this trial.

It can be concluded from this study that certain herbicide programs can be devised for use in bush snap beans that will adequately control weeds and will give crop yields equal to those obtained with normal cultivation practices.

—Garvin Crabtree
Department of Horticulture

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Status of Pole Snap Bean Improvement Described

In recent years, objectives of improvement of pole snap beans have included a complex of plant characters—more vigor and less leafiness than current varieties; prominent, rather long racemes; and pods borne relatively high and concentrated over a shorter period of maturity. Also included in the breeding program have been resistance to root rot, rust, and yellow mosaic virus—preferably combined in single varieties.

To attain a near ideal in which all objectives are reached within single varieties will take many years; yet, progress has been substantial and new combinations of promising lines are being obtained through continued hybridization. As long as there is major acreage of the pole bean in Oregon, and as long as there is work on development of a mechanical harvester for these beans, it is believed advisable to continue their improvement. Such work is not lost, since new combinations in pole beans also may be of value in the improvement of bush beans. In the breeding program at OSU, bush x pole crosses are being continued in efforts to improve both types of beans.

In 1967, pole bean selections were planted in the disease test area on the OSU Vegetable Research Farm. Smaller cooperative trials were planted by the Southwestern Washington Experiment Station at Vancouver and by several processing firms or their growers—Eugene Fruit Growers, Blue Lake Packers, United Flav-R Pack, and Northwest Packing.

Notes on several of the current selections of pole beans follow:

439-12. In all locations racemes were long, pods borne high and rather concentrated. Possible interest for mechanical harvest.

9708. Three sub-lines were tested; pods borne high; vigor above average; pods long, fleshy. Racemes long.

439-1. Prominent racemes, pods borne high on plant.

4240. Vigorous line in most locations; pods set high. Later maturing.

1083. Three sub-lines tested at Corvallis only; appears to be tolerant to root rot; early vigor superior to all other lines. Not uniform in pod type.

1128. Four sub-lines tested; in disease test area at Corvallis only 33 out of 891 plants were infested with yellow mosaic, while 300 plants out of 854 of FM-1, FM-1L, and FM1-K were infected. Approaching FM-1 in pod type, but pod set appeared only fair in some locations.

226. High resistance to yellow mosaic; out of 261 plants, none were infected; pod quality questionable.

4294. An older OSU line with good pod color and quality; more open foliage than FM-1 and other Blue Lakes.

10159. Good tolerance to yellow mosaic; medium vigor; segregating round and oval pods.

In most of these lines, and in several additional lines, single plant selections were made in 1967; additional crosses were also made in the field.

—W. A. Frazier
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Vegetable Notes . . .

Growth rate of tomato seedlings was tested in the greenhouse for several P fertilizer placements by G. E. Wilcox; results were reported in Vol. 90 of the *Proc. of Am. Soc. for Hort. Sci.* Mixing phosphate with the soil at 25 or 50 ppm was not as effective as a band application of 908 mg. P per foot 2 inches directly under the seed. A band placed 1½ inches to the side and 2 inches below the seed did not produce a satisfactory response. Seedling growth rate was not increased by the addition of potash to the band.

Factors affecting curd formation in cauliflower were studied by S. Sadik, and reported in Vol. 90 of the *Proc. Am. Soc. for Hort. Sci.* It was found that the summer type 'Snowball M' did not require a cold temperature for curd formation, but did require a cold period (42 degrees F. was used) for flower induction. Flower induction would not occur until the plants reached a minimum age, in this case the age at which 16 leaves were produced.

In the case of a winter type, 'February—Early-March,' both curd and flower formation required a cold period.

The presence of 100 ppmw of DMPA [0-(2,4-dichlorophenyl) 0-methylisopropylphosphoramidothioate] resulted in less damping-off of peas inoculated with *Pythium* than comparable plots not treated with DMPA; however, damping-off of pea seedlings germinated in soil from plots that had received eight annual applications of DMPA, 15 pounds per acre, was nearly as great as that in the control plots. This work was reported by M. L. Fields and D. O. Hemphill, in *Weeds*, Vol. 15, 1967.

Methods of Fertilizer Application for Vegetable Crops Studied

Fertilizer application methods used for vegetable crop production in the Willamette Valley are being re-evaluated in light of increased application rates, possible changes in row spacings, and the extension of vegetable crop production to more poorly drained acid soils.

