CONVENTIONAL VERSUS ALTERNATIVE PEST MANAGEMENT SYSTEMS IN CABBAGE CROPS

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SUMMARY

A cabbage production system using conventional pesticides was compared with a range of alternative methods over three seasons. Using conventional pesticides gave the highest yields overall, but the use of a crop cover to exclude insects from the crop, gave comparable yields. A system using "natural" insecticides selectively, increased crop yields but only when insect damage levels were high. Companion planting using African marigolds and parsley had no effect on crop yield. The provision of a refuge strip of rank pasture to provide shelter for invertebrate predators, did not improve crop yield and sometimes reduced it. When sown in the spring 65% of the cabbages in the untreated plots were harvestable, but only 34% of summer transplanted cabbages were marketable mainly because of increased white butterfly caterpillar damage.

Keywords: cabbages, *Pieris rapae*, *Deroceras reticulatum*, *Brevicornye brassicae*, crop covers, companion plants, refuge strip.

INTRODUCTION

The sustainability of modern conventional agriculture, with its associated high rate of pesticide use, has been a topic of increasing concern since the publication in 1962 of Rachel Carson's "Silent Spring". The problems associated with excessive pesticide use are well documented (Lampkin 1990), with the resultant public opinion and personal philosophies of some growers leading to alternative systems of production with reduced or no reliance on manufactured chemical inputs. While the effectiveness of pesticides as an efficient and simple tool for crop protection has been well demonstrated, the same cannot always be said for various proposed alternative practices, although some such as crop covers (Antill and Davies 1990; McKinlay 1990), and intercropping (Coaker 1990) show promise. Often these methods are seen by large scale producers as difficult to implement, or ineffective. The objective of this study was to develop recommendations for plant protection methods for growers who wish to reduce reliance on pesticides while continuing to produce crops of marketable quality by otherwise conventional methods.

METHODS

Trials were conducted on a Wingatui silt loam, near Mosgiel on the Taieri Plain, over three consecutive seasons (1990/91-1992/93). On 18 October 1990 and 12 November 1991 cabbage seedlings were transplanted into ground cultivated from ryegrass / white clover pasture earlier in the spring of that year. In 1992 the area had been cultivated from pasture the previous autumn, sown in green manure oats and cultivated again in spring 1992. Successive crops were established by planting alternate rows on 10 November 1992 and the remaining rows on 23 December 1992. The variety 'Gourmet' was planted in 1990, but subsequent crops were 'Stonehead', both varieties which are commonly grown on the Taieri Plain. There were four blocks of six 6 x 9 m plots in a randomised block design. A buffer zone of 3 m surrounded each plot. This was kept free of vegetation by regular rotary hoeing. Seedlings were planted at 55 cm spacings on ridges 75 cm apart.

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Treatments

(1) Untreated; No control of invertebrate pests. Plots were hand-hoed one month after planting to control weeds.

(2) Conventional pesticides. In 1990 endosulfan (Thiodan 35 EC) was applied at 525 ml/ha 6 weeks after transplanting and then fortnightly until cabbage development indicated the majority were 3 weeks away from harvest. In the 1991 and 1992 crops demetom-S-methyl (Metasystox) at 200 ml/ha plus lambdacyhalothrin (Karate) at 10 ml/ha were used 2 weeks after planting and fortnightly until 3 weeks before the estimated peak harvest. Applications of methiocarb (Mesurol 2% baits) were made after 2 and 5 weeks to the 1992 planted crops. Herbicides used were desmetryne (Semeron 25 WP) 250 g/ha applied 6 weeks after planting in 1990 and aziprotryne (Brasoran 50 WP) 2 kg/ha 2 weeks after planting in 1991 and 1992 crops.

(3) "Natural" pesticides applied when damage was observed. Pyrethrum at 35 ml/ha plus piperonyl butoxide at 141.3 ml/ha (Yates Pyrethrum) applied 6 and 11 weeks after planting in 1990; pyrethrum at 92.5 ml/ha, rotenone at 750 ml/ha and piperonyl butoxide at 377.5 ml/ha (Coopers Liquid Derris) applied 5 weeks after planting in 1991, as above at planting and 5 weeks later for the spring planted crop in 1992, and 4 and 9 weeks after planting for the 1992 summer planted crop. Weed control was as for untreated plots.

