OREGON VEGETABLE Digest

VOLUME XIV OREGON STATE UNIVERSITY, OCTOBER 1965 NUMBER 4

Methods of Carrot Improvement Considered

Oregon Horticultural Society Meets November 17-19

Plan to attend the 80th annual meeting of the Oregon Horticultural Society on November 17, 18, and 19 on the Oregon State University campus.

Vegetable Crops sessions will be on Thursday, November 18, and Friday, November 19.

General sessions, a banquet, and exhibits are also scheduled.

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Five avenues are open to the plant breeder in improving a cross-pollinated crop such as the carrot. They will be discussed briefly here, followed by notes on the program at Oregon State University.

1. Mass selection. The most promising roots of a given variety or breeding progeny are selected and then planted together in the open to cross-pollinate at random. Superb uniformity for given characteristics, such as color, shape, and taste can hardly be expected from this method. Yet, as exemplified by such varietal types as Red Cored Chantenay and Nantes, important gross characteristics can be maintained with reasonable attention to selection; and, certainly, some improvement is possible.

2. Hybrids. Generally, with vegetable crops, these first-generation hybrids are made between two inbred lines. The inbreds are obtained via continued self-pollination (inbreeding); the major horticultural characters should be uniform, or the F_1 hybrid cannot be maintained as a dependable type year after year. An F_1 hybrid, in reality, can also be considered as any first-generation cross involving two established varieties (or strains), or two

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breeding stocks of any type. In carrot, onion, sweet corn, and other cross-pollinated vegetable crops, the potential value of F_1 hybrids arising from inbred combinations lies in vastly improved uniformity of various characteristics. Since the search is for improved uniformity for root color, shape, resistance to cracking, smoothness, size and texture, and for freedom from rotting, bolting, branching, internal browning, bitterness or off taste, hollow heart, sloughing when processed, core separation (from cortex), then the ideal theoretical approach is via use of hybrids. It is well to bear in mind, however, that uniformity in an F_1 hybrid for a desirable characteristic might be matched by uniformity for an undesirable characteristic. It is the total combination of characters which is important.

There are distinct problems involved in development of the hybrid carrot. It is a biennial and, in cold climates, short cuts are necessary via greenhouses or shipment to warm production areas after induction of potential flowering by cold storage. Loss of high quality roots by various organisms causing decay is serious; and inbreeding generally results in weak vigor and low seed yields (some inbreds are better than others). Maintenance of inbred lines is costly--two lines must be maintained for the male sterile (female) parent, from which seed is obtained; a third line, the pollen-producing inbred, must also be maintained as one of the F_1 parents. These are costly, time-consuming operations for breeders as well as seedsmen. Sweet corn, for example, because of the separate male and female floral parts, permits far easier artificial selfing and field manipulation by the seedsman.

As a means of improving the potential of carrot hybrid seed yields, the three-way hybrid is being given considerable thought and some combinations are being made. The male sterile (female) seed parent line, for example, would be a hybrid of two lines, say A x B, which preferably should be uniform in their major horticultural characteristics, yet when hybridized would show hybrid vigor for good seed yield. This A x B male sterile hybrid, with good seed-yielding potential, is planted alongside male fertile (pollen-producing) line C; seed harvested from the A x B plants is, then, a three-way hybrid, (A x B) x C. The same picture holds true for onions. A great deal of work is required to develop and test such combinations, as well as to maintain them for seed production purposes.

3. Synthetics. So-called synthetic varieties represent a third method for improving cross-pollinated crops. They arise from carefully selected breeding lines, somewhat similar in desired characteristics; when crossed together, these lines result in a superior open-pollinated stock. Some undesirable characters which might be present if random, mass selection were practiced, can be eliminated by this method. Once selected lines are combined, the synthetic is then maintained by open pollination. It may be that such types will play an interim role in carrot production while hybrids are evolving.

4. Recurrent Selection. This simply represents an extension of the method described in development of the synthetic. For example, after combining several good lines for a synthetic in open pollination, if we select and develop another round of selfed lines from the synthetic superior (after testing) to those originally used, we practice recurrent (repeated) rounds of selection. Time must be taken to determine whether the new round of lines, when again intercrossed in all directions, are in fact superior to the prior rounds. This process may be repeated indefinitely, as long as progress can be demonstrated.

