more closely in soil infested with *Fusarium solani* f. *phaseoli* (5). Narrowing snap bean row spacings allows for increased plant populations compared to wide spacings without increasing in-row plant populations.

Results of these trials indicate that: 1) narrowing snap bean row spacing will increase yields compared to a standard 92 cm row spacing, 2) weed competition was not reduced by altering row spacing alone but when bean plant populations increased as the row spacing decreased, a linear reduction in weed competition occurred, 3) the 92 and 46 cm row spacings responded similarly to the cultivation variables while 2 cultivations increased weed competition and reduced yields at the 31 cm row spacing, 4) a lower level of weed management may be possible with narrower row spacings compared to wide spacings provided increased bean plant populations are utilized at the close row spacings.

Further research is needed in best management weed control practices for snap beans in the areas of timing of cultivation, cultivation implements, the effect of soil type on cultivation, application of band and broadcast herbicides, and the effect of plant population, between and in-row plant spacing and shading on crop and weed competition.

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TOLERANCES OF SEVERAL COLE CROPS TO PRE AND POSTEMERGENCE HERBICIDES ON MINERAL SOILS

W. M. STALL AND S. J. LOCASCIO
Vegetable Crops Department, IFAS
University of Florida
Gainesville, FL 32611

K. D. SHULER
Palm Beach County Extension Service
531 N. Military Trail
West Palm Beach, FL 33406

W. LLEWELLYN
Seminole County Extension Service
4320 S. Orlando Dr.
Sanford, FL 32771

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Abstract. **Cabbage, (*Brassica oleracea* L. Capitata Group), Chinese cabbage bok choy, (*Brassica rapa* L. Chinensis Group), and napa (*Brassica rapa* L. Pekinensis Group), were grown to evaluate crop tolerances to various preemergence and postemergence herbicides. Crops were grown at Gainesville and Zellwood on sandy soils and at Loxahatchee on sandy muck soils. At Gainesville, cabbage vigor one month after transplanting was acceptable with several herbicides but was significantly reduced with tank mix combinations of cinmethylin and oxyfluorfen. Vigor was reduced in bok choy with metolachlor at both 1.5 and 3.0 lb. ai/acre applied posttransplanting at both Gainesville and Zellwood. Yield was reduced at both locations with 3.0 lb. ai/acre but at Gaines-**

ville the yield with 1.5 lb. ai/acre was not significantly reduced. At the Loxahatchee location only metolachlor applied at 3.0 lb. ai/acre postemergent reduced yield in bok choy. Both metolachlor rates reduced yield when applied postemergent to seeded napa at Loxachatchee.

Cabbage is the most extensively grown cole crop in Florida with an annual production of about 19000 acres and a farm value of $50 million (1). Most of this crop is grown on mineral soils where control of weeds has been difficult. Although trifluralin, DCPA and napropomide are currently labelled for use on cabbage, they have not provided satisfactory and consistent weed control. Trifluralin typically provides poor weed control on the lower organic matter containing sandy soil of north Florida. DCPA provides adequate but short term grass control but poor broadleaf weed control. Nitrofen was used extensively on cole crops in Florida until 1980 when its label was withdrawn.

Grower interest is increasing in growing Chinese cabbage (napa, and bok choy) but no herbicide is currently available for use on this crop. In earlier reports, several preemergence herbicides including diethaltyl and metolachlor and postemergence "grass" herbicides, sethoxydim and fluazifop-butyl have provided weed control without injury to several cole crops (3, 5). Oxyflurofen has been reported to provide excellent broadleaf weed control but has caused plant stunting and yield reductions when applied pretransplanting and posttransplanting (2, 4).

The object of these studies was to evaluate several herbicides for weed control and tolerance in cabbage and Chinese cabbage.

Materials and Methods

Herbicide evaluation studies were conducted in the spring of 1986 on cabbage and bok choy at Gainesville, and on bok choy at Zellwood and bok choy and napa at Loxahatchee. Crops were grown on Plummer and Blanton fine sands, and on a Lauderhill sandy muck (11% organic matter) at the 3 locations, respectively.

The Plummer fine sandy soil was fumigated with 15 gal/acre dichloropropene on 10 Feb. On 5 Mar., fertilizer was applied at 120-70-100 lb./acre N-P-K in beds 4-feet apart. 'Conquest' cabbage grown in 1-inch containers (Speedling 100 A) and 'Joy Choi' Chinese cabbage grown in 0.5 in containers (Speedling 080 A) were transplanted 1-foot apart on the beds. Supplemental water was applied by ovrerhead irrigation.

