Threshold-based Management of Pests Affecting Leafy Vegetables with High Pesticide Input

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Abstract

Validation activities on callaloo IPM systems development are in the wrap up phase with the ongoing data collection on farms. The two systems being tested are (1) exclusion of major pests using a row cover of 70 % light transmission in combination with cultural practices; and (2) the use of new biorational chemistries applied within the framework of a resistance management program (rotation of chemicals and the use of the threshold-based pesticide application guide developed for lepidopterous species on callaloo) in combination with cultural practices. To date the five validation plots have been established in two agroecological zones. These two methods continued to show the potential to reduce pesticide input in callaloo production compared to the farmer practice of weekly sprays (lambda-cyhalothrin). Exclusion plots continued to provide superior crop protection compared to the other two management systems while virtually negating the need for other forms of intervention against the cosmopolitan pests of callaloo. On farm 3 leafminers were an occasional pest sometimes causing major losses. This could be attributed to farm characteristics (shade trees near to the plot). This observation indicates the need for callaloo grown under exclusion cages to be located in full sun. A 45%-92% reduction in pesticide applications resulted in plots using strategy 2. However, since the since the events of September 11 (2001) in the United States stringent laws enforced re air transportation of dangerous chemicals have resulted in problems with accessing small (experimental) quantities of biorationals to replenish our supplies and have placed a serious constraint on the continuation of evaluation activities of these biorational pesticides. An exhibition plot of the exclusion system was again set up at the premier annual agricultural show of the Caribbean (Denbigh Agricultural Show), which receives over 40,000 patrons.

Objective

Research objectives for the reporting period:

- Integrate the scouting system into control programs for callaloo pests.
- Integrate exclusion tactics into control programs in callaloo production
- Select and evaluate more effective, safer pesticides for controlling major pests of callaloo
- Develop protocols that would ensure freedom from contamination due to arthropod pests and pesticide residue in callaloo produced in selected areas
- Develop protocols to assist in putting callaloo back on the preclearance list

IPM Constraints

Current grower practice emphasizes prophylactic calendar sprays for control of lepidopteran larvae, resulting in high insecticide inputs. This results in high labor and material costs, minimizes the potential for integrating other management tactics, and creates environmental, health and export constraints.

Pesticides currently used against callaloo pests fail to give effective control, possibly because of the lack of resistant management protocols for pesticide use. New effective chemistries need to be identified and introduced in conjunction with the implementation of stricter management procedures for pesticide use.

IPM seeks to minimize pesticide use in production systems therefore, effective non-chemical methods need to be identified and adapted to this cropping system to reduce dependence on chemicals.

Farmer empowerment through education and transfer of technology will ensure the successful implementation of new methods of crop (pest) management.

Determination of the best IPM strategy to manage the Lepidoptera complex on callaloo in two major agroecological zones and seasons in Jamaica.

(D. Clarke-Harris and F. McDonald)

Objectives

To validate IPM strategies for management of the lepidopteran complex on callaloo

Research Methods

The validation of two IPM strategies was initiated on five sites. Plots were established at the first site in June 2000 in Bushy Park, South St Catherine. Another three plots were established in Linstead, north St Catherine and most recently one plot was established at Thetford, South St Catherine. On each site, a total of three consecutive crops will be established and monitored for 13 weeks each over a calendar year.

The dates of establishment and duration of crops at each site are listed below

FARM	DURATION OF CROP		
	CROP1	CROP 2	CROP3
Farm 1 Bushy Park	June to October 2000	November 2000 to March 2001	May to July 2001
Farm 2 Linstead	February to May 2001	July to October 2001	December 2001 to March 2002
Farm 3 Linstead	May to August 2001	November 2001 to January 2002	March to July 2002
Farm 4 North St Catherine	January to April 2002	discontinued	
Farm 5 Thetford	March to July 2002	August 2002 to present	

The pest management strategies employed at each site were: (1) exclusion of major pests using a row cover of 70 % light transmission in combination with cultural practices; and (2) the use of new biorational chemistries in combination with cultural practices. The pesticides used in strategy (2) were applied within the framework of a resistance management program (rotation of chemicals and the use of the threshold-based pesticide application guide developed for lepidoptera species on callaloo). Biorational pesticides used include Spintor® (spinosad) and Confirm® (tebufenozide). Safer Insecticide® (an acaricidal soap) and fungicides Kocide® and Champion® were used when warranted. The two strategies were compared with the farmers' calendar system of application of pesticide (lambda-cyhalothrin) every eight days.

All seedlings were produced under row cover to exclude pests. Land was prepared by making raised beds 60 cm wide to accommodate plants at a spacing of 30 cm x 45 cm. Prior to transplant, an exclusion cage was constructed at the site designated for that treatment plot. Three treatment plots of 280 plants (114 m^2) each were established.

Two weeks after transplant, plots were monitored once weekly. The parameters measured included pest incidence and damage. The cumulative number of larvae observed on 25 plants (six leaves per plant) was recorded. Spray application decisions were made for IPM strategy (2) based on a sequential sampling plan and a decision guide chart developed from our earlier work. The harvested crop was sorted into yield grades: marketable, insect damaged (>30% feeding hole damage); fungus damaged (>30% necrotic lesions); mechanically damaged; and physiological defects (seeding and rough stems), and then weighed.

Economic analyses of all strategies were conducted for three consecutive callaloo crops of approximately 15 weeks each, which were established and monitored over a 12-month period. On each plot therefore, all inputs and returns were recorded to conduct cost-benefit analyses. To conduct interim assessments, the costs of inputs (row covers, agrochemicals, labor-land preparation, weed management, harvesting, irrigation) were compared to marketable yields at current market price.

Results and Discussion

Generally at all sites and throughout all seasons exclusion plots continued to maintain the lowest cumulative larval frequency among treatments. Cumulative observations recorded per crop in exclusion plots ranged from 3-44 larvae per 25 sample plants compared to ranges of 45-208 and 21-395 in Sampling Plan and Control plots respectively.

The biorational pesticides gave good crop protection against lepidopteran larvae in treatment plots monitored using the threshold-based sampling plan and spray decision guide. Although the cumulative frequencies recorded in sampling plan plots were generally higher than in the control plots this was due to a build up in the population in these plots during the intervals between spray applications. The larval populations declined following each application (Figures1-4). Observations also continue to indicate that the sampling plan is an effective tool in timing pesticide applications and minimizing pesticide input. The arrows in Figures 1-4 indicate the timing of pesticide application in sampling plan plots in relation to varying larval densities. The reduction in pesticide input compared to control plots which were sprayed weekly, ranged from 75%-92%. This reduced spray input resulted in greater or comparable protection against insect damaged losses in yield. Interim analyses showed that differences in insect damaged losses among treatments were significant ($P<0.1$).

Crop loss data gathered from treatment plots generally showed exclusion plots having the lowest insect damage losses (Figures 5a-c). However on Farm 3 leafminers favored conditions in exclusion cages and resulted in significant losses during weeks two and seven of monitoring. In week 9 a missed spray application due to rains led to 100% loss in the Sampling Plan plot. Excluding leafminer damaged losses lepidoptera damaged losses ranged from 0-10.5%. Lepidoptera damaged losses in sampling plan plots ranged from 0-50% (excluding 100% loss due to missed spray date) and 0-50% in control plots. Interim analyses showed differences in insect damaged losses among treatments to be significant ($P<0.01$)

Since the events of September 11 (2001) in the United States stringent laws enforced re air transportation of dangerous chemicals have resulted in problems with accessing small (experimental) quantities of biorationals to replenish our supplies. This has been a serious constraint on the continuation of evaluation activities of spinosad and tebufenozide. On Farm 5 a biorational (insect growth regulator) Match ® has been substituted for the initial biorationals to test its relative efficacy. As Match is commercially available locally if effective it would be a ready option for farmers. However results from Farm 5 are not comparable with other sites and have been excluded from the report.

