Bangladesh J. Environ. Sci., Vol. 44, 69-76, 2023 @ BAED ISSN 1561-9206

PHEROMONE USES FOR INSECT PEST MANAGEMENT IN VEGETABLES: PRESENT SCENARIO AND FUTURE PROSPECT

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ABSTRACT

Using pesticide is detrimental to human health and environment but even knowing this farmer of Bangladesh, which is really a subject to concern. Using pheromone instead of pesticide is one kind of environmentally friendly solution having no residual effects. Hence, this study is organized with different statistical data on the basis of conducting different survey and experiment on using pheromone. Using pheromone is highly cost effective than other conventional agricultural practice. Yield of vegetable crops higher in case of pheromone use than conventional practice and BCR (Benefit Cost Ratio) is also higher in case of pheromone using field than conventional agriculture. The aim of the study is to sort out the problems and make solutions regarding popularize of pheromone to the farmers.

Key words: Pheromone, pest control, IPM

Introduction

Pest infestation is one of the constraints for achieving higher production in agricultural sector. Bangladesh losses about 30% of its crops due to pest and diseases every year (BBS, 2007). The major problem of vegetable production is insect pest infestation which causes a huge loss in vegetables production. Using of pesticides is so much helpful for minimizing the infestation. Pesticide use in Bangladesh negligible until the 1970s, but now it is increasing in dramatic way (Rahman, 2003). Pesticides should use by following the instruction of expert personnel. But farmers use pesticides indiscriminately and in unscientific way that's why insect pest developing resistance and minor pests become major pests and causing food safety hazards (EPA, 2005). That's why we need alternative way to control pests. Pheromone is one kind of biological insect control methods having no residual impacts on human health and environment. According to Islam (2012), "The use of synthetic pheromones for environmentally safe insect control was postulated soon after the discovery of silk moth pheromone." Pheromones are used as monitoring tools (Ridgway *et al.*, 1990; Baker and Heath, 2004). Due to the safe and secure insect pest control many agrochemical industries are now suggesting to the farmers to develop mating disruption and mass trapping of rice stem borer in order to use pesticide (Cork *et al.*, 2005b). "Pheromones are applied in slow release formulations, thus resulting in low exposure; residues of lepidopteran pheromones in pheromone- treated food crops have not been detected (Tinworth, 1990)". Using of bait trapping for fruit fly control with a synthetic pheromone recoved53 to 73% yield lossessin cucurbits (IPM CRSP, 2003). According to Rakshit *et al.* (2011), because of the effectiveness in controlling fruit fly and higher economic returns approximately 90% of the farmers of Jashore district adopted cuelure pheromone traps. There is very few research works have conducted on pheromone in insect pest management. Only a few scientists worked on pheromone traps (Alam *et al.*, 2005; Uddin, 2008; Mazumder and Khalequzzaman, 2010) in Bangladesh but still now nobody identify the pheromone from native insect. According to Islam (2012), the survey report on pheromone practice in Bangladesh agriculture is also limited and it's conducted by Md. Azharul Islam in 2012. The objectives of this study are as follows: (i) to discuss the present scenario and future prospect of using pheromone trap in Bangladesh and (ii) to identify the problems facing by the farmers and solve the problems.

2. Organization of the study: In total 65 relevant and scholary articles of various researchers and practitioners were reviewed. Most of the important information was collected from different publications, thesis, journals and review articles. After that the information were organized, analyzed and summarized.

3. Scenario of pesticide use in Bangladesh: Today agriculture and pesticide are use as synonymous word. Pesticide is now integral part of crop cultivation. Willingly or unwillingly most of the farmers are dependent on pesticide for better crop production. Most of them do not maintain the proper schedule and do not know the dose of application. They use pesticide indiscriminately in the field. So most of the cases it causes adverse effect to the environment and human body.

