Tropentag 2009
University of Hamburg, October 6-8, 2009
Conference on International Research on Food Security, Natural Resource Management and Rural Development

Integrated Pest Management in Organic Vegetable Soybean Production

R. Srinivasan*, Fu-Cheng Su, Chun-Chu Huang, Mei-Ying Lin and Yun-Che Hsu

Entomology Unit, AVRDC – The World Vegetable Center, Shanhua, Tainan 74151, Taiwan. *e-mail: srini.ramasamy@worldveg.org

Introduction

Vegetable soybean (*Glycine max* L. Merrill) is an important crop and source of dietary protein in East and Southeast Asia. The total biological yield of vegetable soybean can be as high as 40 t/ha, consisting of 10 t of marketable pods and 30 t of residue that can enrich the soil or feed animals (Shanmugasundaram and Yan, 2004). The productivity of vegetable soybean is limited by insect pests and diseases (Talekar and Chen, 1983; Talekar, 1987; Yeh et al., 1991; Chen, 2003; Cho and Lee, 2003; Lai et al., 2004). There are insect species damage the crop starting from crop emergence to harvest (Talekar, 1987) and the crop losses can be as high as 100% (Talekar and Chen, 1983). Indiscriminate use of pesticides is common, which has led to pesticide resistance in insects such as beanflies and lepidopterous defoliators (Yeh et al., 1991). Pesticide residue may hinder the export potential of vegetable soybean. Increasing concern about environmental quality, human health, and safer agricultural products has led to the development of organic vegetable soybean production in Taiwan and Southeast Asia (Ma et al., 2008). Since the integrated pest management (IPM) strategy for organic vegetable soybean production systems has not been developed earlier, AVRDC – The World Vegetable Center developed an IPM strategy during 2006-2008.

Materials and methods

Monitoring of insect pests on vegetable soybean under organic production systems

A field trial was conducted during spring 2006 in the organic plots (Field no. 81) of AVRDC – The World Vegetable Center to monitor the incidences of insect pests on vegetable soybean under organic production systems using the cultivar ‘Kaohsiung 9.’ Insect pests (sucking insects and defoliators) were monitored starting from sowing until harvest at weekly intervals. The pod borer damage was calculated at the time of harvest.

Validation of an integrated pest management (IPM) strategy

Field trials were conducted during the spring (February – May) and autumn (September – November) seasons of 2006 to 2008 on the organic farm of AVRDC – The World Vegetable Center, Taiwan. ‘Kaohsiung no. 9’ was used in all trials. The IPM strategy is composed of the following components: (i) sex pheromone traps for *Spodoptera exigua*, *S. litura*, and *Helicoverpa armigera* throughout the growing season; (ii) yellow sticky paper traps for whitefly and leafhopper throughout the growing season; (iii) spraying of neem pesticide (Biofree – I®, 2.5ml/l), followed by neem with *Bacillus thuringiensis* (Bt; Xentari®; 1g/l during spring and 0.25g/l during autumn) in subsequent sprayings to control early season sucking insects and defoliators, respectively; and (iv) spraying of neem, Bt and *Maruca vitrata* nucleopolyhedrovirus (10^9 OBs/l) for pod borers three times during the pod setting stage. The IPM strategy was compared with an untreated control during 2006 (autumn) and 2008 (spring and autumn), but with the farmers' practice as well as untreated control during 2007 (spring and autumn). The farmers' practice was based on the use of synthetic chemical pesticides, and hence this treatment was conducted in the conventional plots next to organic plots. Each treatment was replicated eight times following the randomized block design. The data on sucking insects and defoliators (*i.e.,* number of insects per plant) were collected at regular intervals after each spraying. The percent pod damage due to pod borers was recorded at the time of harvest by recording the total as well as damaged number of pods. However, the data on sucking insects and defoliators was not recorded after spring 2007 trial, as their populations were negligible. At the time of harvest, the total pod yield as well as graded pod yield was recorded. The data were analyzed using analysis of variance (ANOVA) and mean comparisons were conducted using Tukey's test.