Herbicide treatments were arranged in randomized block design experiments with 4 replications for each crop (Table 1 and 2). Herbicides were applied at 26 gal/acre at 30 psi with two 11003 target nozzles. Cabbage was transplanted on 5 Mar. after pretransplant (pre) herbicide applications.

Posttransplant (post) herbicide applications were made on 5 Mar. and delayed post (d post) transplant treatments were applied on 5 May. Bok Choy was transplanted on 11 Apr. after application of pretransplant herbicides and immediately before application of posttransplant treatment. Delayed posttransplant treatments were made on 5 May and 23 May.

Herbicide treatments were applied to transplanted bok choy grown on a commercial farm in Zellwood (Table 4) and to seeded bok choy and napa on a commercial farm in Loxahatchee (Table 5). The soil was fumigated and fertilized according to local practices.

Plant vigor and weed control ratings were made approximately 1 and 2 months after transplanting using a pretransformed 0 to 10 rating scale where 10 equaled no loss of vigor and complete weed control and 0 equaled crop death and no weed control. Crop harvests generally were made and marketable heads weighed.

Table 1. Influence of pre and posttransplant herbicicides on early cabbage vigor and weed control at Gainesville, Spring 1986.

Treatment	Rate (lb. ai/acre)	Method of application	Rating[z] (4 Apr.) Vigor	Broadleaf	Grass
Head Check	—	—	10.00 a[y]	10.00 a	10.00 a
Unhoed Check	—	—	10.00 a	0.00 c	0.00 b
Thiobencarb	4	pre	7.50 bc	7.75 b	10.00 a
Thiobencarb	6	pre	7.25 c	7.75 b	10.00 a
Thiobencarb	8	pre	7.25 c	8.25 ab	10.00 a
Diethaltyl	2	post	7.25 c	9.50 ab	9.75 a
Cinmethylin	0.6	post	8.25 abc	9.25 ab	10.00 a
Cinmethylin	0.75	post	7.50 bc	9.25 ab	10.00 a
Cinmethylin + Oxyflurofen	0.6+0.5	pre	1.00 d	10.00 a	10.00 a
Cinmethylin + Oxyflurofen	0.7+0.5	pre	0.50 d	10.00 a	10.00 a
Oxyflurofen	0.5	pre	7.50 bc	10.00 a	10.00 a
Napropamide	2.0	pre	9.25 ab	8.25 ab	9.75 a

[z]Rating of 10 equals no plant injury or complete weed control, 0 means plant death or no weed control.
[y]Mean separation in columns by Duncan's multiple range test, 5% level.

Results and Discussion

Cabbage vigor ratings taken one month after herbicide application indicated that cabbage tolerance to cinmethylin at the lower rate and napropamide was very good (Table 1). Applications of thiobencarb, diethaltyl, the higher rate of cinmethylin and oxyflurofen applied alone reduced vigor slightly but was considered acceptable. Tank mix combinations of oxyflurofen and cinmethylin severely reduced vigor.

Broadleaf weeds present at the time of the first rating were 50% redroot pigweed (*Amaranthus retroflexus* L.), 30% evening primrose (*Oenathera sp.*) and 20% other assorted species. All herbicide treatments provided excellent broadleaf weed control except the 2 lower rates of thiobencarb which had an unacceptable pigweed control. Goosegrass (*Eleusine indica* L.) was the only grass evident at this time and populations were very low.

The control of grass was very good with all treatments on 16 May except with the low rate of thiobencarb and pyridate (Table 2). Pyridate is not expected to control grass, and the thiobencarb treatment rating was significantly higher than the control.

The broadleaf weed control was not significantly different from the hoed check in all treatments except with the 3 rates of thiobencarb, the napropamide + fluazifop, and the tank mix cinmethylin-oxyflurofen treatments. The lack of control of pigweed in the thiobencarb treatments was evident at this time.

Table 2. Influence of pre and posttransplant herbicides on cabbage vigor, weed control and yield at Gainesville, Spring 1986.