Given the current impasse with obtaining spinosad to complete the planned number of test sites the data obtained from four farm locations will be analyzed to formulate recommendations for using these systems in callaloo production.

Networking

Workshop/Meetings/Seminars

S Tolin, D Clarke-Harris, K M Dalip, S Fleischer, C Edwards and D M Jackson participated in the IPM CRSP Annual Planning Workshop, Blacksburg Virginia, in 15-18 May 2002.

Researcher Investigator Exchanges

Co-Principal Investigator of IPM CRSP, Dr Clive Edwards, Entomologist and Environmental Ecologist, Ohio State University, visited Jamaica 27 February-6 March 2002 to assist in the development of the Year 10 workplan of the IPMCRSP and documentation of progress to date.

Shelby Fleischer, Vegetable Entomologist of the Pennsylvania State University, USA visited the CARDI Jamaica Unit 18 – 25 March 2002. While in Jamaica, Dr Fleischer met with CARDI, Rural Agricultural Development Authority and Ministry of Agriculture officials to discuss progress of IPM CRSP activities specifically callaloo and hot pepper research and to develop the IPM CRSP work plan for Year 10.

D Clarke-Harris, Entomologist and IPM CRSP Site Coordinator (Caribbean Site) was one of a panel of experts at a regional workshop entitled *Reduction / Elimination and Management of Pesticides in the Context of the Stockholm Convention on Persistent Organic Pollutants and the Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal*. Held in Port of Spain Trinidad 22-25 April 2002. This workshop was jointly organised by the United Nations Environment Programme (UNEP) and the Basel Convention Regional Centre for the Caribbean region (CARIRI).

Impacts

The dissemination of information on management of callaloo pests using the two systems described above is now being carried out on a wider scale as the national extension service, RADA, has been convinced of the value of the approaches for callaloo farmers. The Jamaica Organic Agriculture Movement JOAM has also adopted the exclusion method as an option for organic growers and has been given technical assistance towards the establishment of a demonstration plot on the grounds of Kings House (Residence of the Governor General of Jamaica). The Governor General has an avid interest in organic farming and has endorsed the promotion of alternative technologies. During the Denbigh Agricultural Show all technologies and activities conducted by CARDI/ IPM CRSP were displayed. Posters on callaloo IPM developed under IPM CRSP were also displayed and a mini demonstration plot was set up. The Denbigh Agricultural Show is the premier agricultural show in the Caribbean, which is held annually in Jamaica and attended by over 40,000 patrons.

Publications and Presentations

Clarke-Harris, D. and Fleischer, S. (2002). Sequential sampling and biorational chemistries for managing lepidopteran pests of vegetable amaranth in the Caribbean. Submitted to the Journal of Economic Entomology and will be published upon completion of suggested revision.

Clarke-Harris, D. and Fleischer, S. (2002). IPM systems development of pests affecting callaloo. IPM CRSP 8th Annual Report, 2001-2002. (Management Entity, Ed.) Virginia Polytechnic Institute and State University, Blacksburg, VA.

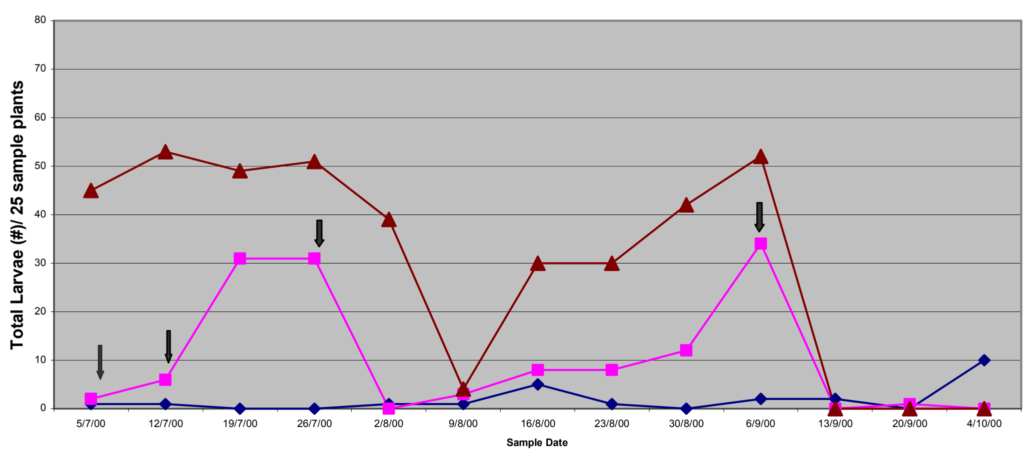
Project Highlights

- Exclusion and biorationals using a threshold-based spray application guide, the use of which gave significantly improved protection of the crop from insect damage when compared to farmer practice.
- Exclusion plots can be a pesticide-free system giving the product a competitive advantage which could fetch a higher price.
- Exclusion as a management option can be maintained without the use of pesticides. However other compatible non-chemical tactics would enhance the system (sticky traps, soaps and oils and biopesticides).
- The threshold-based sampling plan demonstrated the potential to reduce frequency of pesticide applications by 46%-92%.
- The research model for high pesticide input vegetable systems which was developed on vegetable amaranth in Jamaica was explained to nine researchers from Barbados, Trinidad and Tobago.

Table 1: Cumulative larval frequencies recorded from observations in plots maintained under three pest management systems at four locations.

Farm	Season	Exclusion	Sampling Plan	Weekly Sprays
Farm 1 Bushy Park	1 July- October 2000	24	136	395
	2 November-2000-March 2001	38	128	27
	3 May-July 2001	7	208	21
Farm 2 Linstead	1 February to May 2001	3	78	96
	2 July to October 2001	27	136	206
	3 December 2001 to March 2002	25	156	251
Farm 3 Linstead	1 May to August 2001	28	108	52
	2 November 2001 to January 2002	44	95	95
	3 March to July 2002	44	134	161
Farm 4 North St. Catherine	1 January to April 2002	7	45	30
	2 Discontinued	_	_	_

(a)



