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A Study on the Use of Agricultural Chemicals for Tomato Cultivation in Assam, India

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ABSTRACT

Vegetables are very important crops both in terms of supplement of minerals and nutrition and high income generating ability. It is possible to get a better return, provided necessary care such as supplement of nutrients, water and measures to protect the crops from insect-pests and diseases is taken in due time. The present study was conducted to know the use of agricultural chemicals in tomato production in Assam, in three agro-climatic zones of Assam. For analysis of data, both graphical and simple tabular methods calculating mean, percentage was done. The results revealed that all the farmers' groups applied chemical fertilizers and insecticides more than the recommended dose. Regarding the safety measures undertaken by the farmers, only 10 per cent farmers adopted the full safety measures which are found risky for the farmer's health. Thus, it is important to create awareness amongst the farmers on judicious use of agricultural chemicals and taking of necessary safety/ protective measures during the application of pesticides.

KEYWORDS

Minerals, Nutrition, Agro-climatic zones, Insecticides, Recommended dose

INTRODUCTION

Agricultural chemicals are very important for getting higher production of the crops. It generally refers to chemicals like insecticides, fungicides, herbicides, nematicides, synthetic fertilizers, hormones and other chemical growth agents. Due to the rapid growth of population, there is increasing demand of the food. For addressing the growing demand of foods, there is the rigorous use of agricultural chemicals (fertilizers and pesticides) in agriculture sector to minimize the gap between food production and its demand. The pesticides are used in agriculture for control of insect-pests, diseases and weeds. It is estimated that due to the infestation of insect-pests and diseases, more than one third of the potential food production is lost. The percentage of crop losses in India varies from 10 to 30. In monetary terms, every year these losses amount to Rs. 2, 90,000 million. If half of these losses can be reduced, a substantial quantity of food can be made available for human consumption (Agnihotri, 1999). However, the unbalanced and excessive use of these chemicals become a threat to our environment and ecosystem.

Pesticides can be hazardous to both humans and the environment. Numerous chemicals are environmentally stable, prone to bioaccumulation and toxic (Volkmar *et al.*, 2008). Pesticides are known to toxic to human, animals and even to the environment and have both acute and chronic effect on health depending on the quantity of consumption and ways in which a person is exposed. Worldwide, pesticide use has resulted in different cases of acute and chronic poisoning, with effects of varying hazard on human health, from mild effects to death (Dawson *et al.*, 2010). The vegetables occupy and important status in Indian diet because a sizable population in India is vegetarian (Gupta *et al.*, 2015). Vegetables are rich source of proteins, carbohydrates minerals, vitamins and dietary fibers (Kumar and Srivastava, 2015). India is the largest producer in the world next only to China. The use of agricultural chemicals per unit area is higher as compared to many other crops.

In Assam, there are certain pockets where different kind of vegetables are grown extensively on a commercial basis. Out of different commercial vegetables grown in Assam, tomato is found very important because of its demand by consumers as well as for its price remuneration. The vegetable growers of Assam apply different kind of pesticides and other agricultural chemicals in vegetables cultivation for higher production. Presently, the unbalanced and excessive uses of these chemicals become the common concern in all section of the society. But there is very less quantitative information on use of agricultural chemicals in vegetable cultivation. Thus, an attempt has been made to evaluate the quantity of agricultural chemicals used by the farmers and to know the adoption of safety/ protective measures undertaken by the tomato growers during application of these chemicals.

MATERIALS AND METHODS

Selection of agro climatic zones

There are six agro-climatic zones in the state of Assam. Out of these zones, three

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agro climatic zones were selected for the study. These three agro-climatic zones were selected based on the area under vegetable cultivation and its production. They were the North Bank Plain Zone, the Lower Brahmaputra Valley Zone and the Central Brahmaputra Valley zone of Assam. The production of vegetables (both *rabi* and *kharif*) in these three zones in the state of Assam was recorded the highest and they could produce the total requirement of vegetables in the state. So, these three zones were selected for the study.

Selection of district

One district from each agro-climatic zone was selected purposively for the study. The district selected from Lower Brahmaputra Valley Zone was Barpeta district, From North Bank Plain zone, Darrang district was selected and from Central Brahmaputra Valley zone, Nagaon district was selected. The districts selected for the study was done purposively based on area under vegetable cultivation and for ease of data collection especially easily accessible to the destination.

Selection of Agriculture Development Officer (ADO) circles

Out of different ADO circles present in the selected districts, two ADO circles from each district were selected based on the area coverage under vegetable cultivation and its production. The ADO circles were selected in consultation with the concerned officers of Department of Agriculture of the districts.

