Integrated Crop Management Strategies in Snow Pea: A Model for Achieving Sustainable NTAE Production in Central America

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Abstract

Expansion in non-traditional agricultural exports (NTAEs) has stimulated public and private investment throughout Central America, and focused regional policy on promoting continued NTAE expansion. However, in recent years the potential for an entirely new set of constraints to trade have been exposed. Central American NTAEs have experienced an increase in sanitary and phytosanitary regulatory violations at United States and European ports-of-entry as producers and exporters have aggressively sought expansion of their markets without appropriate concern for the field production and post-harvest handling protocols embodied in good management practices. These non-economic constraints to trade represent the newest and potentially most challenging limitations to future regional development in the NTAE sector, because current violations restrict market access and inhibit market expansion.

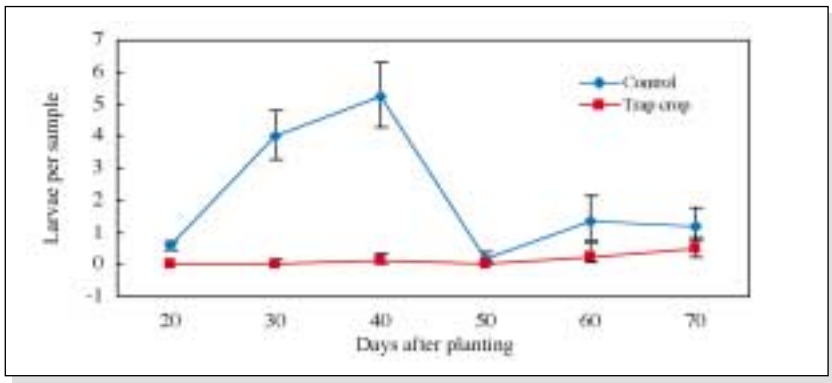
Introduction

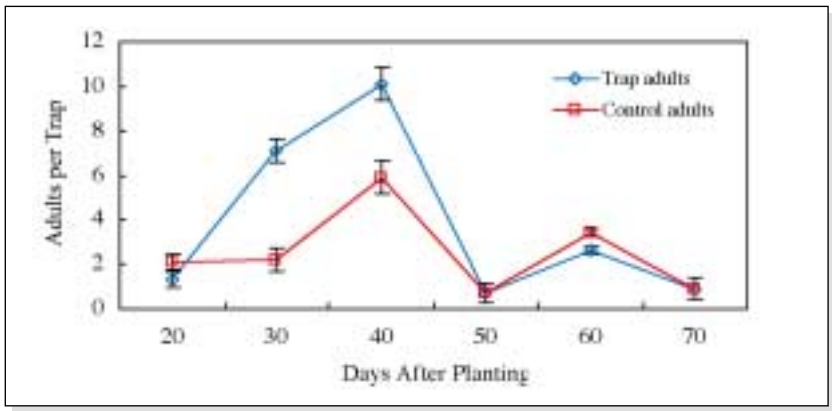
In order to address these issues in a proactive manner, the first requirement focuses on the development and validation of integrated crop management (ICM) strategies that result in economically and environmentally sustainable NTAE crop production. The USAID sponsored Integrated Pest Management Collaborative Research Support Program (IPM CRSP) in Central America targets development of scientifically-based integrated crop management systems. Implementation of such fully integrated crop management programs, along with proper post-harvest handling, help ensure that regional NTAEs meet marketplace demands, and at the same time encourage growth and sustainability in this important sector of rural economies throughout Central America. This paper summarises IPM CRSP integrated biorational pest management strategies developed to achieve these objectives, their impact on reducing reliance on chemical pest control practices, as well as, the economic and socioeconomic implications for enhancing Central America's NTAE production.