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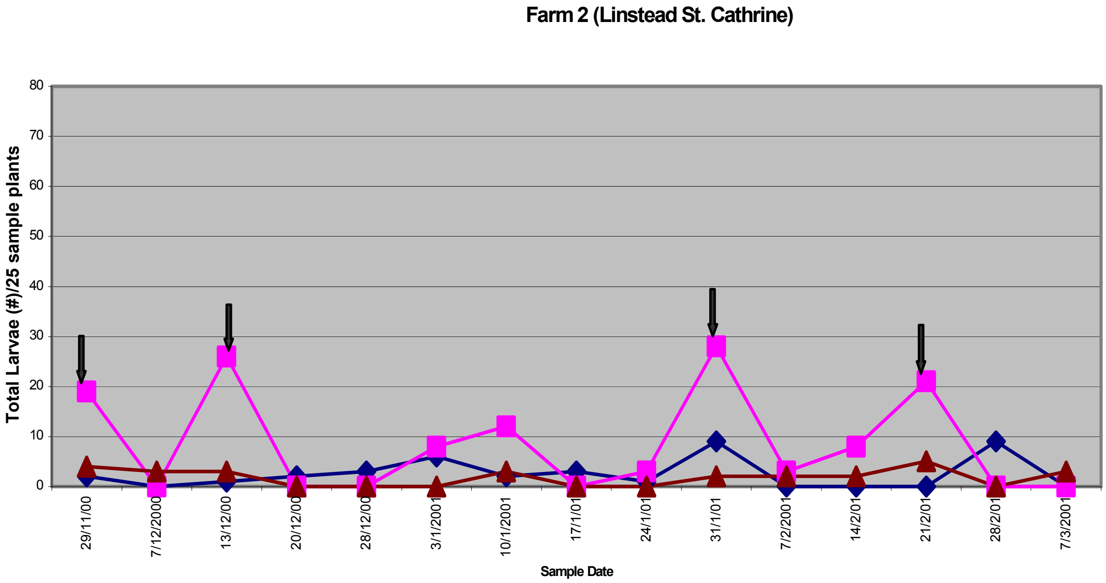

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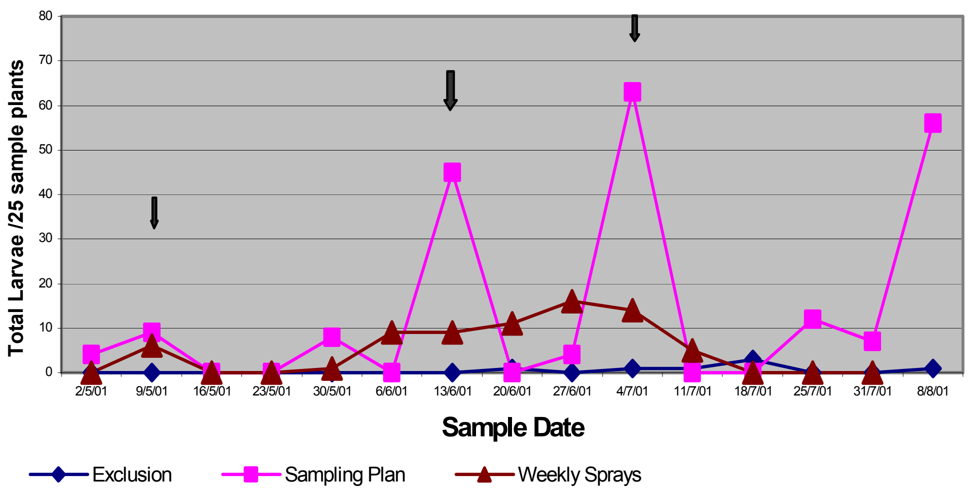
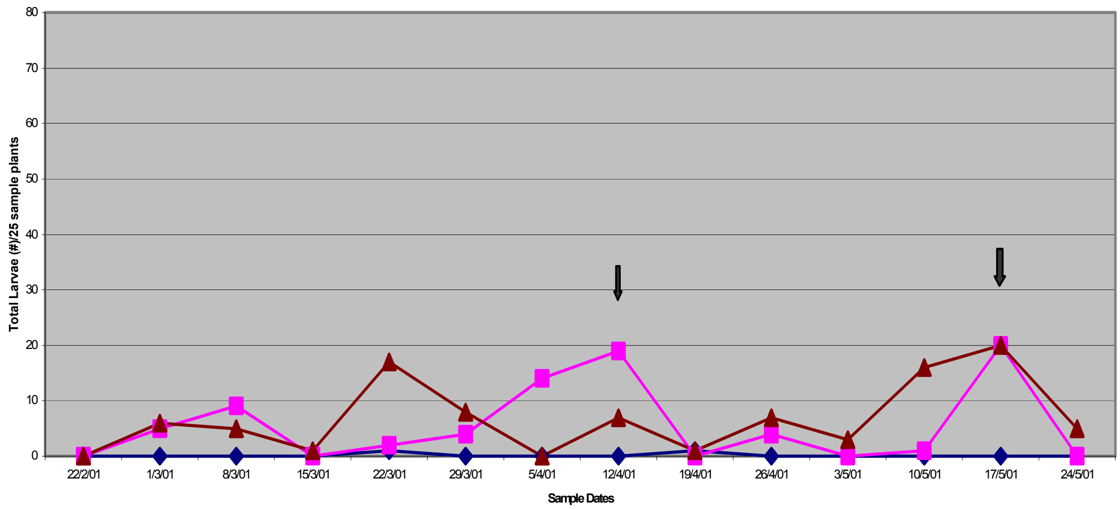


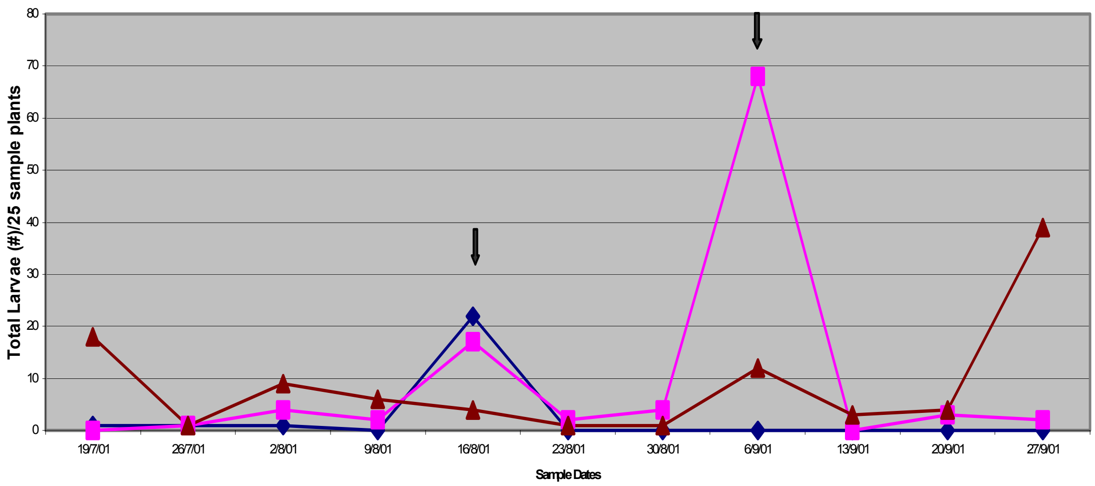
Figure 1 a - c: Relative larval densities recorded during weekly sampling of plots maintained at Farm 1, Bushy Park, St. Catherine using three pest management systems over three crop seasons.

