Physico-Chemical Properties and Effectiveness of the most Common Insecticides used in Bangladesh to Control Brinjal Soot and Fruit Borer (BSFB)

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ABSTRACT

The present study aims at investigating the actual situation prevailing in Bangladesh in respect to quality control and management system of different pesticides. The most commonly used pesticides for insect-pests control of vegetables are diazinon, malathion and fenitrothion. In connection with the quality control and assessment of pesticides, samples of diazinon, malathion and fenitrothion were collected from different sources of formulation/repackaging factories existing in Bangladesh and tested in the laboratory. Analytical results of those samples indicated that quality of pesticides collected from factory premises found comparatively better than that of field samples. Field experiments with collected pesticides were conducted on brinjal to find out the effectiveness of 4-different treatments having 4-different doses of each pesticide to control brinjal soot and fruit borer **(**BSFB) at flowering and fruiting stage. The treatment of fenitrothion was the best with lowest shoot infestation (5.57%) and found superior to control BSFB than all other pesticide treatments.

Keywords: Organophosphorus pesticides, Brinjal plant, Quality control, Pest control, BSFB.

INTRODUCTION

Advancement of Agricultural crop production mainly depends upon the coordinated effects of four major factors. These factors are called inputs in agriculture, such as (i) improved seeds, (ii) manure and fertilizers, (iii) irrigation management and (iv) judicious use of high quality pesticides (Desai, 2002). Among these inputs, pesticides factor is the most important one. It is used to protect the crops and food-grains in the field and store houses against pest attack. "Pesticide" means any substance or mixture of substances used for preventing, destroying, repelling, mitigating or controlling any insect, fungus, bacteria, nematode, virus and weed, rodent or other plant and animal pests directly or indirectly to bring the welfare of human being. The concept about the use of quality pesticides and its proper management is a hot issue, in respect of, agro-socio-economic and environmental aspects of Bangladesh (Hossain *et al*., 2000).

Due to increased population in the world, demand for food supplies is increasing. Insects and Rodents cause annual losses throughout the world of 40 million Ton of stored grains and rice, according to the estimates of the United Nations (UN) and Food and Agriculture Organization (FAO) (Gustavsson *et al*., 2011). In Bangladesh, about 25 to 30% of total crop production is damaging in every year due to attack of insect-pests and

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diseases (Biswas and Das, 2011). Sometimes-severe pest attack causes total damage of standing field crops. Pesticide is a chief mean to satisfy the food problems through increased production and reduction of losses due to attack of insect-pests, diseases and weeds during the growth of crops and after harvest (Dent, 2000).

The control of crop pests mostly depends on artificial chemical treatments. However, experts are always in the favour of judicious application programmes and recommend combination or integration of pest control measures to have long lasting effects on the harmful species without much disturbing the beneficial ones, biotic community and the agro-ecosystem (Gupta and Dikshit, 2010).

The formulated products and active ingredients of pesticides are toxic, hazardous and active on living and non-living bodies and the environment. Their quality control is therefore is most important and essential. In modern agriculture huge quantity of pesticides are being used in Bangladesh to produce better quality and higher yield of crops, vegetables, fruits, food supply and also ensuring its safety during storage. Any substance or mixture of substances in food for human or animal result from the use of a pesticide and include any specified derivatives such as degradation, metabolites reaction products and impurities are considered to be of toxicological importance (Hamilton and Crossley, 2004).

Now a days, Integrated Pest Management (IPM) system to prevent or reduce the attack of agricultural pests is gaining popularity. However, in case of severe pest attack, chemical control through pesticide application is indeed the quickest method against insect-pests and diseases. Nevertheless, the chemical control is costly, risky, tough and sophisticated. However, in case of emergency and pest resurgence into epidemic forms, chemical control measures are well accepted by farmers, users, agricultural scientists, extension workers and professionals. Proper use of pesticides could be ascertained by regular sampling from the field and testing in the pesticide laboratory, survey and proper inspection in the pesticides formulation factory, dealers and retailers shops in the market.