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Oregon's Vegetable Digest **is published four times a year by the Agricultural Experiment Station, Oregon State University, Corvallis. F. E. Price, Director. Address correspondence to the author concerned or to the Department of Horticulture.**

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5. Backcross. This method was used here to develop a bush bean with essential Blue Lake pods. The snap bean is largely self-pollinated, but the method is also applicable to the carrot which is normally cross-pollinated. A desirable parent (for many characters), such as Nantes, is chosen for the recurring parent (continued crossing back to Nantes) with the object of growing the F_2 progeny of each cross, selecting for desired Nantes characters, plus a desired character or characters introduced from the other (nonrecurring) parent. For example, the other parent may have resistance to cracking. The idea is to select crack-resistant roots near Nantes in type, then to hybridize them again to Nantes so that we continue to add genes from Nantes, selecting for resistance to cracking in each backcross generation. In general, at least three or four rounds of backcrosses are necessary for mass transfer of the desired parent (Nantes) genes. More may be required, depending upon complications of the interties of crack resistance with desirable or undesirable inheritance units (genes). This is a very valuable approach in plant breeding, providing a highly desirable recurrent parent is available and the "intertie" complications are not serious. In the case of the snap bean, transfer of pod from pole to bush was easy if one ignored the habit of the bush plant; in reality, it has been very difficult because of the "intertie" of good pod with poor habit.

Two years ago, we initiated a modest program of carrot testing and inbreeding here. This fall we will observe several first- and second-round inbreds. Over a period of five years we hope to develop several promising inbreds and some mass progeny lines and to form a base for possible synthetics and for recurrent selection. Attention is being given to all of the characteristics mentioned in the first paragraph of this article. In each of the two years of the program, industry and institution representatives were asked to rate the raw carrots soon after harvest. The most promising lines were then processed and rated for color, texture, taste, and over-all promise.

Brief highlights of work and observations to date follow:

Several breeding lines from Wisconsin (W. H. Gabelman and associates) have shown excellent color; in general, they have not ranked distinctly high for smoothness, shape, or resistance to cracking.

Breeding lines from Michigan (C. E. Peterson and associates) have rated relatively high for several characteristics, especially smoothness and length. The processed quality of Michigan 1964-6 was especially good in 1964. Dr. Peterson had several combinations of this hybrid on view August 20, near East Lansing, Michigan. The hybrid is in the OSU test this fall; it appears especially promising for slicing.

For small, whole carrots the NK line 156/B97 was given high ranking in 1964; Michigan 1964-1 was also an unusually uniform, small carrot.

Some of the distinctly deep-colored carrots are too dark (brown) when canned. Brightness of color must be determined after processing.

For dicing purposes, the Chantenay or "Semi-Chantenay" lines from Idaho (D. F. Franklin) and from Campbell Soup Company have ranked especially high.

Susceptibility to cracking has been widespread in most of the breeding materials, but there is evidence that progress against this defect can be made in selection.

Feasibility of an "all-purpose" type may be questioned, but it can hardly be ignored. In 1964, the line ranked highest for this possibility was P6202-2 x P. Walt. Hi-color from D. F. Franklin.

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In 1964 an apparent virus disease was widespread in the trial plots. In mid-September of 1965 very few plants show the yellowing and purpling symptoms.

Tables 1, 2, and 3 show the highest ranked carrots for three different purposes in 1964.

Table 1. Carrot Slicing Type Ratings, Corvallis (November 6, 1964)

Line (Accession number)	Shape rating 1/	For shape: No. persons ranking line high	Color rating 2/	Cracking rating 3/	Parent	Source 4/
4506	10	13	5.0	7.5	1964-6	Peterson
3527	9	9	4.0	8.3	Complex	Franklin
48MS x 173	8	7	4.5	10.0	M805 x M809 5/	OSU
4486	8	6	3.9	9.6	P6202-2 x P. Walt. Hi-color	Franklin
4488	8	5	3.7	10.0	P6202-2 x RCC	Franklin
4492	7	4	4.3	9.4	P6104 x Walt. Hi-color	Franklin
4502	7	4	6.0	8.5	1964-2	Peterson
4485	7	3	3.6	10.0	P6202-2 x P. Imp K	Franklin
4252	7	2	3.5	8.4	Nantes TipTop	Asgrow
4363	7	2	4.9	8.5	Code 15	Campbell
4415	7	2	3.8	6.6	Scarlet Nantes	NK
4416	7	2	3.8	7.1	RCC 156/B97	NK
4484	7	2	3.6	10.0	P6104 x P O	Franklin
4489	7	2	4.1	10.0	P6104-2 x RCC	Franklin
4501	7	2	4.0	7.5	1964-1	Peterson
4504	7	2	4.0	5.5	1964-4	Peterson