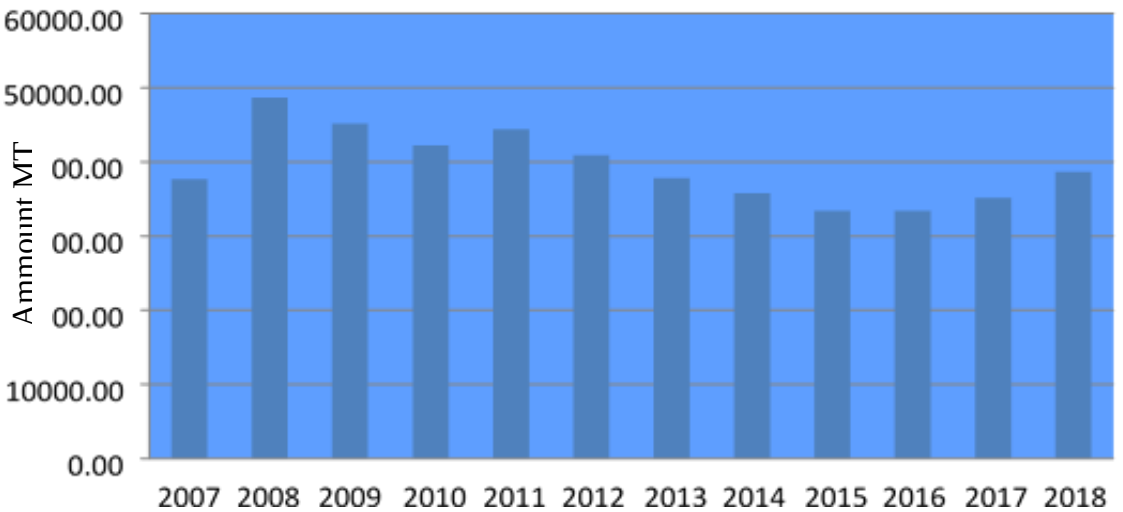

Fig.1. Annual consumption of pesticides in Bangladesh during 2007-2018 (BBS 2012 and BBS 2019)

4. Impact of pesticide uses in Bangladesh: Farmers of Bangladesh are experienced on farming. They always consider the fast result in pest management. Almost all they consider the fast one not best one. They have no concern about the environmental effect they just want result. That's why they apply pesticide in their field indiscriminately. They combine two or more pesticides and then apply in the field. Due to indiscriminate use of pesticide environment is being polluted, soil is losing its productivity and insects are developing resistance. Since the resistance is developing in insect, the application of insecticide is not working. Human being are inhaling pesticides unintentionally during pesticides application and suffering from different diseases.

Table 1. Impact of pesticide use on farmer's health (Nasima *et al.,* 2016)

Diseases	% respondents
Skin diseases	60
Eye diseases	64
Gastro- intestinal diseases	84
Urine and sexual diseases	54
Physical weakness	46.6

A case study conducted by Akhter *et al.* (2016) regarding impact of pesticide application on human health in Jhenidah district reported that most of the farmers used insecticide (80%) in their agricultural fields and about (75%) farmers were could not read the level of the pesticides packet/bottle as a result they applied the higher dose. Some of the pesticides mimic or antagonize the natural hormone in the human body system and disrupt the hormonal signaling. The long-term exposure of pesticide occurred adverse effects on human health through reproduction, hormone disruption, cancer, immunity problems and reducing intelligence (Brouwer *et al*., 1999; Crisp *et al*., 1998; Hurley *et al*., 1998). So we should have use alternatives of pesticides. Pheromone is one of the best alternatives.