Brinjal is susceptible to attack of various insect-pests from seedling to fruiting stage. Biswas *et al*. (1985) stated that about 18 different insects including jassids, aphids, epilachna beetle, shoot and fruit borers Mites are considered as minor pests. Several authors (Gangwar and Sachan, 1981 and Patel *et al*., 1988) stated that pest's infestation varies from season to season and for environmental factors. Several workers (Butani and Jotwani, 1984 and Kalloo, 1988) mentioned that the damage caused by brinjal shoot and fruit borer (BSFB) from 1 to >90 % in India and according to Islam and Karim (1993), about 67 to 86 % of brinjal infested by BSFB (*Leucinodes orbonalis* Guenee, Pyralidae, Lepidoptera) in Bangladesh.

Brinjal shoot and fruit borer (BSFB-*Leucinodes orbonalis* Guenee, Pyralidae, Lepidoptera) is the most dangerous pest of brinjal. Farmers of intensive crop growing areas spray insecticides at every day, subsequent day and even at a very higher dose without considering the toxicity, type and categories of pesticides and their residual effect. These sorts of frequent, unscrupulous and indiscriminate use of pesticides are helping in developing insect resistance against toxic chemicals and ultimately efficiency of applied pesticides is reduced to control them. As a result, more pesticides are being used in the crop fields causing hazards to the man and environment. However, the main objectives of the study was to develop a suitable quality control and better management system of pesticides through integrated approaches for pest free crop production and maintenance of healthy environment in Bangladesh.

MATERIALS AND METHODS

Collection of Pesticide Samples

Representative pesticide samples of diazinon, malathion and fenitrothion were collected at random from seven different formulation/repackaging factories situated at different places of Bangladesh and thirty six different pesticide dealer shops of twelve Upazilas under Mymensingh district. Of them, thirteen different pesticide brands including diazinon - 4 samples, malathion - 5 samples and fenitrothion - 4 samples were collected from production site of formulation/ repackaging factories. Thirty six different pesticide samples including diazinon - 12 samples, malathion - 12 samples and fenitrothion - 12 samples having different trade names were collected from pesticide dealer shops in the market.

Selection of Pesticides and Analytical Experiment for Quality Assessment

We selected the most popular pesticides according to the farmer's and pesticide dealer's information and witnesses. All of the collected pesticide samples were analyzed for their quality assessment following suitable and standard analytical methods (Ashworth *et al*., 1980; Tomlin, 2003) by using GLC (FID) and other Lab. equipment in the Pesticide Administration and Quality Control Laboratory, Plant Protection Wing, Department of Agricultural Extension, Khamarbari, Dhaka, Bangladesh.

Field Experiment

Field experiments were conducted with three selected organophosphorus insecticides- diazinon (Rison 60 EC), malathion (Cyfanon 57 EC) and fenitrothion (Sumithion 50 EC). Pesticides were applied on brinjal (variety: Uttara) by using traditional spray method to find out the effectiveness of 4-different dosages of each insecticide to control BSFB (Brinjal Shoot and Fruit Borer) at flowering and fruiting stages. The dosage rate of each insecticide was fixed on the basis of national standard as 1.70 L/ha for diazinon and 1.12 L/ha for both malathion and fenitrothion. Applied doses of all those treatments were (O = control - 0.00 L/ha for all insecticides; HR = half of the recommended dose - 0.85 L/ha for diazinon, 0.56 L/ha for both malathion and fenitrothion; R = recommended dose - 1.7 L/ha for diazinon, 1.12 L/ha for both malathion and fenitrothion and DR = double of the recommended dose - 3.4 L/ha for diazinon and 2.24 L/ha for malathion and fenitrothion), respectively. The infestation situation of BSFB in leaf, shoot, fruit and effect on yield performance were observed under different treatments of diazinon, malathion and fenitrothion after 7 - 15 days of single spray application.

Statistical Analysis

All of the collected data about insect-pest (BSFB) infestation situation in brinjal shoot and fruit were processed as stated earlier and analyzed statistically after necessary appropriate transformation. The statistical analysis was carried out employing one way ANOVA ($p < 0.05$). A statistical package (SPSS version 11.0) was used for the data analysis.

