Seasonality of major cabbage pests and incidence of their natural enemies in Central Kenya

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Abstract

The population dynamics of major brassica pests and occurrence of their natural enemies were monitored weekly for a period of 9 months on cabbage (var. Copenhagen Market) at a research station plot (no pesticides applied) and a farmer's field (weekly application of Permethrin 10 EC or Dimethoate 40 EC) in Central Kenya. Pest infestations occurred within 14 days after the seedlings were transplanted and persisted thereafter. Diamondback moth (DBM) (*Plutella xylostella*) and cabbage aphid (*Brevicoryne brassicae*) were the major pests at the two sites. At the station, the average population of DBM encountered were mainly larval-pupal parasitoids including *Diadegma* sp. and *Oomyzus sokolowskii* whose combined parasitism rarely exceeded 20% at any one time. The mean combined parasitism for the three growing seasons was about 7% with *Diadegma* sp. being more dominant (60.5%). Mean infestation by cabbage aphid for three seasons was about 41%. The mean rate of parasitism of the aphid by *Diaretiella rapae* was about 1.2%. In the farmer's field, the average population of DBM larvae and pupae per plant were 1.12 and 1.2, respectively. Natural enemies encountered included *Diadegma* sp., *O. sokolowskii*, bacteria and entomopathogens whose mean combined parasitism for the two seasons was about 7%. *B. brassicae* was also the most common aphid with mean infestation and parasitism of about 26 and 0.8%, respectively, for the two seasons. Other commonly observed pests included leafminers (*Liriomyza brassica*), *Thrips* sp., loopers (*Plusia* sp.) and foliar diseases. No parasitoids of DBM eggs were observed at the two sites.

Key words: *Plutella xylostella, Brevicoryne brassicae,* natural enemies, cabbage, Kenya.

Introduction

Cabbage (*Brassica oleracea* var. *capitata*) is a popular vegetable crop in Kenya. It is grown throughout the year by small-scale farmers in central and western districts of the country. The commonly grown varieties include Copenhagen Market, Giant Diant Drumhead, Savoy and Sugarloaf. The total hectarage of the crop is about 25,826 ha with a production of 266,467 tonnes valued at Kenya £126 038 891 (MALDM, 1994).

One major constraint to the production of cabbage in Kenya are pests, particularly, the diamondback moth (DBM) *Plutella xylostella* (L.) (Lepidoptera: Yponomeutidae) (Madumadu *et al*., 1991). Like in some other parts of the world, the control of pests of cabbage in Kenya relies mainly on the use of chemical pesticides. However, repeated use of these pesticides elsewhere has led to the selection of pesticide resistance in DBM to the available pesticide arsenal (Bell and Fenemore, 1990; Hama, 1990; Zoebelein, 1990; Talekar, 1992). This necessitates a rethink in the control strategies currently employed in Kenya, and therefore, control measures which reduce dependence on pesticides need to be developed.

This paper presents preliminary results of a study on seasonality of major pests of cabbage and incidence of their natural enemies in Central Kenya with emphasis on DBM. This information is important to complement a biological control program for DBM.

Materials and Methods

The study was conducted between November 1995 and June 1996 at the National Agricultural Research Centre, Muguga, Kenya Agricultural Research Institute, (1° 13' South, 36° 38, 2096 m asl) (on-station) and at farmers' fields (on farm) 30 km away.

In the on-station trial, cabbage variety Copenhagen Market was planted every two months alternately in one of the three 50 x 10 m plots at a spacing of 50 x 65 cm. Diammonium phosphate (DAP) was used at planting and the plants were watered during the dry season. The plots were weeded two to three times in the growing season and no pesticides were applied to the plants. The trial was conducted for three consecutive seasons.

