OREGON VEGETABLE Digest

Volume XX Oregon State University, October 1971 Number 4

Density, Row Spacings Affect Bush Bean Yield

Cutworms Damage Oregon Crops

Cutworms are caterpillars—the larvae of noctuid moths. The common name includes those species whose larvae at some period in their development may crawl under the surface of the ground where they feed by cutting off plants near the soil surface. This behavior often causes cutworms to be of particular importance in the spring, when they can seriously reduce seedling stands of table beets and other crops.

There are various modifications in feeding behavior according to the species of cutworm, stage of larval development, and food plants available. As a result, the cutworm group is sometimes subdivided into such categories as climbing, boring, and subterranean cutworms. These pests all pass through the egg, larval, pupal, and adult stages, but life histories can differ importantly for different species: e.g., the red-backed cutworm of central Oregon overwinters in the egg stage and has only one generation per year. The variegated cutworm, on the other hand, overwinters either as a pupa or as a partly grown larva and there are two to three generations per year in the Willamette Valley.

High populations of cutworms tend to occur in cycles due principally to the influences of weather and natural enemies. 1971 was a peak year in western Oregon for the variegated cutworm, *Peridroma saucia*. Other high population years on record are 1900, 1914, 1925, 1952, 1958, and 1965.

During the past summer, light trap catches of the variegated cutworm moths early in the season warned of a later infestation of larvae. About mid-July, potato growers in south Benton County discovered that climbing cutworms

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Highest yields of Oregon 58 Blue Lake bush snap beans were obtained from the highest population (261,400 plants per acre) and the closest row spacing (6 inches) in a test in 1971.

Oregon 58 bush beans were planted on June 9 in 6, 9 and 12-inch rows at the OSU Vegetable Research Farm. After emergence of seedlings, plants were thinned to five within row spacings to give 24, 36, 48, 60, and 72 square inches per plant—261.4, 174.2, 130.7, 104.5, and 87.1 thousand plants per acre. Individual plots consisted of four, 20-foot rows. Treatments were replicated five times. Fertilizer, 100-150-50 pounds N, P_2O_5, K_2O per acre, was broadcast and disked in before planting. Trifluralin at ¾ pound per acre was disked in before planting and 3 pounds DNBP amine per acre was used before emergence for weed control. Irrigation was at about weekly intervals. Three replications of treatments were harvested by hand in a once-over harvest on August 12 and the remaining two replications were harvested on August 13. Pods of treatments were bulked by replicates on the two harvest dates and sieve size distribution was obtained by use of a commercial size grader.

Yield differences were not statistically significant when the three row spacings were compared, although average yield at the 6-inch row spacing (all populations combined) was highest and was about 15% higher than the yield produced from 12-inch rows (Table 1).

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Bush Bean Yield . . .

Table 1. Effects of row spacing and populations on yield and sieve sizes of Oregon 58 bush beans, 1971

Row spacing	Yield	Sieve size 4 and smaller
inches	*tons/A*	%
6	9.1	55
9	8.2	55
12	7.9	58
LSD 1%	NSD	....
Population (area/plant) *sq. in.*		
24	10.4	51
36	8.6	55
48	8.4	56
60	7.3	57
72	7.3	60
LSD 1%	1.1	....

Yield of plants at 24 square inches of space (three row spacings combined) was highest and was significantly higher than the 36 to 72 square inch spacings (Table 1). Yields from the 36 and 48 square inch populations were significantly higher than the 60 and 72 square inch spacings. Yield increase of the 24 square inch spacing was 42% over the 72 square inch spacing and 21% higher than the 36 square inch population level. Yield relationships of row spacings and populations are shown in Figures 1 and 2.

There was a trend for a higher percentage of sieve size 4 and smaller pods at the wider spacings and lower population levels. This is contrary to earlier work in which the highest populations and narrow spacings have resulted in production of higher percentages of small pods at a given harvest date (*Oregon Vegetable Digest,* Vol. XVIII, No. 2, April 1969).

