BA medium and shoots elongated and roots also formed within 2 months (Fig. 4). Some plantlets produced additional adventitious shoots. Numerous plantlets with roots were produced by repeated subculture of individual plantlets on 1 ppm BA medium. Rooted plantlets were transferred to a mixture of 2 peat:1 sponge rock:1 vermiculite in pots or trays and covered with plastic film or bag to avoid dessication. Plants were hardened after rooting by removal of the plastic cover and later by exposure to full sun in the nursery.

Promotion of *in vitro* branching by cytokinin in ginger was similar to that reported in a number of monocotyledons (2). Production of buds after removal of scale leaves produced *in vitro* was similar to that observed in studies on the induction of protocorm-like bodies in Vanda orchid (3).

This tissue culture technique has considerable potential for rapid clonal propagation of ginger. Successful increase in total yield of rhizomes, however, will only be attained if the commercial grower follows through with soil fumigation.

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Selection for Lygus Bug Resistance in Carrot[1]

Donald R. Scott

University of Idaho, SW Idaho Research and Extension Center
Parma, ID 83660

Additional index words: Daucus carota, Lygus hesperus, Lygus elisus

Plant resistance to insects of the genus *Lygus* Hahn has been reported in bean (4), alfalfa (1) and cotton (2). The level of resistance of carrot (*Daucus carota* L.) to lygus bugs (*L. hesperus* Knight, *L. elisus* van Duzee) varies within and among cultivars (3). I carried out the present study to ascertain if the resistance level could be increased by inbreeding and selection.

Seeds were saved from 3 resistant carrot plants, derived from the open-pollinated 'Imperida', found earlier (3). Selfed seed was obtained by caging umbels before bloom. Only 1 plant produced sufficient seed for testing; its progeny is discussed here.

S_1 plants were not tested for resistance; therefore, no selection was made in this generation. First order umbels on each plant were caged before bloom. The seed was harvested and planted in the greenhouse to produce stecklings for field planting the next spring.

S_2 stecklings were tested for resistance by introducing 8 field-collected lygus bugs into each caged umbel at petal fall. Percent lygus mortality was measured as the indicator of resistance after 10 days. Four second order umbels were caged on each plant and were treated as replicates. One S_2 plant with a high level of resistance produced sufficient seed for testing the S_3 generation.

A progressive increase in resistance by selection is suggested by the increase in the mean (4 umbels per plant) % mortality over the 3 generations studied (Table 1). Nineteen of the 36 S_2 plants tested showed greater resistance than any of the original parent plants. Fifteen S_3 plants showed greater resistance than the S_2 parents and all S_3 plants were more resistant than the original parent. The mean % mortalities for the parental, S_2 and S_3 generations were 26, 41 and 85 respectively.

These studies were conducted over a period of years; therefore, direct comparison from one generation to another involves comparisons from one year to another. However, progeny from other, less resistant parental stock were being tested at the same time. These did not exhibit such a high level of lygus mortality.

The lygus bug is the most destructive pest of carrot seed production. High lygus bug mortalities on the S_3 plants indicate that little damage would be caused by feeding under field conditions on a carrot seed field with that level of resistance. Most carrot cultivars carry resistance genes (3), and a cultivar breeding program based on improving resistance to lygus bugs appears feasible and would be useful.

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Table 1. Mortality of lygus bugs caged on individual carrot plants of 3 selfed generations derived from an open pollinated 'Imperida' carrot. S_2 and S_3 generations are progenies from single plants indicated.

Lygus bug mortality (%) on individual carrot plants					
Parental		S_2		S_3	
38[z], 36	a[y]	81,78	a	97	a
33	ab →	75(2)	ab →	95,93(4)	ab
29,25,23(2)[x]	abc	72(2),69,62(2)	abc	90(2),85(6),80	ab
18,16	bc	59(2)	bcd	75	b
14	c	56(2)	bcde	37	c
Mean = 26		50,47,41(4)	bcdef	Mean = 85	
		34(4),31(5)	cdef		
		28	def		
		10(3)	ef		
		9(2),6	f		
		Mean = 41			

[z]Percentage shown is mean of 4 umbels per plant.
[y]Mean separation within generation by Duncan's multiple range test, 1% level.
[x]Number in parenthesis is the number of plants with the mean noted.

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Influence of Genotype and CO_2 on Discoloration, Phenolic Content, Peroxidase, and Phenolase Activities in Snap Beans[1]

J. R. Henderson, R. W. Buescher, and T. E. Morelock[2]

Department of Horticultural Food Science, University of Arkansas, Fayetteville, AR 72701

Aditional index words. Phaseolus vulgaris, controlled atmospheres, broken-end discoloration

Abstract. **The role of phenolic content and phenolase activity in the postharvest discoloration of broken snap bean pods (*Phaseolus vulgaris* L.) was studied by measuring their levels in broken pods which discolored in 24 hours and in broken pods in which discoloration was inhibited by CO_2. Elevated CO_2 atmospheres (30%) inhibited the increase in phenolics content but did not affect phenolase activity. In addition, phenolic content, peroxidase, and phenolase activities were determined in 2 genotypes which discolor slightly ('Blue Crop' and 'NCX8005') and two which discolor severely ('Provider' and 'GP72-122'). Again, discoloration was associated with increased levels of phenolic substances after injury regardless of phenolase and peroxidase activities. Systems which inhibit production of phenolics in response to injury reduce the problem of discoloration.**