Weekly sampling at the on-station and on-farm plots was started two weeks after transplanting. Each of 20 randomly selected plants was examined for pests and diseases. The total numbers and stages of development of the lepidopteran pests observed on each plant were recorded. Emphasis was placed on the DBM. The populations of aphids (*Brevicoryne brassica, Lipaphis erysimi* or *Myzus persicae*) were estimated based on the following population score: 1 = no aphids, 2 = a few, 3= several colonies, 4 = half of a leaf covered with aphids and 5 = whole leaf covered with powdery/sooty mould. The presence of other pests was also recorded.

Some larvae and pupae of the lepidopteran pests were collected and individually placed in plastic containers (4 cm diameter x 3 cm high) with tight fitting lids. The former were reared on cabbage leaves in the laboratory. Colonies of aphids were cut from infested leaves, placed in 9 cm diameter plastic Petri dishes and fed with fresh cabbage leaves every other

day. These pests were observed daily for parasitoids and/or pathogens. Emerged parasitoids were labelled, preserved in clear gelatin capsules in plastic tubes and placed on the laboratory bench. However, diseased pests in gelatin capsules were stored in a refrigerator at 4 °C.

To study field parasitism of DBM eggs, 30 moths (males and females) were collected from the field using aspirators and released into nylon mesh cages (50 x 50 x 50 cm) containing four potted cabbage seedlings. The moths were allowed to oviposit on the seedlings for a period of 24 h. The seedlings were thereafter carefully examined and the areas bearing the eggs were marked using a felt pen. The seedlings with the eggs were then transferred to the cabbage plots (on-station/ on-farm) and exposed to parasitoids for two days. Leaves having the eggs were then removed from the field, the cut ends of their petioles placed in moist cotton wool, and maintained in covered plastic Petri dishes in the laboratory. All eggs were counted and monitored daily for emergence of parasitoids or larvae. Emerged larvae were reared to adult stage to check further for parasitoids. The experiment was done during the 2nd and 3rd growing season at the on-station plots and for two seasons at farmers' fields.

Meteorological data was taken from Muguga Meteorological Station sited at the National Agricultural Research Centre, Muguga. This information was considered not appropriate for the on-farm plots which were about 30 km away from the meteorological station, and therefore, was not used in this study.

Since the information presented is preliminary and the study is still on-going, the data obtained were not analyzed statistically.

Results

On-Station: The major pests were DBM and aphids. DBM was found to infest cabbage plants two weeks after transplanting. However, its population was low during the three growing seasons not exceeding two larvae/pupae at any one season *(Table 1)*. Percent parasitism was likewise low throughout the seasons being less than 20% at any one time. The parasitoids observed were *Diadegma* sp. and *Oomyzus sokolowskii.*

The relationship between DBM population, parasitoids and climatic data during the three growing seasons are illustrated in *Figures 1–3*. It is apparent that DBM population is inversely related to amount of rainfall as reflected in *Figures 2* and *Figure 3*. However, DBM population quickly picked up when the rains subsided.

Relationship between temperature and DBM populations could not be clearly discerned as the weekly average temperature differences were small (12.2–15.8 °C). The trend in parasitism reconciled with DBM larval populations *(Figures 1–3).*

Cabbage plants were also infested with aphids but the population score never exceeded 3 (several colonies). The population of *B. brassicae* was on the average higher than of *L. erysimi*. No *M. persicae* were observed during the three seasons *(Table 2)*. Percent infestation by *B. brassicae* and *L. erysimi* was on average about 41 and 29%, respectively. Both the species were parasitized by *Diaretiella rapae* and the mean percent parasitism for the three seasons was about 1.2%. However, the level of parasitism increased from one season to the next *(Table 2)*. In addition, a few hoverfly (Syrphidae) larvae were observed feeding on the aphids.