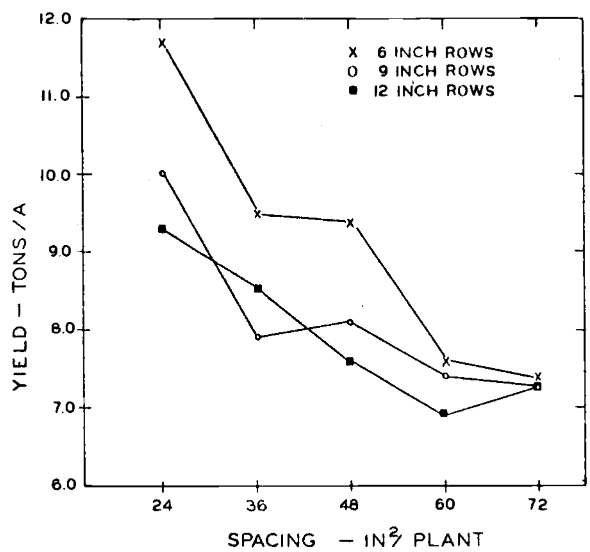

Figure 1. **Effect of area per plant on yield of bush beans.**

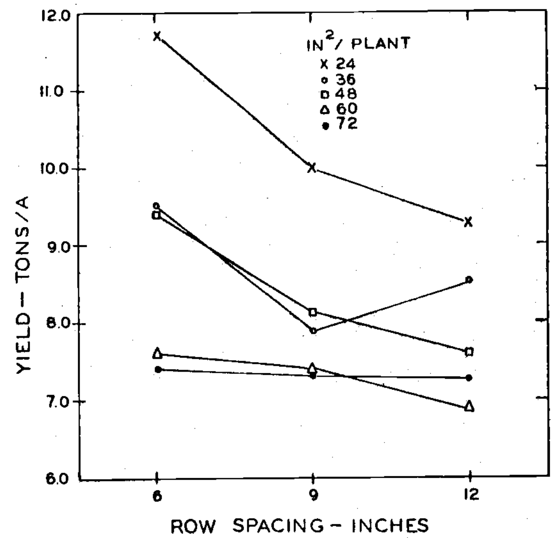

Figure 2. **Effect of row spacing on yield of bush beans.**

Incidence of Sclerotinia white mold was evident in some locations but did not appear to be severe. The mold was not consistent with any given row spacing or plant density, but it may have contributed to some of the yield variability.

Availability and efficiency of planting equipment, with the possibility of band placement of fertilizer at planting, should be considered in determining optimum row widths. Seed cost and seed quality also must be taken into account in determining the most economic populations to be used in high density plantings of bush beans.

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Oregon Vegetable Digest is published four times a year by the Agricultural Experiment Station, Oregon State University, Corvallis, G. Burton Wood, Director. Address correspondence to the author concerned or to the Department of Horticulture.

Cutwork Damage . . .

were defoliating small areas of their fields and that most of the acreage had a large enough population to threaten the shallowly buried tubers as the worms matured and entered the soil. Bush beans were heavily attacked in Lane and other counties. In some cases the presence of the worms was unsuspected until harvest, when pod damage involving a high percent of the beans was discovered. Other crops suffering economic loss from this cutworm included peppermint and table beets. Green tomatoes in home gardens were attacked, but the growers generally were unaware of the problem until the end of August when the ripening fruits were found with large disfiguring feeding scars. The larvae had matured weeks earlier and migrated to the soil for pupation.

During and immediately following a mid-summer outbreak of cutworms, there is considerable concern among growers regarding the next generation of the larvae and what precautions should be taken to protect crops. Our experience with this pest indicates that cooling temperature and parasites will keep the population at a low level for the remainder of the year. The Federal-State Cooperative Economic Insect Report for the period August 16-20 indicated that large numbers of parasites were emerging from larvae and pupae which were collected from untreated potato

Table 1. Results of baiting and spraying bush bean plots for variegated cutworm control 48 hours after application (Junction City, 1971)

	Materials and formulations	Rates	Mean no. larvae per sq. yd.	Percent dead or moribund
		lbs./A		
1	Lannate (1%) bait	25	9.3	50
2	Lannate (1%) bait	50	9.3	86
3	N-2596 (4%) bait	50	5.3	94
4	Dyfonate (4%)	50	19.7	47
5	Sevin (5%) bait	25	6.0	39
6	Sevin (5%) bait	50	13.3	50
7	Thuricide (B.T.) bait ..	25	15.3	26
8	Thuricide (B.T.) bait ..	50	2.7	63
9	Untreated check	....	5.7	6
10	Dipel (B.T.) bait	25	26.3	1
11	Dipel (B.T.) bait	50	23.3	6
12	Dylox (5%) bait	25	8.0	25
13	Dylox (5%) bait	50	3.7	27
14	Dylox 4 e.c.	1 ai	6.0	0
15	Dylox 4 e.c.	2 ai	4.7	14
16	Dipel (B.T.) W.P.	¼	5.7	0
17	Dipel (B.T.) W.P.	1	6.3	5
18	Biotrol X K (B.T.) W.P.	¼	15.0	4
19	Biotrol X K (B.T.) W.P.	1	21.7	3
20	Untreated check	....	12.0	8
21	Lannate L	1 ai	13.3	43
22	Lannate L	2 ai	7.3	45
23	Sevin 50 W.P.	1 ai	14.3	5
24	Sevin 50 W.P.	2 ai	2.3	0
25	Sevin mol 4	1 ai	1.0	0
26	Sevin mol 4	2 ai	0.3	0
			Mean = 9.9	