Results and discussion

Insect pests on vegetable soybean

Total of 11 insect pest species were observed in the 2006 monitoring trial. Slight defoliation caused by tomato fruit worm (TFW, *Helicoverpa armigera*), common armyworm (CAW, *Spodoptera litura*), and beet armyworm (BAW, *S. exigua*) were observed four weeks after sowing (WAS). Soybean webworm (*Omiodes indicata*) emerged from the fifth to eight week after sowing, but without causing significant damage. Taiwan tussock moth (*Porthesia taiwana*) appeared after two months of sowing, but it was not a major pest. Limabean pod borer (LBPB, *Etiella zinckenella*) damage on pods increased from 4.15% at 9 WAS to 7.56% at 11 WAS. Whitefly (*Bemisia tabaci*), smaller (small?) green leafhopper (*Edwardsiana flavescens*), and green stink bug (GSB, *Nezara viridula*) were also present throughout the growing season without causing any significant damage. Other than those insect pests observed in spring season, thrips (*Megalurothrips usitatus*) and legume pod borer (LPB, *Maruca vitrata*) also occurred mostly during the autumn season.

Earlier studies at AVRDC indicated that agromyzid bean flies, GSB, scarabaeid beetles (*Anomala* spp.), LBPB and aphid were the major insect pests infesting soybeans (Talekar and Chen, 1983). However, we did not record any damage due to bean flies and scarabaeid beetles during the three-year study, although LBPB was confirmed to be the major production constraint. LPB also emerged as a major pest, as reported earlier in vegetable soybean in Taiwan (Chang and Chen, 1989) and grain soybean in Vietnam (Chinh et al., 2001). The LPB population has increased in Taiwan due to the introduction of *Sesbania cannabina*, a popular green manure crop (Liao and Chen, 1998).

Effects of IPM strategy on pests and vegetable soybean yield

Effect of organic IPM strategy on selected lepidopteran and hemipteran pests of vegetable soybean was evaluated during spring 2007 (Table 1). For most insects except *T. ni*, *P. taiwana,* and *E. flavescens*, the treatment effects were not significant. This could be due to the lower incidences of the other insect pests.

The IPM strategy did not have any significant effect on *T. ni* and *E. flavescens*, although the farmers' practice, which is based on chemical pesticides, completely controlled these insects. However, *P. taiwana* was controlled by the IPM strategy and the effects were comparable with pesticide-based management. Most of these secondary phytophagous insects occur occasionally on vegetable soybean. It has been proven that soybean yield reduction is not so significant, even up to 25% defoliation (Talekar and Lee, 1988). As the defoliation by these insects rarely exceeds

25%, significant yield loss is not expected. Although GSB was earlier reported as a key constraint, it was found to be a minor pest in our study. Talekar and Chen (1983) found that GSB infestation begins in May and continues until October with a peak in June. As our crop period fell during February-May and September-November, the crop might have escaped GSB damage.

Table 1. Effects of various management practices on the incidence of secondary phytophagous insect pests on vegetable soybean in the 2007 spring trial

Pest species	No. of insects / plant			F value	P value
	Organic IPM	Farmers' practice	Check		
Lepidoptera					
Cabbage looper (*Trichoplusia ni*)	0.06 a	0.00 b	0.07 a	11.94	0.0003
Soybean webworm (*Omiodes indicata*)	0.03	0.01	0.02	2.49	0.11
Common armyworm (*Spodoptera litura*)	0.02	0.01	0.03	1.11	0.35
Beet armyworm (*Spodoptera exigua*)	0.01	0.01	0.004	0.69	0.51
Tomato fruitworm (*Helicoverpa armigera*)	0.01	0.02	0.02	0.63	0.54
Taiwan tussock moth (*Porthesia taiwana*)	0.04 b	0.00 b	0.11 a	11.14	0.0005
Hemiptera					
Green stink bug (*Nezara viridula*)	0.02	0.02	0.01	0.40	0.67
Smaller green leafhopper (*Edwardsiana flavescens*)	0.49 a	0.00 b	0.61 a	40.40	<0.0001

Means followed by same letter(s) in a row are not significantly different at p=0.05

Damage due to pod borers was significantly reduced by the IPM strategy when compared to the untreated control, except in autumn 2007 (Table 2). Pod borers, especially LBPB, emerged as a major pest, as observed by Talekar and Chen (1983) who found that the first-generation moths of LBPB start appearing late in September and remain active until the following April or May. LPB also could cause significant damage in both seasons, as it produces at least nine generations a year in Taiwan (Huang et al., 2002).

Table 2. Effects of various management practices on the pod damage of vegetable soybean due to pod borers

Treatments	Pod damage (%)			
	2007		2008	
	Spring	Autumn	Spring	Autumn
Check	10.70 a	10.10 a	17.90 a	2.45 a
Organic IPM	4.00 b	11.20 a	6.93 b	1.32 b
Farmers' practice	1.80 c	0.92 b	---	---

Means followed by same letter(s) in a column are not significantly different at p=0.05

Although the total pod yield was mostly higher in IPM plots than control plots, the graded pod yield is always higher in IPM plots than in control plots (Table 3). The graded pod yield may act as an indicator of the pest management strategies.

