

Current Knowledge of Mango and Fruit Fly (Diptera: Tephritidae) Control in Myanmar: A Review

Kyaw Lin Maung, Yin Yin Mon, Myat Phyu Khine, Khin Nyein Chan, Aye Phyo, Aye Thandar Soe, Thae Yu Yu Han, Wah Wah Myo, Sein Su Su San, Aye Aye Khai*

Biotechnology Research Department, Department of Research and Innovation, Ministry of Education (Science and Technology), Kyaukse, Myanmar

Email: *drayeayekhaing@moe.edu.mm

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Abstract

Mango is one of the largest commercial fruits in Myanmar and the fruit fly, *B. dorsalis* and *B. correcta* are the major pests. Mango is a kind of native fruit which can grow well as natural vegetation throughout the entire country under the various climatic conditions. We aimed to point out overuse of insecticide application in agricultural sector of Myanmar and further criteria of effective fruit fly control techniques were also proposed for worldwide ecosystem. Traditional fruit fly control is primarily focused on the uncoordinated use of insecticide applications which is orchard-by-orchard strategy. However, in view of flying distance, this localized strategy is not successful and harms the ecosystem. Occasionally, fruit bagging technique was applied by some farmers. In Myanmar's agricultural sector, numerous varieties of cheap insecticides which mostly imported from China were plentiful. While conventional insecticide application controls were implemented annually, the population of fruit flies increased year after year, particularly in tropical region. The requirement of technical-scientific research reduced the worldwide fruit fly records. Furthermore, traditional insecticide application approach inhibits the yield and quality of mangoes that have adversely affected international trade. Importantly, in long term period of the entire previous decade, the conventional insecticide application controls make more fruit fly infestation.

Keywords

Mangoes, Fruit Fly, Control Technique, Insecticides Application, Myanmar

1. Introduction

Mango (*Mangifera indica* L.) is originated in Asia particularly Myanmar, southern Asia and eastern India, then it spread to Africa and United State of America [1] [2] [3]. Mango is an important major fruit crop in the tropical and subtropical region of Asia [4] [5] [6]. 38.67 million tons of mangoes were produced worldwide in 2010 [7]. 76.49% of the world's mango production came from Asia with India being the largest producer of 42.25% of the world's mango production [8]. Myanmar is the sixth highest country in mango production of Asia accounting as 19.8% of global production in 2000 [9]. The production of mangoes has now been spread worldwide although the species and quality are quite different.

There are four major genera of fruit fly tephritidae such as *Bactrocera*, *Anastrepha*, *Ceratitis* and *Rhagoletis* [10] [11]. Over 75 species of the genus *Bactrocera* fruit flies were updated and *B. dorsalis* is serious destructive pest around the worldwide [12] [13] [14]. *B. dorsalis* was a destructive polyphagous pest that has damaged more than 250 species of fruits and vegetables over the last decade [15] [16] [17] [18] [19]. The guava fruit fly, *B. correcta* is also a destructive pest in Asia [20] [21]. Thus, *Bactrocera* fruit flies are major key pests in tropical region of Asia.

2. Mangoes Cultivation in Myanmar

The cultivation area of mangoes in Myanmar exceeds 93,890 ha and the harvested area is 76,313 ha in 2010 [22]. Rich farmers occupy 45% of the total mango's cultivation area while 30% is backyard farm and government occupies only 25% [9]. More than 200 varieties of mangoes were recognized in Myanmar. The popular varieties were listed as Sein-ta-lone, Aung Din, Bingalar-hteik-ni, Bingalar, Daw-tha-phyu, Hteik-ni, Ma-chit-su, Mya-kyauk, Maung-yin-pan-swe, Ma-soemin, Manaw-nwe, Moot-the, Ma-thi, Mataya-khaung-choe, Ngwe-thaw, Oo-cheik, Oo-shit, Pata-mya, Pan-swe, Pya-yae-san, Pya-yae, Sai, Shwe-wine, Shwe-ni, Shwe-hin-thar, Sin-swe, Sein-sa, Shwe-pha-lar, Sin-paung, Thone-lone-ta-taung, Tha-Kyar, Wa-so and Yin-kwe [23]. Among them, Sein-Ta-Lone which means solitary diamond is the most famous mango fruit and exported to China, Singapore, Japan, Dubai, Malaysia and some European countries in 2000 [24] [25] [26]. However, some countries have now rejected for the exported mango from Myanmar since 2018 to until now because of fruit quality.