(a)



Total Larvae (#)/25 sample plants
80
70
60
50
40
30
20
10
0
22/2/01
1/3/01
8/3/01
15/3/01
22/3/01
29/3/01
5/4/01
12/4/01
19/4/01
26/4/01
3/5/01
10/5/01
17/5/01
24/5/01
Sample Dates

(b)



Total Larvae (#)/25 sample plants
80
70
60
50
40
30
20
10
0
19/7/01
26/7/01
2/8/01
9/8/01
16/8/01
23/8/01
30/8/01
6/9/01
13/9/01
20/9/01
27/9/01
Sample Dates

(c)

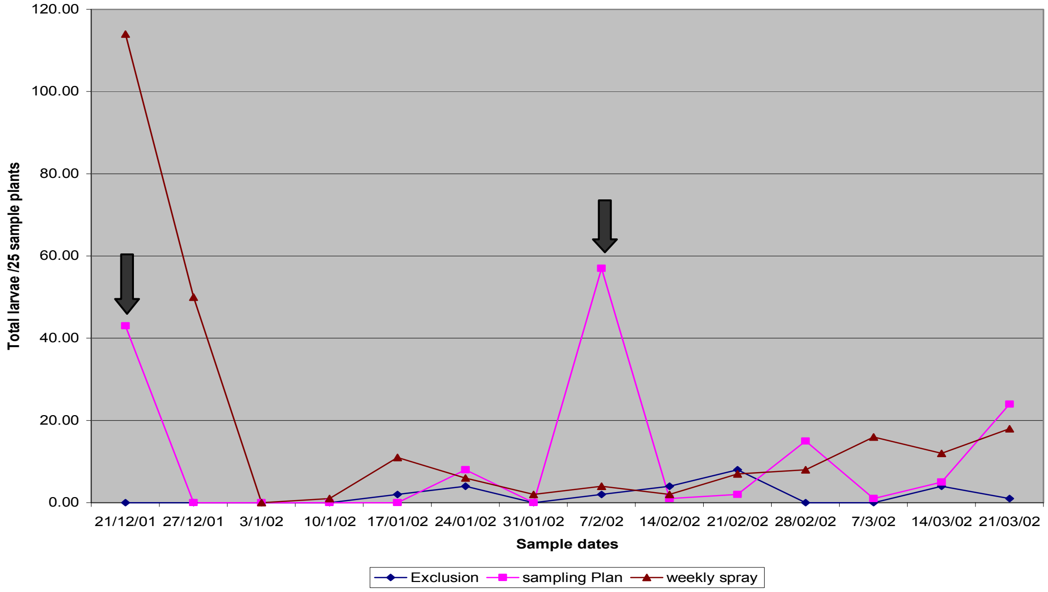
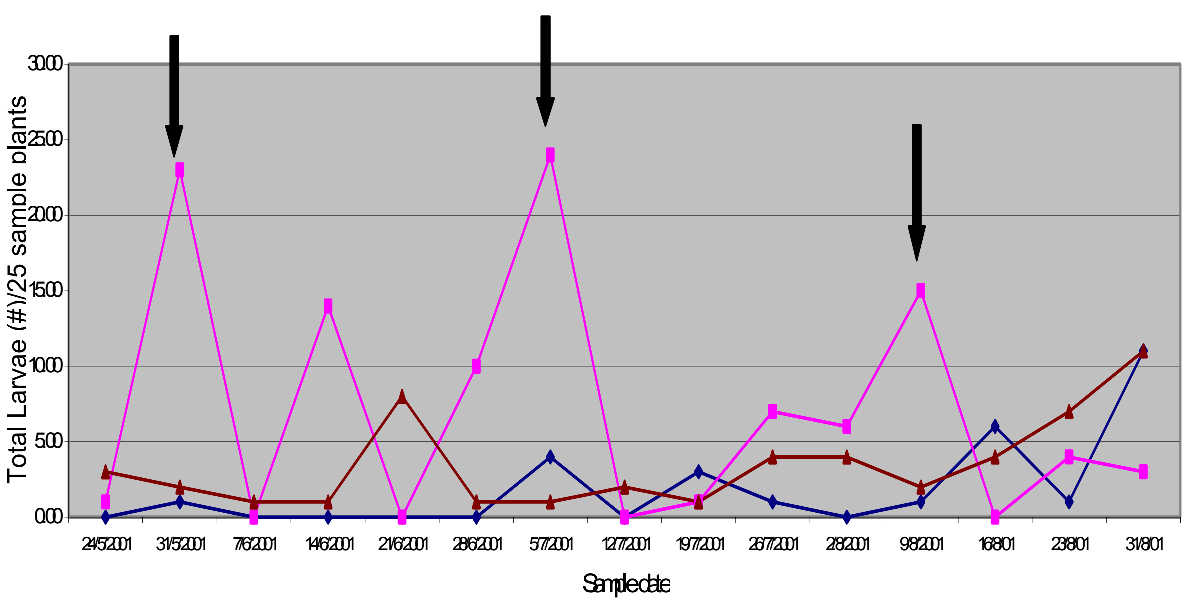


Figure 2 a - c: Relative larval densities recorded during weekly sampling of plots maintained at Farm 2 Rose Hall Linstead, using three pest management systems over three crop seasons.

(a)



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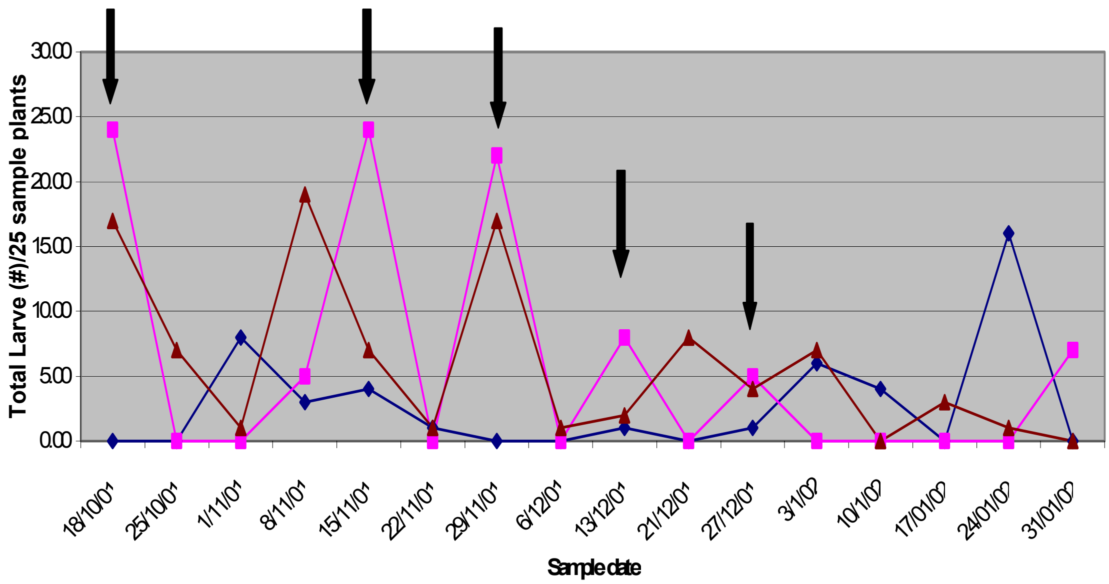