ai = active ingredient
W.P. = wettable powder
e.c. = emulsifiable concentrate
B.T. = *Bacillus thuringiensis*

fields in the Gresham area by State Department of Agriculture entomologists.

A planting of bush beans at Junction City was inspected on July 28 as a possible test site to compare the effectiveness of several insecticidal baits and sprays on cutworm control. This field had been treated by air two days earlier with carbaryl (Sevin) spray at the rate of 2 pounds active ingredient per acre. A pretreatment estimate of the cutworm population averaged 11 cutworms per square yard, indicating unsatisfactory control from the Sevin treatment. This population had caused feeding damage affecting about 30% of the bean pods, resulting in the field being turned down by the processor. (Pod damage of between 5 and 10% is considered by processors as the maximum that can be handled economically. It is not known how low a cutworm population would cause damage at this level.)

The tests were made in unreplicated plots 50 feet long and 4 rows wide (900 square feet). Bait formulations of different insecticides were broadcast on 12 plots and sprays were applied to another 12; two plots were arbitrarily set aside as untreated checks. Both the baits and the sprays were applied with a STIHL back-pack mist blower on July 28. All of the plots were examined 48 hours later. Scoring was accomplished by laying out 3 square yard subplots in each 900 square foot plot and carefully searching the plants and soil for living, dead, and dying cutworms within these areas. The results are summarized in Table 1.

Since the interval between treatment and evaluation was rather short (48 hours), larvae from eight plots treated with *Bacillus thuringiensis* formulations were collected,

Table 2. Results of second evaluation of *Bacillus thuringiensis* treatments five days after application (Junction City, 1971)

	Treatments	Field evaluation: Mean no. larvae per sq. yd.	Field evaluation: Percent dead	Collected larvae: Total no. larvae	Collected larvae: Percent dead
7	Thuricide bait (25 lbs.)	7.7	38	15	13
8	Thuricide bait (50 lbs.)	4.7	57	7	0
9	Untreated check	6.7	10	9	0
10	Dipel bait (25 lbs.)	1.0	33	21	19
11	Dipel bait (50 lbs.)	11.3	3	19	32
16	Dipel spray (¼ lb.)	5.3	13	9	0
17	Dipel spray (1 lb.)	4.3	8	13	0
18	Biotrol X K spray (¼ lb.)	5.7	0	15	0
19	Biotrol X K spray (1 lb.)	15.0	7	7	0
20	Untreated check	9.3	7	11	0

held at 25° C with food available, and examined three days later (5 days after treatment). The same field plots also were re-examined five days after treatment for numbers of living, dead, or dying larvae. This additional information, summarized in Table 2, indicates that even after five days, mortality from *Bacillus* field treatments may be quite

(*Continued next page*)

Effect of Herbicides on Carrot Seedling Vigor Studied

From general applications of linuron to carrots in variety evaluation plantings and plots established in breeding work, the observation has been made that plants with low seedling vigor may be more susceptible to herbicide damage than plants of vigorous varieties.

On this basis, a trial was established at Corvallis in 1971 with a planting of four strains of carrots, representing two vigorous (Red Core Chantenay and D301A x M6000C, a hybrid breeding line from Dessert Seed Co.) and two weak seedling vigor types (OSU 26-2, an inbred breeding line from Oregon State University and M6000C, an inbred breeding line from Dessert Seed Co.).

