The Agriculturists 14(1): 54-62 (2016) ISSN 2304-7321 (Online), ISSN 1729-5211 (Print)
A Scientific Journal of Krishi Foundation ***Indexed Journal***
Impact Factor: 0.402 (GIF, 2014)

Evaluation and Economic Analysis of Some Integrated Pest Management Packages for Suppressing Tube Spittle bug (*Machaerota planitiae* Distant) Infesting Jujube (*Zizyphus mauritiana* Lamk), in North-Western Bangladesh

M. Z. H. Prodhan[1], M. S. Noman[2]*, M. T. Hasan[1] and M. A. Maleque[3]

[1]*On- Farm Research Division, Bangladesh Agricultural Research Institute, Bogra;*
[2]*Hill Agricultural Research Station, Bangladesh Agricultural Research Institute, Khagrachari;*
[3]*Department of Entomology, Faculty of Agriculture, Sylhet Agricultural University, Sylhet 3100*

**Corresponding author and Email: shibly.ent@gmail.com*

Received: 9 January 2016 Accepted: 12 June 2016

Abstract

To develop a suitable integrated pest management (IPM) package(s) against tube spittle bug attacking jujube, the study was conducted at the farmer's orchard at Sherpur Upazilla of Bogra district, Bangladesh during the two consecutive winter seasons of 2011-12 and 2012-13. There were five IPM packages viz., P_1 = Clean cultivation + collection and destruction of tube with alive nymph from the branches, $P_2 = P_1$ + two sprays of Detergent @ $2gl^{-1}$ of water applied (at initial stage of infestation and 10 days after 1st spray), $P_3 = P_1$ + two sprays of crushed Neem seed extract @ 150 gl^{-1} of water (at initial stage of infestation and 10 days after 1st spray), $P_4 = P_1$ + sprays of Cypermethrin @ 1 mll^{-1} of water at initial stage of infestation, $P_5 = P_4$ + one additional spray of Cypermethrin @ $1mll^{-1}$ at 10 days after 1st spray and an untreated control. In both the years, treatment P_5 was found most effective, which resulted lower damage to inflorescence and produced higher yield, followed by P_4 and P_3. In case of marginal benefit cost ratio, the highest value (15.69 & 20.63) was obtained from the treatment P_5 which was closely followed by P_4 (15.07 &20.12) in both of years, respectively.

Keywords: Tube spittle bug, damage assessment, neem seed extract, pesticide, yield loss

1. Introduction

The jujube (*Zizyphus mauritiana* Lamk), tropical fruit species belonging to the family Rhamnaceae is locally known as 'kul' or 'boroi'. Ber is a popular fruit in Bangladesh (Ibrahim *et al.,* 2009). It is gaining popularity among the growers because of its higher yield, higher economic return and suitable for the arid and semi-arid regions of Bangladesh where most of other fruit crops cannot be grown either due to lack of proper irrigation facilities or adverse climatic and soil conditions (Bose and Mitra, 1990). Jujube is a cross pollinated crop and generally propagated by seeds. As such, variability exists among these genotypes. Fruits of jujube are nutritionally rich (Sharma *et al*., 2002). The fruit is containing the major mineral components such as potassium, phosphorus, calcium, manganese, iron, sodium, zinc and copper. The fruit is enriched with vitamin C and vitamin B complex (Bal *et al*., 1984). The vitamin C content of fruit is higher than that of orange. Studies have shown that the antioxidant content of fresh fruit is higher than that of strawberries, plums, apples, blueberries, and blackberries raspberries (Li *et al*., 2007). In the past the crops were being cultivated following the age–old practices using local varieties. But there has been an ample development on ber production in the country. A good number of improved varieties (e.g. Apple Kul, BAU Kul, Thai Kul, BARI Kul-1, BARI Kul-2 and BARI Kul-3) along with improved production technologies have been developed which produces much higher yield than the existing varieties. Now jujube has been emerging as an important commercial fruit crop in Bangladesh (Prodhan *et al*., 2012). In 2008-09, the crop covered the area of 1114 thousand ha of land and had an annual production of 71949 metric tons (BBS, 2010).