The OSU fertilizer recommendations have emphasized the advantage of banding phosphorus fertilizer close to the seed (2 or 3 inches to the side and 2 inches below the seed) at planting time for snap beans, sweet corn, and many other crops. Phosphorus application at 1 to 1½ inches below the seed has given good results on table beets. However, if banded fertilizer materials are included that have a higher "salt effect" than most of the phosphate and ammonium phosphate materials presently used, then the possible injury from salt has to be balanced against the increased efficiency gained from band placement for each nutrient. When high rates of fertilizer are to be used, consideration should also be given to plowing down part of the fertilizer before planting. There have been cases, especially on acid Dayton soils, where banded fertilizers containing chloride have increased the uptake of manganese enough to reduce crop yields.

There are at least four factors that affect the difference in efficiency of fertilizer that is plowed down when compared with fertilizer banded close to the seed at planting:

1. Fixation or chemical reaction between fertilizers added and clays present in soils—"phosphorus fixation" is the best example of this problem.

2. Possible "salt effects" can reduce vigor of germinating seedlings.

3. Possible toxicity of certain elements when concentrated near seedlings.

4. Increased availability of fertilizer that is banded close to the row.

Several experiments were conducted during 1963-1967 to evaluate the effects of rates and methods of application of P (phosphorus) and K (potassium) fertilizers on bush snap beans and sweet corn. Sources of K also were studied. Soil analyses from the experimental locations are given in Table 1.

Table 1. Soil analyses from experimental sites

Soil	Exp. no.	Reaction (pH)	Phosphorus (P)	Potassium (K)		Calcium (Ca)	Magnesium (Mg)	Total bases
			Lbs./A	*Lbs./A*	*me/100g*	*me/100g*	*me/100g*	*me/100g*
Dayton	412-1963	4.9	40	100	0.13	2.6	1.5	4.4
Dayton	441-1965	4.7	20	230	0.21	2.5	1.2	3.9
Dayton	442-1965	4.7	20	230	0.21	2.5	1.2	3.9
Chehalis	445-1966	6.0	70	620	0.80	19.4	8.1	28.3
Amity	453-1967	5.8	45	410	0.53	6.8	2.3	9.6
Willamette	450-1967	5.5	120	860	1.10	6.4	2.6	10.1

Table 2. The effect of rate and method of phosphorus application on the yield and phosphorus content of sweet corn (Amity soil, 1967)

Treatment no.	Method of P_2O_5 application: 2 x 2[a]	Method of P_2O_5 application: Plowed down[b]	Yield No. 1 (unhusked ears)	Phosphorus in leaf
	Lb./A	*Lb./A*	*T/A*	*%*
1	0	0	3.48	0.24
2	0	60	5.19	0.23
3	0	120	7.26	0.34
4	0	240	7.51	0.44
5	60	0	6.62	0.58
6	120	0	7.69	0.59
7	30	30	6.30	0.38
8	30	90	7.18	0.45

[a] Fertilizer banded 2 inches to side and 2 inches below seed at planting.
[b] Broadcast before spring plowing.

Fertilizer Application . . .

Experiment 453 (phosphorus)

Methods of application. Results from an experiment on Amity soil evaluating the effects of rates and methods of application of phosphorus fertilizer on sweet corn, planted on June 14, 1967, are shown in Table 2.

There was a marked increase in yield from P fertilizer application, and P fertilizer increased the P content of leaves sampled on July 20. Banding 60 pounds P_2O_5 at planting gave a higher content of P in leaves than higher rates of P plowed down or a combination of band-plowed down application. Banding 120 pounds P_2O_5 produced the highest yield, but additional data are needed to determine whether this treatment is significantly different from plowing down 120 and 240 pounds P_2O_5 or the combination of 30 pounds P_2O_5 banded plus 90 pounds plowed down. These data strengthen the recommendation to band P at planting time even after soils have become warm in mid-June and they raise a question about plowing down any part of the P application on sweet corn in western Oregon.

Experiment 450

Comparison of placement methods. The importance of banding phosphorus close to the seed at planting has resulted in suggestions to band some of the fertilizer directly with the seed (this has been called a "pop up" application in the eastern part of the United States) or directly below the seed. Recent work in New York and other eastern states has shown that low rates of dry materials (5-10-5, 5-10-0, 1-5-0) banded in direct contact with the seed on 30-inch row spacings resulted in marked stand reduction for many vegetable crops. If soil moisture conditions are excellent and frequent rains follow planting, these rates of fertilizer with the seed will not always cause damage.

The publicity about "pop up" fertilizer treatments raised the question about banding P treatments directly below the seed at planting. An experiment was conducted on snap beans at the North Willamette Experiment Station in 1967 to compare P banded directly below the seed with the conventional placement to the side and below the seed.