Major mango production areas were observed in Mandalay, Yangon, Bago, Sagaing, Ayeyarwaddy Region and southern Shan State whereas the entire country possessed natural vegetation (Table 1). Under the numerous climatic conditions in Myanmar, mangoes can grow very well. However, we analyzed the harvest time is different as from February to March in Tanintharyi Region and Mon State, from April to May in Ayeyarwaddy, Yangon and Bago Regions, and April to July in Mandalay, Sagaing and Magway Regions. In addition, we analyzed that only one time in one year is the harvest time.

Table 1. Summary of mangoes' cultivation and fruit fly control in Myanmar (*present).

No	Region (1 - 7)/State (8 - 14)	Cultivation			Controlling Technique of fruit fly					
		Major	Natural	Insecticide	SIT	MAT	BAT	Bagging	Sanitation	Others
1	Yangon (17°0'0"N, 96°10'0"E)	*	*	*		*		*		*
2	Mandalay (21°0'0"N, 95°45'0"E)	*	*	*		*	*	*		*
3	Sagaing (21°30'0"N, 95°37'0"E)	*	*	*				*		
4	Magway (20°15'0"N, 94°45'0"E)		*							
5	Bago (18°15'0"N, 96°0'0"E)	*	*	*				*		
6	Tanintharyi (13°0'0"N, 98°45'0"E)		*							
7	Ayeyarwady (16°50'0"N, 95°10'0"E)		*							
8	Kachin (26°0'0"N, 97°30'0"E)		*							
9	Chin (22°0'0"N, 93°30'0"E)		*							
10	Shan (21°30'0"N, 98°0'0"E)	*	*	*				*		
11	Mon (16.3003°N, 97.6982°E)		*							
12	Rakhine (19°30'0"N, 94°0'0"E)		*							
13	Kayah (19°15'0"N, 97°20'0"E)		*							
14	Kayin (17°0'0"N, 97°45'0"E)		*							

3. *Bactrocera* Fruit Fly in Myanmar

Fruit fly is one of the most destructive pests and infestation percentages are very high in Myanmar's tropical region meanwhile *B. dorsalis*, *B. correcta* and *B. cucurbiata* are economically important fruit flies [27]. *B. dorsalis*, and *B. correcta*, were distributed in the mangoes orchard of Mandalay, Yangon, Bago region and Shan state of Myanmar [28]. *B. correcta* and *B. dorsalis* were the most abundant fruit flies and accounted for 29.3% and 28.6% of total emerged adults in the different fruit samples of Myanmar [29]. The control tactics of fruit fly, *B. dorsalis* by protein bait were conducted in Myanmar's tropical region which is effective not only female fruit flies but also cockroaches male [30]. Oriental fruit fly, *B. dorsalis* population fluctuated in Yezin Myanmar [31].

The total of 22 *Bactrocera* fruit flies were identified in Myanmar such as *B. dorsalis*, *B. correcta*, *B. cucurbitae*, *B. latifrons*, *B. cilifera*, *B. tau*, *B. carambolae*, *B. arecae*, *B. zonata*, *B. latilineola*, *B. diversa*, *B. rubigina*, *B. neocognata*, *B. lateritaenia*, *B. caudate*, *B. kandiensis*, *B. malaysiensis*, *B. raiensis*, *B. verbascifoliae*, *B. nigrofemoralis*, *B. raiensis* and *B. verbascifoliae* Myanmar (Figure 1) [27] [28] [29] [31] [32] [33]. Fruit fly population increased year after year in Myanmar as in 2011 and 2016 [33] in 2012 and 2017 [31] from 2016 to 2018 [27].