A total of 130 species of insect pests of ber have been so far recorded in India, but only a few species have attained pest status and caused substantial economic damage to jujube (Balikai., 2009). In the extensive jujube growing district of Karnataka State, India, 22 insects and non-insect pests were recorded to feed on the fruit. Out of these, three insect pest species viz., ber fruit borer, *Meridarchis scyrodes* Meyrick and two species of jujube fruit flies, *Carpomyia vesuviana* Costa and *Dacus correctus* (Bezzi) were recorded as major insect pests causing from high to very high degree of damage to jujube. While five insect pests namely green striped leafhopper, *Eurybrachys tomentesa* Fab., Jassid, *Amrasca biguttula biguttula* (Ishida), tube spittle bug, *Machaerota planitiae* Distant, lac insect, *Laccifer lacca* Kerr. and jujube butterfly, *Tarucus theophrastus* (Fabricius) have recently been recorded as negligible pests (Balikai., 2009). Out of those insects, tube spittle bug has recently been considered major pest. The insect constructs calcareous hard tubes which are attached to stem and twigs near the inflorescence and sucks cell sap from flowers. Affected flowers are dried completely and make fruit less trees (Figure 1. a-e). Heavy infestations can cause complete failure of the crop. Nonetheless, management approaches for suppressing spittle bug have not yet been properly explored. Based on the facts above, the present study was undertaken i) to evaluate IPM packages for suppressing infesting jujube, and ii) to evaluate economic analysis of these packages to ensure the steady production of jujube in the country.

2. Materials and Methods

2.1. Study site

The study was conducted during the two consecutive winter seasons of 2011-12 and 2012-13 in the farmer's orchard, Sherpur Upazilla, Bogra (Figure 2). The variety of jujube was Apple kul and age of the plant was five years. The height was 3.5 to 4.4 meter and row -row and plant-plant distance was 4 m. The months from October to February of the year is considered as winter season in Bangladesh. The climate of the study site is subtropical, characterized by three distinct seasons, the winter season (November–February; night time temperature: 8–12°C; day time: 20–25°C), the pre-monsoon period or hot season (March–April; temperature at night time: 15–18°C; day time: 35–40°C) and the monsoon period (May–October; temperature at night time: 18–24°C; day time: 30–35°C). The soil of the experimental areas belongs to AEZ 4 characterized by very lowland to highland (FRG, 2012).

2.2. Design and treatment application

The experiment was laid out in a randomized complete block design (RCBD) with three replications. Single tree was considered as an experimental unit. All the treatments were assigned at random to each replication. The treatment packages used in this study were: P_1 = Clean cultivation + collection and destruction of tube (with alive nymph) from the branches, P_2 = P_1 + Two sprays of detergent @ 2gl^{-1} of water (at initial stage of infestation and 10 days after 1st spray), P_3 = P_1 + two sprays of crushed neem seed extract @ 150g^{-1} of water (at initial stage of infestation and 10 days after 1st spray), P_4 = P_1 + sprays of Cypermethrin @ 1mll^{-1} of water at initial stage of infestation, P_5 = P_4 + one additional spray of Cypermethrin @ 1mll^{-1} at 10 days after the 1st spray and an untreated control. The sprays were done with a high volume foot pump sprayer.

a. Tube

b. Nymph

c. Adult

d. Fresh inflorescence

e. Infested inflorescence

Figure 1(a-e). Infestation symptoms on the jujube inflorescence caused by tube spittle bug

2.3. Data collection and analysis

A main branch of the selected trees were examined thoroughly (at three days interval) to record the number of tube per branch, number of alive nymph per branch and infested inflorescence per branch. Data were collected during the flowering period of the crop. After ripening all the fruits of each tree were harvested (4 times harvested at a season because jujube never ripe at a time) and mean yield of each plant was calculated and converted to yield per hectare. Data were analyzed using MSTAT software and the treatment means were separated by LSD. Economic evaluation of the treatments on the yield of ber was made for each treatment based on the Marginal Benefit Cost Ratio (BCR).