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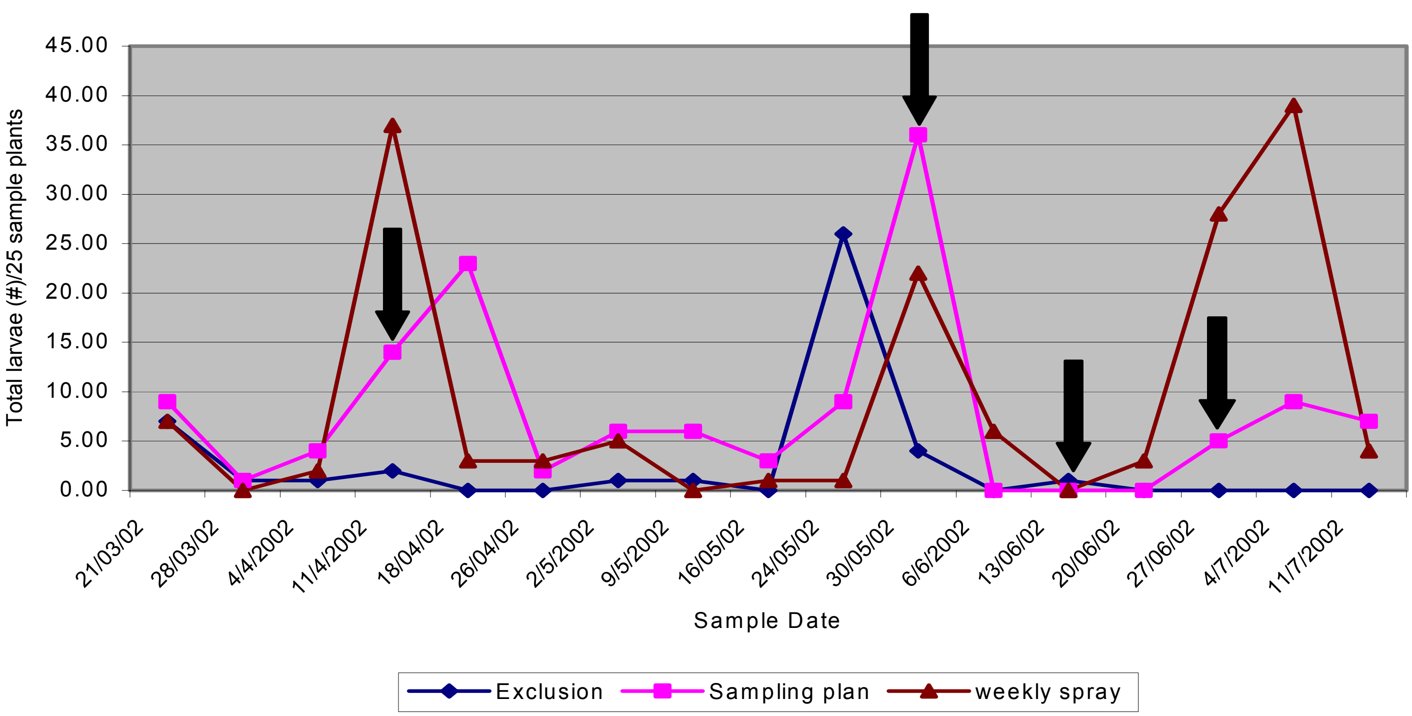


Figure 3: Relative larval densities recorded during weekly sampling of plots maintained at Farm 3 Rose Hall Linstead, using three pest management systems over a single crop season

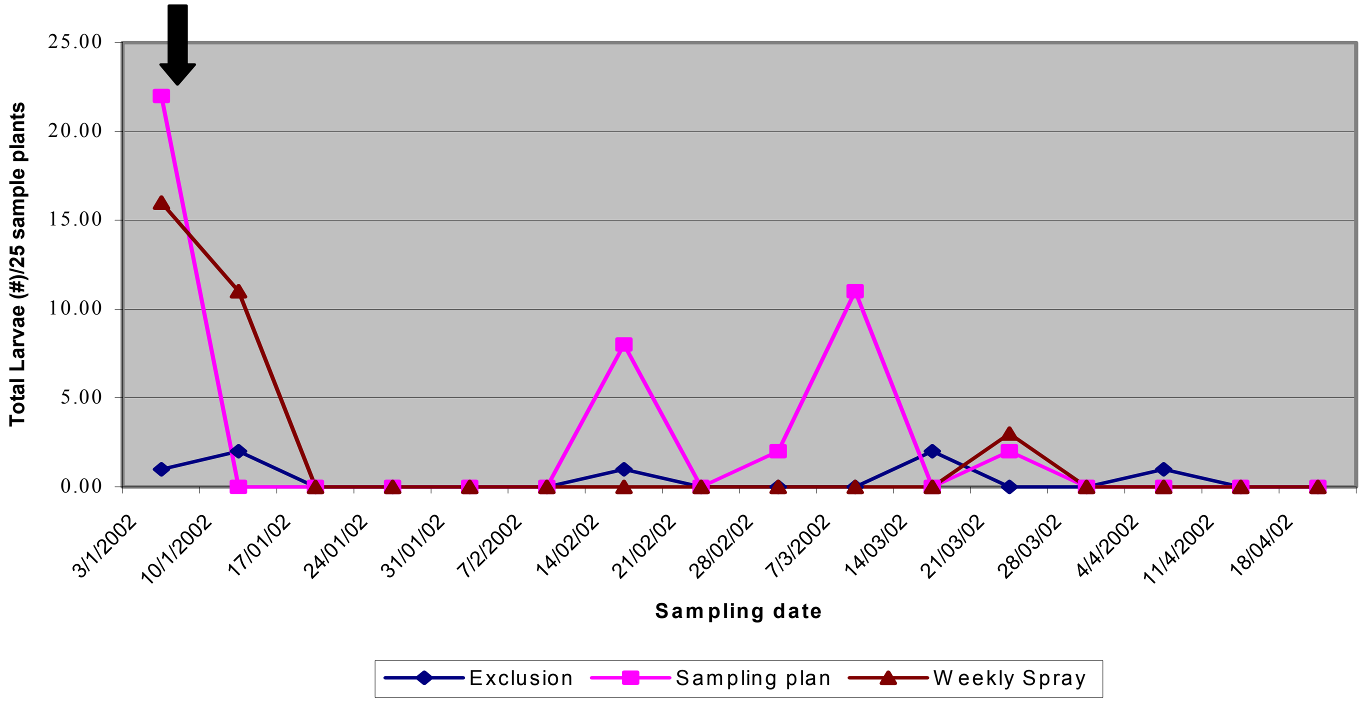
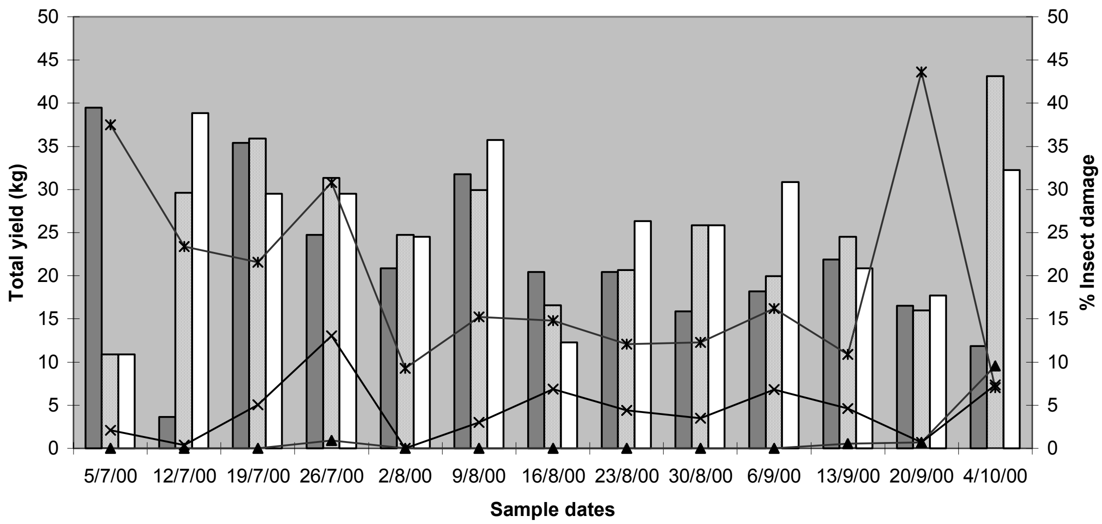


