removal of the terminal bud resulted in correspondingly later maturity and plants that were not disbudded were ready for single-harvesting, on the average, 2 days later than those that were disbudded at the 11-whorl stage (Table 2).

The most beneficial effects of termial bud removal were earlier maturity and increased yields of smaller sized sprouts. These results indicate that terminal bud removal from 'Jade Cross' plants after 9 whorls of sprouts have formed does not affect total marketable yields. Therefore, by scheduling terminal bud removal, the optimum harvest period can be extended to approximately 12 to 14 days without affecting total marketable yields and over a considerably longer period if the aim is to produce maximum yields of smaller sized sprouts. Knowledge of the effect of terminal bud removal on the maturity and size of 'Jade Cross' sprouts can be of assistance to a grower or processor in obtaining earlier production, in scheduling an extended harvesting period and in producing desirable product size.

Table 2. Means and standard errors for number of days from transplanting to terminal bud removal and to single-harvest of 'Jade Cross' Brussels sprouts (1965, 1966, 1967, 1968).

Treatment no.	No. whorls formed when terminal bud removed	Days to terminal bud removal	Days to harvest
1	1	43 ± 1.2	69 ± 4.1
2	3	48 ± 1.0	74 ± 3.4
3	5	53 ± 2.4	79 ± 4.5
4	7	58 ± 3.3	84 ± 4.6
5	9	64 ± 3.5	92 ± 3.6
6	11	74 ± 2.6	102 ± 4.5
7	Terminal bud not removed		104 ± 4.2

The application of terminal bud removal on 'Jade Cross' can not be justified exclusively on the basis of increased marketable yields of sprouts within diameter sizes 1.27-4.13 cm (1/2 to 1 5/8 inch).

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Incompatibilities Between Herbicides and Insecticides in Direct-Seeded Brassica Crops[1]

Jack A. Freeman and D. G. Finlayson[2]

Canada Department of Agriculture

Agassiz, British Columbia

Abstract. **The compatibility of 5 preemergence herbicides and 3 insecticides applied in silt loam was assessed in 4 brassica crops by comparing their effects on germination, plant stand, and yield. Several combinations were deleterious. The herbicides CDEC and DCPA in combination with the insecticide thionazin reduced plant stand in cabbage and cauliflower. Herbicide C-7019 in combination with the insecticide fensulfothion was incompatible for cabbage and broccoli. Cabbage germination was reduced; while with broccoli both the germination and crop yield were affected. C-7019 alone reduced the germination of cauliflower and in combination with fensulfothion the damage was increased. This herbicide was phytotoxic to rutabaga. When nitrofen was combined with the insecticides, plant stands of cauliflower and rutabaga were affected. Nitrofen and thionazin together reduced the plant stand of cabbage. Propachlor at 4 lb./acre was compatible with any of the three insecticides for the four crops. However, the plant stand and yields of all four crops were reduced in plots treated with propachlor at 6 lb./acre in combination with thionazin. Propachlor with the insecticide carbofuran injured only broccoli. The herbicides did not affect the efficacy of the insecticides.**

In coastal British Columbia stem brassica crops are normally transplanted and harvested over a long period. With ever-increasing labor costs this has become uneconomic, and the industry requires a method for direct seeding and mechanical harvesting. It follows that selective herbicides must be available for weed control. In addition, the cabbage maggot *(Hylemya brassicae* Bouche), a serious pest of these crops, must be controlled. Since recommendations for chemical control of weeds and root maggots are needed, information is essential on the compatibility of herbicides and insecticides applied to field-seeded brassica crops. Compatibility, as defined by Sharvelle (9) is the ability of the plant-protective materials to be used together without loss of effectiveness or damage to the host.

In 1967 a study was initiated to examine the actions of herbicides and insecticides and their interactions in combinations applied to field-seeded brassica crops. Preliminary results (5) revealed that the herbicide C-7019 used as a preemergence treatment on field-seeded cabbage was incompatible with the insecticides fensulfothion (Dasanit) and thionazin (Zinophos). The investigation was broadened in 1968 to include 5 herbicides, 3 insecticides and 4 brassica crops.

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[2]Canada Department of Agriculture, Vancouver 8, British Columbia.

The 5 preemergence herbicides and rates in pounds of active ingredient per acre were: 2-azido-4-isopropylamino-6-methylmercapto-*s*-triazine (C-7019) at 2 and 4 lb./acre; 2-chloroallyl diethyldithiocarbamate (CDEC) at 4 lb./acre; dimethyl tetrachloroterephthalate (DCPA) at 9 lb./acre; 2,4-dichlorophenyl *p*-nitrophenyl ether (nitrofen) at 2 lb./acre; and 2-chloro-*N*-isopropylacetanilide (propachlor) at 4 and 6 lb./acre. These were selected because of previous work or reported effectiveness for weed control in brassica crops. The insecticides were: 2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate (carbofuran), *O,O*-diethyl *O-p*-(methylsulfinyl) phenyl phosphorothioate (fensulfothion), and *O,O*-diethyl *O*-2-pyrazinyl phosphorothioate (thionazin). They were selected because of proven efficacy (3, 4) and current or pending registration for control of cabbage maggots resistant to organochlorine insecticides. The crops included stem and root brassicas: broccoli, cv. 'Northwest Waltham 29'; cabbage, cv. 'Earlihead'; cauliflower, cv. 'Snowball Y'; and rutabaga, cv. 'Laurentian.'