3. Results and Discussion

3.1. Infestation

The effect of different IPM packages on tube spittle bug infestation jujube be of two consecutive winter seasons (2011-12 and 2012-13) are presented in Table 1.The effects of IPM packages on all the parameters observed due to tube spittle bug infestation varied more or less significantly in both the years.

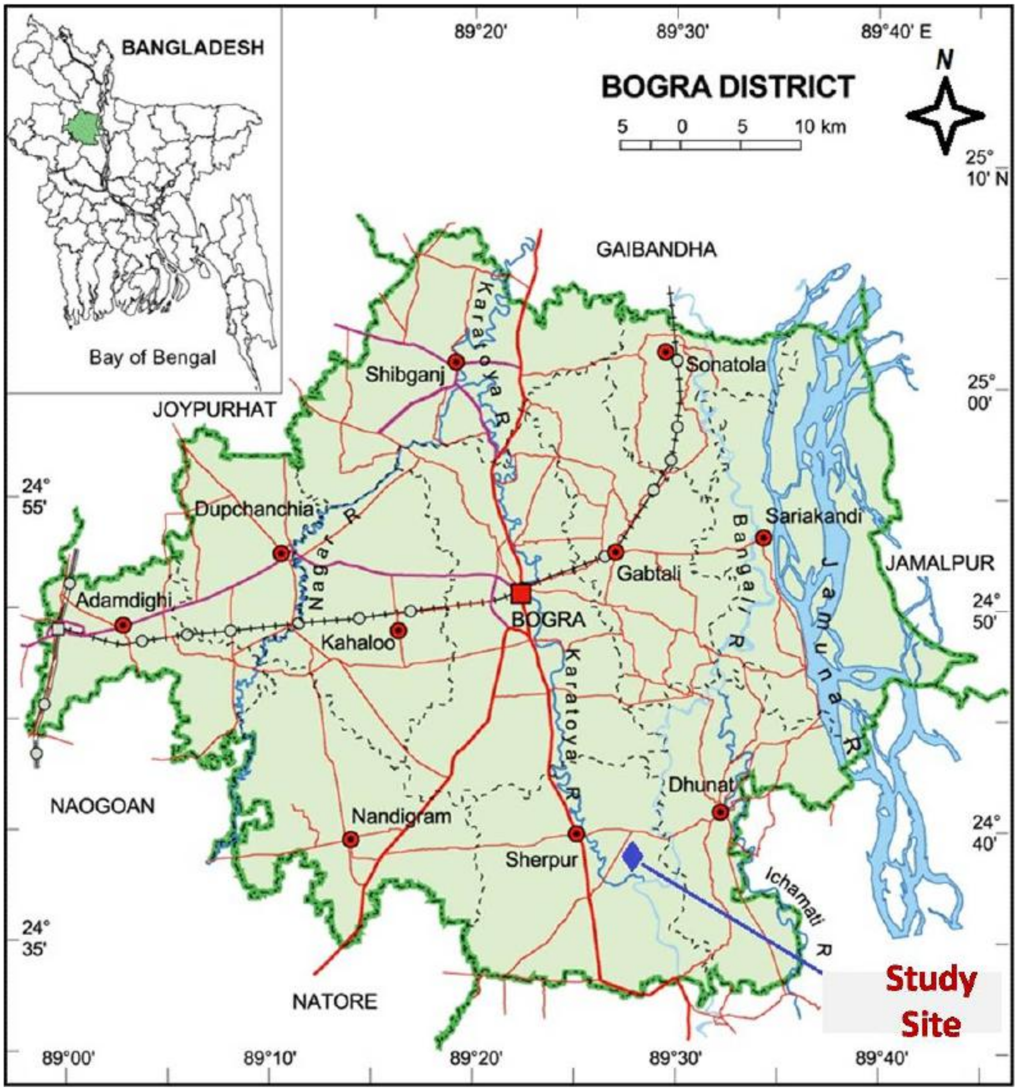

Figure 2. Map showing the study sites of Bangladesh (Sherpur, Bogra)