As would be expected, there were large differences in plant populations between carrot strains. With the resulting thin stands in the inbred lines, considerable variability is evident in the percent stand reduction values between these inbred line plots. From the results shown in Table 1, it appears that weak seedling vigor types are not, in general, more susceptible to herbicide damage and that there is more variability between strains than between groups comprised of weak or strong seedling vigor types. With a given type of application, pre- or post-emergence, there appears to be little difference between herbicides at the rates used in this trial. The pre-emergence type of applications resulted in somewhat more crop injury in the form of stand reduction (average of 12% for pre-emergence compared to 8% for post-emergence).

Table 1. Percent stand reduction in four carrot strains as a result of urea herbicide applications

	Application		Carrot strains			
Herbicide	Timing	lbs/A	Red Core Chantenay	Hybrid D301A x M6000C	Inbred OSU 26-2	Inbred M6000C
Linuron	Pre-emerge	2	12*	19	14	17
	Post-emerge	1	8	10	18	2
	Post-emerge	2	6	15	1	7
Chlorbromuron	Pre-emerge	4	6	13	16	4
	Post-emerge	2	7	15	0	5
	Post-emerge	4	9	11	25	0
Chloroxuron	Pre-emerge	4	10	4	26	8

* Average of four replications.

Three herbicides, linuron (Lorox), chlorbromuron (Maloran), and chloroxuron (Tenoran), were compared with an untreated check treatment. Stand counts were made from 10 feet of row in each plot and results were expressed as percent stand reduction. Those plants that survived the early effect of the herbicide treatment grew normally and showed no visible herbicide injury at harvest time. The results of this test, expressed as percent crop stand reduction, are summarized in Table 1.

The general conclusion from this trial is that carrot susceptibility to urea-type herbicides is not associated with seedling vigor.

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Cutworm Damage . . .

low with this species of cutworm. Whether or not the *Bacillus* treatments caused the larvae to stop feeding (as advertised in the literature on this biological insecticide) was not determined in this study.

DDT was formerly the insecticide of choice in most cases where cutworms (particularly the variegated cutworm) were a threat to crops. This summer's brief studies indicate that bait formulations are generally more effective than sprays. Lannate (methomyl), Dyfonate, and N-2596 are promising replacements for DDT, but lack of federal registrations limits their use to only a few crops at the present time.

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Bush Bean Varieties Tested in Seven-Inch Rows

Several varieties of bush beans with inherent differences in growth habit and pod sizes were grown in 7-inch rows at the OSU Vegetable Research Farm, Corvallis, during 1971. Eight varieties and breeding lines were planted on June 4 in "beds" of eleven, 7-inch rows with space between beds of about 12 to 18 inches. Another planting of four varieties was made on June 17.

Varieties varied in seed size as follows:

Variety	Seeds per pound
Oregon 58	1,125
Oregon 190	1,800
Gallatin 50	1,450
Tempo	1,920
FM-14	945
Oregon 949	1,665
Keystone 4672	1,710
Earliwax	1,575

A Stanhay precision seeder was used and belts were punched for a spacing of 5 inches in the row and a hole size of 18/32 inch for a seed size of about 1,350 to 1,400 seeds per pound. Subsequent stands in the row were related to seed size and germination, averaging as follows:

Variety	Spacing in row (inches)
Oregon 58	9
Oregon 190	3.5
Gallatin 50	4.5
Tempo	4
FM-14	7
Oregon 949	3.5
Keystone 4672	4
Earliwax	4

Fertilizer was broadcast before planting at a rate of 50-150-50 pounds N, P_2O_5, K_2O per acre and was banded at planting at a rate of 20-60-20 pounds N, P_2O_5, K_2O per acre. Weed control was accomplished through use of ¾ pound trifluralin per acre disked in before planting and a pre-emergence application of 3 pounds DNBP amine per acre. Plots 1/1,000 acre in size were harvested by hand in a once-over harvest.

Yields and sieve sizes were affected by varieties, planting dates, and harvest dates (Tables 1 and 2). For the June 4 planting (Table 1), yields ranged from 5.1 to 7.8 tons per acre for the first harvest date and from 7.2 to 11.5 tons per acre for the third harvest date. All varieties were past optimum maturity on the third harvest date. Yields for the June 17 planting (Table 2) varied from 5.6 to 7.6 tons per acre on the first harvest date and from 8 to 12 tons per acre on the fourth harvest date.