Treatment	Rate (lb. ai/acre)	Method of application	Rating[z] (16 May)			Yield (crates/acre)
			Vigor	Broadleaf	Grass	
Hoed Check	—	—	10.00 a[y]	10.00 a	10.00 a	719 a
Unhoed Check	—	—	8.75 ab	0.00 g	0.00 c	568 a
Thiobencarb	4.0	pre	7.25 b	5.25 def	5.50 b	523 bc
Thiobencarb	6.0	pre	7.25 b	5.00 ef	7.50 ab	500 bc
Thiobencarb	8.0	pre	7.50 b	5.50 cdef	7.50 ab	484 c
Diethaltyl	2.0	post	8.25 ab	6.75 abcdef	9.75 a	524 bc
Cinmethylin	0.6	post	8.75 ab	8.75 ab	9.75 a	679 ab
Cinmethylin	0.75	post	8.00 ab	8.50 abc	9.75 a	644 abc
Cinmethylin + Oxyflurofen	0.6+0.5	pre	2.50 c	5.50 cdef	9.50 a	137 d
Cinmethylin + Oxyflurofen	0.75+0.5	pre	2.25 c	5.75 bcdef	10.00 a	119 d
Oxyflurofen	0.5	pre	8.25 ab	9.00 a	8.75 a	569 abc
Napropamide	2.0	pre	9.25 ab	9.50 a	10.00 a	595 abc
Napropamide + Sethoxydim	2.0+0.1	pre + d post	8.50 ab	9.50 a	9.75 a	595 abc
Napropamide + Sethoxydim	2.0+0.2	pre + d post	8.25 ab	8.25 abcd	10.00 a	594 abc
Napropamide + Sethoxydim	2.0+0.3	pre + d post	8.25 ab	9.25 a	9.75 a	519 bc
Napropamide + fluazifop	2.0+0.25	pre + d post	8.25 ab	3.75 f	8.75 a	535 bc
Pyridate	0.9	d post	8.75 ab	7.00 abcde	2.00 c	499 bc
Pyridate	1.8	d post	9.00 ab	8.50 abc	0.50 c	601 abc

[z]Rating of 10 equals no plant injury or complete weed control. 0 equals plant death or no weed control.
[y]Mean separation in columns by Duncan's multiple range test, 5% level.

Napropamide provided good broadleaf weed control in all other treatments, and the lack of control in the napropamide-fluazifop treatment is unexplained.

An antagonism may exist between cinmethylin and oxyflurofen when applied as a tank mix. The increased phytotoxicity and reduced broadleaf control of these materials over each applied separately indicates more research should be done to check this phenomenon.

Differences in yield between treatments can be attributed directly in most cases to the loss of vigor due to either lack of specific weed control or phytotoxicity from the herbicide or both.

Bok choy vigor ratings were taken on 25 Apr. in Gainesville to evaluate early phytotoxicity (Table 3). Weeds were not evident at this time. The use of oxyflurofen, metolachlor and diethaltyl, significantly reduced vigor over the untreated bok choy. The symptoms ranged from stunting and leaf twisting to death of the plants. On 11 May, the loss of crop vigor was still evident (Table 3). Several weeks before harvest, however, the plants started to grow out of the stunting.

Bok choy treated with both rates of oxyflurofen, the low rates of metolachlor and diethaltyl produced yields equal to the hoed check. The yield with the higher rate (2 x) of metolachlor was reduced significantly from that with the hoed check and that with diethaltyl but not significantly lower than with any of the other treatments.

Grass control was excellent with all treatments. Broadleaf weed control was not obtained, nor expected to be obtained with sethoxydim or fluazifop-butyl. The yield reduction in these treatments can be attributed to broadleaf weed competition in the plots.

Table 3. The influence of pre and posttransplant herbicides on Bok Choy vigor, weed control and yield at Gainesville, Spring 1986.

Treatment	Rate (lb. ai/acre)	Method of application	25 Apr.	11 May[z]			Yield (crates/acre)
			Vigor	Vigor	Broadleaf	Grass	
Hoed check	—	—	10.00 a[y]	10.00 a	10.00 a	10.00 a	538 ab
Unhoed check	—	—	10.00 a	10.00 a	0.00 d	0.00 c	418 bc
Metolachlor	1.5	post	6.75 b	6.75 cd	10.00 a	10.00 a	472 abc
Metolachlor	3.0	post	5.75 c	5.25 de	10.00 a	10.00 a	389 c
Diethaltyl	2.0	post	7.25 b	7.00 bcd	10.00 a	10.00 a	570 a
Napropamide	2.0	post	9.50 a	9.50 a	9.00 a	10.00 a	462 abc
Oxyflurofen	0.25	pre	5.25 cd	6.00 de	10.00 a	10.00 a	432 abc
Oxyflurofen + Sethoxydim	0.25 0.25	pre + d post	4.50 d	6.25 d	10.00 a	9.75 b	410 bc
Oxyflurofen	0.50	pre	3.00 e	4.00 e	10.00 a	10.00 a	456 abc
Sethoxydim	0.30	d post (3 app.)	10.00 a	9.00 ab	1.00 cd	10.00 a	378 c
Fluazifop	0.25	d post (2 app.)	10.00 a	8.50 abc	2.25 c	10.00 a	411 bc
Fluazifop	0.50	post (2 app.)	10.00 a	7.25 bcd	5.00 b	10.00 a	436 abc

[z]Rating of 10 equals no plant injury or complete weed control. 0 equals plant death or no weed control.
[y]Mean separation in columns by Duncan's multiple range test, 5% level.