(4) Companion plants. African marigolds var. Crackerjack (*Tagetes erecta*) to attract parasitic insects, and parsley (*Petroselinum crispum*) to mask the odours of cabbage plants, were planted between cabbage plants, in alternate rows of cabbages, at the time of cabbage planting in 1990 and 1991. In 1992 these species were planted at the same time as the spring planted crop and the summer cabbage crop was planted into the same rows as the parsley plants. Weed control was as for untreated plots.

(5) Refuge strip. Retention of uncultivated ground within the crop as a habitat for predators. A 2 m wide strip of pasture was left running the length of the plots and allowed to grow rank. Weed control was as for untreated plots.

(6) Crop covers. Prevention of invertebrate migration into the crop by using an exclusion net. In 1991 and 1992 (but not in 1990) plots were covered with Marix frost protection cloth at the time of planting and after application of pyrethrum plus piperonyl butoxide at the same rate as in Treatment 3. The edges of the cloth were covered with soil to prevent invertebrate entry. There was no weed control.

Measurements

Marketable cabbages, determined as those with no damage to heart, minor damage to wrap leaves and the complete absence of pests, were recorded and harvested as they reached the minimum acceptable head size of 175 mm diameter. The percentages of marketable cabbages harvested were analysed by analysis of variance. The number and cause of unmarketable cabbages were recorded. These were; leaf damage (caterpillar and slug feeding), aphids (presence or result of feeding) and other (twin heads, failure to heart or bolting). Cabbages rejected for harvest were not removed from the plots.

The invertebrate pest fauna of the crop was determined at the beginning of harvesting of each crop by dissecting five cabbages from each plot and recording the numbers of each pest. The data for each season were analysed as a generalised linear model with Poisson distribution and log link function, fitting terms for block and treatment. Average standard errors were calculated for each case, scaled by the residual standard deviation if there was evidence of extra Poisson variation.

RESULTS AND DISCUSSION

Cabbage yields

In the 1990/91 crop, the percentage of marketable cabbages grown under the conventional pesticide treatment was lower than for other treatments (Table 1). This was attributed to phytotoxicity from the use of desmetryne and poor control of weed grasses resulting in competition. Furthermore, the decision to stop applying insecticide to these plots to meet the required with-holding period was made too early and

subsequent attack from white butterfly (*Pieris rapae* (L.)) larvae occurred before the cabbages were ready for harvest, resulting in low yields. In subsequent years the marketable yields from this treatment were significantly greater than from the untreated plots with virtually no losses due to insects (Table 1).

Similarly in 1991/92 the crop cover was damaged by strong winds soon after being put in place allowing white butterfly and brassica aphids (*Brevicornye brassicae* (L)) to gain entry. The result of this treatment at this time cannot therefore be regarded as indicative of the potential of the method. In 1992/93 the crop cover successfully excluded insects from both crops and gave similar yields to the conventional management system in both cases (Table 1).

The untreated plots for all spring plantings yielded on average 65% marketable cabbages suggesting that by using action thresholds, such as reported by Beck *et al.* (1992), pesticide use could be reduced and perhaps eliminated from spring planted cabbage crops in the area. No evidence was found that the "natural" insecticide, companion plant or the refuge strip treatments improved on the yield from the untreated plants. The refuge strips were associated with depressed yields in the 1991/92 crop (Table 1) possibly as a result of slugs moving from the strip into the crop and increased white butterfly presence due to the shelter provided by the rank vegetation.

The untreated cabbages planted in summer 1992/93 suffered more damage than any of the spring planted crops (Table 1), indicating greater pest pressure on the cabbages at this time. In this case the selective use of "natural" insecticides did improve yields, but the companion plant and refuge strip treatments gave no relief from insect attack.

Of cabbages rejected for harvest in all crops, the majority (87-99%) were as a result of leaf feeding by white butterfly caterpillars.

Weeds growing under the crop covers did not appear to affect cabbage growth but docks (*Rumex* spp.) were able to penetrate the material resulting in holes that could allow insect entry.

TABLE 1: Cabbages harvested as a percentage of cabbages planted.

Treatment	1990/91	1991/92	1992/93 (spring)	1992/93 (summer)
untreated	68	57	70	34
conventional pesticides	42	83	91	98
natural pesticides	63	60	70	65
companion plants	66	58	74	34
refuge strip	61	30	67	29
crop cover	-	51	98	93
SED	7.4	4.5	6.1	7.7

Pest fauna

The most significant pest found in all the crops was white butterfly. There were no significant differences between treatments in numbers of these caterpillars found in cabbages in the 1990/91 crop (Table 2). In the 1991/92 crop caterpillars were not found in the conventional pesticide treatment but were present in all other treatments at similar densities (Table 2). In the 1992/93 crops caterpillars were not found in the conventional or crop cover treatments of either the spring or summer planted crop. In the 1992/93 spring crop there were no differences between other treatments (Table 2). Numbers in the refuge strip treatment in the 1992/93 summer crop were significantly higher than other treatments (Table 2). White butterfly adults were frequently observed seeking shelter in the lee of the strips during windy weather.

