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QUESTIONS ABOUT DETASSELING AS A CONTROL TECHNIQUE AGAINST THE ASIAN CORN BORER (*OSTRINIA FURNACALIS* (GUENEE), PYRALIDAE, LEPIDOPTERA)[1]

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ABSTRACT

A review of previous studies on detasseling as a control technique for the corn borer indicated that the technique does not always translate to higher yields. The following are possible reasons. The effect of detasseling is restricted to only a fraction of the population infesting corn late in the growth stage of the plant and these are larvae of egg masses deposited about a week or two before detasseling and those larvae that happen to be on the tassel. Furthermore, the majority of the larvae found on the tassel (the individuals that are eliminated by detasseling) usually bore the stalk above the ear and these borings have only minimal effects on yield. It is suggested that the technique should be further evaluated moreso in the light of recent findings elsewhere that pollens are supplementary food items for several predators of the corn borer.

Keywords: Detasseling, Asian corn borer, *Ostrinia furnacalis* (Guenee)

BACKGROUND

Several local studies have suggested that by removing the tassel (detasseling) of maize plants just before pollen shedding, there is a significant reduction in corn borer larval numbers, consequently lessening loss in yield due to this borer (see Bato et al. 1989; Klitsaneephaiboon 1983; Rejesus and Javier 1985).

Studies by Schreiner and Nafus (1988) in Guam also indicated that detasseling can significantly reduce corn borer larvae (Table 1). However, they observed that detasseling maize did not always result to higher yield. They observed that in the second trial of their experiment, despite the relatively low numbers of corn borers on detasseled plants (Trial I - 3.6 larvae/plt versus Trial II - 2.6 larvae/plt) the level of damage to the ears was very high (Trial I - 40% damaged ear versus Trial II 70% damaged ear).

Similarly, although Bato et al. (1989) observed that detasseled plots tend to have higher yield compared to the plots with tassel in their verification trials in several corn areas of the Philippines, there was large variability in the ability of detasseling technique to reduce damage to yield by the corn borer (Table 2). There was large variability in yield between the detasseled plots and in the control plots from season to season and between trial sites. The results of field trials by Ambanloc et al. (1988), on the other hand, showed that detasseling did not result in a higher yield (Table 3).

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Table 1. Effectiveness of tillage method, detasseling and insecticide use on corn borer numbers and on percent damaged ears. (From Schreiner and Nafus, 1988, Table 1, Variety Hawaiian Super Sweet #9, conducted in Guam.)

TREATMENT	No. Borer/Plt		% Damage Ears	
	Till	No Till	Till	No Till
Trial I				
Untreated	11.6	7.6	51	40
Detasseled	3.6	5.2	41	42
Dipel + Detass.	4.6	3.7	37	40
Trial II				
Untreated	3.9	4.4	78	74
Detasseled	2.6	2.7	76	62
Dipel + Detass.	2.7	2.0	82	72

The analysis of the issue is complicated by studies showing that detasseled plants tend to result in higher yields than those with intact tassels for another reason: more nutrient for the ear and more sunlight for photosynthesis when tassels are removed (see Grogan 1956; Duncan et al. 1967) [Table 4].

ISSUES

The following questions are, therefore, critical: Why does detasseling not always lead to higher yield? Is the higher yield observed on detasseled maize plants due to the reduction in cornborer larval damage or due to other reasons?

This paper attempts to answer the first question - why detasseling does not always lead to a significantly higher yield? To answer this question, one should first understand how detasseling operates in reducing cornborer numbers and the effect of reduced number of borer to corn yield.

Table 2. Results of a verification study of the effect of detasseling on corn in different locations in the Philippines. (Corn Hybrid Pioneer 6181) yield. (Extracted from the data of Bato et al. 1989.)