Table 4. Influence of posttransplant herbicides on Bok Choy vigor and weed control at Zellwood. Spring 1986.

	Rate (lb. ai/acre)	Method of Application	Ratings[z] Vigor	Weed Control
Hoed check	—	—	10.0 a[y]	10.0 a
Unhoed check	—	—	10.0 a	0.0 e
Metolachlor	1.5	post	4.25 b	7.25 bc
Metolachlor	3.0	post	1.0 c	8.0 b
Diethaltyl	2.0	post	5.5 b	6.0 cd
Napropamide	2.0	post	4.25 b	6.5 cd
Fluazifop-p-b	0.5	d post	10.0 a	6.75 bc
Fluazifop-p-b	0.5	d post	10.0 a	6.0 cd
Sethoxydim	0.3	d post	10.0 a	5.25 d

[z]Rating of 10 equals no plant injury or complete weed control. 0 equals plant death or no weed control.
[y]Mean separation in columns by Duncan's multiple range test, 5% level.

Table 5. Influence of pre and postemergence herbicides on yield of Napa and Bok Choy at Loxahatchee. Spring 1986.

Treatment	Rate (lb. ai/acre)	Method of appication	*Yield (crates/acre)* Napa	Bok Choy
Hoed check	—	—	412 a[y]	587 ab
Unhoed Check	—	—	329 c	487 ab
Diethaltyl	2.0	pre	—	542 ab
DCPA	6.0	pre	—	547 ab
Napropamide	2.0	pre	—	565 ab
Metolachlor	1.5	pre	—	582 ab
Metolachlor	3.0	pre	—	572 ab
Metolachlor	1.5	post	350 bc	520 ab
Metolachlor	3.0	post	325 c	442 b
Fluazifop	0.25	d post	363 abc	560 ab
Fluazifop	0.5	d post	376 abc	545 ab
Sethoxydim	0.3	d post	392 ab	660 a
Sethoxydim	0.3 + 0.3	d post	354 abc	557 ab

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

At the Zellwood location (Table 4), metolachlor, diethaltyl and napropamide significantly reduced vigor of the transplants. The high rate of metolachlor severely reduced the plant stand. Although yield was not obtained, it was noted that the plants treated with the lower rate of metolachlor, diethaltyl, and napropamide recovered from the stunting as the crop neared harvest.

At the Loxahatchee location, herbicides were applied both pre and postemergence to the crops (Table 5). The major weeds present were grass species. All herbicides provided excellent weed control with no significant differences in weed control among the herbicide treatments. Napa yield was not significantly different between the hoed check and the delayed post grass herbicides, fluazifop and sethoxydim treatments. Yield was reduced where the 2x rate of metolachlor was used, but it was not significantly lower than with the weedy check and the other treatments except the hoed check and sethoxydim at 0.3 lb./acre.

Bok choy yields were good with all treatments. The metolachlor treatment at 3 lb./acre, yield was lower than the single 0.3 sethoxydim treatment. All other yields were not significantly different from each other.

The studies demonstrate that there are differences in tolerance between related crops, i.e. cabbage and bok choy at Gainesville and bok choy and napa at Loxahatchee to several herbicides. Bok choy also demonstrated differences in tolerance to the same rate of several herbicides at the 3 locations in this study.

The herbicides in this study show promise for possible future use in the 3 vegetables. More work is needed to establish proper rates for weed control and crop tolerances among the different soil types and cropping practices within the state.

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IMPROVED STAND ESTABLISHMENT AND YIELD OF SAND LAND GROWN LETTUCE BY SEED TREATMENT AND SOIL AMENDMENTS

D. N. Seale and D. J. Cantliffe
Vegetable Crops Department
University of Florida, IFAS
Gainesville, FL 32611

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Abstract. **Experiments were conducted to determine if stand establishment and yields of lettuce (*Lactuca sativa* L.) grown on sandy soils could be improved by the use of seed treatments and/or soil amendments at the time of sowing. Pregerminated seeds resulted in rapid emergence under cool temperature conditions, however, total emergence was generally reduced. Seed priming generally improved stand uniformity but total stands were similar to nontreated seeds. Stand establishment was improved most when seeds were covered with high temperature fired (LVM) calcine clay (GrowSorb) regardless of the moisture conditions during the emergence**