Table 1. Incidence of diamondback moth on cabbage (var. Copenhagen Market) and its parasitism at on-station and on-farm plots in Central Kenya (1995)

	Mean number				
	On-station (no-sprays)			On-farm (weekly sprays)[a]	
	Growing seasons				
	1	2	3	1	2
Larvae/plant	0.7	0.2	1.1	1.8	0.4
Pupae/plant	0.3	0.6	0.2	2.1	0.3
Level of parasitism (%)[b]	7.5	8.2	3.7	6.5	7.5

[a]Weekly application of Permethrin 40 EC (1st season) and Dimethoate 40 EC (2nd season)
[b]Pooled parasitism by *Diadegma* sp. and *Oomyzus sokolowskii*; figures for on-farm also included bacteria and fungi

Other insect pests observed on cabbage included leafminers (*Liriomyza brassica*), thrips (*Thrips* sp.), cutworms (*Agrotis* sp.) and loopers (*Plusia* sp.). Also taken into account was incidence of cabbage diseases of which the most common were ring spot (*Mycosphaerella brassicicola*), downy mildew (*Peronospora parasitica*) and black rot (*Xanthomonas campestris* pv. *campestris*) *(Table 3)*.

Quest for DBM egg parasitoids proved negative; none of 91 eggs exposed to parasitization in the field for 48 h yielded parasitoids.

On-farm: Populations of DBM in the on-farm plots were higher than in on-station despite of the weekly insecticidal sprays with Permethrin 10 EC or Dimethoate 40 EC *(Table 1)*. The mean number of larvae and pupae in two growing seasons was 1.8 and 0.4 and 2.0 and 0.3 per plant, respectively. Changes in DBM population and rates of parasitism in two seasons are depicted in *Figures 4* and *Figure 5*. The number of larvae reached up to about 6 per plant early in the season but gradually declined to about 1 per plant as the crop matured. However, the number of pupae increased with time.

Similar to the on-station plots, the main parasitoids recovered included *Diadegma* sp. and *O. sokolowskii*. The former was predominant. Parasitism rates are given in *Table 1*. In the second season insect pathogens were encountered [bacteria (2.8%) and fungi (2.6%)].

Aphids were fewer than in the on-station plots *(Table 2)*. *B. brassicae* was the major species, and *M.*