Figure 4: Relative larval densities recorded during weekly sampling of plots maintained at Farm 4 Linstead St. Catherine

(a)



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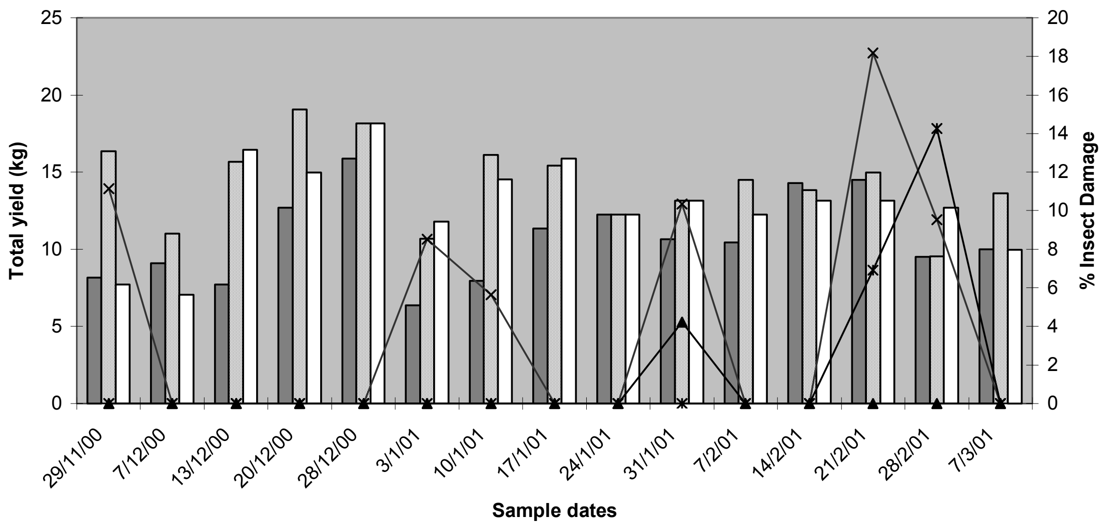

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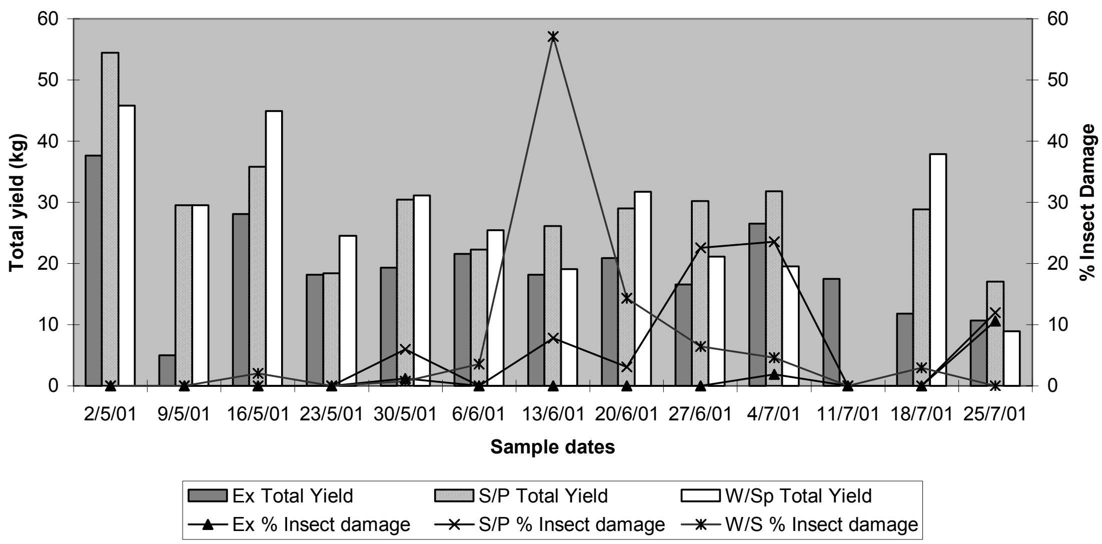
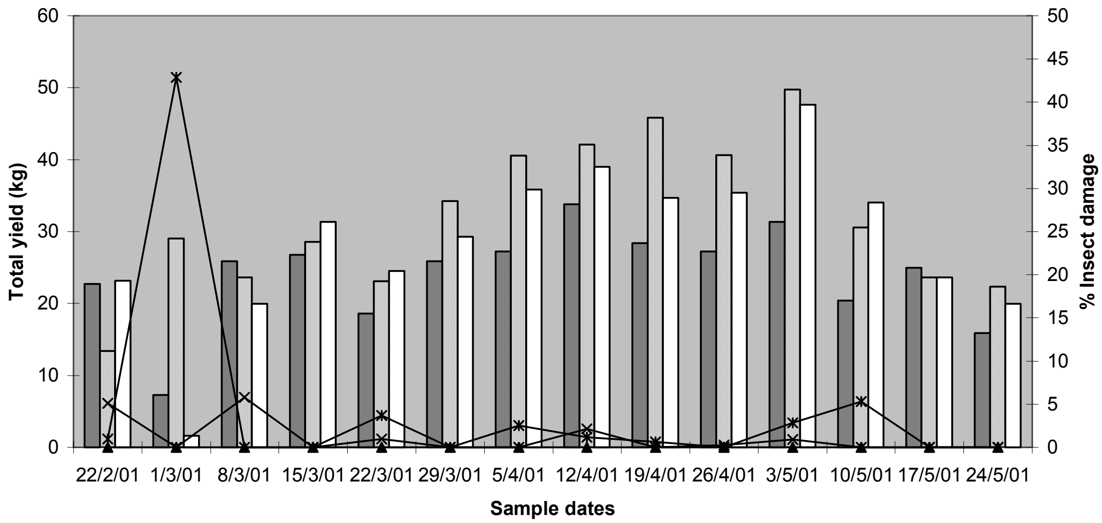


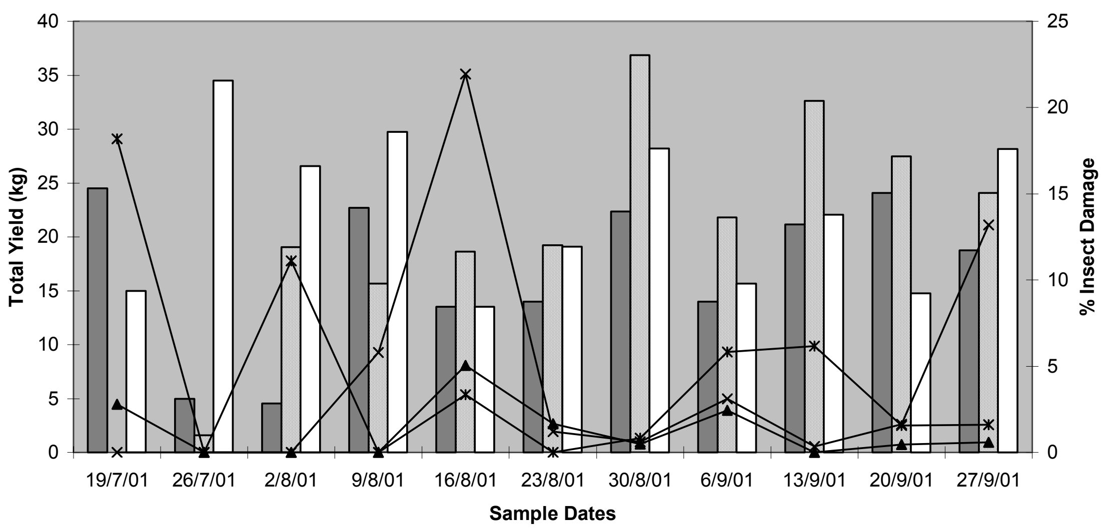
Figure 5a-c. Yields and percentage insect damaged rejects obtained from plots under three different management systems on Farm I in Bushy Park St Catherine between May 2000 and July 2001