RESULTS AND DISCUSSION

Survey and Selection of Most Popular Vegetable Crop and Pesticides

Both the farmer's and pesticide dealer's information and witnesses were analyzed statistically on the basis of marking, scoring and ranking method. The results showed that most commonly used pesticides for crop (vegetables) production at Mymensingh district were malathion, dichlorvos, fenitrothion, diazinon and cypermethrin. Although dichlorvos was very popular and commonly used insecticide, but it was declared as

banned item on that time in the country. Malathion, fenitrothion and diazinon insecticides of organophosphorus group were finally selected for quality assessment in the laboratory and efficacy tests against BSFB in the field experiment were carried out.

In Bangladesh, farmers of Mymensingh district also believe that frequent spraying of insecticides is the way and means for insect-pests control. It is their usual technique for the control of BSFB, which is the major insect-pest for brinjal cultivation. Thus, It has been established from the summary of collected survey data and on the basis of statistical analysis covering marking, scoring and ranking method that brinjal was the most popular and main vegetable. Shoot and fruit borer was the most harmful insect for vegetable-brinjal and malathion, fenitrothion and diazinon were found most commonly used insecticides for the cultivation of this fruity-vegetable in the aforesaid district of Bangladesh**.**

Quality Assessment of Collected Pesticide Samples

Samples of commercially formulated products of three selected organophosphorus insecticides- diazinon, malathion and fenitrothion were collected at random from seven different pesticide formulation and repackaging factories in Bangladesh and thirty six different pesticide were collected from dealer shops of all Upazilas under Mymensinhgh District. Total number of collected pesticide samples from different factories and dealer shops were 13 and 36, respectively (Tables 1and 2).

Table (1): Comparative test results of pesticide samples collected from different formulation and repackaging factories existing in Bangladesh.

Sl. No.	Name of pesticide (Common/ Trade name)	Toxicant content (% w/v)	Physical state / appear-ance	Sp. gr.	pH value	High temp. storage stability
A.	**Diazinon**					
1.	Rison 60 EC	60.22	Clear liquid	1.04	6.7	96.2 %
2.	Diazinon 60 EC	60.04	"	1.02	6.7	95.0 %
3.	Dizinol 60 EC	59.25	"	1.02	6.4	93.8 %
4.	Diazon 60 EC	59.24	"	1.04	6.5	94.0 %
B.	**Malathion**					
5.	Limithion 57 EC	56.84	Clear liquid	1.04	6.3	93.5 %
6.	Cyfanon 57 EC	57.14	"	1.03	6.4	95.0 %
7.	Hilthion 57 EC	56.82	"	1.08	6.5	93.0 %
8.	Fyfanon 57 EC	57.12	"	1.05	6.6	95.0 %
9.	Maladan 57 EC	56.84	"	1.04	6.3	93.5 %
C.	**Fenitrothion**					
10.	Emithion 50 EC	49.34	Clear liquid	1.06	6.6	92.8 %
11.	Sovathion 50 EC	49.28	"	1.12	6.4	91.0 %
12.	Fenitox 50 EC	49.24	"	1.05	6.4	92.2 %
13.	Sumithion 50 EC	50.14	"	1.05	6.7	96.4 %

Table (2): Comparative test results of pesticide samples collected from different pesticide dealer shops of all Upazilas under Mymensingh, Bangladesh.