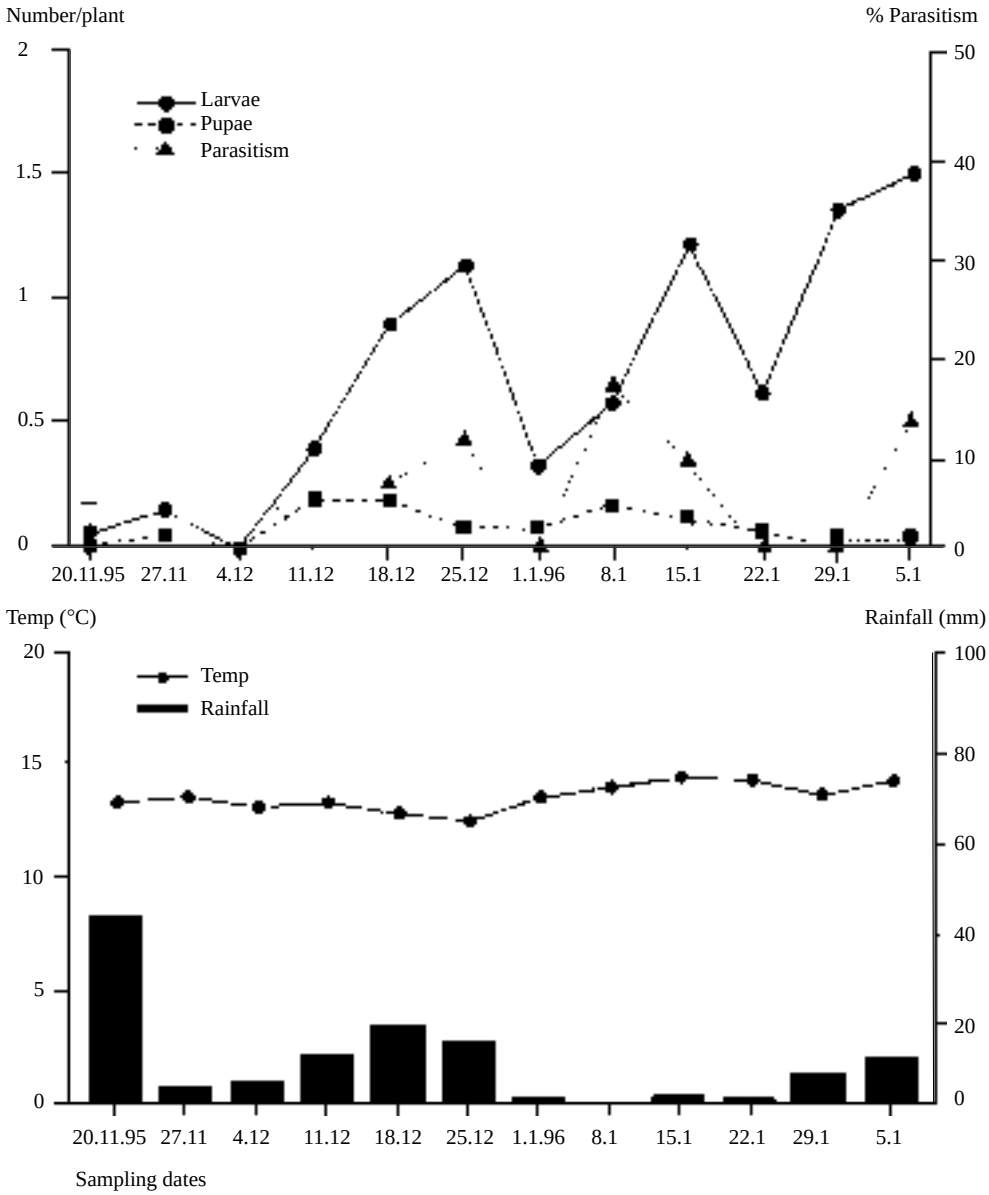


Figure 1. Population dynamics and percent parasitism of diamondback moth (top) and prevailing weather conditions (bottom) at the no-spray on-station field of cabbage during the first growing season in Central Kenya

persicae was not found on the crop. *D. rapae* was observed attacking aphids in the first season during which weekly sprays of Permethrin 10 EC were applied. In the second season Dimethoate 40 EC was used following which a few aphids were observed and no parasitoids were recovered.

In addition to DBM and aphids, a same complement of insect pests and cabbage diseases was recorded albeit at varying levels *(Table 3).*

A total of 102 DBM eggs were exposed for 48 h to parasitization in the field. No parasitoid was recovered as all the eggs hatched and developed into adults.

Discussion

On the basis of this study it is apparent that diamondback moth (*P. xylostella*) and aphids (*B. brassicae and L. erysimi*) are the major pests of cabbages in Central Kenya. The two were observed consistently for three seasons at on-farm and on-station fields with and without insecticidal application, respectively. However, DBM populations during the three seasons at both sites were generally low not exceeding 6 larvae/plant and there was hardly any difference in larval numbers between sprayed and no-spray fields. Furthermore, it was observed that rainfall suppressed DBM population. Probable explanation of the above could be a low population pressure during the material time of the study due to prevailing unfavourable weather conditions particularly rainfall and temperature despite the possible development of pesticide resistance in DBM to Permethrin 10 EC and Dimethoate 40 EC at the weekly sprayed fields. Similar results were reported in Taiwan (Anonymous, 1991) and in other Far-East countries (Chen and Su, 1986; Harcourt, 1986; Ong and Soon, 1989; Talekar, 1992).