4. Fruit Fly's Control in Myanmar

Area-wide integrated pest management (AW-IPM) is the successful eradication approach of the integrating the technique such as Sterile Insect Technique (SIT),

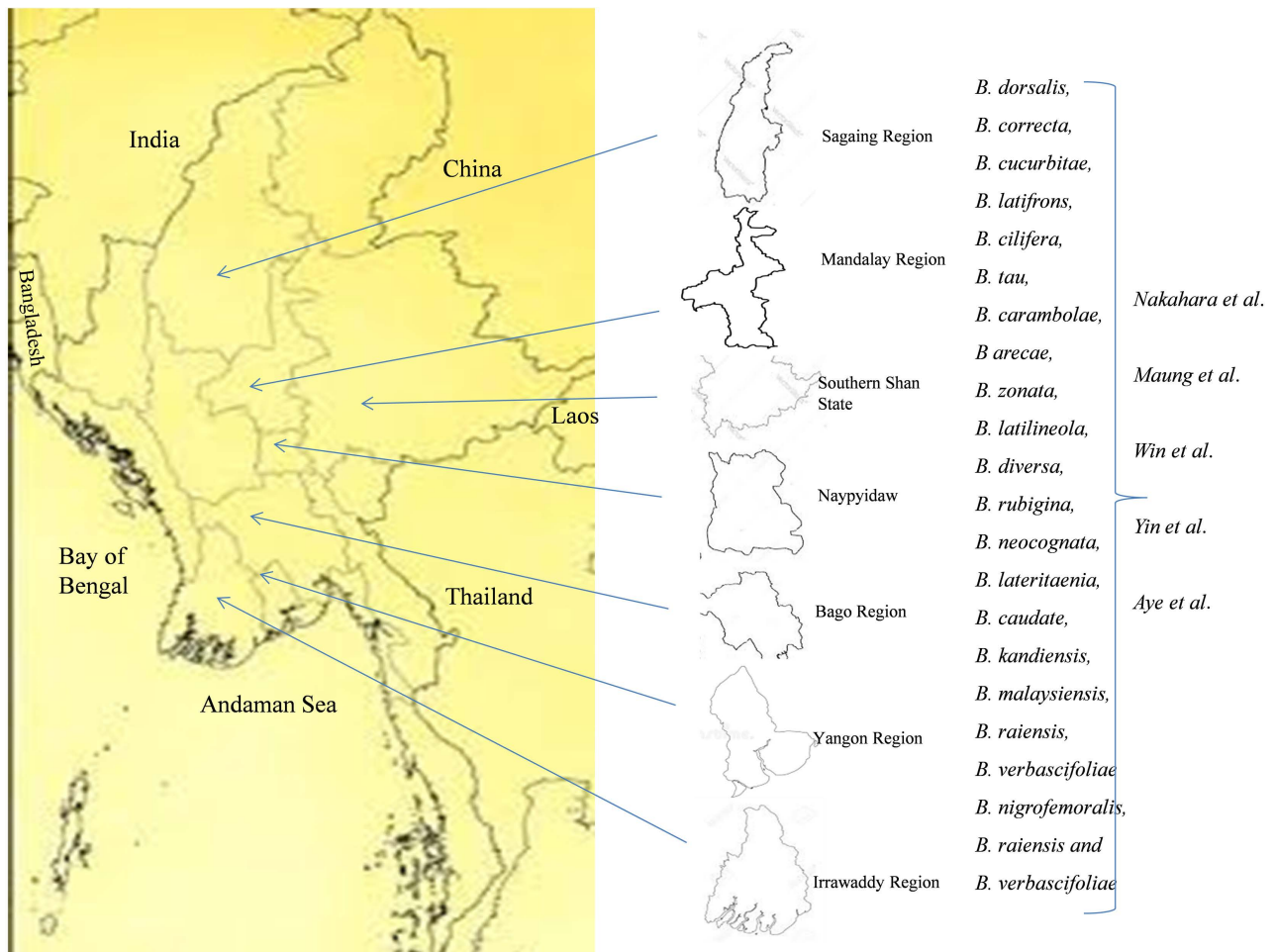


Figure 1. *Bactrocera* fruit fly distribution in Myanmar’s tropical region and the location of major mango cultivation area such as (Sagaing Region (21°30'0"N, 95°37'0"E), Mandalay Region (21°0'0"N, 95°45'0"E), Southern Shan State (21°30'0"N, 98°0'0"E), Naypyidaw union territory (20°7'N, 96°13'E), Bago Region (18°15'0"N, 96°0'0"E), Yangon Region (17°0'0"N, 96°10'0"E) and Irrawaddy Region (16°50'0"N, 95°10'0"E) in Myanmar.

Male Annihilation Technique (MAT), Bait Application Technique (BAT), biological control technique, fruit bagging technique and field sanitation technique [34] [35] [36] [37]. It is the biological insect birth control with the inundative release of sterile males [38] and environmentally safe method target only on specific insect [39].

MAT is the technique of against adult stages of fruit fly by attraction on male using a mixture of sex pheromones lure and insecticides in order to affect high mortality of target species [40] [41] [42]. BAT is the control of female fruit fly using insecticidal protein baits (mixtures of protein hydrolysates and insecticides) was successfully demonstrated in field trials in Hawaii in the early 1950s [43] [44].

Biological control of parasitoids in the HAWPM program was examined at three levels of application: 1) conservation; 2) classical releases; and 3) augmentative releases [45] [46]. Fruit bagging technique is the simple control method of wrapping individual fruit to prevent fruit fly infestation [47] and it is effective

method in mangoes orchards [48]. Field sanitation technique is an effective suppression method to prevent fruit fly larvae from developing young emerging adult flies so that they cannot return to the crop to reproduce [49] [50] and important in AW-IPM [51].