Integrated Biorational Strategies

Integrated crop management strategies are increasingly being recognised as important NTAE production practices to achieve reduced pesticide applications, increased product quality and more sustainable economic benefits. Biorational strategies focus on component production practices that are sensitive to balance and sustainability in the overall ecosystem when integrated into holistic production management systems. IPM CRSP research in Central America during the last seven years has concluded that fully integrated management approaches incorporating intercropping, scouting, trap cropping, mobile trapping, minimum threshold pesticide applications, optimum crop cultural practices, cultivar selection, and the coordinated transfer of this knowledge to growers provides a solid foundation for future growth and sustainability in the NTAE production sector in a substantially biorational manner. The underlying premise of IPM CRSP is that when current, scientifically proven production technologies are properly

Figure 1
Changes in larval density over time
Figure 2
Change in adult population over time





transferred, integrated and precisely managed, the production goals of immediate economic gain, long-term sustainability, and safe food supplies are mutually reinforcing. Snow pea research in the IPM CRSP provides just one example of how fully integrated biorational production management strategies provide the basis for achieving the aforementioned objectives for NTAE crops in Central America.

Research approach

Snow pea (Pisum sativum) is an important non-traditional export crop in Central America, and leaf miner (Liriomyza huidobrensis) has become an increasingly important pest problem. Control of leaf miners using total chemical means on a calendar application basis has become the standard practice in many production regions throughout Central America. As the leaf miner pest has developed greater resistance to chemical insecticides labelled for its control, producers have been forced to seek alternative approaches to achieve effective control. The IPM CRSP approach includes non-chemical component research regimes that are integrated into a holistic system to effectively control leaf miner problems in a more sustainable manner. When incorporated into a holistic crop management system, these various component strategies enable snow pea producers to achieve the overall objectives of fully integrated crop management. The objective of our research was to establish a fully integrated demonstration site for grower training and technology transfer.

A holistic, ICM system was evaluated at nine field sites in the Guatemalan highlands where 80% of snow pea production occurs. The ICM plots were managed by IPM CRSP technicians, and pest control measures were based on scouting and the determination of pest thresholds. Incorporation of trap crops, sticky traps, and minimum-use pesticide applications were included in the pest management regimes. This was in contrast to farmer managed plots where pest control relied primarily on application of pesticides using a 7-10 day calendar programmed application schedule. Most producers were small family farmers with < 0.5 ha. Few were acquainted with integrated pest management (IPM), and relied heavily on the agrochemical distributors for pest management information.

The IPM CRSP integrated crop management system was based on performance proven component research, including effective intercropping techniques, which had previously been evaluated for leaf miner control. Laboratory and field experiments conducted with 'Oregon Sugar Pod II' snow pea and faba bean (Vicia faba) investigated the potential of faba bean as a trap crop for leaf miner. Trap crops are used to attract insect pests away from the primary income crop being produced, in this case snow peas, thereby lowering the insect pressure in the crop and reducing the need for chemical pesticide applications. Greenhouse choice and no choice experiments previously investigated leaf miner preference for faba bean versus snow pea. The greenhouse and laboratory results indicated faba bean was highly attractive to leaf miner adults and showed excellent potential as a trap crop.

Field experiments in 1999 at Xeabaj, Chimaltenango, Guatemala were established to confirm these positive greenhouse results using faba bean trap cropping strategies for leaf miners. Plots were managed using proven agricultural practices without use of pesticides. The experiment included two treatments: faba beans as a barrier trap crop around snow peas and snow peas alone as the control. Sampling of leaf miner infestation was conducted 20, 30, 40, 50, 60, 70 and 80 days after planting at eight locations in the trap crop and at 13 locations within the snow peas. Sampling involved cutting the upper 50 cm of the plant stem and counting emerging larvae after six days.