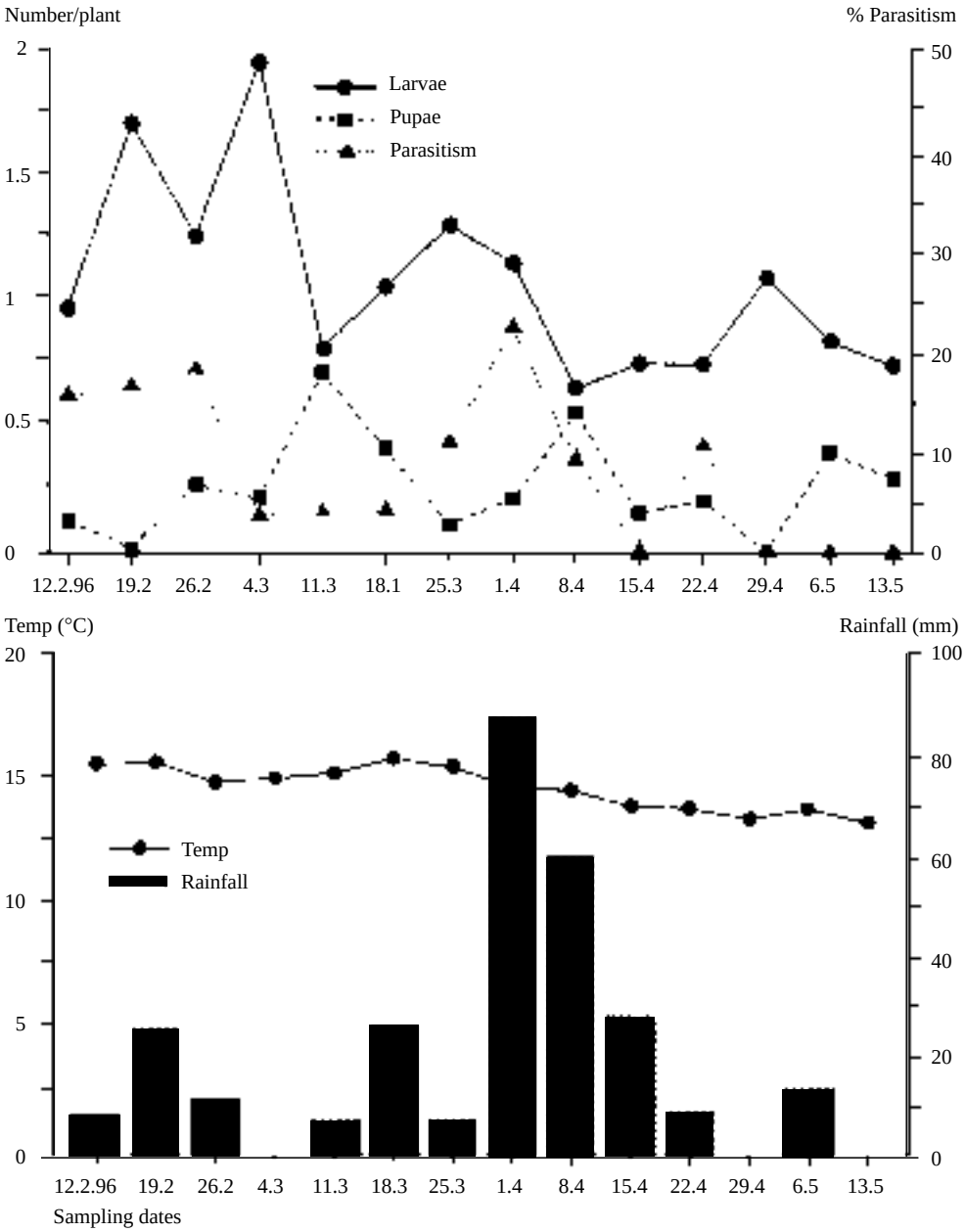


Figure 2. Population dynamics and percent parasitism of diamondback moth (top) and prevailing weather conditions (bottom) at the no-spray on-station field of cabbage during the second growing season in Central Kenya

In this study it was found that parasitism rates on DBM in all fields, irrespective of crop protection practices employed, were low. This was particularly evident in on-station fields where no pesticides were applied and could be attributed to the topography of the sites which were up-hill and windy. Such an environment was apparently unfavourable to the build-up of the populations of natural enemies of DBM. The major local parasitoids recovered from all the fields included *Diadegma* sp. and *Oomyzus sokolowskii* of which the former was predominant. Isolated cases of bacterial and fungal pathogens were encountered. Because of low numbers of natural enemies their impact on DBM population could only be minimal. In addition, no egg parasitoids were found in any of the sites. However, the study will be repeated at different areas within the Central Kenya and, will also be undertaken in other agroecological zones for proper inventory taking and impact assessment of the indigenous natural enemies of DBM.