5. Present status of pheromone use in Bangladesh: As we know that using pesticide is harmful for ecological balance. Environmental pollution, pest resistance are common scenario now-a-days. So, Governments of Bangladesh are becoming aware of the environmental hazards and health issue of human body. So they are searching alternatives of pesticides. At this condition pheromone can be a good alternative of pesticides. Pheromone lure are both effective and cost efficient in controlling the insect pests of rice which occur 70-80% damage (Anonymous, 2003). Alam *et al*. (2003), reported that sex pheromone for the control of shoot and fruit borer in brinjal and cucurbits and yellow stem borers are available in Bangladesh. After that for a very few insects the pheromone components are available in Bangladesh. Most of the pheromone components are imported from abroad which are not properly tested in the lab. Imported component should test in the lab because the regional variation in chemical communication of the same species occurred due to their races (Vang *et al.*, 2008). So, imported pheromone may not be effective with the Bangladeshi Insect. BARI (Bangladesh Agriculture Research Institute), DAE (Department of Agriculture Extension) are running some project relevant to pheromone in Jashore, Narsingdi, Comilla, Bogura, and Pabna (Islam, 2012). Governments of Bangladesh, Ministry of Agriculture, Department of Agriculture allowed a very few organizations to import pheromones from abroad. It's time to increase now. A survey was conducted in Nilphamari about knowledge and practice of pheromone by Md. Azharul Islam in 2012. According to Islam (2012), 14%, 45% and 41% of total 70 farmers from 7 village of Nilphamari District possessed high, moderate and low level of knowledge in pheromone respectively. He also claimed that farmers of that locality were dependent on pesticide because they had no enough knowledge in pheromone. Among the 10 IPM practices suggested by IPM IL, farmers adopted pheromone traps the most, followed by poultry refuse for soil amendment (Table 3). Only a few farmers used yellow sticky traps and tricho-compost. Other recommended IPM practices were not adopted by the farmers.

Table 2. Distribution of respondents on the basis of level of knowledge in pheromone (Islam, 2012)

Level of knowledge	Number of respondents	% of respondents
High	10	14
Moderate	31	45
Low	29	41

Table 3. Percentage of farmers adopting different IPM practices in study areas based on field survey in 2015 (Rahman *et al*., 2018)

IPM practices	Vegetables					
	Eggplant	Bitter gourd	Tomato	Cucumber	Cabbage	Country bean
Sex pheromone trap	28	38	21	21	7	10
Yellow sticky trap	1	1	3	–	–	1
Poultry refuse	12	17	24	17	13	14
Tricho-compost	2	1	1	2	–	1

6. Efficiency of using pheromone: Fruit fly and fruit borer is the major insect pest of vegetable in Bangladesh. If the proper control management is not taken at the right time, then it can be caused 100% loss of crops. An experiment was conducted by Mazumder and Khalequzzaman (2011) on efficiency of pheromone on BSFB (Brinjal Shoot and Fruit Borer) in Rajshahi District. The study revealed that, the pheromone trap with 1m lure height was highly effective than lure with 0.5m height in the respective parameters like moth catch, shoot damage, fruit damage and finally fruit yield. In Table 5 it was shown that, the IPM block performed better than the non-IPM block and the insect infestation was lower in IPM block with trap operated. Whereas the non-IPM block with no trap operated performed very poor.

In Rajshahi, an experiment about the effect of sex pheromone was conducted by BARI in 2007-2008. They revealed that, the block of cucurbit in which they set sex pheromone was performed better than other treatments. The infested fruits were minimum whereas the fresh fruits, average weight and fruit yield were maximum in the treatment with sex pheromone.

Table 4. Comparison of Average moth catch, damaged shoot, fruit and yield between trap installed field and no trap installed brinjal field (Mazumder and Khalequzzaman, 2011)

Treatment	Average moth catch	Damaged shoot (%)	Damaged fruit (%)	Fruit yield (q/ha)
Trap installed	4.54 ±0.94	29.74±1.87	32.56±6.63	143.47±2.19
NoTrap installed	-	34.59± 2.65 -	47.27± 2.38	90.00±3.21

Table 5. Impact of using pheromone trap on non-IPM block and IPM block on Brinjal field (Mazumder and Khalequzzaman, 2011)

Criteria of evaluation	No trap operated		Trap operated	
	Non-IPM Block	IPM Block	Non-IPM Block	IPM Block
Moth catches/trap	-	-	10.25	1.23
Shoot damage (%)	3.48	1.56	1.12	0.81
Fruit damage (%)	31.15	10.66	32.56	12.34
Fruit yield (kg/100 m^2)	13.70	27.54	8.50	9.95

Table 6. Effect of sex pheromone on cucurbit crops in Rajshahi (BARI, 2009)

Treatment	Infested fruit	No. of fresh fruit/plant	Average fruit weight (kg)	Yield (t/ha)
T_1 (Sex pheromone)	2.73	4.78	5.57	36.90
T_2 (with insecticide)	25.03	3.47	4.20	20.0
T_3 (without insecticide)	32.83	2.83	4.78	18.91

From above discussion we can summarize that, use of pheromone is more efficient then use of pesticide.