1/ Shape rating: 11 or more persons rating line high, value 10; 8 to 10 persons, value 9; 5 to 7 persons, value 8; 2 to 4 persons, value 7.
2/ Color ratings: 1 to 10, with 10 ideal deep orange. The higher the rating, the better the color.
3/ Rating of 10, free of cracking on November 9; the lower the rating, the more severe the cracking.
4/ Key to sources:
Peterson = C. E. Peterson, Mich. State Univ., East Lansing, Michigan
Franklin = D. F. Franklin, Idaho Agr. Expt. Sta., Parma, Idaho
Asgrow = Asgrow Seed Co., New Haven, Connecticut
NK = Northrup-King Seed Co., Minneapolis, Minnesota
5/ Cross made at OSU between two single selections from Peterson lines M805 and M809. Limited root number in sample.

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Table 2. Carrot Dicing Type Ratings, Corvallis (November 6, 1964)

Line (Accession number)	Shape rating1/	For shape No. persons ranking line high	Color rating2/	Cracking rating3/	Parent	Source
4491	9	8	4.1	8.4	P6104 x RCC	Franklin
4362	8	7	4.8	9.7	Code 12	Campbell
4363	8	5	4.9	8.5	Code 15	Campbell
4364	8	5	5.1	7.0	Code 11	Campbell
4494	8	5	3.4	10.0	PRCC x PRCC	Franklin
4416	7	3	3.8	7.1	Red Cored Chantenay 156/B97	NK
4489	7	3	4.1	10.0	P6104-2-2 x RCC	Franklin
4485	7	2	3.6	10.0	P6202-2 x P. Imp K	Franklin
4486	7	2	3.9	9.6	P6202-2 x P. Walt. Hi-color	Franklin

1/ Shape rating: 11 or more persons rating line high, value 10; 8 to 10 persons, value 9; 5 to 7 persons, value 8; 2 to 4 persons, value 7.

2/ Color ratings: 1 to10, with 10 ideal deep orange. The higher the color rating, the better the color.

3/ The higher the cracking rating, the less severe the cracking, with 10 representing no cracking on November 9.

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Vegetable Note . . .

In central Washington, Bienz found that the most significant factor correlated with splitting of carrots was spacing-- the wider the spacing, the greater the amount of splitting. The size of the carrot had a significant effect on its tendency to split. He suggested that with the heterozygosity which exists in an open-pollinated variety of a cross-pollinated crop such as carrots, it should be possible to isolate lines which show greater or less tendency to split than does the bulk of the variety.

(Proc. Amer. Soc. Hort. Sci. 86:406-410. 1965)

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Table 3. Whole Carrot Type Ratings, Corvallis (November 6, 1964)

Line (Accession number)	Shape rating[1]	For shape No. persons ranking line high	Color rating[2]	Cracking rating[3]	Parent	Source
4416	9	8	3.8	7.1	Red Cored Chantenay 156/B97	NK
4501	8	6	4.0	7.5	1964-1	Peterson
4489	7	4	4.1	10.0	P6104-2-2 x RCC	Franklin
4415	7	3	3.8	6.6	Nantes 149/H-19	NK
4486	7	2	3.9	9.6	P620-2 x P. Walt. Hi-color	Franklin
4488	7	2	3.7	10.0	P6202-2 x RCC	Franklin
4490	7	2	4.1	9.0	P6105-1 x RCC	Franklin
4502	7	2	6.0	8.5	1964-2	Peterson

1/ Shape rating: 11 or more persons rating line high, value 10; 8 to 10 persons, value 9; 5 to 7 persons, value 8; 2 to 4 persons, value 7.

2/ Color ratings: 1 to 10, with 10 ideal deep orange. The higher the color rating, the better the color.

3/ The higher the cracking rating, the less severe the cracking, with 10 representing no cracking on November 9.

--W. A. Frazier
Horticulture Department

George Varseveld
Food Science & Technology Department

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Staff Changes . . .