Yield and plant emergence data are presented in Table 3. There was an increase in yield when the P was banded 2 x 2, but banding P below the seed did not give comparable yield increases. There was some reduction in stand when the P was placed below the seed (Treatments 5 through 8). Also, there was lower emergence of seedlings with the GV-50 variety. The reduction in seedling vigor with no P or with P banded directly below the seed when compared with P banded 2 x 2 was visually evident until about blossom time.

There was a fairly high P content in the bean leaves on the check plots (0.40% P) so P fertilization gave only small increases in P content. Banding 30 pounds P_2O_5 per acre directly below the seed actually may have reduced the P content.

The results from these two experiments indicate that major emphasis should be placed on banding P fertilizer near the seed but to the side and below at planting. If applications are made directly below the seed for snap beans, the rate should be lower than 15 pounds P_2O_5 per acre on 30-inch rows.

Table 3a. The effect of phosphorus placement on yield, phosphorus content, and emergence of snap beans (North Willamette Experiment Station, Experiment 450, 1967)

Treatments[a]			Yield average[b]		P content[c]
	P placement		Planting date		Average
No.	2 x 2	0 x 1	5/4	6/8	6/8 planting
	Lbs./A	*Lbs./A*	*T/A*	*T/A*	%
1	0	0	6.6	5.8	0.40
2	30	....	7.0	6.2	0.42
3	60	....	7.4	6.4	0.42
4	120	....	7.0	6.1	0.45
5	....	15	6.7	5.9	0.42
6	....	30	6.5	5.6	0.38
7	30	30	6.5	5.9	0.41
8	45	15	7.0	6.0	0.43

[a] Phosphorus was banded 2 inches to the side and 2 inches below the seed or 1 inch directly below the seed.

[b] Rogers Bros. 206 and GV-50 were included on both planting dates. Rogers Bros. 206 yielded more than GV-50 but all treatment differences were comparable.

[c] The 6/8 planting date was sampled on 7/8; first trifoliate leaves fully developed.

Fertilizer Application . . .

Table 3b. Effect of phosphorus placement on the emergence of snap beans (North Willamette Experiment Station, Experiment 450, 1967)

Treatment no.[a]	5/4 Planting				6/8 Planting			
	Rogers Bros. 206		GV-50		Rogers Bros 206		GV-50	
	11 days	15 days	11 days	15 days	11 days	15 days	11 days	15 days
	No.[c]	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
1	36	43	6	20	35	28	19	19
2[b]	39	48	8	22	35	29	26	25
3[b]	35	43	6	24	30	29	24	26
4[b]	33	42	9	22	35	29	20	23
5	31	45	8	19	36	26	21	23
6	29	45	5	21	28	25	20	20
7	27	42	9	24	29	27	20	25
8	37	46	6	21	35	27	20	21

[a] Treatment numbers are identical to those in Table 3a.
[b] Treatments 2, 3, 4 consistently showed the best seedling vigor for both varieties on both planting dates.
[c] Number of plants per 5-foot row.

Table 4. Effects of rate and source of potassium on bush snap bean yields[a] (Vegetable Research Farm, 1966)

Source of potassium	Rate of K_2O (lbs./A) banded 2 x 2 at planting			
	0	25	50	100
	T/A	*T/A*	*T/A*	*T/A*
Muriate of potash (KCl)	5.9	5.8	5.7	5.2
Sulfate of potash (K_2SO_4)	5.9	6.2	6.0	5.9

[a] Yield figures are the average of two varieties replicated five times.

Experiment 445

Source and rate of potassium. Potassium (K) "fixation" is not as much of a problem as P "fixation" in western Oregon, so the advantage from banding K fertilizer is in the increased efficiency in uptake of K by plants. This advantage has to be weighed against possible salt effects and situations where chloride might aggravate manganese toxicity.

Data from an experiment on a river bottom soil at the Vegetable Research Farm where rates and sources of K were compared are shown in Table 4.

While the yield at the low rates of K does not differ significantly, there was some yield increase from potassium sulfate with some yield decrease from potassium chloride. The high rates of KCl did reduce the yield. Potassium chloride has greater solubility and thus more salt effect than potassium sulfate. Similar results have been obtained from other experiments.

Experiment 453 (potassium)

Methods of application. Experiment 453 on Amity soil also included comparisons on banded and plowed down potassium. Results are shown in Table 5.