Selection of villages

The list of revenue villages under each ADO circle was prepared in consultation with the concerned ADOs of department of Agriculture of the districts and Krishi Vigyan Kendras. The selection of villages for the study was done purposively based on the coverage of vegetable growing area. From each ADO circle, 5 (five) numbers of villages were selected for the study.

Selection of farm families

The list of farm families/ households with their operational holding under vegetable production was prepared in consultation with the concerned officials like Agriculture Development Officer, VLEW and Village Head (*Gaon Burha*). The farm families were selected randomly from each village. From each village, 15 (fifteen) number of commercial vegetable grower were selected randomly. Thus, the total number of respondent farm families in each district was 150 and the total number of farm families covered for the study was 450.

The farmers were categorized as group I, group II and group III based on the area under vegetable cultivation using the Cumulative Square Root frequency method (Singh and Mangat, 1996). The farmers' group I included the farmers having vegetable cultivation area less than 0.4 ha, group II included the farmers having vegetable growing area 0.4 – 0.8 ha and group III included the farmers having more than 0.8 ha vegetable growing area. Simple graphical and tabular analysis was done calculating mean, percentage etc.

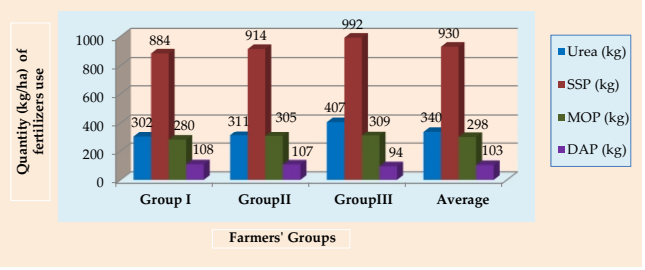

Fig. 1: Quantity of chemical fertilizers used in tomato cultivation by the sample farmers of Nagaon district

RESULTS AND DISCUSSION

Quantity of chemical fertilizers used in tomato cultivation

Tomato is a very popular vegetable crop in Assam as well as in India. Farmers can earn a good return over cost from this crop provided the proper management practices are followed. The quantity of chemical fertilizers used by the vegetable growers had been presented graphically in Fig. 1, Fig. 2 and Fig. 3. It was observed from the Fig. 1. that the average quantity of urea application in tomato crop was the highest (340 kg per hectare) in Nagaon district of Central Brahmaputra Valley zone (Fig. 1) followed by Darrang district Lower Brahmaputra Valley zone (327 kg per hectare) (Fig. 2) and Barpeta district of North Bank Plain zone (327 kg per hectare).

The average quantities of application of SSP was recorded the highest for Central Brahmaputra Valley zone (930 kg per hectare) followed by North Bank Plain zone (912 kg per hectare) and Lower Brahmaputra Valley zone (866 kg per hectare). The average quantities of MOP used by the farmers was found the highest for Central Brahmaputra Valley zone (298 kg per hectare) and the lowest was calculated for North Bank Plain zone (285 kg per hectare). In terms of average quantity of DAP application, Central Brahmaputra Valley zone accounted for the highest (103 kg per hectare) and the lowest was accounted for North Bank Plain zone (84 kg per hectare).

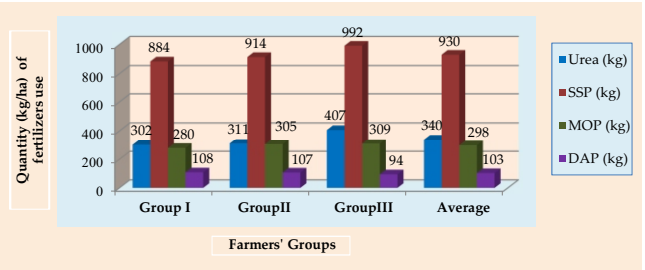

Fig. 2: Quantity of chemical fertilizers used in tomato cultivation by the sample farmers of Darrang district

In North Bank Plain zone and Central Brahmaputra Valley zone, the quantity of urea consumption per hectare was found the highest in group III and the lowest was recorded for group I; whereas in Lower Brahmaputra Valley zone, the highest quantity of urea was consumed by the farmers of group III (349 kg per hectare) followed by group I (317 kg per hectare) and group II (315 kg per hectare) against the recommended dose of 165 kg per hectare. In terms quantity of SSP application, the farmers' group III used the highest in Lower

