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THE EFFECT OF DEFOLIATION ON YIELD OF BRUSSELS SPROUTS

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Summary

The effect of defoliation on yield of brussels sprouts (*Brassica oleracea* var. *gemmifera*) was examined by using white butterfly (*Artogeia rapae*) larvae and artificial means to remove leaf area at stages throughout plant growth. Significant negative correlations were found between larval numbers and yield. Artificial defoliation revealed that greatest yield losses follow mid-season defoliation but that compensation was an important factor especially in the early stages of crop growth.

INTRODUCTION

The general effect on yield of plant defoliation, whether by insect pests, hail or other means is not always clear. Frequently yield losses are reported following defoliation but often compensatory growth may occur resulting in no yield loss and even overcompensation when the defoliation results in an increase in yield (Bardner and Fletcher 1974). In order to predict the effects of defoliation and to establish efficient control actions the shape of the yield response curve must be determined. This will vary both between crops (Southwood and Norton 1972) and between growth stages within a crop (Jackson 1980).

In these experiments the effects of defoliation, both by white butterfly larvae and artificial means, were assessed on brussels sprout plants at defined periods throughout their growth.

METHODS

(a) Defoliation by white butterfly larvae

Plants for defoliation were randomly selected from within temporarily unsprayed plots of brussels sprouts, var. 'Jade X', transplanted at 60 x 60 cm spacing on 20 December 1978. In the first experiment, known as A1, fourth instar white butterfly larvae were placed on the plants in numbers ranging from 0-15 per plant 35 days from transplanting. These were arranged in a randomized block design with 6 treatments in each of the 4 blocks. The plants were covered with a cylindrical wire and fine gauze cage until larval pupation. The cages were then removed, the degree of defoliation visually assessed and the treated plants brought back into the normal spray schedule of the crop.

The second experiment, known as A2, was conducted with larval numbers ranging from 0-60 within 4 treatments. This trial was established on 30 March 1979 with all other procedures as described above. At harvest for both experiments, on 22 May 1979, all sprouts were removed from each stem and weighed.

(b) Artificial defoliation

To simulate the effects of larval feeding, plants were defoliated by 0, 25, 50, 75 or 100% of the leaf area at early, mid or late plant development. These stages were separated by approximately 6 weekly intervals. Leaves were cut, with scissors, alongside the midrib and defoliation followed the method described by Jackson (1980). The experiment was arranged as a randomized block design with the 15 treatments in each of six blocks. Each plot consisted of 12 plants and at the end of May the two centre plants in each plot were harvested, their sprouts removed and weighed.

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RESULTS AND DISCUSSION

Sprout weight following white butterfly defoliation is shown in Fig. 1. In both experiments significant negative correlations exist between defoliation and yield. There is, however, some suggestion that the response curve is non-linear but the trends appear to be masked by variations in factors such as plant size, feeding position and larval survival.

Fig. 1 Effect of white butterfly larval feeding on yield of brussels sprouts. Feeding commenced for A1 on 24 January 1979 and for A2 on 30 March 1979

The yields obtained following artificial defoliation are shown in Fig. 2. In each case there is a significant decrease ($P \leq 0.05$) in yield over the range of defoliation but it is clear that the shapes of these relationships vary between times of defoliation. Following early defoliation at T1, trend analysis (Denenberg 1976) indicates that the line of best fit contains a significant ($P \leq 0.05$) cubic element indicating, perhaps, strong compensation to intermediate levels of defoliation. After mid-season defoliation, at T2, a significant ($P \leq 0.01$) quadratic trend indicates that as the level of defoliation increases the rate of yield loss increases while following late defoliation at T3, the relationship is best explained by a linear function ($P \leq 0.05$) with no significant improvement by applying the quadratic or cubic models.

It seems that generally the curves obtained display elements of the sigmoid compensatory curve described by Tammes (1961). After larval feeding, curve A1 shows severe yield depression due to high levels of defoliation of the young plant while for A2, with maximum estimated defoliation less than 40%, it appears that only the upper compensatory portion of the curve is produced revealing little yield loss.

From the artificial defoliation curves it seems that at the early growth stage there is high yield loss only with extreme levels of defoliation. Greatest yield loss will follow mid-season defoliation when measured as a proportion of total leaf area. This has also been found for potatoes (Cranshaw and Radcliffe 1980) and sugar beet (Dunning and Winder 1972) and it has been suggested that the plant is able to recover from earlier defoliation while for late defoliation a considerable portion of the product is already formed. At the final defoliation time, T3, the relationship tends to be linear but losses are low as demonstrated by the shallow slope.

It seems clear from these results that plant compensation is an important factor that must be considered when determining pest control actions and also that it is a dynamic process which will vary throughout the growth of the plant.

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Fig. 2 Relationship between yield and artificial defoliation at three stages of brussels sprout growth. Defoliation dates; T1, 1 February 1979; T2, 13 March 1979; T3, 23 April 1979.

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REFERENCES

- Bardner, R., and Fletcher, K.C., 1974. Insect infestations and their effects on the growth and yield of field crops: a review. *Bull. ent. Res.* 64: 141-160.
- Cranshaw, W.S. and Radcliffe, E.B., 1980. Effect of defoliation on yield of potatoes. *J. econ. Ent.* 73: 131-134.
- Denenberg, V.H., 1976. Statistics and experimental design for behavioural and biological researchers. 344 pp. John Wiley and Sons, New York.
- Dunning, R.A. and Winder, G.H., 1972. Some effects, especially on yield, of artificially defoliating sugar beet. *Ann. appl. Biol.* 70: 89-98.
- Jackson, T.A., 1980. The effect of defoliation on yield of radish. *Ann. appl. Biol.* 94: 415-419.
- Southwood, T.R.E. and Norton, G.A., 1972. Economic aspects of pest management strategies and decisions. In *Insects: studies in population management*, Geier, P.W., Clark, L.R., Anderson, D.J. and Nix, H.A. (Ed.). Ecol. Soc. Aust. (Memoirs 1), Canberra: 168-184.
- Tammes, P.M.L., 1961. Studies of yield losses II. Injury as a limiting factor of yield. *Tijdschr. Plziekt.* 67: 257-263.