Table 3. Effects of various management practices on the total and graded pod yield in vegetable soybean

Treatment	Pod yield (t/ha)									
	Autumn 2006		Spring 2007		Autumn 2007		Spring 2008		Autumn 2008	
	Tot	Grad	Tot	Grad	Tot	Grad	Tot	Grad	Tot	Grad
Check	6.00 b	3.20 b	9.00 c	4.20 c	5.08 b	1.66 b	12.06 a	5.00	6.20 a	2.06 b
Organic IPM	9.90 a	7.10 a	9.90 b	4.90 b	6.31 a	3.80 a	11.49 b	5.69	5.69 b	2.83 a
Farmers' practice	---	---	13.80 a	8.90 a	4.53 b	2.00 b	---	---	---	---

Figures followed by same letter(s) in a column are not significantly different at p=0.05

Conclusion

The IPM strategy can reduce damage due to pests, especially pod borers, in organic vegetable soybean production systems, and contribute to higher graded pod yield. However, the yield may be lower than the traditional farmers' practice, which is based mostly on chemical pesticides. Hence, the yield gap in tropical organic vegetable soybean should be compensated with the premium price for the produce, which would encourage the growers to adopt the IPM strategy. In addition, future research should be focused to demonstrate the safety of organic vegetable soybean by measuring the pesticide residue levels in produces from the fields receiving the traditional farmers' practice.

References

1. Chang, T.C., Chen, C.C. 1989. Observation of three lepidopterous pests attacking leguminous vegetables in Taiwan. Bulletin of Taichung District Agricultural Improvement Station. 24: 21-29
2. Chen, Y.C. 2003. Powdery mildew of vegetable soybean in Taiwan. Plant Pathol Bull 12: 209-211.
3. Chinh, N.T., Dzung, D.T., Long, T.D., Tam, H.M., Ramakrishna, A., Johansen, C. 2001. Legumes in Vietnam: constraints and opportunities. pp. 111–125. *In* C.L.L. Gowda, A. Ramakrishna, O.P. Rupela and S.P. Wani (eds.), *Legumes in Rice-based Cropping Systems in Tropical Asia: Constraints and Opportunities*, International Crops Research Institute for the Semi-Arid Tropics, Patancheru, AP, India.
4. Cho, E.K., Lee, S.H. 2003. Cowpea mosaic virus from vegetable soybeans in Korea. Plant Pathol J 19(3): 166-170.
5. Huang, C.C., Peng, W.K., Talekar, N.S. 2002. Larval population changes in the bean pod borer, *Maruca vitrata* (Lepidoptera: Pyralidae) on *Sesbania cannabina* on an AVRDC farm, Tainan, Taiwan. Formosan Entomol 22: 271-278.
6. Lai, P.S., Lien, T.J., Chen, R.S., Tsay, J.G. 2004. The occurrence of downy mildew of vegetable soybean and its detection by PCR. Plant Prot Bull 46: 155-162.
7. Liao, C.T., Chen, C.C. 1998. Distribution of *Maruca testulalis* Geyer (Lepidoptera: Pyralidae) eggs and larvae on *Sesbania*. Bull. Taichung DAIS, 59: 47-52.
8. Ma, C.H., Juroszek, P., Palada, M., Srinivasan, R., Wang, T.C., Yang, R.Y. 2008. Integration of production technologies for organic vegetable soybean in Taiwan. HortScience 43(4): 1106.
9. Shanmugasundaram, S., Yan, M.R. 2004. Global expansion of high value vegetable soybean. In: World Soybean Research Conference, 7th. Londrina: Brazilian Agricultural Research Corporation, National Soybean Research Center. p. 915-920.
10. Talekar, N.S. 1987. Insects damaging soybean in Asia, pp. 25-45. *In* S. R. Singh, K. O. Rachie and K. E. Dashiell (eds.), Soybeans for the tropics: research, production and utilization. Wiley, New York.
11. Talekar, N.S., Chen, B.S. 1983. Seasonality of insect pests of soybean and mungbean in Taiwan. J Econ Entomol 76(1):34-37.
12. Talekar, N.S., Lee, H.R. 1988. Response of soybean to foliage loss in Taiwan. J Econ Entomol 81: 1363-1368.
13. Yeh, C.C., Hartman, G.L., Talekar, N.S. 1991. Plant protection technology for vegetable soybean. Pp. 85-91. *In* Proceedings of the Workshop on vegetable soybean: Research needs for production and quality improvement, Apr 29 – May 2, 1991, Taiwan.