There was an increase in yield from K (Treatment 12 versus 6 or 9), but including 60 pounds K_2O per acre in the band reduced the yield. More K was taken up by plants from the band treatments than from the plowed down treatments (Treatments 6 versus 9 or 10). Plants from treatments having 30 or 60 pounds K_2O per acre in a band had higher K content in seedling stages than plants with 120 pounds K_2O per acre plowed down. Other research has shown that plant uptake from K plowed down increases as the root system becomes more extensive.

Banded N was limited to 40 pounds per acre in this experiment. The salt effects from ammonium nitrate and potassium chloride are nearly comparable.

Fertilizer Application . . .

Table 5. The effect of rate and method of potassium application on the yield and potassium content of sweet corn (Amity soil, 1967)

Treatment no.[a]	Method of K application		Yield No. 1 (unhusked ears)	K in leaf July 20
	2 x 2	Plowed down		
	Lb/A	*Lb/A*	*T/A*	%
12	0	0	6.76	2.63
6	0	120	7.69	3.23
9	30	0	7.35	3.70
10	60	0	5.69	4.60
11	30	90	7.28	4.00

[a] All treatments had 120 pounds P_2O_5/A banded 2 x 2 at planting.

Table 6. The effect of lime and of potassium source and method of application on the yield of sweet corn (Dayton soil, 1965)

Lime treatment	Potassium treatments at 75 pounds K_2O per acre			
	None	KCl banded	K_2SO_4 banded	KCl broadcast
	T/A	*T/A*	*T/A*	*T/A*
No lime	2.9	2.6	4.6	4.1
3 tons lime per acre	7.6	7.3	6.7	8.1

[a] All plots had 120 pounds P_2O_5 per acre in the band plus optimum nitrogen and sulfur.
[b] KCl refers to muriate of potash (potassium chloride), K_2SO_4 refers to potassium sulfate.

Experiments 441 and 442

Effects of potassium source and method of application. The effects of K sources and methods of application on acid soils can be illustrated by results of experiments on sweet corn and bush snap beans on Dayton soil in 1965 and 1966 (Tables 6 and 7).

There was some variability in the yield data, as would be expected when Dayton soils are first used for vegetable crop production. Three important points should be noted: 1) There was a marked response from lime; 2) potassium sulfate was superior to potassium chloride before the soil was limed; and 3) the broadcast treatments of KCl yielded more than the banded KCl. Irrigation problems resulted in greater variability in the 1966 data; however, the same general effects were evident for both years.

Data in Table 7 illustrate several points: 1) Application of K without lime on a very acid soil can aggravate soil acidity problems (1966 and 1963 data); 2) if soils

Table 7. The effects of lime and of potassium source and method of application on yield of snap beans (Dayton soil, 1963, 1966, 1967)

Lime treatment	Potassium treatments at 60 pounds K_2O per acre			
	None	KCl banded	K_2SO_4 banded	KCl broad-cast
	T/A	*T/A*	*T/A*	*T/A*
1963 Yields—Experiment 413				
No lime	5.9	2.6	....	....
3 tons lime per acre	3.6	7.0	....	....
1965 Yields—Experiment 441				
No lime	0.5	0.3	0.7	0.6
3 tons lime per acre	2.4	2.6	2.5	3.2
1966 Yields—Experiment 441				
No lime	2.5	1.1	1.7	1.6
3 tons lime per acre	4.7	5.1	5.0	5.4

are very low in K, the application of lime can accentuate a K deficiency problem (1963 data); 3) in these experiments on Dayton soils the broadcast application of K generally gave the highest yields; and 4) KCl reduced the yield more than K_2SO_4 on acid soils.

Additional experiments reported in 1966 *Soil Science Society of America Proceedings* (page 70) have shown that plots receiving band applications of potassium chloride (KCl), or potassium sulfate (K_2SO_4) with a chloride salt resulted in consistently higher manganese contents of plants than those fertilized with potassium sulfate in the band or with potassium chloride broadcast and disced or plowed down.

Summary

Effects of methods of application of P and K and comparisons of sources of K for sweet corn and snap beans in the Willamette Valley have been studied. Response from lime has also been evaluated from these experiments. The following conclusions may be drawn from these experiments:

1. Banding all of the phosphorus close to the seed (2″ x 2″) gave the best increases in yield with the greatest increase in P content of plants.

2. Banding low rates of P (15 pounds P_2O_5 per acre on 30″ rows) directly below the seed of bush beans gave some reduction in stand, delayed emergence, and reduced yields.