Sl. No.	Name of pesticide (Common/Trade name)	Toxicant content (% w/v)	Physical state / appear-ance	Sp. gr.	pH value	High temp. storage stability
A	**Diazinon**					
1.	Rison 60 EC	59.50	Clear liquid	1.02	6.7	94.2 %
2.	Diazinon 60 EC	60.14	,,	1.03	6.6	94.6 %
3.	Diazinon 60 EC	60.00	,,	1.04	6.5	93.2 %
4.	Dizinol 60 EC	59.08	,,	1.024	6.4	94.8 %
5.	Sabion 60 EC	56.84	Viscous oily liquid	1.045	6.3	86.4 %
6.	Diazon 60 EC	59.85	Clear liquid	1.03	6.7	93.6 %
7.	Diazinon 60 EC	59.42	,,	1.03	6.5	92.8 %
8.	Dizinol 60 EC	59.80	,,	1.04	6.4	92.0 %
9.	Rison 60 EC	60.14	,,	1.04	6.7	94.5 %
10.	Sabion 60 EC	59.72	,,	1.02	6.7	93.05 %
11.	Diazinon 60 EC	60.02	,,	1.04	6.5	92.5 %
12.	Rison 60 EC	60.12	,,	1.04	6.7	94.0 %
B.	**Malathion**					
13.	Cyfanon 57 EC	56.80	Clear liquid	1.12	6.4	93.2 %
14.	Malataf 57 EC	56.12	,,	1.08	6.5	92.4 %
15.	Limithion 57 EC	56.84	,,	1.06	6.3	92.0 %
16.	Fyfanon 57 EC	56.75	,,	1.05	6.5	95.0 %
17.	Malataf 57 EC	54.02	Oily liquid	1.04	6.3	88.0 %
18.	Fyfanon 57 EC	57.14	Clear liquid	1.05	6.5	93.0 %
19.	Zithiol 57 EC	56.70	,,	1.024	6.4	91.0 %
20.	Maladan 57 EC	56.02	,,	1.012	6.5	92.0 %
21.	Fyfanon 57 EC	56.04	,,	1.02	6.6	92.0 %
22.	Cyfanon 57 EC	57.18	,,	1.06	6.5	94.0 %
23.	Limithion 57 EC	56.48	,,	1.04	6.4	92.05 %
24.	Malatox 57 EC	54.80	Oily liquid	1.12	6.3	85.0 %
C.	**Fenitrothion**					
25.	Sumithion 50 EC	49.93	Clear liquid	1.09	6.6	95.0 %
26.	Sovathion 50 EC	50.06	,,	1.20	6.4	94.0 %
27.	Fenitox 50 EC	49.04	,,	1.08	6.5	93.0 %
28.	Sovathion 50 EC	47.12	Oily liquid	1.22	5.6	85.0 %
29.	Sumithion 50 EC	50.05	Clear liquid	1.044	6.5	94.0 %
30.	Fentro 50 EC	49.50	,,	1.08	6.4	93.0 %
31.	Emithion 50 EC	48.75	,,	1.066	6.5	93.0 %
32.	Sumithion 50 EC	50.07	,,	1.045	6.5	94.4 %
33.	Fentro 50 EC	49.08	,,	1.08	6.3	91.0 %
34.	Fenitox 50 EC	49.87	,,	1.20	6.4	92.0 %
35.	Sumithion 50 EC	50.04	,,	1.045	6.5	93.0 %
36.	Sumithion 50 EC	50.12	,,	1.045	6.5	94.0 %

The representative gas chromatograms of reference standard and commercially formulated pesticide samples of diazinon (Rison 60 EC), malathion (Cyfanon 57 EC) and fenitrothion (Sumithion 50 EC) were analyzed, respectively. It was observed from the test results that comparatively pesticide samples collected from formulation and repackaging factories found superior and better quality rather than the field samples of the same group of pesticide collected from pesticide dealer shops present in the market. These differences in respect of quality caused for the transport, distribution and storage under different circumstances of hot humid weather conditions and situations prevailing in Bangladesh. Comparative test results of pesticide samples collected from different formulation and repackaging factories have shown in Table 1. Table 2 shows the test results of pesticide samples collected from different pesticide dealer shops of all Upazilas under Mymensingh district.

These substandard and unsatisfactory pesticides were – (i) Sabion 60 EC of diazinon group; (ii) Malataf 57 EC and (iii) Malatox 57 EC of malathion group; (iv) Sovathion 50 EC of fenitrothion group. Besides, in few cases, there were some information found omitted on the labeling of the marketed and stored product of commercially formulated pesticides in the dealer shops. Those omitted and miss-information were as follows: - (i) date of expiry, (ii) sign of danger/poison, (iii) imbalance in actual quantity and net content with the quantity of pesticide mentioned in the labeling of bottle and sealed containers, (iv) omission of batch and lot number and (v) corroded sealed cap (in case of aluminium/iron cap) due to corrosive action of the poison/pesticide (FAO/WHO, 2005).