Table 1. Effect of different IPM packages on tube spittle bug infestation in jujube during the 2011-12 & 2012-13 winter cropping season at Bogra, Bangladesh

Treat-ments	No of tube/branch		No of alive nymph /branch		Infested inflorescence (%)		Infestation reduction over control (%)		Yield (tha^{-1})	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
P_1	50.30	25.06 b	15.33	9.34 b	8.43	5.1 b	16.29	28.57	7.41	8.76 b
P_2	38.53	22.10 b	12.23	7.73 bc	7.94	4.8 bc	21.15	32.77	8.16	9.18 b
P_3	28.06	19.26 b	9.73	6.60 c	6.69	4.6 bc	33.57	35.57	8.44	9.87 ab
P_4	20.77	18.53 bc	7.50	6.30 c	6.00	4.2 bc	40.42	41.18	8.99	10.42 ab
P_5	16.23	11.50 c	6.10	4.29 d	5.71	3.4 c	43.30	52.38	9.54	11.10 a
Control	75.89	41.40 a	24.66	15.16 a	10.07	7.14 a	-	-	7.24	8.12 b
Lsd	11.76	7.14	3.90	1.94	2.61	1.58	-	-	1.37	1.73
CV(%)	10.89	11.38	10.61	11.62	11.13	10.27	-	-	9.12	10.49

Means in a column having the same letter did not differ significantly (*P*>0.05).
P_1 = Clean cultivation + collection and destruction of tube (with alive nymph) from the branches
P_2 = P_1 + two sprays of detergent
P_3 = P_1 + two sprays of crushed neem seed
P_4 = P_1 + sprays of Cypermethrin
P_5 = P_4 + one additional spray of Cypermethrin
Control

Table 2. Economic analysis of different IPM packages to suppress the tube spittle bug infestation in jujube crop during 2011-12 and 2012-13 winter cropping seasons

Treat-ments	Gross return (US $/ha)		Cost of pest management (US $/ha)		Net return (US $/ha)		Adjusted net return (US $/ha)		Marginal Benefit Cost Ratio (MBCR)	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
P_1	4631.25	5475.00	50.00	50.00	4581.25	5425.00	56.25	350.00	1.13	7.00
P_2	5100.00	5737.50	66.63	66.63	5033.38	5670.88	508.38	558.38	7.63	8.38
P_3	5275.00	6168.75	105.63	105.63	5169.38	6063.13	644.38	988.13	6.10	9.00
P_4	5618.75	6512.50	68.06	68.06	5550.69	6444.44	1025.69	1369.44	15.07	20.12
P_5	5962.50	6937.50	86.13	86.13	5876.38	6851.38	1351.38	1776.38	15.69	20.63
Control	4525.00	5075.00	-	-	4525.00	5075.00	-	-		-

Notes: Spray volume 650 litreha^{-1}; 3 labor required for per ha spray; Cost of labor 2.5 US \$.$^{-1}$labor $^{-1}$day; Detergent @ 0.63 US \$Kg^{-1}; Cypermethrin (Ripcord 10 EC @ 1.63 US \$100 ml^{-1}; neem seed @ 0.63 US \$Kg^{-1}; Ber @ 0.63 US \$TkKg^{-1}; 3 labor needed for crushing neem seeds; 20 labor needed for Clean cultivation + Collection and destruction of tube (with alive nymph) from the branches.