Dr. A. A. Duncan, OSU Vegetable Production Specialist, is due to return about November 1 from sabbatical leave spent at the National Vegetable Research Station in England. Andy also attended an extension workers conference in The Netherlands.

Dr. T. L. Jackson, Soils Department, is on a one-year exchange with Dr. N. H. Peck, Department of Vegetable Crops, New York State Agricultural Experiment Station, Geneva. Dr. Peck's primary research interest is in fertility and nutrition of vegetable crops.

New telephone number for OSU vegetable crops personnel is 754-2456. Information on other campus numbers may be obtained by dialing 754-0123.

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Effects of Nitrogen and Boron on Table Beets

Yield of table beets was increased about 4 tons per acre when a nitrogen rate of 100 pounds nitrogen per acre was compared to a rate of 30 pounds nitrogen in a test at Corvallis in 1965. There also appeared to be a slight increase in yield from application of boron. Incidence of boron deficiency or canker of roots was less at the higher rate of nitrogen, and foliar sprays of boron were superior to soil applications (sprays after seeding prior to emergence of seedlings) in reducing canker.

Although growers are using soil or a combination of soil plus foliar applications of boron to effectively control canker in table beets, the present study was conducted to evaluate the effects of nitrogen rates in combination with boron treatments on yield and incidence of boron deficiency. Many table beet growers in New York state are banding soluble boron fertilizer over the row after seeding for weed control and also for boron nutrition of the crop. This treatment is included here.

Detroit Dark Red (Morse strain) table beets were planted at the OSU Vegetable Research Farm on May 8, with approximately 400 pounds 8-24-8 fertilizer per acre being banded 2 to 3 inches to the side and 2 inches below the seed. Additional nitrogen was sidedressed on June 21 and July 14 to make the higher rate of 100 pounds nitrogen per acre. Five boron treatments, which included rates of 0, 5, and 10 pounds boron per acre, were used in combination with the two nitrogen rates (Table 1). The boron source was a soluble material--Solubor. Two foliar sprays of boron (treatment 5) were made on July 7, when beet roots were up to about 1 inch in diameter, and on July 22. Yields and boron deficiency readings of roots were taken on August 17 and 18.

Yields and percent of roots with boron deficiency, as influenced by nitrogen and boron treatments, are shown in Table 1. Yields of beets at the higher nitrogen rate, 100 pounds per acre, were consistently higher than those at 30 pounds nitrogen per acre. Sixty-seven percent of roots had canker at the 30-pound nitrogen rate when no boron was applied. Approximately one-half as many roots had canker at the 100-pound nitrogen rate as at the 30-pound rate of nitrogen. Plots were under adequate irrigation; if plants were under moisture stress, different results may have been found. Incidence of boron deficiency in roots less than 3 inches in diameter was about one-half that of roots over 3 inches in diameter.

Soil application of boron (sprays) reduced percentage of roots with canker as compared to the check, but the sprays were not as effective as foliar sprays, which almost eliminated incidence of canker. Under the conditions of this one-year test, the band application of 5 pounds boron over the row at seeding was not as effective as foliar sprays of boron in reducing canker. No detailed measurements of weed control were made, but this treatment did not appear to be especially effective against pigweed, the predominant weed species in these plots.

Although no soil-incorporated treatments of boron were included for comparison, it appears that for most effective control in areas of severe boron deficiency, foliar sprays should be included in the boron fertilizer program.

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Effects of Nitrogen and Boron . . . (Continued from page 7)

Table 1. Effects of nitrogen and boron treatments on yield and boron deficiency of table beets, Corvallis, 1965

Boron treatment	Yield--tons/A		Percent roots with boron deficiency (canker) Over 3" size		Under 3" size	
Rates of B per acre	30 lbs. N	100 lbs. N	30 lbs. N	100 lbs. N	30 lbs. N	100 lbs. N
1) No B added	14.8	19.2	67	27	32	16
2) 5 lbs. B --broadcast spray after seeding	15.2	20.4	34	19	16	5
3) 10 lbs. B --broadcast spray after seeding	18.4	22.0	25	10	11	5
4) 5 lbs. B --band spray over row after seeding	15.3	20.8	23	11	15	7
5) 5 lbs. B --foliar sprays (2-2.5 lb. sprays)	17.7	20.0	2	4	1	0
Nitrogen means	16.3	20.5	30	14	15	7

--H. J. Mack
Horticulture Department

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