Effect of Lepidopterous Larval Populations On Processed Cabbage Grades[1]

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ABSTRACT

J. Econ. Entomol. 75: 141–143 (1982)

Lepidopterous larval populations on processed cabbage, from head initiation until harvest, were compared with percent cull material (a direct function of grade) in 27 commercial fields in New York over a 2-year period. Although larval populations varied considerably between fields and between years, no significant correlation (r^2 = 0.004, 25 df) between percent cull material and larval populations existed. The majority of cull material was green tissue which would have been removed regardless of lepidopterous injury. The rationale for strict control of lepidoptera on processing cabbage, from head initiation until harvest, was not found to be cost effective.

The major lepidopterous pests on cabbage in the United States are the imported cabbageworm, *Pieris rapae* (L.), the diamondback moth, *Plutella xylostella* (L.), and the cabbage looper, *Trichoplusia ni* (Hübner). Thresholds for lepidopterans on fresh market cabbage have been proposed by Green (1972), Shepard (1973), and Chalfant et al. (1979). These thresholds are unrealistic for sauerkraut (processed) cabbage, because it can tolerate more peripheral feeding injury since trimming occurs at harvest and during processing (Eckenrode et al. 1981). Furthermore, since the return per ha of processed cabbage is considerably less than that of fresh market ($1,842 and $8,790, respectively) (Anonymous 1979), growers cannot afford to adhere to strict fresh market standards.

U.S. Department of Agriculture (USDA) standards for processing cabbage have been defined (Anonymous 1944); however, processors in New York do not subscribe to these standards. Instead, most have adopted their own grading system based on a scale in which a grower is paid for the weight of a load multiplied by a factor indicating its quality. Cabbage is downgraded for quality factors such as insect damage, undersized heads, burst heads, tipburn, green material, and other factors involving appearance. Cabbage grown for processing is rarely treated for pests other than insects. Because of the quality rating system currently used by processors, growers assume they can increase their rating by preventing insect feeding damage to the head.

Our purpose was to investigate the relationship of processed cabbage grades to insect populations from head initiation until harvest. This knowledge will aid in determining the economic rationale for controlling lepidopterans on processed cabbage during this period.

Materials and Methods

In 1979 and 1980, weekly counts were taken of diamondback moth, imported cabbageworm, and cabbage looper larvae on 13 and 14 commercial fields, respectively. Counts were obtained by randomly sampling five plants per site at eight sites per field. Fields ranged in size from 2.5 to 12 ha. Counts are reported only for the period from initial head formation until harvest, since lepidopterous feeding during this period is suspected to be a threat to cabbage grade. Insect counts were standardized to take into account the foliage consumption of each pest. This method was employed to effectively relate insect feeding to head damage. Counts are reported in cabbage looper equivalents (CLE) per plant, where 1 CLE = 1 cabbage looper = 1.5 imported cabbageworm = 19 diamondback moth larvae (Harcourt 1954). Weekly counts in CLE per plant were added together to indicate a total exposure period to the larvae of the three species. This total was then correlated to percent cull material from the sampled fields.

At harvest, grade slips were procured from a cooperating processing company for each of 316 loads (ca. 8,000 kg per load) of cabbage harvested from the 27 sampled fields. Payment to growers is based on the grading of a subsample consisting of ca. 100 kg of randomly chosen cabbage per load. Unacceptable plant material (insect feeding damage, green leaves, or other imperfections) is trimmed, and other cull material (small, burst, or tipburn infected heads) is also discarded. All discarded material is combined to give a total weight of cull material. The remaining cabbage is the basis for payment, although another 10 to 20% more plant material will be removed during processing because of additional trimming and core removal. A merit system is invoked which penalizes growers whose cabbage grade (100% – percent total cull material), as determined by New York State Agriculture and Market graders, is below average (88–89%), and rewards those whose cabbage is above average.

Additional grade slips of all loads delivered to the processing plant were obtained for 1979 and 1980 as a comparison for our samples. In 1979, all types of cull material were combined into a single total. In 1980, weight of cull material was separated into five categories: (1) insect damage; (2) tipburn; (3) burst

[1] Approved by the Director of the N.Y. State Agric. Exp. Stn. for publication as Journal Paper No. 3361. Received for publication 26 May 1981.

0022-0493/82/0101-4103$02.00/0

heads; (4) undersized heads, diameter < 15 cm; and (5) green tissue.