AREA: SEASON	Yield (Tons/Ha) Detasseled	Intact Tassel	% Yield Difference
1. Bay, Laguna			
Wet 1982	4.9	3.5	39
Dry 83/84	6.6	5.6	17
2. Ilagan, Isabela			
Wet 1982	2.6	2.1	19
Dry 83/84	4.4	4.3	2.5
3. Villaverde, Nueva Viscaya			
Wet 1982	6.3	5.4	17
Dry 83/84	5.6	5.2	7.6
4. Pili, Camarines Sur			
Wet 1982	1.6	0.3	400
Dry 1983/84	4.7	4.2	11
5. Malaybalay, Bukidnon			
Wet 1982	1.6	1.0	64
Dry 1983/84	5.0	4.3	16
6. Valencia, Bukidnon			
Wet 1982	6.98	6.92	0.8
Dry 1983/84	5.2	5.1	2.3
7. Isulan, Sultan Kudarat			
Wet 1982	5.1	2.8	84
Dry 1983/84	4.3	2.7	56
8. Esperanza, Sultan Kudarat			
Wet 1982	4.7	2.2	112
Dry 1983/84	3.6	1.2	196

Table 3. The effect of detasseling on corn borer infestation and corn yield (Isabela Experiment Station #3 seeds). (Extracted from data of Posadas-Ambanloc et al. 1988.)

	No. Tunnel Per Plant	Damage Rating	No. Kernels Per Ear	Yield (Ton/Ha)
DRY SEASON 1988				
Detass 75% bet. rows	1.26	1.67	987.44	1.63
Detass 75% w/in rows	0.09	0.96	1102.22	1.62
Control	0.11	1.01	1099.67	1.63
WET SEASON 1988				
Detass 75% bet. rows	5.50	2.24	179.61	0.72
Detass 75% w/in rows	4.81	2.19	173.94	0.79
Control	5.84	2.20	198.50	0.68

Table 4. Percent increase in yield as affected by detasseling corn and plant spacing. (From Grogan 1956, Table 1.)

Corn Variety	Percent Increase in Yield					
	1951-52 Season			1952-53 Season		
	(Plant Spacing)					
	12"	18"	36"	9"	18"	36"
Jackson White	49.6	12.6	25.4	51.3	8.0	0.7
American White	28.5	11.2	11.1	42.2	4.7	13.3
Yellow Bushman	18.1	4.0	8.5	23.5	-4.2	-2.0

POSTULATED MECHANISM OF ACTION OF DETASSELING

Despite the popularity and alleged effectiveness of detasseling there has been no systematic study to elucidate how the technique can result to a reduction in cornborer and its damage to yield. The most that previous workers have offered were untested hypotheses which were based on field experiments comparing borer numbers, their damage (entrance holes) and yield between detasseled plots and undetasseled plots.

The first hypothesis was put forward by Rejesus and Javier (1985). They suggested that by removing the tassels, damage may be reduced since it is the habit of newly hatched "second generation" corn borer larvae to feed and stay on the tassels up to the third instar. In a later report, Rejesus (1988) stated that " At the tassel stage, many of the young larvae find their way into the unopened tassel of the corn plant, feed on the pollen grains and remain inside the tassel up to the third instar." Beginning the fourth instar, larvae usually bore into the stem. While their observations may be valid there are some questions when these observations are related to detasseling.

The second hypothesis is that by Schurr and Holdaway (1970) and they suggested that damaged plants, like by detasseling, may repel the European Corn Borer moths (*O. nubilalis*) to oviposit on these plants. Hasse (1981) and Klitsaneephaiboon (1983) proposed that this may also be true for the Asian Corn Borer (*O. furnacalis*). However, the results of Klitsaneephaiboon (1983) study indicated otherwise; more egg masses at 55 and 65 days after emergence were observed on detasseled plants but this was not significantly different from the undetasseled plants (Table 5). Further studies are needed to exhaustively test this hypothesis.

Table 5. Mean number of egg masses of the corn borer at 55 and 65 days after plant emergence (DAE) as affected by detasseling. (Data from Klitsaneephaiboon 1983, Table 33, Dry season, Feb.-May 1983).

	No. Egg Masses*	
	55 DAE	65 DAE
Detasseled	0.35	0.10
Intact Tassel	0.60	0.16

*No significant differences between treatment means.

To evaluate the proposed mechanism of action of detasseling by Rejesus and Javier (1985), one has to know a) the larval dispersal behavior, and b) the survival rate of the corn borer when feeding on pollen.

Larval Dispersal Behavior

There are evidences that early instar larvae are indeed found in large numbers on the tassels and it appears that the concentration point of the larval population on a plant is on this plant part (Camarao 1976, Klitsaneephaiboon 1983) [Table 6]. But during the vegetative stage larvae are concentrated in the whorl (Camarao 1976).