Aphid populations consisting of mainly *B. brassicae* and *L. erysimi* were higher in no-spray than in pesticide sprayed fields. In the latter instance permethrin and dimethoate effectively controlled both species but at the same time dimethoate drastically reduced the rate of parasitism by *D. rapae*. Surprisingly, *M. persicae* was not observed on cabbage plots despite its high populations on adjacent Irish potato crop. A tangible explanation to such an incidence could be host preference: that is the aphid preferred potatoes to cabbages.

It is hoped that the results of this study once duly completed will aid in formulating appropriate management strategies for the major pests of cabbage

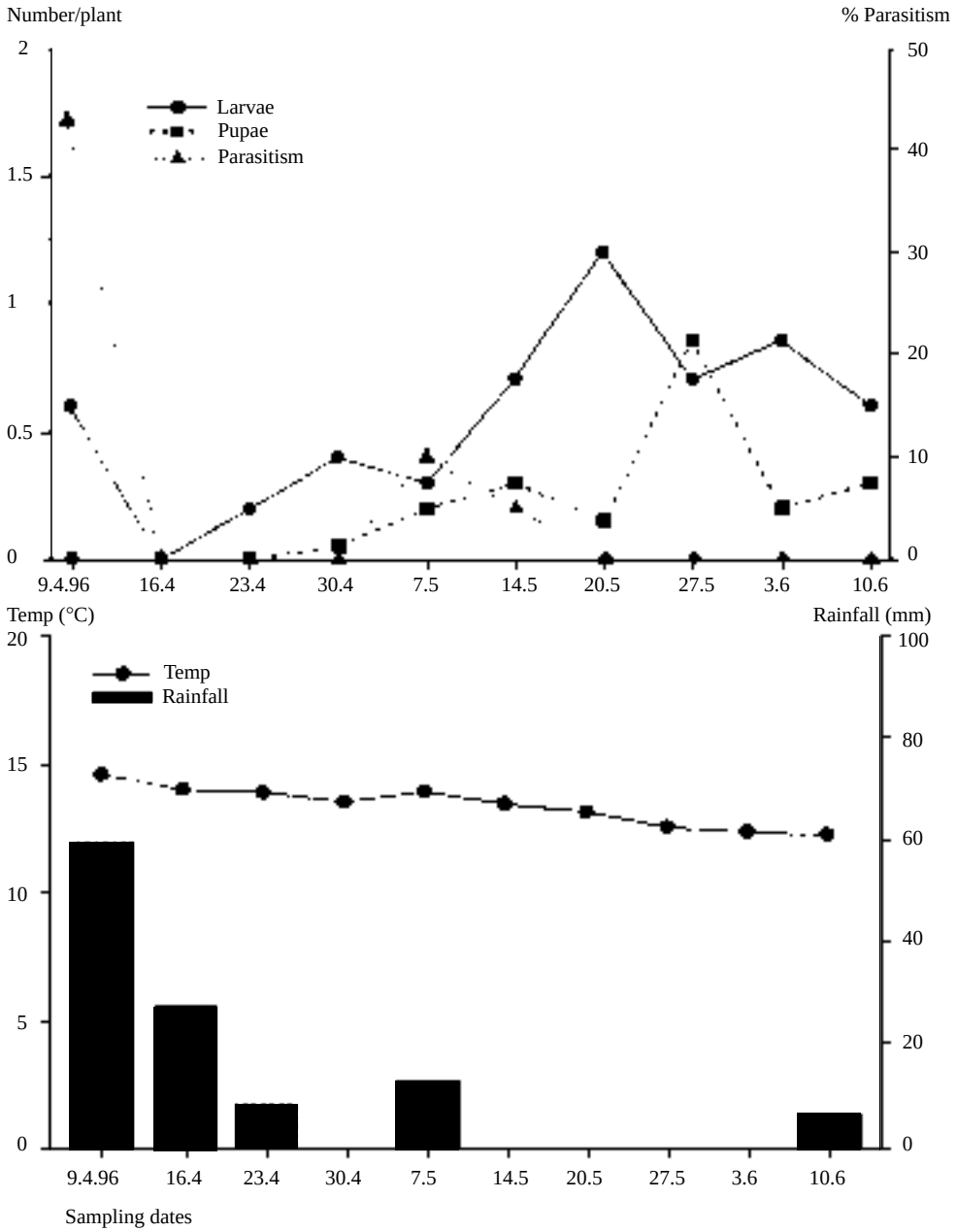