Broken-end discoloration (BED) of snap beans occurs during transport to the processor or when held at nonrefrigerated temp. Discolored pods are detrimental to appearance and grade of the processed product (11). Enzymatic discoloration of many different commodities has been shown to be due to the oxidation of *o*-diphenols by polyphenoloxidase (phenolase, catecholase) (1, 3, 8, 12). In snap beans, the oxidation of phenolics by catecholase was associated with the development of BED (2). Discoloration is inhibited by maintaining 20 to 30% CO_2 in the ambient atmosphere (5). Discoloration might also be controlled by choice of cultivars. Stahl and Mustard (9) found no differences in discoloration between 4 snap bean cultivars. However, we observed more than 50 different genotypes grown at the Arkansas Agricultural Experiment Station, Fayetteville, for 2 seasons and found that, while the majority of genotypes discolored moderately, there were a few that discolored severely and a few that discolored very slightly (6). Genotypes which consistently do not discolor offer an attractive approach to eliminating the problem of BED.

This study was undertaken to determine the influence of storage in high CO_2 levels on phenolic content and phenolase activity in snap beans and to determine if differences between cultivars in discoloration are associated with differences in phenolic content, phenolase, or peroxidase activities.

In the first part of the study, snap beans ('Early Gallatin' and 'Cascade') were obtained from local processors. Whole pods of sieve sizes 4 and 5 were cut with scissors, dipped in water, and duplicate samples of about 300g were held at 27° in air or in atmospheres containing 20 or 30% CO_2 (5). Initially, and after 24 hr, phenolase activity and phenolic content were determined. Data for the 2 cultivars were combined as the results were similar. In the second part of the study, 2 cultivars which discolored very slightly in 24 hr ('Blue Crop' and 'NCX8005') and 2 which discolored intensely ('Provider' and 'GP72-122') were selected for comparative studies. Phenolase and peroxidase activities and phenolic content were assayed in triplicate samples initially and 24 hr after wounding. In each experiment, 2 mm of the broken ends were deseeded and used for extractions. Phenolase and peroxidase activities were determined as previously described (2). Total phenolics were extracted with ethanol and were determined by the Folin-Ciocalteau method as modified by Swain and Hills (10). Results are expressed as total optical density (O.D.) per g fresh wt of tissue. BED was evaluated visually on a scale from 0 (no discoloration) to 4 (severe discoloration). Each experiment was repeated at least 3 times and each repetition was considered a replication for statistical analysis.

Table 1. Effects of storage in elevated CO_2 levels on phenolic content and phenolase activity in broken snap pods.[z]

Treatment	Total phenolics[y]	Phenolase activity[x]
Initial	2.43 a[w]	34.01 a
Air	4.01 c	38.99 a
20% CO_2	3.34 bc	36.59 a
30% CO_2	2.88 ab	37.71 a

[z]Assays conducted 0 (initial) and 24 hr after injury.

[y]Expressed as optical density (O.D.) units as 725 nm/g fresh wt.

[x]Expressed as change in O.D. at 420 nm/g fresh wt-min.

[w]Mean separation in columns by Duncan's multiple range test, 5% level.

After 24 hr, broken pods held in air were markedly discolored. Total phenolics had increased 70% above initial levels, while phenolase activity increased only slightly (Table 1). Discoloration was reduced by storage in 20% CO_2, as compared to pods held in air, and almost completely prevented by storage in 30% CO_2 for 24 hr. Phenolase activity was not affected by either storage atmosphere, but the rise in phenolics was appreciably suppressed by holding the broken pods in 30% CO_2 for 24 hr. Under these conditions, the rise in phenolics was only 19% above initial levels.

In the cultivar study, no associations were observed between initial phenolase or peroxidase activities and susceptibility to BED of the different genotypes (Table 2). 'Blue Crop', a cultivar which discolored slightly, had the highest initial activity for both enzymes. Likewise, increases in phenolase and peroxidase activities after mechanical injury did not correspond with the development of BED (Table 3). Apple (4) and peach (7) cultivars which do not discolor have been shown to have lower phenolic levels than cultivars

Table 2. Initial phenolic content, phenolase and peroxidase activities in different snap bean genotypes.

Selection	Susceptibility to discoloration	Phenolase[z]	Peroxidase[y]	Phenolics[x]
NCX8005	Very slight	31.3 a[w]	48.8 a	3.55 a
Blue Crop	Very slight	34.7 b	61.3 b	3.68 ab
Provider	Severe	31.8 a	57.4 b	4.18 c
GP72-122	Severe	34.3 b	52.5 a	3.85 b

[z]Expressed as change in O.D. at 460 nm/g fresh wt-min.

[y]Expressed as change in O.D. at 420 nm/g fresh wt-min.

[x]Expressed as O.D. units at 725 nm/g fresh wt.

[w]Mean separation in columns by Duncan's multiple range test, 5% level.

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[2]Department of Horticulture and Forestry.