Therefore**,** the pesticide samples collected from factory premise found better quality and superior than the field samples collected from pesticide dealer/retailer shops of local market. This is due to improper storage for a long time in a pesticide dealer shops and careless distribution, transport and supply to the field level caused degradation of pesticides. So, regular inspection, supervision, collection of pesticide samples from formulation/repacking factories and dealer shops and their analyses in the laboratory for quality control and quality assurance are most essential for national interest of the country (WHO, 2005).

Effects of Three Selected Organophosphorus Pesticides on Insect-pest (BSFB) Control of Brinjal Plant

Field experiments with diazinon (Rison 60 EC), malathion (Cyfanon 57 EC) and fenitrothion (Sumithion 50 EC) were conducted on brinjal (variety: Uttara) to find out the effectiveness of 4-different treatments of each insecticide to control BSFB at flowering and fruiting stages. The results of those 4-treatments for every insecticide on leaf, shoot, fruit and yield performance of brinjal plant against infestation of BSFB found statistically insignificant, except the treatment D_4-having DR @ 3.4 L/ha of diazinon and F_4-having DR @ 2.24 L/ha of fenitrothion on shoot were found statistically significant. The F_4-treatment of fenitrothion (Sumithion 50 EC) was the best with lowest shoot infestation (5.57%) and found superior to control BSFB than all other insecticide treatments comparatively.

Effects of fenitrothion (Sumithion 50 EC) on BSFB infestation situation on leaf, shoot, fruit and yield performance of brinjal plant

(i) Leaf

Among the four different treatments of fenitrothion (Sumithion 50 EC) insecticide, the performance and efficacy of F_3 treatment having recommended dose found comparatively more effective and better to reduce

leaf infestation by BSFB in brinjal plant. The leaf infestation of brinjal plant under F_3 (R) – treatment was 9.60 %, which was the lowest. The infestation situation of BSFB under other treatments were F_1 (O) -10.68 %, F_2 (HR) -12.30 % and F_4 (DR) - 10.69 %, respectively. The range of variations of BSFB infestation in brinjal leaf was 9.60 % to 12.30 %. These variations were found statistically insignificant at 0.01 and 0.05 level of probability (Table 3).

(ii) Shoot

Among the four different treatments of fenitrothion (Sumithion 50 EC) insecticide, the performance and efficacy of F_4 treatment having double of the recommended dose found comparatively better to reduce shoot infestation by BSFB in brinjal plant. As shown in Table 3, the shoot infestation of brinjal plant under F_4 (DR) treatment was 5.56 %, which was the lowest. The infestation situation of BSFB under other treatments was F_1 (O) - 11.64 %, F_2 (HR) - 12.84 % and F_3 (R) – 9.54 %, respectively. The range of variations of BSFB infestation in brinjal shoot was 5.56 % to 12.84 %. These variations were found statistically significant at 0.01 and 0.05 level of probability.

(iii) Fruit

Among the four different treatments of fenitrothion (Sumithion 50 EC) insecticide, the performance and efficacy of F_4 treatment having double of the recommended dose found comparatively more effective and better to reduce fruit infestation by BSFB in brinjal plant. The fruit infestation of brinjal plant under F_4 (DR) treatment was 32.01 %, which was the lowest. But the infestation situation of BSFB under other treatments was F_1 (O) - 39.92 %, F_2 (HR) - 34.18 % and F_3 (R) - 37.72 %, respectively. The range of variations of BSFB infestation in brinjal fruit was 32.01 % to 39.92 %. These variations were found statistically insignificant at 0.01 and 0.05 level of probability (Table 3).

Table (3): The pest (BSFB) infestation situation in brinjal shoot after application of fenitrothion insecticide.

Treatment	Dose	BSFB infestation in percentage		
		Leaf	Shoot	Fruit
F_1	O	10.68 ± 0.7^{a}	11.64 ± 1.0^{a}	39.92 ± 0.7^{a}
F_2	HR	12.30 ± 1.1^{a}	12.84 ± 1.0^{a}	34.18 ± 0.8^{a}
F_3	R	9.60 ± 1.2^{ab}	9.53 ± 0.9^{ab}	37.70 ± 1.0^{a}
F_4	DR	10.69 ± 0.6^{b}	5.56 ± 1.1^{b}	32.01 ± 0.7^{a}

F_1, F_2, F_3, F_4 – Four different treatments of fenitrothion;

O - Control (No pesticide); HR – Half of the recommended dose;

R - Recommended dose; DR – Half of the recommended dose Values in the same column with different superscripts are significantly different ($p< 0.05$).