Figure 3. Population dynamics and percent parasitism of diamondback moth (top) and prevailing weather conditions (bottom) at the no-spray on-station field of cabbage during the third growing season in Central Kenya

in Kenya. Information on the inventory and impact of indigenous natural enemies will give guidance to a rational decision on whether to import exotic parasitoids (*Diadegma semiclausum* and/or *Cotesia plutellae*) for classical biocontrol of DBM in Kenya.

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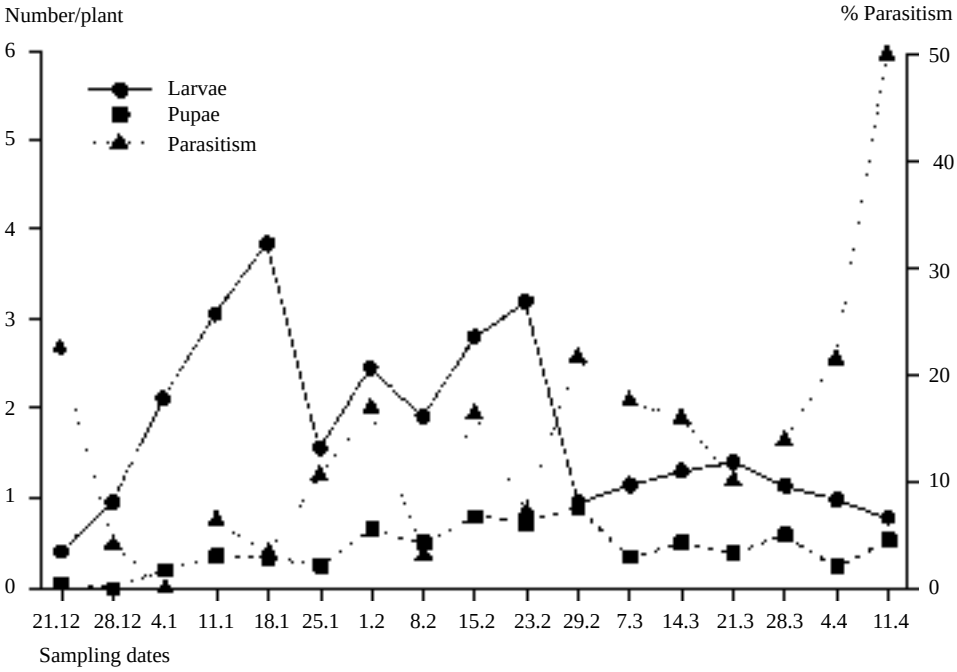


Figure 4. Population dynamics and percent parasitism of diamondback moth at the sprayed on-farm field during the first growing season