Additional studies were conducted for incorporation into ICM systems to determine the effect of intercropping on leaf miner infestations and the economic impact on returns to growers in snow pea production. Intercropping strategies, sometimes referred to as strip-cropping, incorporate multiple crops of economic value into the production regime in an effort to achieve lower pest problems and greater net returns per area of production. Field trials at Xeabaj (Table 1) tested crop combinations of: snow pea+black bean (Phaseoulus vulgaris); snow pea+carrots (Daucus carota), snow pea+beets ; snow peas+lettuce (Lactuca sativa); and two monocultured snow pea plots treated exclusively with insecticides for leaf miner management (farmers control); or leaf miner control in snow pea plots with portable yellow sticky traps called 'toritos'.

Factors evaluated were snow pea export-quality yield and leaf miner larval populations 35, 65 and 90 days after planting. All plots except the chemical control plot

Table 1. Summary of the economic analysis performed on yields and total direct costs of strip-cropping field trial for snow peas in the Guatemalan highlands. 1999.

Treatment	Unit	Unit Cost (US$)	Unit Price (US$)	Yield (Ha)	Direct Cost (US $)	Net profit	Profit margin
Snow pea monoculture non-chemical	Kg	0.37	0.73	6,126	$2,267	$2,205	97.3%
Snow pea +	Kg	0.36	0.73	3,083	$1,110	$1,141	120.6%
Lettuce	Kg	0.07	0.17	12,727	$891	$1,273	
Snow pea +	Kg	0.14	0.73	3,247	$455	$1,916	251.6%
Black beans	Kg	0.39	0.92	1,711	$667	$907	
Snow pea +	Kg	0.38	0.73	2,982	$1,133	$1,044	71.3%
Beets	Dozen	0.31	0.35	1,300	$403	$52	
Snow pea+	Kg	0.41	0.73	2,763	$1,133	$884	52.6%
Carrots	Dozen	0.30	0.24	1,324	$397	-$79	
Snow pea monoculture Chemical	Kg	0.47	0.73	6,337	$2,978	$1,648	55.3%

Table 2[1]. Number of eggs and pupae per gram of fresh weight of tissue per species in no choice and choice experiment[2].

	No choice experiment		Choice experiment	
Treatment	Eggs/g FW	Pupae/g FW	Eggs/g FW	Pupae/g FW
Faba bean	2.06**	0.43**	5.41**	2.14**
Snow pea	0.20	0.04	0.12	0.25

[1] Data presented are means for three separate experiments.
[2] Data were analyzed using a square root transformation. Data presented for the untransformed values.
** Significant difference at P<0.01 found between means.

were managed according to the IPM CRSP integrated crop management guidelines. Leaf miner populations were monitored twice a week and insecticide applications made at the threshold of 10 adult leaf miners per meter.

SUMMARY RESULTS

These biorational pest management strategies were fully integrated using the IPM CRSP integrated crop management approach, and managed by trained on-site field technicians. The ICM snow pea test plots (1100 m2) were compared to identical plots managed entirely by regional farmers using traditional pest management regimes. In contrast to traditionally managed plots, ICM-managed plots required half, or less than half, the amount of insecticides applied by farmers in the control plots, and achieved equal or better results. Insect pest populations and diseases were similar in the ICM plots and the control plots even though farmers applied insecticides on a program scheduled basis in the control plots. In nine out of nine comparisons, the ICM plots required less insecticide sprays and in seven out of nine comparisons, the ICM plots had higher yields. This translates into an average 61% reduction in pesticide use, and a 6% increase in average total yield. In two of the sites, export-quality yields were 30–50% higher than the national average, with outputs ranging from 9500–10 800 kg/ha. These results indicate that the production and export of high quality edible NTAE crops is entirely possible using performance proven IPM strategies. The key to success centres on the effective transfer of such performance proven production knowledge, and the implementation of highly focused grower training programs on a regional basis.

When leaf miners were exposed only to faba bean or only to snow peas, there was a significantly higher number ($P < 0.01$) of eggs laid on faba beans (2.06/g FW) than on snow peas, (0.20/g FW) (Table 2). The number of emerging pupae from faba bean foliage (0.43/g FW) was also greater than from snow pea foliage (0.04/g FW). In choice experiments there was a higher ($P < 0.01$) number of eggs laid on faba beans (5.41/g FW) than on snow peas (0.12/g FW) (Table 2), and the number of emerging pupae from faba bean foliage (2.14/g FW) was also greater than the number emerging from snow pea foliage (0.25 /g FW). Greenhouse data concluded that female leaf miners prefer faba beans over snow peas as a host for oviposition.