In 2011-12 winter season, the lowest number of tubebranch^{-1} (16.23%) was observed in P_5 (Clean cultivation + collection and destruction of tube + two sprays of Cypermethrin) which was statistically similar to that of P_4 (clean cultivation + collection and destruction of tube + one spray of Cypermethrin) and P_3 (Clean cultivation + collection and destruction of tube + neem seed extract spray). The highest number of tube branch^{-1} was obtained from the package P_6 which differed significantly from the rest treatments. Similar results were also found from the number of alive tubebranch^{-1}. In case of percent infested inflorescence the lowest infestation was also obtained from the package 5 (P_5) (clean cultivation + collection and destruction of tube + two sprays of Cypermethrin) which was statistically similar to that of all the packages except the untreated control. The infestation reduction over control by different IPM packages ranged from 16.29% to 43.3%. The highest reduction (43.3%) of infestation over control was observed in P_5 followed by P_4 , P_3 and the lowest (16.29) was in P_1. The fruit yield varied significantly depending on the level of infestation. Significantly the highest yield (9.54 t/ha and) was also obtained from the treatment P_5 (Clean cultivation + collection and destruction of tube + two sprays of Cypermethrin) which was statistically similar to that of other packages except P_1 and P_6.

In the 2012-13 winter season, the lowest number of tubebranch^{-1} (11.50) was observed in P_5 (clean cultivation + collection and destruction of tube + two sprays of Cypermethrin) which was statistically similar to that of P_4 (clean cultivation + collection and destruction of tube + one spray of Cypermethrin), P_3 (clean cultivation + collection and destruction of tube + neem seed extract) and P_2 (clean cultivation + collection and destruction of tube + detergent). The highest number of tube/branch was obtained from the untreated Control (41.40) which differed significantly from the remaining packages. Similar results were also observed in case of infested inflorescence. Significantly the lowest number of alive nymphbranch^{-1} was recorded in P_5 (4.29) which was followed by P_4 (6.30) P_3 (6.60) and P_2 (7.73). The infestation reduction over Control by different IPM packages ranged from 28.57% to 52.38%. The highest reduction (52.38%) of infestation over control was observed in P_5 followed by P_4, P_3 and the lowest (28.57) was in P_1. The fruit yield varied significantly depending on the level of infestation. Significantly the highest yield (11.10 tha^{-1}) was also obtained from the package P_5 (clean cultivation + collection and destruction of tube + two sprays of Cypermethrin) which was statistically similar to that of P_3 and P_4 but differed from the remaining IPM packages.

3.2. Gross return and Marginal benefit cost ratio (MBCR)

The Gross return and Marginal benefit cost ratio (MBCR) of different IPM packages are presented in Table 2. The cost of management in both 2011-12 and 2012-13 cropping seasons was the same. In the 2011-12 winter season, the maximum gross return of US $ 5962.50 was obtained from the package P_5 due to higher yield followed by P_4 (US $ 5618.75), P_3 (US $5275.00), P_2 (US $5100.00), P_1 (US $4631.25) and the lowest was in untreated control (US $ 4525.00). But in case of Marginal Benefit Cost Ratio, the highest value was obtained from the IPM package P_5 (15.69) followed by P_4 (15.07), P_2 (7.63), P_3 (6.10) and the lowest was in P_1 (1.13). In 2012-13 winter season, the maximum gross return of US $ 6937.50 was obtained from the IPM package P_5 due to higher yield which followed by P_4 (US $ 6512.50), P_3 (US $ 6168.75), P_2 (US $ 5737.50), P_1 (US $ 5475.00) and the lowest was in untreated control (US $ 5075.00). In case of Marginal Benefit Cost Ratio, the highest value was also obtained from the treatment P_5 (20.63) followed by P_4 (20.12).