(a)



Total yield (kg)
% Insect damage
Sample dates
22/2/01
1/3/01
8/3/01
15/3/01
22/3/01
29/3/01
5/4/01
12/4/01
19/4/01
26/4/01
3/5/01
10/5/01
17/5/01
24/5/01

(b)



Total Yield (kg)
% Insect Damage
Sample Dates
19/7/01
26/7/01
2/8/01
9/8/01
16/8/01
23/8/01
30/8/01
6/9/01
13/9/01
20/9/01
27/9/01

(c)

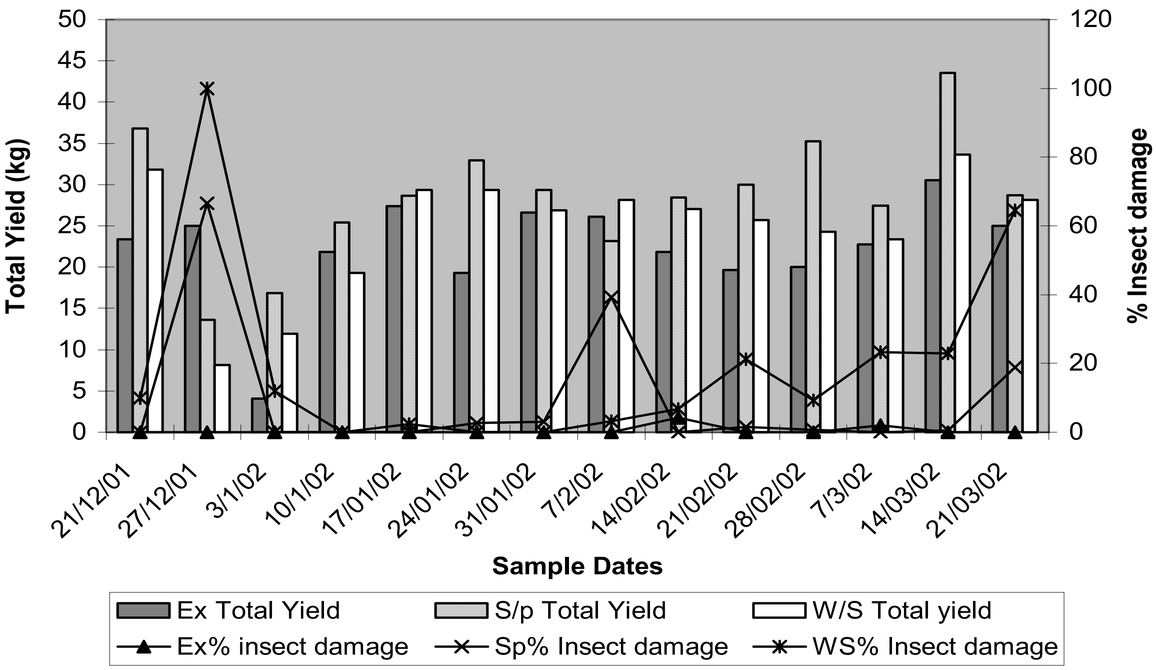
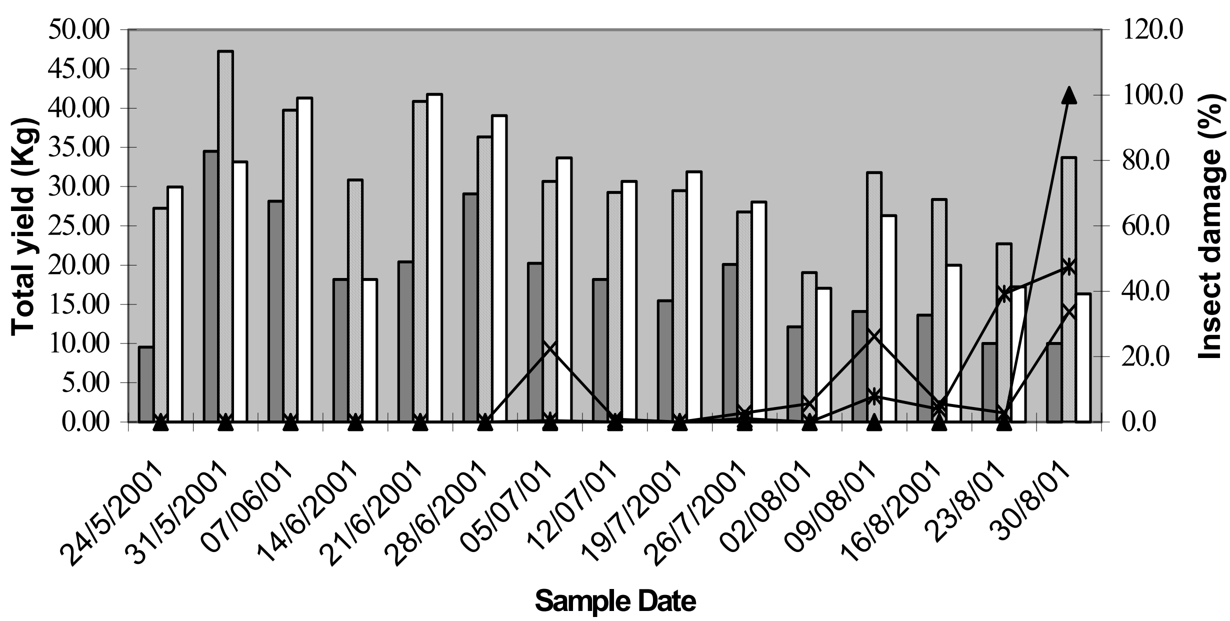


Figure 6a-c Yields and percentage insect damaged rejects obtained from plots under three different management systems on Farm 2 in Linstead, St Catherine between February to September 2001

(a)