Table 1. Yields and sieve sizes of bush bean varieties in 7-inch rows (planted June 4, 1971)

	Harvest dates					
	8/6		8/9		8/11	
	T/A	% 4's & smaller	T/A	% 4's & smaller	T/A	% 4's & smaller
Oregon 58	7.8	43	9.0	20	11.5	18
Oregon 190	6.9	88	7.9	35	9.2	34
Gallatin 50	5.1	84	6.4	46	7.2	28
Tempo	7.8	82	8.9	43	10.7	40
FM-14	5.5	....	6.8	....	7.6	....
Oregon 949	....	....	6.7	44	8.4	35
Keystone 4672	....	....	5.5	33	8.0	31
Earliwax	....	....	6.4	59	7.7	43

A comparison between 7, 14, and 35-inch rows of Tempo showed that the 7-inch row spacing produced the highest yield (Table 3). There was not much difference in yield between 14 and 35-inch rows. At a given harvest date the percentages of pods sieve size 4 and smaller was highest at the 7-inch row spacing, followed by the 14 and 35-inch spacings. Spacing of plants within the row was the same, about 4 inches, for the three row spacings.

Table 3. Effect of row spacing on yields and sieve sizes of Tempo bush beans, 1971

	Harvest dates			
	8/17		8/19	
Row spacing (inches)	T/A	% 4's & smaller	T/A	% 4's & smaller
7	6.6	68	7.9	66
14	5.7	59	6.4	57
35	5.7	49	6.1	44

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Table 2. Yields and sieve sizes of bush bean varieties in 7-inch rows (planted June 17, 1971)

	Harvest dates							
	8/16		8/17		8/19		8/24	
Variety	T/A	% 4's & smaller	T/A	% 4's & smaller	T/A	% 4's & smaller	T/A	% 4's & smaller
Oregon 58	7.6	56	8.2	53	9.4	41	9.9	25
Oregon 190	7.2	78	8.4	76	9.7	63	12.0	41
Gallatin 50	5.6	81	5.7	72	6.2	66	8.0	35
Tempo	7.0	74	6.6	68	7.9	66	....	....

Bush Bean Varieties . . .

These varieties all appear to have a potential for producing reasonably high yields of small sieve size pods at 7-inch row spacings. Earlier results with varieties in 5-inch rows were similar (*Oregon Vegetable Digest*, Vol. XIX, No. 4, October 1970). Actual seeding rates, row spacings, fertilizer rates, and other cultural practices for possible commercial high density plantings of bush beans will require further study. Adequate weed control, other pest control methods, and efficient machines for seeding and harvesting also will be required.

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Vegetable Notes . . .

Resistance of broccoli to clubroot changed with plant age, according to work of Vriesenga and Honma in Michigan. A clubroot susceptible (MSU 705) and resistant line (MSU 134) of broccoli were crossed and the parents, F_1 and F_2, were tested for resistance. Three distinct phenotypic classes were observed in the F_2, with increasing susceptibility found with advancing age, culminating in mature plant susceptibility for all plants. F_1 and F_2 segregation suggests a two-gene system with resistance controlled by an incomplete dominant and a recessive gene. (*HortScience*, 6(4):395-396, 1971.)

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Crandall and associates in Washington found that Tempo bush beans planted in rows 12 inches apart yielded 64% more crop and had 64.4% more leaf surface per unit area than those planted in 36-inch rows. Row direction in relation to the prevailing wind had little effect on yields, but a perpendicular arrangement caused lower relative humidity and higher air temperatures than parallel. Widening the row spacing increased the effect on relative humidity. Mist application increased relative humidity and lowered air temperature. (*HortScience*, 6(4):345-347, 1971.)

Studies by Brown, Deakin, and Hoffman in South Carolina suggest the possibility of screening segregating bean populations by paper chromatography and discarding undesirable plant types at an early stage. Paper chromatograms of flavonoid compounds extracted from the leaves of 43 snap bean cultivars and breeding lines produced characteristic patterns which allowed all but seven to be classified into one of three major categories. One of the flavonoid compounds was consistently associated with bush and not runner type plants and was thus useful for early classification of populations segregating for plant type. (*J. Amer. Soc. Hort. Sci.*, 96(4):477-481, 1971.)

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Vigor of beans following unfavorable storage conditions was tested by Roos and Manalo in Colorado. A new technique for testing vigor of beans in which epicotyl weight measurements are taken showed a loss in bean seed vigor after only three weeks of storage, while the standard laboratory germination test showed a drop in germination after nine weeks of storage at about 90°F and 90% relative humidity. (*HortScience*, 6(4):347-348, 1971.)