Balikai (2009) indicated that the tube Spittle bug, *Machaerota planitiae* Distant was recorded as negligible pests in India. But there was no information available about this insect pest and the author observed the same scenario few years ago in Bangladesh as in India. But at present the scenario is totally different. Tube spittle bug causes serious damage in jujube by attacking stem and twigs near the inflorescence and suck cell sap from flowers. Affected flowers are being completely dried which do not bear fruits. The nymphal stage of the pest causes more damage which constructs a calcareous hard tube and stay in it with spittle like substances. This drastically reduced by IPM package 1 which consisted of clean cultivation + collection and destruction of tube with alive nymph. This activities help sunlight to pass easily through the canopy which reduce infestation by tube spittle bug. The toxicity of Cypermethrin group insecticides is low and its preharvest interval (PSI) ranged from 5-7 days. Application of this insecticide may be added as IPM component if PSI is followed strictly. Therefore IPM package 5 composed of clean cultivation + collection and destruction of tube + two sprays of Cypermethrin would be better management package as found in this study considering yield contributing characters, yield and MBCR.

4. Conclusions

From the study, it was observed in two consecutive winter cropping seasons of jujube, the lowest infestation and highest fruit yield was obtained from the IPM package P_5 followed by P_4, P_3 and P_2. The tube spittle bug often attacks the crop at the time of flowering and suck cell sap from the inflorescences. So, measures should be taken at the beginning of infestation at flower initiation stage. Considering the present results, the treatment "clean cultivation + collection and destruction of tube + two sprays of Cypermethrin" (P_5) would be the best management package to minimize the tube spittle bug infestation and at the same time to obtain the maximum economic yield.

5. Acknowledgements

The authors are thankful to Dr. Ai-Ping Liang, Chair, Division of Systematic & Evolutionary Zoology, Institute of Zoology, Chinese Academy of Sciences, 1 Beichen West Road, Chaoyang District, Beijing 100101, PR China for his help in identifying this bug.

References

Bal, J. S., Singh S. N., Randhawa, J. S. and Jawanda, J. S. 1984. Effect of growth regulators on fruit drop, size and quality of ber (*Zizyphus mauritiana* Lamk). *Indian Journal of Horticulture,* 41 (3-4): 182-185.

Balikai, R. A. 2009. Insect pest status of ber (*Ziziphus mauritiana* lamarck) in india and their management strategies. *Acta Horticulture* (ishs) 840: 461-474

BBS (Bangladesh Bureau of Statistics) 2010. Yearbook of Agricultural Statistics of Bangladesh. Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh. website: www.bbs.gov.bd

Bose, T. K. and Mitra, S. K. 1990. Fruits: Tropical and Subtropical Naya Prokash, 206 Bidham Sarani, Calcutta 700-006, India, 592-615 pp.

FRG (Fertilizer Recommendation Guide) 2012. Fertilizer Recommendation Guide, Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka 1215, 11 p.

Li, J.W., Fan, L.P., Ding, S.D. and Ding, X.L. 2007. Nutritional composition of five cultivars of Chinese jujube. *Food Chemistry*, 103: 454–460.

Ibrahim, M., Shafique, M.Z., Helali, M.O.H., Rahman, M.M, Biswas, S.K. and Islam, M.S. 2009. Studies on the Physiological and Biochemical Composition of Different ber (*Zizyphus mauritiana* Lamk.) Cultivars at Rajshahi. *Bangladesh Journal of Scientific and Industrial Research*, 44 (2): 229-232.

Prodhan, M.Z.H., Hossain, M.A., Munmun, T. S. and Alam, S.N. 2012. Development of management approach against fruit wevil (*Aubeus* sp.) attacking ber. *Bangladesh Journal of Entomology*, 22(1): 61-67.

Sharma, V.P., Kore, V.N. and Mitra, S.K. 2002. Ber. In: *Fruit-Tropical and subtropical volume II*, (eds.) T.K. Bose, S.K. Mitra and D. Sanyal, Naya Udyog, 206 Bidhan Sarni, Calcatta, India, 209 p.