Faba beans have excellent potential as a trap crop for leaf miners in snow pea fields. In field experiments, the number of larvae emerging per snow pea plant was significantly ($P = 0.05$) higher in monoculture control treatments than in snow peas surrounded by the trap crop treatment (Figure 1) for tissue sampled at 20 to 60 days after crop planting (larvae were significantly different at $P = 0.10$ level for days 50 and 70 after planting). There were no significant differences in the number of larvae emerging from snow pea plants in either treatment 80 days after planting. The number of adults caught on sticky traps in the trap crop treatment compared to the control treatment was significantly different only on days 30 ($P = 0.05$) and 40 ($P = 0.1$) after planting (Figure 2). Faba beans were again found to be a preferred host for leaf miner oviposition compared to snow pea. Further, faba beans were found to have excellent potential as an effective season-long trap crop to reduce leaf miner infestations in snow pea culture. This translated into a reduction in the level of leaf miner infestation, as well as the number of insecticide applications required to control the pest. Currently, over 30% of Guatemalan snow peas are grown using the faba bean trap crop system developed by in the IPM CRSP research, and incorporated into an ICM production system (G. Sánchez, pers. comm, 2000).

Intercropping was found to be an attractive option for farmers in the highlands of Guatemala. There were no significant total yield differences in any of the various cropping combinations (Table 1). However, economic assessments found that the most profitable regime was the intercropped snow pea black bean combination with net profit margins exceeding 251% (Table 1). In contrast, mono-cultured snow pea using standard chemical pest control practices had only a 55.3% net profit margin as a result of increased chemical applications and associated labour costs. The diversification of crops favours long-term sustainability for both export and locally marketed vegetables. The results obtained in this study suggest that the ICM strategy developed by the IPM CRSP in Guatemala is applicable to multi-crop systems throughout Central America, thus resulting in increased economic benefits to the farmer. Profit margins were increased due to lower pest pressures and reduced usage of chemical insecticides, plus the fact that farmers can diversify crops grown to take advantage of not only the NTAE market, but local and regional markets as well. The ICM systems described above, developed through IPM CRSP research, have been shown to be critical elements for achieving potential long-term sustainability in the NTAE production sectors of Central America.

CONCLUSIONS

Our research concludes that NTAE producers and exporters throughout Central America can benefit from a serious effort to institutionalise policies that encourage the adoption of fully integrated biorational crop management practices. Performance proven component pest management strategies, when fully integrated into a holistic production and post-harvest management system, result in more effective

IPM CRSP collaborators in Guatemala are: (from front left) Guillermo Sánchez, Glenn Sullivan, Steve Weller, and (back row) Rich Edwards

insect and disease control with less reliance on chemicals. Further, these fully integrated crop management systems generate higher marketable yields, safer food supplies, and greater economic sustainability at all levels. Perhaps even more importantly, biorational crop management systems help assure long-term sustainability to the fragile natural resources and overall ecosystem which serve as the foundation of all NTAE production activity in Central America.

The component research summarised in this paper clearly validates the underlying premise of the IPM CRSP; when current scientifically tested and proven production technologies are properly integrated and precisely managed, the production goals of immediate economic gain and long-term sustainability are mutually reinforcing. The research and development initiatives of the IPM CRSP have shown that when integration is the critical focus of IPM, Central American NTAE producers can expand production in a manner commensurate with market expectations and consistent with their economic and socioeconomic development objectives. In both the near and long-term, fully integrated crop management strategies serve to significantly increase the region's capacity to meet product quality standards for safe food supplies and help compete more successfully in an increasingly more demanding international marketplace.

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