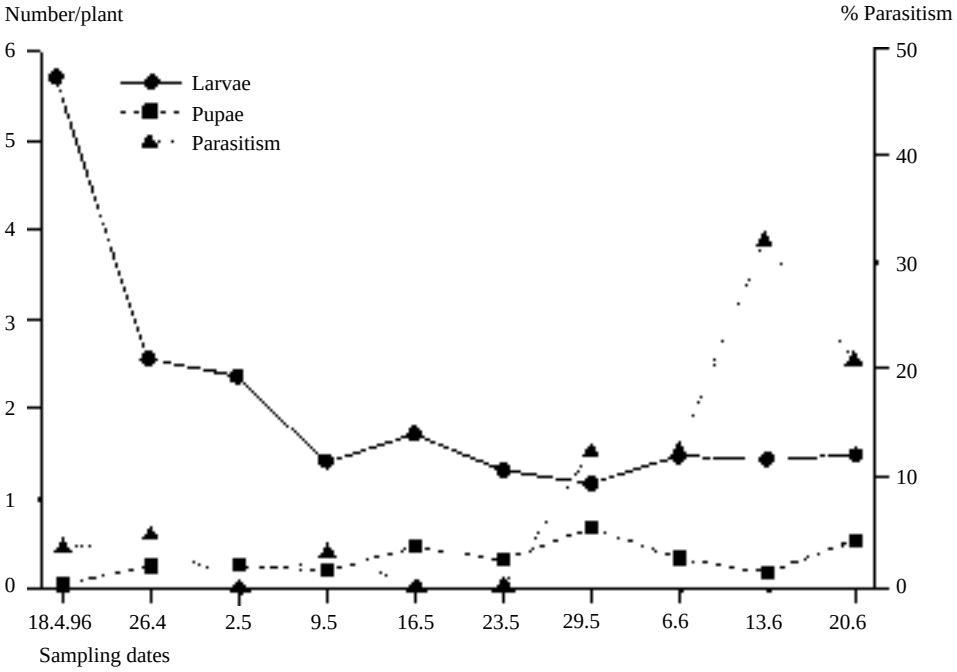


Figure 5. Population dynamics and percent parasitism of diamondback moth at the sprayed on-farm field during the second growing season

Table 2. Incidence, population score and parasitism of three aphid species infesting cabbage (var. Copenhagen Market) at on-station and on-farm plots in Central Kenya (1995)

Growing season		*Brevicoryne brassicae*	*Lipaphis erysimi*	*Myzus persicae*
On-station:				
1.	Plants infested (%)	26.7	41.2	0.0
	Mean population score[a]	1.4	1.5	1.0
	Mean parasitism (%)	0.6	1.5	0.0
2.	Plants infested (%)	54.3	16.2	0.0
	Mean population score	1.6	1.2	1.0
	Mean parasitism (%)	1.0	0.5	0.0
3.	Plants infested (%)	42.0	29.5	0.0
	Mean population score	1.5	1.3	1.0
	Mean parasitism (%)	1.9	1.6	0.0
On-farm:				
1.	Plants infested (%)	48.2	6.2	0.0
	Mean population score	1.6	1.1	1.0
	Mean parasitism (%)	1.7	0.0	0.0
2.	Plants infested (%)	3.5	11.0	0.0
	Mean population score	1.0	1.1	1.0
	Mean parasitism (%)	0.0	0.0	0.0

[a]Population score for aphids: 1= no aphids, 2= a few, 3= several colonies, 4= half of leaf covered with aphids and 5= severe attack (leaf covered with powdery/sooty mould)

Table 3. Incidence of other pests on cabbage (var. Copenhagen Market) at on-station and on-farm plots in Central Kenya (1995)

Pests	Mean incidence (%)	
	On-station (no sprays)	on-farm (weekly sprays)[a]
Arthropod pests:		
Liriomyza brassicae	61.3	33.4
Thrips sp.	25.9	45.4
Agrostis sp.	6.2	0.0
Plusia sp.	0.7	4.5
Plant diseases:		
Mycosphaerella brassicicola	46.6	59.0
Peronospora parasitica	22.1	13.6
Xanthomonas campestris pv. *campestris*	6.1	6.9

[a]Refer to *Table 1*

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