Brahmaputra Valley zone and North Bank Plain zone followed by group I and group II, respectively. But, in Central Brahmaputra Valley zone, the quantity of SSP, the highest was recorded for group III (992 kg per hectare) and the lowest was recorded for group I (884 kg per hectare) with an average of 930 kg per hectare against the recommended dose of 375 kg per hectare. The quantity of MOP application was calculated the highest for group II (310 kg per hectare) in Lower Brahmaputra Valley zone and the lowest for group I (288 kg per hectare) and thus, all were using more than the recommended dose of 98 kg per hectare. In case of application of DAP, the highest quantity was applied by group III farmers (108 kg per hectare) of Lower Brahmaputra Valley zone followed by group I (99 kg per hectare) and group II (89 kg per hectare) farmers. In North Bank Plain zone, the highest quantity was applied by farmers of group II (92 kg per hectare) and the lowest was calculated for group I (77 kg per hectare). The quantity of use of DAP in Central Brahmaputra Valley zone were found the highest in group I (108 kg per hectare) and the lowest was found in group III (94 kg per hectare). Usually, the farmers applied a higher quantity of NPK in the form of urea, single super phosphate (SSP) and murate of potash (MOP). In addition to that they applied DAP which adds more nitrogen and phosphorus. Thus, the nutrient supplied to the crop was very high which directly effect on the increase in the cost of cultivation and thus, reducing the income, misuse of nutrients and deteriorating the soil health.

From the above discussion, it was observed that the farmers were applying more quantities of urea than the recommended dose. The quantity of SSP applied was not sufficient to meet up the requirement of phosphorus for hybrid tomato crop. But the application of DAP fulfilled the requirement of phosphatic fertilizers to the crop and ultimately it exceeded the requirement of phosphorus by the crop. The quantities of MOP application were found to be less than the requirement for hybrid varieties of tomato; but for HYV tomato the quantity applied was more than the recommended dose.

Hence, it was clear that all farmers' groups were using more quantity of chemical fertilizers than the recommended dose for high yielding varieties. There was no particular trend or sequence on the use of the fertilizers amongst the farmers. This was because the majority of farmers did not know the recommended dose of fertilizers. Some farmers believed that the application of more quantity of chemical

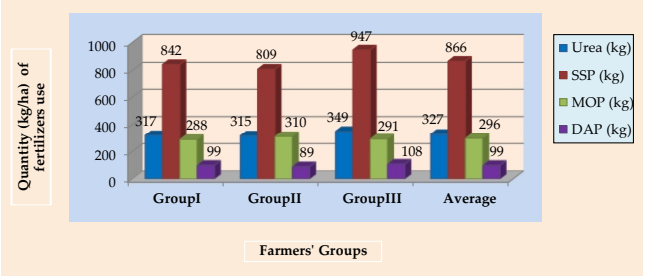

Fig. 3: Quantity of chemical fertilizers used in tomato cultivation by the sample farmers of Barpeta district

fertilizers enhanced the productivity of vegetables. The hidden competition between the farmers on the application of chemical fertilizers was also one of the important reasons of application of high dose of fertilizers in the vegetable production in the study area. Due to such practices, the farmers had to incur direct economic loss. Moreover, the excess quantity of fertilizer remained unused and mixed with soil, ultimately the quality of soil was deteriorated. A study conducted by Ibitoyel *et al.* (2015) in Kogi State revealed the similar results. He also observed that the farmers utilized over dose of fertilizers in tomato cultivation.

Dose (quantity) of insecticides (ml/lit water or kg/ha) used in vegetable cultivation

Insecticides are any toxic substance that is used to kill insects. The concentration of insecticides varies with the types of insects and its population. Many insecticides are available in the market with different trade names. The dose (quantity) of insecticides (ml/lit water or kg/ha) used by the farmers in tomato crop against different insect-pests was presented in Table 1.

The table depicted that the chemicals used by the farmers in tomato crop were Dimethoate 30 EC, Malathion 50 EC, Chloropyriphos 20 EC, Endosulphan 35 EC, Monocrotophos 36 WSC, Cypermethrin 25 EC, Carbofuran 3G. It was observed from the table that on an average the highest quantity of Dimethoate 30 EC was used by the farmers of Central Brahmaputra Valley zone (5.47 ml per litre water) followed by Lower Brahmaputra Valley zone (5.09 ml per litre water) and North Bank Plain zone (4.85 ml per litre water). Similarly, for Malathion 50 EC, the highest concentration of the chemical was used by the farmers of Central Brahmaputra Valley zone (5.03 ml per litre water) followed by North Bank Plain zone (4.93 ml per litre water) and Lower Brahmaputra Valley zone (4.55 ml per litre water). The highest quantity of Chloropyriphos 20 EC was used by the farmers of Lower Brahmaputra Valley zone (4.87 ml per litre water) and the lowest was used by North Bank Plain zone (4.03 ml per litre water). The farmers of Lower Brahmaputra Valley zone used Endosulphan 35 EC at the highest concentration (5.06 ml per litre water) than the farmers of other two agro-climatic zones. The lowest concentration was used by the farmers of North Bank Plain zone (4.63 ml per litre water). The farmers of Central Brahmaputra Valley zone ranked top in terms of the use of Monocrotophos 36 WSC with a dose of 5.04 ml per litre water followed by North Bank Plain zone (4.71 ml per litre water) and Lower Brahmaputra Valley zone (4.55 ml per litre water).