The crops were sown in 4 blocks, one for each crop, in silt loam. One untreated and 7 herbicide-treated plots comprised a replicate for each of the 4 brassicas. Each plot consisted of two 40-foot rows, seeded with a multiple-gear V-belt seeder at 2 g of seed per row. The plots were divided into four 10-foot sub-plots, one for each insecticide and one left untreated. All treatments were replicated 4 times. The herbicides were applied with a self-propelled plot sprayer at 20 psi preemergence to weeds and crop. The insecticides were applied as granules at 2 oz toxicant per 1000 ft of row in a 4-inch band over the seeded row immediately before the herbicide treatment. The granules were raked gently into the top inch of soil. A second application was made 28 days after seeding as a drench of 2 oz toxicant in 7 gal per 1000 ft to wet the plants and 3 inches of soil on each side of the row. The drench was applied under pressure with a Hudson Clipper Sprayer #6215. The rutabaga were drenched again at the same rate 49 and 70 days after seeding.

The compatibility of the pesticides was assessed by comparing their effects on germination, plant stand, and yield. Germination was determined by seedling counts made when the plants were in their first true-leaf stage. Plant stand was determined by counting the number of plants in each sub-plot at thinning, approximately 28 days after seeding. Effect on yield was determined by harvesting mature produce from each sub-plot. Several harvests were made in the stem brassica crops but rutabaga were harvested only once, 122 days after seeding. Sprinkler irrigation was applied when necessary.

Several deleterious combinations were identified in this study as follows: Both CDEC and DCPA in combination with thionazine reduced plant stand in cabbage and cauliflower. When C-7019 was used in combination with fensulfothion the combination was incompatible for cabbage and broccoli. Cabbage germination was reduced; while with broccoli both the germination and crop yield were affected. There was also a tendency for the C-7019-thionazin combination to affect these crops. C-7019 alone reduced the germination of cauliflower and in combination with fensulfothion the damage was increased. Also this herbicide was phytotoxic to rutabaga. When nitrofen was combined with the insecticides, plant stands of cauliflower and rutabaga were affected. Nitrofen and thionazin together reduced the plant stand of cabbage, but no detrimental effect appeared in broccoli when nitrofen was applied in combination with any of the insecticides. Propachlor showed considerable promise as a preemergence herbicide for direct-seeded brassica crops. At 4 lb./acre this herbicide was compatible with any of the three insecticides for the four crops. However, at the 6-lb. rate in combination with thionazin the plant stand and yields of all four crops were reduced. Propachlor with carbofuran injured only broccoli. The herbicides did not affect the efficacy of the insecticides. Carbofuran and fensulfothion proved more effective than thionazin for maggot control. Cauliflower was the crop most susceptible to maggot attack, broccoli the least and cabbage and rutabaga intermediate.

Other investigators have reported deleterious interactions of pesticide combinations. In 1964, Ranney (7) found that the hexachlorophene-captan fungicide mixture when applied at planting time to control cotton seedling disease if used with phorate or Di-Syston resulted in root abnormalities. Applications of mercuric chloride and several organophosphorus insecticides in the transplant water for clubroot and maggot control in cauliflower resulted in loss of effectiveness of the insecticides (2). Shirakawa *et al.* (10) found that leaf injury occurred when solan, a herbicide, was used too soon before or after application of several insecticides or fungicides. Combinations of the herbicide diuron with the insecticides disulfoton and phorate in the soil resulted in synergistic phytotoxicities (6). Experiments by Waywell *et al.* (11) indicated that propanil should not be used with the insecticides Sevin, Thimet or malathion on potatoes. Ranney *et al.* (8) examined combinations of fungicides, herbicides, and insecticides and found several that were incompatible. In contrast, Crabtree and Crowell (1) found that soil incorporation of thionazin and trifluralin, applied as a tank mix of emulsifiable concentrates in water, did not change the biological activity of either pesticide or produce observable phytotoxicity to any of seven crucifer crops studied.

In order to reduce the possibility of economic losses it is essential to know of interactions of plant protectant materials which result in deleterious conditions in plants. While physical and chemical incompatibilities of materials can occur in spray tank mixes, very serious interactions do occur by applying pesticides to soil or plants either simultaneously or serially within a short period of time. The results emphasize the importance of studying different phases of crop protection.

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