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Evaluation of pre-harvest interval for pesticides on different vegetables in Bangladesh

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Abstract

A study was conducted to evaluate the pre-harvest interval (PHI) for pesticides on different vegetables in Bangladesh. Data were collected from selected 330 vegetable farmers of eleven districts- Bogra, Joypurhut, Rangpur, Gaibandha, Jessore, Jhenaidah, Magura, Khulna, Satkhira, Kustia and Chuadangha in 2013. The interview schedule containing direct questions with appropriate scales were prepared according to the objectives of the study and data were collected from the vegetable farmers. The recommendation rate of the pesticides was used in the vegetables field of the study area. The highest and the lowest amount of highly toxic vegetables were harvested by the farmer of Jhenaidah and Gaibandha districts, having an average mean values of 40 and 10%, respectively. The result also demonstrated that the brinjal was the vegetables whose PHI was the lowest receiving highest toxic vegetable among all vegetables under consideration in this study. The green banana and green papaya proved to be non toxic vegetables among all vegetables. Fifty percent farmer followed the PHI 0-2 days of pesticide for brinjal those are highly toxic. No farmer used pesticide before at least one month of harvesting in case of green banana and green papaya. Though the lowest amount of highly toxic vegetables were harvested by the farmer of Gaibandha district, the overall vegetables those were harvested by the farmer of Satkhira district that was comparatively less toxic than the other districts. The farmers of this district harvested 20% non toxic and 13.33% slightly toxic vegetables. This study provides information on the knowledge, attitudes, and practices of vegetable farmers in the eleven districts of Bangladesh regarding pesticide use. Survey responses indicate the widespread improper use of pesticide especially inadequate PHI that pose hazards to the human health and environment.

Introduction

Bangladesh is predominantly an agricultural country with an area of 147570 sq. km. (BBS, 2016). Agriculture plays an important role in the lives of Bangladeshi people. Vegetables are highly valued in human diet mainly for vitamins and minerals (Hanif *et al*., 2006). Due to tropical and subtropical climates, variety vegetables are grown in Bangladesh. In 2015-16, cropped area under vegetable crop production was 992000 acres and the total vegetable crop production was 3877000 MT in Bangladesh (BBS, 2016). The farmers of vegetable production in the country do not know the proper doses of the pesticides as well as their toxicity level (Miah *et al*., 2014). While it is difficult to ascertain the optimum use of these chemicals, it is certainly valid to question the excess use of these chemicals. Environmentalists and nutritionists warn that if the farmers increase the use of chemicals in farming injudiciously food adulteration might be increased tremendously in Bangladesh. Food safety is presently a global concern that is directly related with pesticide residue. The present food safety issues are mainly concerned with food-borne illness, safe use of pesticides and ripening chemicals, and detection and assessment of food adulteration (Van Boxstael *et al*., 2013). Currently, in Bangladesh, there is public outcry regarding the indiscriminate use of chemicals in vegetables production system (Rahman, 2015). As high-value product value chain is more demanding in food safety and quality standards, greater attention is required for certification and quality enforcement.

Pesticides are the only toxic substances released intentionally into our environment to kill living things (Sarwar, 2015). In the most cases, they are designed to kill pests; however, many pesticides can also pose risks to the peoples (Sarwar, 2015). Chemical pesticides contaminate surface water and as a result, affect fish population, livestock, poultry and human health. To regain the lost status of safe food, it is high time to start agriculture with judicious use of agricultural inputs without further delay. The health effects of pesticides depend on the type of pesticide, some chemicals such as the organophosphates and carbamates; affect the nervous system, while others may irritate the skin or eyes (Sarwar, 2015). There are several classes of pesticide including insecticides (control insect infestations), fungicides (control the spread of fungal diseases), herbicides (control the competing effects of weeds), molluscicides (control the destructive effects of slugs

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and snails) and rodenticides (control the activities of rats and mice) (Aktar *et al*., 2009; Agrawal *et al*., 2010). Inappropriate use of pesticides can have negative effects on human health and agro-ecosystems, damage wildlife habitats, create pesticide resistance of insects and diseases, and pollute ground and surface water resources (Recena *et al*., 2006; Polidoro *et al*., 2008; Shormar *et al*., 2014).

Most of the people in Bangladesh are indirect consumers of pesticides through food intake (Prodhan *et al*., 2018). Due to lack of education, the farmers of our country do not follow the prescribed dosages and use pesticides at any stage of the crop without any awareness of the residues and their ill effects on human health (Prodhan *et al*., 2018). Every pesticide has a withholding period or pre-harvest interval (PHI), which is defined as the number of days required to lapse, between the date of final pesticide application and harvest, for residues to fall below the tolerance level established for that crop or for a similar food type (Prodhan *et al*., 2018). The PHI differs from pesticide to pesticide and crop to crop. However, most of the vegetables are supplied from the different districts of northern and southern part of Bangladesh. But very little or limited research work has so far been done to determine how long time the farmer wait for vegetable harvesting after spraying of pesticide. Therefore, the current research work was undertaken to evaluate the pre-harvest interval for pesticides on different vegetables in Bangladesh.