Studies by Hasse (1981), however, appear to contradict the above findings. He reported that newly hatched larvae have a strong urge to actively disperse and that they exhibit "ballooning" by spinning silken threads. This is a means by which interplant movement is effected. The disturbing questions are : How can there be a concentration of larvae in the whorl at vegetative stage, and on the tassel at reproductive stage if newly emerged larvae actively disperse? Or if they do concentrate, does concentration of the larvae in the whorl and on the tassel occur after the dispersal phase?

Alternatively, one has to bear in mind that we are dealing with a population -- that some individuals balloon, but other individuals may not. Some of the individuals that do not balloon may be those that end up aggregating in the whorl or on the tassel. However, data have to be generated on the proportion of the population that aggregates in the whorl and on the tassel if we are to put more weight on this hypothesis.

It appears, however, that neither the whorl nor the tassel is a highly preferred habitat for the early instar larvae. In other words, their aggregation on these plant parts is not a behavioral one dictated by resource availability (e.g. pollen and young leaves); the larvae are found in the whorl and on the tassel not because of the food but for other unknown reasons. In a field study conducted at the UPLB Experimental Station to establish the larval dispersal behavior of

Table 6. The proportion of corn borer larvae found on different corn (variety Pioneer Hybrid 6181) plant parts at tassel emergence. (Extracted from the data of Klitsaneephaiboon 1983.)

Plant Part	Proportion of Larval Population (%) Wet Season	Dry Season
Tassel	86.40	68.11
Above Ear	5.56	14.72
Ear and Shank	5.31	10.50
Below Ear	2.74	6.86
Actual Larvae No.	61.39	20.85

newly-emerged larvae using IPB Var. 1 corn plants, unpublished data (Velasco, Obra and Rejesus 1990, Table 7) showed that: a) 50% of the larval population ballooned 1 hr after they were introduced, but after 2 hrs very few individuals ballooned; and, b) that only about 15% of the population were found on the emerged tassel after 24 hrs.

There may be another reason to explain the aggregation of larvae on the tassel. Larvae found on the tassel are those individuals that were on the whorl and when the tassel emerges they are carried along. There is, however, inadequate data about larval behavior to confirm this interpretation but this is the most plausible explanation considering that larvae are not particularly attracted to pollens.

Table 7. Within plant dispersal of newly hatched corn borer larvae under field conditions, UPLB-CES, IPB Var. 1. Newly- hatched larvae in an egg mass were introduced on to the under surface of the 9th leaf of plants with emerged tassel. There were three replicates per trial; a plant represented a replicate. (Unpublished data, Velasco, Obra and Rejesus 1990).

	Proportion of the Population (%)	
	Trial I	Trial II
Observation 1 hr After Introduction:		
Dispersing	87.62	70.47
Ballooning	53.78	38.58
Observation 2 hrs After Introduction:		
Dispersing	100	96.31
Ballooning	0	0
Observation 24 hrs After Introduction:		
Tassel	6.30	11.17
Silk/Ear	12.78	15.39
Stalk/ Leaf Axil	21.61	13.26

Larval Survival As Influenced By Pollen

There are studies to show that pollen can significantly increase survival of developing larvae of *Ostrinia nubilalis,* at least under laboratory conditions (e.g. Guthrie et al. 1969). There is no study to show that this is true for *O. furnacalis.* Furthermore, there is still a need to quantify the importance of pollen to larval survival under field conditions and to relate this to the behavior of the larvae and the damage they inflict. This is made urgent, in the light that larvae do not seem to be attracted to the tassel (Table 7) where pollen are found before these are shed.