(iv) Yield

The yield performance of brinjal fruits under F_3 treatment having recommended dose of fenitrothion (Sumithion 50 EC) insecticide found higher and better in comparison with fruit yield of all other treatments. The yield of fruits under F_3 (R) – treatment was 57.05 t/ha, which was highest. But the yield of fruits under other treatments were F_1 (O) – 40.60 t/ha, F_2 (HR) – 35.24 t/ha

and F_4 (DR) – 44.97 t/ha, respectively. The fruit yield were varied among those treatments and ranged from 35.24 t/ha to 57.05 t/ha. These variations were found statistically insignificant at 0.01 and 0.05 level of probability (Table 4).

Table (4): The yield performance of brinjal fruit under the treatment of fenitrothion insecticide.

Treatment	Dose	Yield of Brinjal fruit (Ton/Hectare)
F_1	O	40.60 ± 0.6^a
F_2	HR	35.24 ± 1.0^a
F_3	R	57.04 ± 0.9^a
F_4	DR	44.97 ± 0.6^a

F_1, F_2, F_3, F_4 – Four different treatments of fenitrothion;

O - Control (No pesticide); HR – Half of the recommended dose;

R - Recommended dose; DR – Half of the recommended dose

Values in the same column with different superscripts are significantly different ($p < 0.05$).

CONCLUSIONS AND RECOMMENDATIONS

On the basis of overall experimental results and findings, it is concluded that training and demonstration programmes for farmers and pesticide dealers is very essential to increase their knowledge, skills and abilities for better understanding about pest and pesticide (toxicity, safety) management in Bangladesh. Regular inspection and monitoring system of pesticides for the quality control of commercially formulated products in the factory and dealer shops is very essential in Bangladesh. Simultaneously, strengthening of laboratory facilities and efficient manpower both in field and laboratory to activate the present situation of pesticide administration and quality control system is urgently needed for the country. Amongst the three selected organophosphorus pesticides (diazinon, malathion & fenitrothion), fenitrothion (Sumithion 50 EC) insecticide was the best to reduce and control of brinjal shoot and fruit borer infestation, and to increase yield performance of brinjal plant. It is also inferred that integration of modern cultural operations with pest and pesticides management practice is the best and effective measure for the control of BSFB infestation in brinjal plant, because single spray application of those pesticides was not sufficient to control this insect-pest of brinjal.

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الخواص الفيزيائية – الكيميائية وكفاءة أكثر المبيدات استعمالاً في بنغلاديش لمكافحة حافرة الأفرع والثمار على الباذنجان

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ملخص

تهدف هذه الدراسة إلى بحث الوضع الحقيقي السائد في بنغلاديش بخصوص ضبط الجودة والإدارة في استعمال مبيدات الآفات. المبيدات الأكثر استعمالاً لمكافحة الآفات الحشرية على الخضراوات تشمل ديازينون، مالاثيون، وفينتروثيون.
بخصوص ضبط الجودة وتقييم المبيدات، تم جمع عينات من المبيدات الثلاثة من مصادر مختلفة من مصانع التجهيز أو إعادة التعبئة في بنغلاديش، وتم اختبارها في المعمل. نتائج تحليل هذه العينات أبرزت أن نوعية المبيدات التي تم جمعها من المصانع كانت أفضل نسبياً من العينات التي تم جمعها في الحقل.
المبيدات التي تم جمعها من الحقول ثم تجربتها لمعرفة كفاءتها باستعمار أربع تركيزات من كل مبيد لمكافحة حافرة الأفرع والثمار على الباذنجان في مرحلة الإزهار والثمار.
كانت معاملة مبيد فينتروثيون هي الأفضل مع أقل نسبة إصابة للأفرع (5.57%) وكان المبيد متفوقاً على جميع معاملات المبيدات لمكافحة حافرة ثمار الباذنجان.

الكلمات الدالة: مبيدات فسفورية عضوية، نبات الباذنجان، ضبط الجودة، مكافحة الآفات، حافرة الأفرع والثمار في الباذنجان.

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