The chemical Cypermethrin 25 EC was applied by the framers of Lower Brahmaputra Valley zone at the highest dose of 4.60 ml per litre water and the lowest dose was used by the farmers of North Bank Plain zone (4.09 ml per litre water). The granule type plant protection chemical Carbofuran 3G was applied by the farmers of Lower Brahmaputra Valley zone at the highest concentration of 32.5 kg per hectare followed by the farmers of Central Brahmaputra Valley zone (31.92 kg per hectare) and the lowest dose was applied by the farmers of

Table 1: Dose (quantity) of insecticides (ml/lit water or kg/ha) used in tomato cultivation by the respondent farmer

Chemical Insecticides	Barpeta				Darrang				Nagaon			
	Group I	Group II	Group III	Average	Group I	Group II	Group III	Average	Group I	Group II	Group III	Average
Dimethoate 30 EC (ml/lit)	5.21	4.93	5.13	5.09	4.96	4.83	4.77	4.85	5.64	5.44	5.33	5.47
Malathion 50 EC (ml/lit)	4.86	4.39	4.41	4.55	5.23	4.83	4.73	4.93	5.26	5.1	4.73	5.03
Chlorpyriphos 20 EC (ml/lit)	4.86	5.75	4.01	4.87	4.23	3.95	3.92	4.03	5.01	3.83	4.82	4.55
Endosulphan 35 EC (ml/lit)	5.96	3.89	5.32	5.06	4.93	4.75	4.21	4.63	5.22	4.83	4.73	4.93
Monocrotophos 36 WSC (ml/lit)	5.25	4.03	4.36	4.55	5.23	4.72	4.18	4.71	5.17	5.13	4.83	5.04
Cypermethrin 25 EC (ml/lit)	4.50	5.10	4.20	4.60	4.31	4.05	3.90	4.09	4.78	4.76	4.14	4.56
Carbofuran 3G (kg/ha)	33.75	33.75	30	32.5	32	30	30	30.67	33.75	32	30	31.92

North Bank Plain zone (30.67 kg per hectare) It was clear from the above discussion that in the study area, all the farmers were using the insecticides at a very higher dose as compared to the recommended dose (1.5 – 2.0 ml per lit water, 25 kg per hectare for Carbofuran 3G). The table revealed that in comparison to Central Brahmaputra Valley zone and Lower Brahmaputra Valley zone the farmers of North Bank Plain zone applied plant protection chemicals at a lower concentration in tomato crop.

Farmers' group-wise analysis revealed that in all the three agro-climatic zones, the farmers of group I used higher dose of plant protection chemicals than the other two groups to control the insect-pests of tomato except in the case of Chlorpyriphos 20 EC and Cypermethrin 25 EC in Lower Brahmaputra Valley zone. The reason behind the use of high dose of insecticides might be due to the ignorance about the recommended dose of the insecticides, there was increase in resistance of insect-pests against the chemicals due to repeated use of these chemicals, ignorance about the negative impact of high dose of insecticides to human health, soil health and to the environment.

The farmers opined that the insects could not be controlled at a lower concentration of the insecticides. Sometimes due to wrong identification of insect-pests, the farmer used incorrect insecticides and to control them they used the insecticides at a higher concentration. The farmers generally used the insecticides as suggested by the input dealers. Since, most of the input dealers were not a technical experts; certainly there was maximum chance to prescribe a wrong insecticide against an insect-pest and this ultimately led to direct economic loss to the farmers and health hazardous to human, animal a s well as soil and environment. Mohiuddin *et al.* (2009) in a study conducted at Satkania, Patiya and Hathazari upazilas of Chittagong reported that about 95% of the farmers relied on the application of insecticides to control insect pests.