7. Future scope of pheromone uses in Bangladesh: The yield and yield contributing characters of cucumber are presented in Table 7. There were a significant difference in yield and yield contributing characters among the all treatments. The maximum yield was obtained in the treatment with pheromone trap, poison bait and sanitation. That means the use of pheromone trap with other component was beneficial for the farmers. That's why it has huge opportunities of pheromone in future.

Table 7. Cucumber yield as influenced by sex pheromone trap at Mithapukur, Rangpur during 2015-16 (Alam *et al*., 2019)

Treatment	No of fresh fruit/ plant	No of infested fruit /plant	Wt. of fresh fruit/Plant (kg)	Wt. of infested fruit/ Plant (kg)	Fruit yield (t/ha)
Sex pheromone + Poison bait +Sanitation	21.85a	0.80b	5.30a	0.19b	36.66a
Sex pheromone + Poison bait +Sanitation	22.46a	0.74b	5.36a	0.17b	36.99a
Farmers Practice	11.30b	9.0a	2.31b	1.87a	27.99b
CV (%)	4.76	6.87	6.35	3.21	5.33

Table 8. Cost and return analysis of cucumber at Mithapukur, Rangpur during 2015-16 (Alam *et al*., 2019)

Treatment	Fruit yield (t/ha)	Gross return (Tk/ha)	Total variable cost (Tk/ha)	Gross margin (Tk/ha)	BCR
Sex pheromone + Poison bait +Sanitation	36.66	366600	71894	294706	5.09
Sex pheromone + Poison bait +Sanitation	36.99	369900	73652	296248	5.02
Farmers Practice	27.99	231940	68520	163420	3.38

The economic benefits were much higher from plots with pheromone lure than without pheromone lure, despite the higher initial cost of pheromone lure with materials (Table 8). In table 8 it was described that the benefit cost ratio (BCR) was comparatively higher in the treatment which was combined with sex pheromone, poison bait and sanitation rather than other treatments. That's why it can be said that using pheromone trap is profitable than other conventional practices.

8. Problems facing in pheromone use by farmers and their solutions: According to above discussion there are some limitations in pheromone use. These limitations are- insufficient research work, insufficient investment by Bangladesh Governments, lack of proper training to the agricultural personnel, insufficient laboratory facilities, insufficient knowledge in modern technology, materials of pheromone are limited, very little scope of spreading out the knowledge to the farmers. Another important problem which is faced by the farmers that, pheromones are often specific to one or two particular pests, so it is possible that additional treatment will be needed for others. The unscientific use of pesticide in agriculture is a big concern to the governments. So it's very urgent need to take action to minimize the pesticide use. It's important to grow public concern about the health hazards of pesticide use. Farmers have to motivate to the integrated crop management system. Governments are importing pheromone in a little amount. It should increase the import of pheromone.

A major advantage of the pheromone is that it provides protection for a whole season, and, once positioned in the right place, they last up to 180 days and are barely dependent on weather conditions such as temperature, sunlight/UV, or rain. Finally, to overcome the limitations of pheromone use it's necessary to work all together e.g. governments, private sector, research organizations and other personnel who are engaged in agriculture and should be concern about the following suggestions: It has to synthesize the pheromone in our country because sometimes imported pheromone don't work against the pest present in our country because of their physiological changes in insect body. More and more projects have to run in pheromone by research organizations that's why huge fund will be needed and this fund have to provide by governments. Private sectors as well as NGOs have to contribute in pheromone production and also have to provide training to the farmers. It must be understood to the farmers that integrated pest management is more economical and environmentally friendly rather than pesticide. There are very few pheromone components are available in Bangladesh which are used on pest of vegetable. So it should give same concern to synthesize the pheromone components of major crops. Proper training programs have to provide to the farmers and encourage to pheromone. There is a huge gap among different government organizations, private organizations and research organizations which are involved in pheromone commercialization. It has to minimize the gap. It's great news to the farmers that, pheromone of BSFB, fruit flies are synthesized in the laboratory of Bangladesh and the lure of many pheromones are being available in the local market at a low cost.