WHY DETASSELING DOES NOT ALWAYS LEAD TO A SIGNIFICANTLY HIGHER YIELD

In the proposed mechanism of action of yield increase due to detasseling Rejesus and Javier (1985) argued that detasseling should be done before pollen shedding because the old larvae on the tassel begins to migrate to lower plant parts when pollen grains are shed. The assumption here is that the larvae on the tassel migrating to the lower plant parts are capable of doing damage to the plant and that this will lead to a significant reduction in yield. There are observations confirming that the larvae on the tassel do migrate to lower plant parts after pollen shedding and that they bore into the stem. In a study conducted by Regis and Velasco (1991, Unpublished data, Table 8) it was observed that the newly-hatched larvae that were introduced migrated later on to the lower plant parts and some bored into the stem. However, the damage (boring) to the plant will lead to a significant reduction in yield only if there is boring in the (a) ear shank, or (b) in the harvestable ear, or (c) if the boring is done in the stem below the ear. If boring is done in stems above the ear, especially near the tassel or in the tassel, reduction in yield is insignificant. The effect of boring the stem above the ear would be similar to detasseling. Thus, the location of the boring is critical to effect reduction in yield. The experimental results of Regis and Velasco (1991, Table 8) showed that the larvae from the tassel bored mainly in stems above the ear and it is expected that the damage done by these individuals will not result in a significant reduction in yield.

Thus, though detasseling can reduce significantly corn borer numbers and larval boring on the plant this does not always translate to higher yield. A regression analysis of the data of Rejesus and Javier (1985) indicated that there is a weak cause and effect relationship between borer numbers and number of entrance holes, and between number of entrance holes and yield (Table 9). Reduction in larval number does not always lead to a higher yield because what is critical is the location of boring. Even if larvae are numerous on the tassel but if boring are concentrated on the stem above the ear yield reduction will be insignificant.

The effectiveness of detasseling to eliminate larvae is obviously limited to individuals that happen to be on the tassel. Detasseling is recommended 56 days after plant emergence and this is before pollen shedding (Rejesus and Javier 1985). This means that the tassel had been out for only about a few days. The larvae on the tassel are most likely from egg masses that were laid about a week or two before tassel emergence (i.e. 45-50 days after plant emergence). Larvae of egg masses laid before and after this period will be unaffected by detasseling. The effectiveness of detasseling to eliminate larvae is, therefore, dependent on the colonization behavior of adults and when egg masses are laid. This aspect has not been recognized in any of the previous work.

Table 8. Entrance holes by the corn borer larvae in different corn (IPB Variety 1) plant parts when newly-hatched larvae were introduced at pre-tassel stage and at tassel stage. Potted corn plants were used and the experiment was conducted inside a greenhouse. (Unpublished data, Regis and Velasco 1991.)

	Entrance Holes Per 5 Plants		
		Replicate	
Plant Part	I	II	III
LARVAE INTRODUCED AT PRE-TASSEL STAGE: [a]			
Tassel	2	2	2
Leaf Axil	8	7	6
Ear Shank	1	1	2
Below Ear	0	1	0
Total No. of Larvae Released	103	98	105
LARVAE INTRODUCED AT TASSEL STAGE: [b]			
Tassel	5	4	
Leaf Axil	7	7	
Ear Shank	3	1	
Below Ear	0	0	
Total No. of Larvae Released	75	110	

[a] Newly hatched larvae were introduced onto the leaves.

[b] Newly hatched larvae were introduced on the emerged tassel.

Colonization time and oviposition by adults on corn plants are affected by a multitude of complex and interacting environmental factors, these will surely vary from season to season and from place to place. Even in large adjacent fields, population dynamics of cornborer will differ significantly in many respects.

In a situation where egg deposition mainly occurs a week before tassel emergence then detasseling can reduce larval numbers. However, in a situation where egg masses are laid regularly beginning the time moths are attracted to corn plants (a month after emergence) until harvested, detasseling would be less effective in reducing corn borer larvae. Such a scenario will occur when corn is planted all year round and in an overlapping cropping pattern as in the situation in the U.P. Los Baños Experimental Station (Table 10), in Cebu and in most of Mindanao.

Table 9a. Regression analysis between number of corn borer larvae and borer holes. (From Rejesus and Javier 1985, Table 1, IPB Var 1, UPLB-CES.)