Grey field slug (*Deroceras reticulatum* (Muller)) numbers throughout the trial were low and slug feeding was generally confined to the older lower leaves of the cabbages which did not form part of the harvestable cabbage. This is not necessarily

the case when densities are higher (Ferguson, unpublished). There were no significant differences between treatments in numbers of slugs found per 5 cabbages in 1990/91 (range of treatment means = 0.3 - 4.5 slugs, SED = 1.4) or 1991/92 (range = 0 - 1.5 slugs, SED = 0.5,) except between the crop cover treatment and the conventional pesticide treatment (0 and 1.5 slugs respectively). In the spring 1992/93 crop there were more slugs found under the crop cover treatment (8.5) than all other treatments (0 - 1.5 slugs, SED = 1.0). McKinlay (1990) has reported slug activity to be increased by crop covers. There were no significant differences in slug numbers in the 1992/93 summer crop.

TABLE 2: Number of white butterfly caterpillars per five cabbages at harvest.

Treatment	1990/91	1991/92	1992/93 (spring)	1992/93 (summer)
untreated	4.0	1.8	1.3	6.5
conventional pesticides	4.5	0	0	0
natural pesticides	4.3	1.5	1.5	4.3
companion plants	2.5	2.0	3.0	6.0
refuge strip	6.0	3.8	3.3	12.8
crop cover	-	3.0	0	0
SED	1.5	2.1	1.1	1.8

Generally, very low numbers of brassica aphids were found during the trial. There were no significant differences between treatments in the number of aphids found in cabbages in 1990/91. In 1991/92 a higher geometric mean number of aphids per 5 cabbages occurred in the crop cover treatment (3425) than in all other treatments (range = 0 - 40, SED = 15), as a result of the crop cover being damaged by strong winds, allowing aphid entry to the crop where conditions under the cover favoured survival and increase. This population explosion was followed by a collapse immediately prior to harvest allowing some of the cabbages to be harvested. Aphid numbers in the 1992/93 spring crop showed no differences between treatments (range = 0 - 63, SED = 35). In the 1992/93 summer planted crop no aphids were found in the conventional pesticide treatment, crop cover or the refuge strip treatments, but they were present in the other treatments (range = 13 - 64, SED = 25).

The trial did not allow for efficacy comparisons between a regular conventional and "natural" pesticide spray programme. If the latter were applied on a routine basis, regardless of damage to the cabbages, the results may have been more similar to those achieved by the conventional pesticides.

CONCLUSIONS

When it was carried out correctly, there was a clear advantage in producing cabbage crops using the conventional pesticide treatment or crop covers to exclude insects. Crop covers are expensive but the grower will reduce pesticide costs by using them and they have the advantage of accelerating growth and advancing the harvest date. The selective use of "natural" insecticides in this study did not provide the same level of plant protection as the routine use of conventional pesticides, but gave a higher yield than the untreated control when insect attack was most severe. The companion plants used had no effect on cabbage yields, and the refuge strip was ineffective. On the Taieri Plain spring planting of cabbages can yield satisfactory crops without the use of any pesticides. The loss of market returns relative to using a conventional spray programme would be compensated for by savings on pesticides.

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REFERENCES

Antill, D.N. and Davies, J.S., 1990. The use of nonwoven crop covers to prevent insect pests on field vegetables. Organic and Low Input Agriculture. *BCPC Mono. No. 45*: 213-217.

Beck, N.G., Herman, T.J.B. and Cameron P.J., 1992. Scouting for lepidopteran pests in commercial cabbage fields. *Proc. 45th N.Z. Plant Protection Conf.*: 31-34.

Carson, R., 1962. Silent Spring. Houghton Mifflin, Boston. 317p.

Coaker, T.H., 1990. Intercropping for pest control. Organic and Low Input Agriculture. *BCPC Mono. No. 45*: 71-76.

Lampkin, N., 1990. Organic Farming. Farming Press Books. United Kingdom. 701p.

McKinlay, R.G., 1990. Pest management in vegetable brassicas without insecticides. Organic and Low Input Agriculture. *BCPC Mono. No. 45*: 205-208.