9. Future challenges of farmers: Bangladesh is densely populated country and cultivable land is reducing day by day that's why population dependence on agriculture is also reducing. The total cultivable land in Bangladesh is 87 lakhs 51 thousand hactre or 2 crore 21 lakh acre BBS (2020). Cultivable land is reducing day by day. In 1970 total cultivable land was 9.80 million hactre but in 2020 the total cultivable land is 5.66 million hactre. In coastal areas the salinity problems are increasing that's why cropping intensity is also reducing. With the population increasing demand of food is also increasing. Still now food production also increasing. But the important thing is that the challenges of increasing food production is very unpredictable and food production reducing due toloss of arable land, population growth, climate change, imbalanced use of fertilizers, inefficient water use, lack of quality seed, inadequate credit supports to farmers, unfair prices to agricultural produces, insufficient investment in research and indiscriminate use of pesticide in the field. Farmers always want quick result of any problem that's why they depend on synthetic pesticide without considering the impact of using pesticide. Using more pesticide and fertilizer are harmful for the environment and land loses its natural fertility. If the process goes in that way finally we will lose the fertility of land which is very much alarming for us.

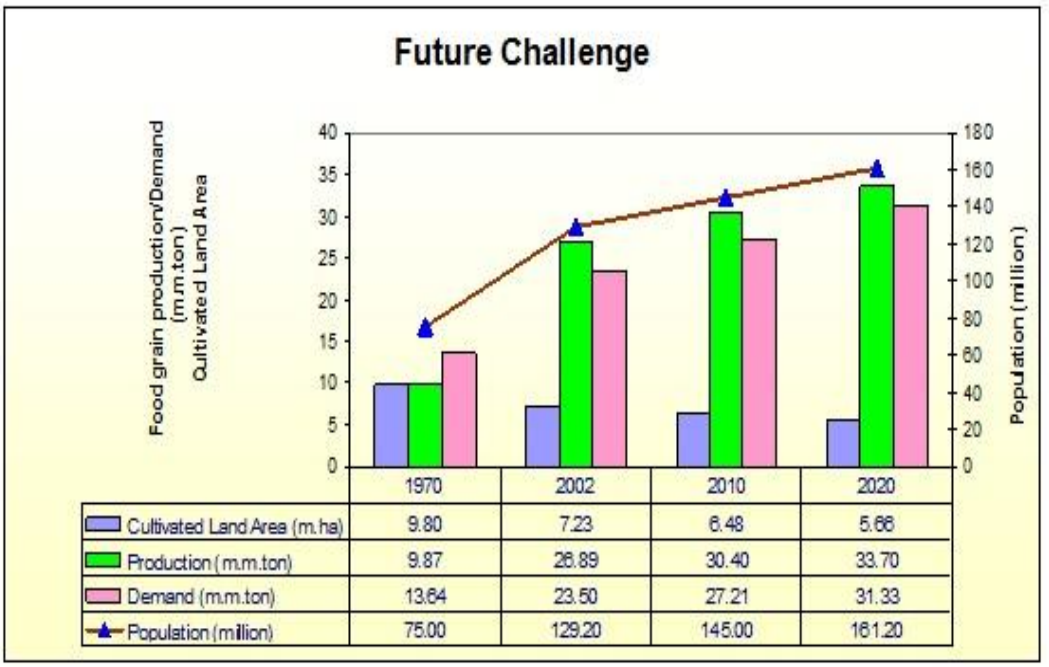

Fig. 2. Future challenges of farmers in Bangladesh (Pretty *et al*., 2003)

At the same time we are losing many fishes as the pesticide mixed land water finally mixes with the water of river, canals and ponds. To overcome all of these problems farmers should give more concern about their challenges in cultivation and make out the solutions.

Conclusion

Pheromone uses is cost effective than traditional pest management practices in vegetables. Benefit Cost Ratio is also higher in case of pheromone using field than farmer's traditional practices. That's why in near future pheromone can be adopted as one of the effective tools for eco-friend crop cultivation in Bangladesh.

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