In Myanmar, traditional control of mangoes is the constant insecticide application and fruit rarely bagging. Constant uses of insecticide application were analyzed even after harvesting fruits before transport to markets. The control techniques of MAT, BAT, bagging, sanitation and insecticide application were conducted only in Mandalay region. Myanmar's mangoes cultivation and traditional control of fruit flies were shown in **Table 1**.

5. Insecticide Resistance of Fruit Fly

Various varieties of cheap insecticide for controlling fruit flies which imported from China were list as malathion, spinosad, avermectin, formothion, cyfluthrin, trichlorfon, β -cypermethrin, phoxim, cyantraniliprole, naled and fenitrothion. Insecticide application is a controlling approach of fruit fly for only a short limited period in meanwhile long term using insecticides let forward to resistance of fruit fly [52]-[59]. Resistance factor to malathion in Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) increased to high level of resistance in males; 89.19 - 100.8 fold and moderate to high level in females; 29.34 - 99.45 fold within 48 h treatment [60]. As the survey provided the comprehensive information of insecticide resistance in fruit fly, insecticide resistance management plans have to implement in fruit fly control.

6. Conclusion

In view of fruit fly movement, tradition control of insecticide application orchard-by-orchard approach increases the frequency of insecticide application which turned into overusing. Various insecticides were applied even after harvesting until exporting and also chemical to be ripening suddenly. This approach damages the environment and adversely affected national consumers' health. The higher doses of insecticides have to apply year after year because of insecticide resistance of fruit fly. As depending on the current market prizes of mango, some farmer absent any control and it let be individual breeding sides. The fact of mangoes farm occupied only 25% by government be lead to uncoordinated use of controlling technique. Thus, fruit fly population increased year after year. High fruit fly infestation and conventional constant insecticide application reduced the fruit quality. Therefore, sustainable biological controls of fruit fly were urgently needed in Myanmar.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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