Methodology

Target areas and population

The sample selection method was purposive random sampling technique (Tongco, 2007). There were eleven districts in Bangladesh selected purposively as the study area (Table 2). Two to three villages were purposively selected from each district. Vegetables cultivators of these selected villages constituted the population farmers of the study. Thirty farmers were randomly selected from each selected district. Thus a total of 330 farmers constituted the sample farmers for the study (Table 2). List of the vegetables with their local name, scientific name and family those were cultivated by the farmers of this research area that is shown in Table 1.

Data collection

A questionnaire consisting of structured, semi-structured and unstructured items was designed based on published literature on the subject (Ngowi *et al*., 2007; Pervin *et al*., 2018) as well as experiences of the authors in the field. Data was collected through a farm survey by face-to-face interviews with farmers during farming activities. The interview schedule containing direct questions with appropriate scales were prepared according to the objectives of the study. Each of the three draft schedules were pre-tested for necessary corrections, additions and adjustments before going for final data collection. Validity and reliability of some scales were properly determined. Identification and determination of chemical pesticides were done by asking direct questions to the respondents. The questionnaire was designed in English and translated into Bangla, the national language, which is understood by the majority of the farmers and pretested using small samples of farmers in the same areas before using it in this study.

Data analysis

Data regarding the number of farmer based on the waiting period for vegetable harvesting were collected and divided into four groups, viz. 0-2, 3-7, 8-15 and 15-30 days. Then the percentage of farmer based on the vegetable harvesting at different PHI of pesticide was calculated. Depending on the previous literature (Prodhan *et al*., 2018), the toxicity levels of the vegetables were categorized based on PHI of pesticide as 0-2 days = highly toxic, 3-7 days = moderately toxic, 8-14 days = slightly toxic, 15-30 days = non toxic. Data were subjected to two factorial (district/vegetable* waiting period, day) analyses of variances (ANOVA-2) without replication followed by Duncan's Multiple Range Test (DMRT) at 5% level of significance for mean comparison by using SAS software (SAS Institute, 2001).

Results and Discussion

The respondents of the current study population were 18 to 70 years of age and around 36.37% of middle-aged (41 to 50) farmers have been involving in vegetable cultivation (Tabulated data were not shown). According to the survey, around 37.27% of the farmers were illiterate and educational qualification (grade 1 to graduate) of rest of the farmers were 62.72% (Tabulated data were not shown). A similar phenomenon was observed that the respondents were 21 to 75 years of age and around 38% of younger farmers were involved in vegetable cultivation. Around 69% of the farmers had knowledge in medium level (Grade 6 to Advanced level) of education (Sharaniya and Loganathan, 2016).

The results showed significant differences among the districts based on the PHI of pesticide (Table 2). Significant differences were also observed among the vegetables on percentage of farmer based on the PHI of pesticide (Table 3). The highest and the lowest amount of highly toxic vegetables were harvested by the farmer of Jhenaidah and Gaibandha districts, having average mean values of 40 and 10%, respectively (Table 2). The result also demonstrates that the brinjal was highly toxic vegetable among all vegetables under consideration in this study (Table 3). Fifty percent farmer followed the PHI 0-2 days of pesticide for brinjal those are highly toxic (Table 3). The green banana and papaya proved to be non toxic vegetables among all vegetables under consideration in this study (Table 3). No farmer used pesticide before at least one month of the harvesting in case of green banana and papaya.

Table 1. List of the vegetables with their local name, scientific name and family cultivated in the study area

English name	Local name	Scientific name	Family
Brinjal	Begoon	*Solanum melongena* L.	Solanaceae
Chili	Morich	*Capsicum annuum* L.	Solanaceae
Tomato	Tomato	*Solanum lycopersicum* L.	Solanaceae
Bean	Deshi shim	*Lablab purpureus* L.	Leguminoseae
Bottle gourd	Lau	*Lagenaria siceraria* (Molina) Standl.	Cucurbitaceae
Cucumber	Shosha	*Cucumis sativus* L.	Cucurbitaceae
Bitter gourd	Korola	*Momordica charantia* L.	Cucurbitaceae
Pointed gourd	Potol	*Trichosanthes dioica* Roxb.	Cucurbitaceae
Ribbed gourd	Jhingga Bandhakopi	*Luffa acutangula* (L.) Roxb.	Cucurbitaceae
Cabbage	Phulkopi	*Brassica oleracea* var. *Capitata* L.	Cruciferae
Cauliflower	Dherosh	*Brassica oleracea* var *gongyloides* L.	Cruciferae
Okra	Pepe	*Abelomschus esculentus* (L.) Moench	Malvaceae
Green papaya	Kancha kola	*Carica papaya* L.	Caricaceae
Green banana		*Musa acuminata* Colla	Musaceae