Treatment	Before Detasseling		After Detasseling	
	Larvae/Plt	Holes/Plt	Larvae/Plt	Holes/Plt.
1	0.43	0.47	1.92	0.98
2	0.77	0.28	2.32	1.37
3	0.85	1.13	2.97	2.28
4	1.13	1.58	2.43	7.72
5	1.05	0.77	7.23	2.37
6	1.60	0.67	2.50	1.80
7	2.27	1.50	3.02	3.32
8	3.80	2.00	3.08	3.62
9	2.12	0.08	3.20	2.78
10	2.58	0.30	3.60	2.98
11	1.88	0.30	2.57	2.28
12	2.53	1.78	3.62	3.47
13	3.22	1.30	3.23	3.87
Regression Coefficient:				
r=	0.45		0.79	

Table 9b. Regression analysis between a) number of corn borer larvae and borer holes, and b) borer holes and yield. (From Rejesus and Javier 1985, Table 4, IPB Var 1, UPLB-CES.)

Treatment	Borer/ 20 plts	Holes/ 20 plts	Yield (Tons/Ha)
1	2.20	4.40	1.93
2	4.40	5.20	2.02
3	3.43	4.63	1.58
4	3.28	5.07	1.79
5	2.30	3.48	2.04
6	3.48	3.90	2.31
7	1.72	3.35	2.98
8	4.17	4.70	2.38
9	3.35	4.60	1.57
Regression Coefficient:			
r=	0.79	-0.58	

Table 9c. Regression analysis between a) number of corn borer larvae and borer holes, and b) borer holes and yield. (From Rejesus and Javier 1985, Table 5, IPB Var 1, UPLB-CES.)

Treatment	Borer/ 20 plts	Holes/ 20 plts	Yield (Tons/Ha)
1	2.45	4.80	2.61
2	2.22	4.57	2.70
3	3.07	5.30	2.36
4	3.30	5.28	2.33
5	2.88	5.28	2.58
6	2.18	4.08	2.22
7	2.60	5.43	2.07
8	3.47	6.23	1.73
9	3.48	6.08	1.94
10	2.92	5.17	2.54
11	2.42	5.13	3.14
12	3.15	5.88	2.46
13	2.65	5.62	1.39
Regression Coefficient:			
r=	0.83	-0.48	

Table 10. Number of eggs (or egg masses) of corn borer collected in the field in relation to plant growth stage.

	TOTAL EGGS OR EGG MASSES OBSERVED					
	Camarao 1976 Eggs/ 400 plts.		Klitsaneephaiboon 1983 Egg Masses/ plt.		Rejesus-Buctuanon 1983 Egg Masses/ 100 plts.	
	Jun-Sept'75	Oct-Jan'76	Aug-Nov'82	Feb-May'83	Jun-Sept'82	Dec-May'83
(Weeks After Emergence)						
2	182	78				
3	325	136	0.25	0.25		
4	340	1751	0.40	0.38	1	5
5	235	3080	1.85	0.50	5	33
6	2910	2956	1.13	0.90	27	159
7*	3020	972	0.13	1.13	24	73
8*	175	163	0.12	0.53	10	22
9	63	30	0.08	0.25	9	3

* Larvae of egg masses laid about this time are likely to be removed or "killed" by detasseling.

CONCLUSIONS AND RECOMMENDATIONS

From the foregoing discussion, it is evident that there are several questions to the effectiveness of detasseling to protect corn yield from the corn borer. The assumption that larvae on the tassel (the population eliminated by detasseling) could inflict significant loss in yield when they migrate to lower plant parts after pollen shedding requires more extensive testing. Moreso, in the light of the following: (a) that boring per se does not always lead to reduction in yield; it is where boring is done that is critical to yield, and (b) that detasseling affects only a fraction of the larval population from egg masses deposited a week or two earlier. The hypothesis that detasseling tends to result to an increase in yield due to physiological reasons as suggested by Grogan (1956) and Duncan et al. (1967) should also be further tested and its interaction with the ability of detasseling to protect yield from corn borer should be also elaborated.

The effect of detasseling on the survival and performance of existing natural enemies (e.g., *Micraspis crocea*) should also be investigated. By detasseling, we may be depriving natural enemies of an important food item (e.g., pollen) critical to their performance. For example, Coll and Bottrell (1991) have shown that corn pollen is critical to the colonization behavior, survival and predatory performance of *Orius insidiosus* (Say) [Anthocoridae: Hemiptera], an important predator of *O. nubilalis* in Maryland, USA. In the Philippines, *Orius tantillus* is present and is considered a promising biological control agent of corn pests.

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