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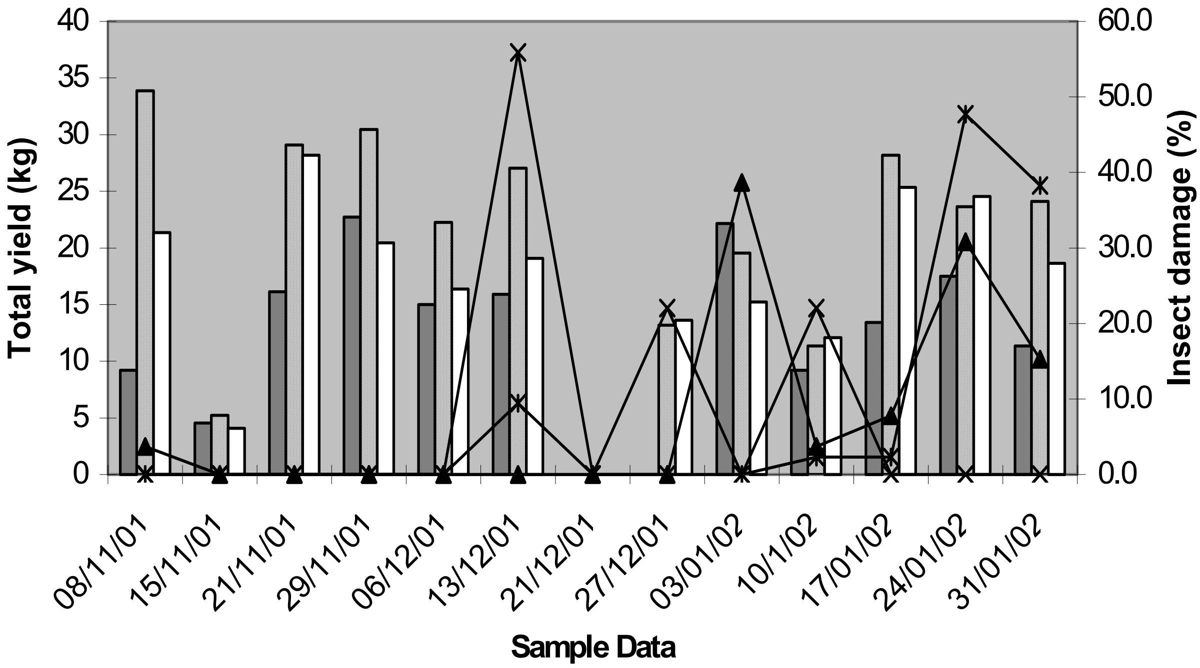

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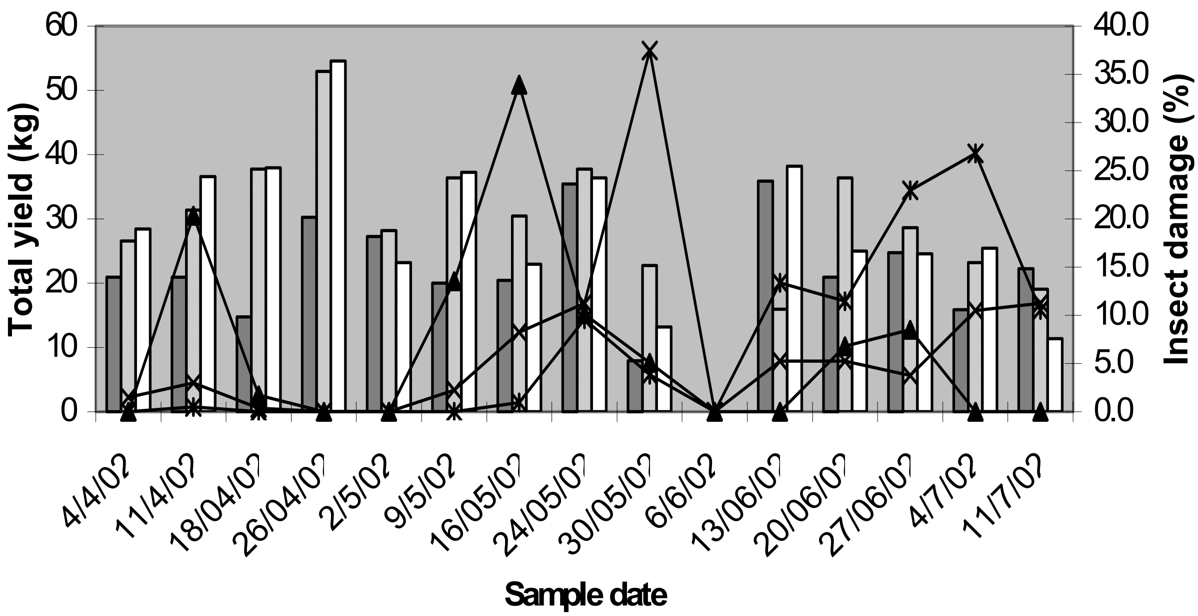

Figure 7 a – c. Yields and percentage insect damaged rejects obtained from plots under three different management systems on Farm 3 in Linstead St Catherine between May to July 2001

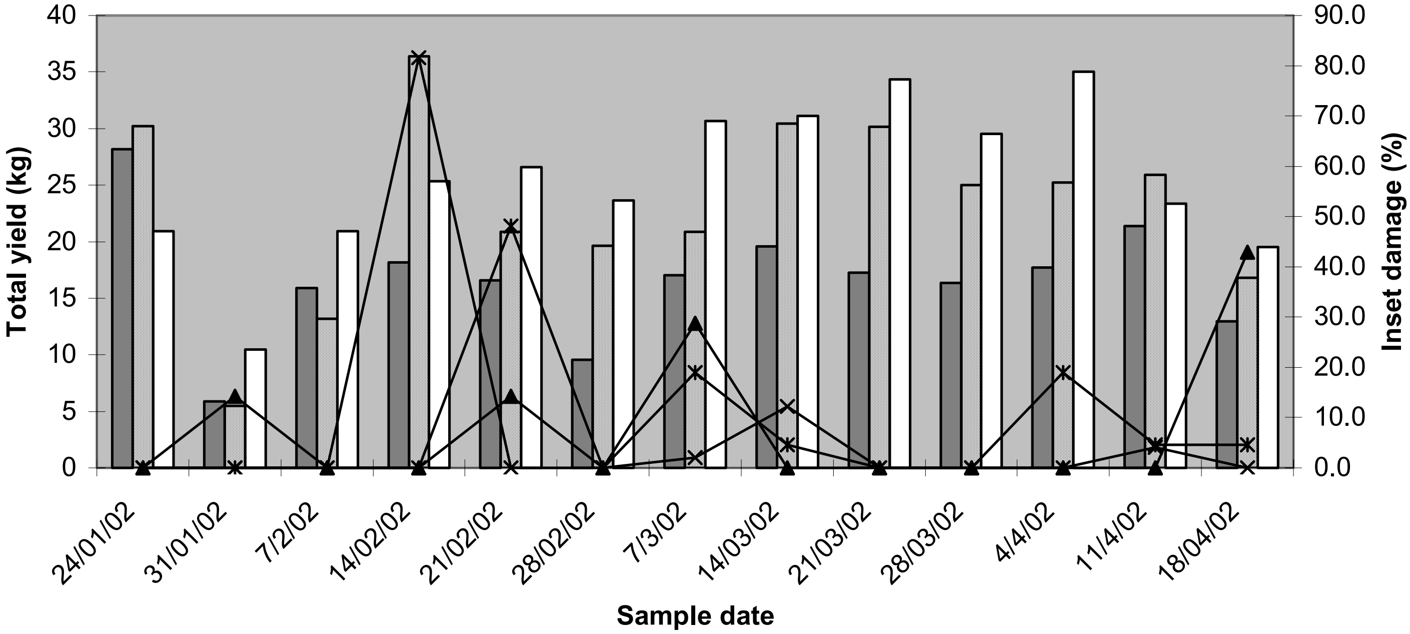

Figure 8. Yield and percentage insect damaged rejects obtained from under three different management systems on Farm 4 Linstead St. Catherine between January to April 2002