Table 2. Percentage of farmer among the districts based on the PHI of pesticide

Name of district	Sample size		Percentage of farmer based on the PHI of pesticide			
	Number of farmer	Area (decimal)	0-2	3-7	8-14	15-30
Bogra	30	2310	33.33	46.67	16.67	3.33
Joypurhut	30	978	16.67	60.00	23.33	0.00
Rangpur	30	1270	30.00	53.40	16.67	0.00
Gaibandha	30	1050	10.00	66.67	16.67	6.67
Jessore	30	4265	36.67	36.67	10.00	3.33
Jhenaidah	30	2240	40.00	53.33	6.67	0.00
Magura	30	736	26.67	50.00	16.67	6.67
Khulna	30	2153	30.00	56.67	10.00	3.33
Satkhira	30	3878	13.33	53.33	13.33	20.00
Kustia	30	355	30.00	46.67	20.00	3.33
Chuadangha	30	1951	23.23	53.33	20.00	3.33
Mean	30	1926	26.40 b	52.40 b	15.50 ab	4.50 a
$F = 8.01$; $df = 10, 54$; $P < 0.0001$						

0-2 days = Highly toxic, 3-7 days = Moderately toxic, 8-14 days = Slightly toxic, 15-30 days = Non toxic
Means with the same letter within a row are not significantly different (DMRT-test, $P < 0.05$).

Table 3. Percentage of farmer among the vegetable based on the PHI of pesticide

Name of vegetable	Number of farmer	Percentage of farmer based on the PHI of pesticide			
		0-2	3-7	8-14	15-30
Brinjal	202	50.00	43.50	5.94	0.49
Chili	89	25.25	48.48	10.10	10.10
Tomato	55	21.81	56.36	9.09	12.72
Bean	90	42.22	53.33	4.44	0.00
Bottle gourd	98	8.16	54.08	11.22	26.53
Cucumber	48	44.83	46.55	5.17	3.45
Bitter gourd	93	26.88	65.59	6.45	1.08
Pointed gourd	77	27.27	57.14	14.29	1.30
Ribbed gourd	43	46.51	44.49	0.00	9.30
Cabbage	85	17.65	67.06	9.41	5.88
Cauliflower	79	22.78	60.80	11.39	5.06
Okra	47	48.94	38.30	0.00	12.77
Green papaya	45	0.00	0.00	0.00	100.00
Green banana	41	0.00	0.00	0.00	100.00
Mean	78	27.31 b	45.41 b	6.25 a	20.62 b
$F = 3.34$; $df = 13, 69$; $P = 0.0004$					

0-2 days = Highly toxic, 3-7 days = Moderately toxic, 8-14 days = Slightly toxic, 15-30 days = Non toxic
Means with the same letter within a row are not significantly different (DMRT-test, $P < 0.05$).

Our current findings are in match with the results of previous report which revealed that 2% farmers harvested the product same day of the pesticide application, 3% of them following day and 55% of the farmers who had harvest the products after 3-4 days interval. Altogether around 60% farmers who had harvested the product within seven days from the application of pesticides; but 36% farmers harvested after one week and around 4% of them harvested after two weeks (Sharaniya and Loganathan, 2016).

According to the results of this survey, farmers didn't consider about residual toxicity of pesticides and their health impacts and they considered only their income. This suggesting that the farmers in the study either they do not have clear knowledge regarding residual toxicity of pesticides or they completely ignoring it. Previous research finding also indicates that 8% farmers applied pesticides prior to exposure of pesticides occur mainly through eating food and drinking water contaminated with pesticides (Davis *et al*., 1992).

Environmental Protection Agency (EPA) of USA recommended that farmers should allow 1-3 weeks period to reduce the residual effects of pesticides before harvesting the crop and it's depending on the type of pesticides (Sharaniya and Loganathan, 2016). But most of the Bangladeshi farmers do not follow the EPA guidelines. The maximum residual limit (MRL) of pesticides in the vegetables for human is 0.1-0.3 mg/kg (depending on the type of pesticides and vegetables) that is only possible to get within one week after spraying of pesticides (Prodhan *et al*., 2018). It indicates that maximum vegetables in Bangladesh cross the MRL. However, though the lowest amount of highly toxic vegetables were harvested by the farmer of Gaibandha district, the overall vegetables those were harvested by the farmer of Satkhira district comparatively less toxic than the other districts. The farmers of this district were harvested 20% non toxic and 13.33% slightly toxic vegetables.

Conclusion

This study provides information on the knowledge, attitudes, and practices of vegetable farmers of eleven districts in northern and southern part of Bangladesh regarding PHI of pesticide. Survey responses indicate the widespread improper use of pesticides especially inadequate PHI of pesticide that pose hazards to the human health and environment. Most of the farmers of our country ignore potential threats to personal health and environmental contamination. Therefore, they appear to be unaware about the extent of pesticide residue levels on local food products or long-term health effects of pesticide residues on consumers. Further research is needed to investigate the amount of the residual toxicity of pesticides on different vegetables in Bangladesh.

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