Results and Discussion

Since growers do not have recommended action thresholds for processed cabbage, they apply control strategies based on personal judgments, and these varied considerably. Growers applied an average of 2.9 (range 1–4) and 2.8 (range, 1–5) sprays per field specifically against lepidopterans in 1979 and 1980, respectively. Hence, population pressure in individual fields from head initiation to harvest varied from 2.48 to 8.25 CLE per plant ($\bar{x}$ = 5.4) in 1979 and 1.84 to 28.2 ($\bar{x}$ = 13.6) in 1980. Although differences in population pressure caused differences in feeding injury to cabbage heads, they did not affect the amount of cull material or grade based on regression analyses. Regression equations for cull material versus CLE exposure were not different between years, so data were combined to give a better estimate of *P* (Snedecor and Cochran 1967). The correlation was not significant at any level (r^2 = 0.004, 25 df) (Fig. 1).

In 1980, green plant tissue accounted for 9.4%, by weight, of harvested cabbage and thereby 91.2% of all cull material. Any other cull category did not contribute more than 0.61%, by weight, of harvested cabbage (Table 1). Only one load in 316 during 1980 was downgraded for insect damage, and this was for thrips found between head leaves. This load still had an acceptable grade of 89%. In the 27 sampled fields of 1979–1980, total cull material averaged 10.1%, similar to the 10.8% cull material of all loads received by the processor.

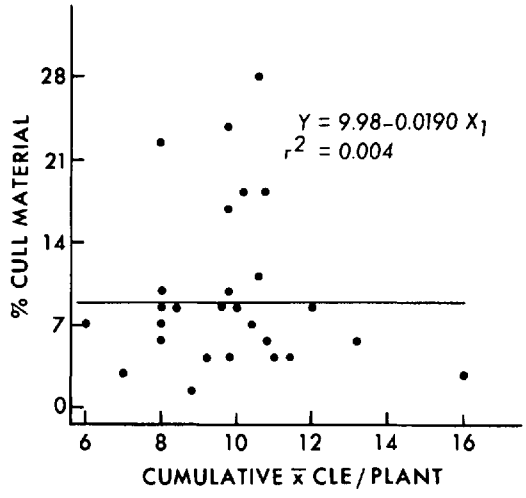

FIG. 1.—Relationship of percent cull material, by weight, to cumulative mean CLE per plant from head intitiation until harvest. Ontario and Yates Counties, N.Y., 1979–1980.

Based on figures supplied by one processor, at an average yield of $1,842/ha, a 3% increase in grade would return $144/ha more to the grower. Such a high profit incentive might easily encourage growers to adhere to very strict control of lepidopterans in the hope that it would increase profits. Even with three additional insecticidal sprays to control lepidopterans, a grower would still retain about half of this increase in profit. This rationale, however, becomes suspect because of the lack of relationship between larval counts and percent cull material. This phenomenon is due to the nature of feeding by these insects. Because they do not bore into the head, but rather graze on the outer leaves, there is little chance that they would become contaminants of sauerkraut, since removing the outer leaves effectively removes these insects also. Most importantly, however, these populations are found on the outer green head leaves which are trimmed during harvesting and processing anyway. This green tissue has been identified as the chief quality defect in sauerkraut, since its incorporation causes discoloration of the sauerkraut (Promisel 1977). Under normal population pressures, when lepidopterans will confine their feeding to the frame or peripheral green head leaves, strict control of the populations is not cost effective. Under unusual and heavier lepidopteran pressure, it is conceivable that deeper head injury could occur so that trimming of potentially usable cabbage would result. However, under the population pressure experienced during the 2 test years, processing grades were not a direct function of lepidopterous populations. The question of lepidopterous feeding injury to frame and head leaves and possible reduction of head weight remains to be answered.

Acknowledgment

We express sincere thanks to the New York Vegetable IPM Program, local growers, and processors.

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Table 1.—Mean percent cull material, by weight, of 316 loads of processing cabbage harvested from 14 commercial fields, Ontario County, N.Y., 1980

Cull category					
Green tissue	Undersized heads[a]	Burst heads	Tipburn	Insect	Total
9.40	0.61	0.14	0.13	0.03[b]	10.31

[a] Head diameter < 15 cm.
[b] Only one sample downgraded for thrips infestation. No loads were downgraded specifically for lepidopteran injury.

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