3. There are at least five factors that need to be considered when deciding how potassium fertilizer should be applied: a) Band application increases the uptake of K and is thus more efficient; b) the "salt effect" from high rates of potassium fertilizers can reduce seedling vigor and stand (potassium chloride is more soluble than potassium sulfate and thus has a greater "salt effect"); c) potassium chloride or any soluble salt containing chloride will generally increase the uptake of manganese (Mn) when banded close to the seed on acid soils (this increase may be great enough to accentuate and/or sometimes cause manganese toxicity); d) optimum soil moisture conditions with frequent rains or irrigation immediately following planting will allow higher rates of potassium to be banded close to the seed without adverse "salt effects"; and e) nitrogen fertilizers (ammonium sulfate and ammonium nitrate) that might be included in the band with dry materials also have a "salt effect." Thus the total amount of K plus N in the band needs to be considered.

4. The total amount of N plus K in the fertilizer band must be considered when salt effects are evaluated. Ammonium nitrate would have the greatest salt effect of the N materials included in mixed fertilizers, with ammonium sulfate and ammonium phosphates having less salt effect.

5. Since there is little advantage from including high rates of N or K in a band, it appears necessary to limit the amount of K banded close to the seed at planting time to about 40 pounds of K_2O per acre in a 3-foot row. (The per acre rate could be increased on narrower row spacings but should be decreased on wider rows.) The amount of N as ammonium sulfate or ammonium nitrate in the band should also be limited. When higher rates of K (more than 40 pounds K_2O per acre in 3-foot rows) are included in the band at planting, potassium sulfate is a safer source of K to use.

6. Acid soils will accentuate the effects of fertilizer salts on uptake of excessive manganese. Greater efficiency in phosphorus utilization and better nitrification will be present after acid soils have been limed.

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Onion Spacing Trial Shows Promising Results

High plant population or high plant density has created considerable interest during the past few years. Research has shown that plant spacing has a marked influence on crop yield and size. With the introduction of precision seeders, it is now possible and practical to regulate seed and row spacing; however, a lack of harvest equipment to harvest these altered plant spacings is preventing adaptation of these new methods. This is not the case with onions. Onions are seeded in 5-foot beds and the present harvest equipment will harvest the whole bed; therefore, if alteration of plant spacing produces favorable results, a significant change may occur in the onion production of western Oregon.

Procedures

An onion spacing trial was established in the Lake Labish area during the summer of 1967. The plots were 12½ feet long and 3¼ feet wide; they were replicated five times. The whole area received 100 pounds nitrogen, 300 pounds phosphorus, 300 pounds potash, and 50 pounds sulfur. Weed control consisted of two applications of Randox (at emergence and at the three-leaf stage). The plots were seeded with a Stanhay precision seeder unit, and the area was irrigated four times.

The extremely hot summer resulted in reduced onion yield and onion size throughout the onion-growing area of western Oregon. This also caused some reduction in yields of the experimental area.

Table 1. Treatments for plant spacing trial

Treatment	Spacing between rows	Spacing between seeds
	Inches	*Inches*
1	13[a]	1½
2	13	3
3	6½	1½
4	6½	3
5	3¼	3
6	13[b]	1½
7	6½[b]	1½
8	3¼[b]	1½

[a] Standard spacing.
[b] Double rows 1½ inches apart.

With onions, size of bulbs is just as important as yield. Normally, onions under 2 inches in diameter are worth very little, so the effective yield is only those onions over 2 inches.

Table 2. Effect of plant spacing on onion yield and size

Treatment	Weight	Over 2 inches	Under 2 inches
	Cwt/A	%	%
1. 13″ x 1½″ (check)	312	72	18
2. 13″ x 3″	223	90	10
3. 6½″ x 1½″	384	57	43
4. 6½″ x 3″	421	91	9
5. 3¼″ x 3″	381	54	46
6. 13″ D[a] x 1½″	235	64	36
7. 6½″ D x 1½″	359	56	44
8. 3¼″ D x 1½″	473	45	55

[a] D = double rows.

The most promising treatment is Number 4 (6½″ x 3″). Not only did this treatment outyield the check by 109 hundredweight, but it also produced onions of much better size. Although treatments 3, 5, 7, and 8 outyielded the check, the size of the onions was so greatly reduced that it more than offset any increase in yield. Treatment 2 produced good sized onions, but the yield was very low. From these data, it appears that 6½ inches between rows and 3 inches between seed is the best treatment.

Experiments repeated

Since the summer was extremely hot and onion yields were reduced, this experiment will be conducted again next year. If another year's data supports this year's work, onion growers may be able to obtain significant yield increases with very little additional work. The fact that present harvest equipment will harvest any of these row spacings makes the transition to a new cropping pattern quite easy.

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