Protective measures or safety measures undertaken by the respondent farmers during pesticide application

Different categories of pesticides are available in the market. Some of them are less poisonous, some are medium and some are highly poisonous. All the categories of pesticides were used by the farmers in their vegetables and other crops. To protect themselves from the hazardous effect of the chemicals the farmers should have to follow the basic norms during its applications. Table 2 presented the response of farmers regarding the protective measures or safety measures undertaken by them during pesticide application. The table revealed that in the study area, on an average 10.00 per cent farmers took full protective measures during the application of pesticides. Another 45.56 per cent farmers took partial protective measures and 44.44 per farmers did not take any protective measures. There was not a significant difference between the farmers regarding the undertaking of protective or safety measures during the application of plant protection chemicals in the three agro-climatic zones.

It was observed that 44.00 per cent farmers of Lower Brahmaputra Valley zone, 49.33 per cent farmers in North Bank Plain zone, and 43.33 per cent farmers in Central Brahmaputra Valley zone took partial protective measures. The percentage of farmers who did not undertake any protective measure was found the highest in Central Brahmaputra Valley zone (47.33 per cent) followed by Lower Brahmaputra Valley zone (46.00 per cent) and North Bank Plain zone (40.00 per cent). Thus, from the above discussion, it was clear that there was a little difference in the undertaking of protective/ safety measures by the farmers concern in the three agro-climatic zones.

Farmers' group wise analysis reveals that in Lower Brahmaputra Valley zone, about 10 per cent farmers used full protective measures in all the groups of farmers. The percentage of farmers followed partial protective measures was found the highest in group I (46.00 per cent) and the lowest was recorded in group III (42.11 per cent). The percentage of farmers who did not take any protective measures was recorded the highest in group III (47.37 per cent) and the lowest was recorded for group I (44.00 per cent). In North Bank Plain zone, the highest 14.29 per cent farmers took the full protective measures in group III and the lowest percentage (6.94 per cent) was recorded for group I. Regarding undertaking of partial protective measures, the highest 57.14 per cent farmers (Group III) took the partial protective measures and lowest percentage (47.22 per cent) was recorded for group I. In case of not taking any protective measures, the group I farmers recorded the highest (45.83 per cent) and the lowest percentage (28.57 per cent) was recorded for group III. In Central Brahmaputra Valley zone, the group III farmers followed the highest full protective measures (12.50 per cent) followed by group I farmers (9.21 per cent) and group II farmers (8.00 per cent). Regarding the undertaking of partial protective measures, the group III recorded the highest (50.00 per cent) and the lowest was recorded for the group II farmers (40.00 per cent). In case of not taking any protective measures, the highest was recorded for group II farmers (52.00 per cent) and the lowest percentage (37.50 per cent) was recorded for group III.

Table 2: Protective measures or safety measures undertaken by the respondent farmers during pesticide application

Districts	Farmers group	Full protective measures	Partial protective measures	Not taken any protective measures	Total number of farmers
Barpeta	Group I	5	23	22	**50**
		(10.00)	(46.00)	(44.00)	**(100.00)**
	Group II	6	27	29	**62**
		(9.68)	(43.55)	(46.77)	**(100.00)**
	Group III	4	16	18	**38**
		(10.53)	(42.11)	(47.37)	**(100.00)**
	Total of all groups	**15**	**66**	**69**	**150**
		(10.00)	**(44.00)**	**(46.00)**	**(100.00)**
Darrang	Group I	5	34	33	**72**
		(6.94)	(47.22)	(45.83)	**(100.00)**
	Group II	8	28	21	**57**
		(14.04)	(49.12)	(36.84)	**(100.00)**
	Group III	3	12	6	**21**
		(14.29)	(57.14)	(28.57)	**(100.00)**
	Total of all groups	**16**	**74**	**60**	**150**
		(10.66)	**(49.33)**	**(40.00)**	**(100.00)**
Nagaon	Group I	7	33	36	**76**
		(9.21)	(43.42)	(47.37)	**(100.00)**
	Group II	4	20	26	**50**
		(8.00)	(40.00)	(52.00)	**(100.00)**
	Group III	3	12	9	**24**
		(12.50)	(50.00)	(37.50)	**(100.00)**
	Total of all groups	**14**	**65**	**71**	**150**
		(9.33)	**(43.33)**	**(47.33)**	**(100.00)**
Grand Total		**45**	**205**	**200**	**450**
		(10.00)	**(45.56)**	**(44.44)**	**(100.00)**

Figures in the parenthesis indicates percentage to the total

Mohiuddin *et al.* (2009) in a study conducted at Satkania, Patiya and Hathazari upazilas of Chittagong reported that during the application of chemicals, very few farmers used protective measures or safety measures. It was reported that 39% of the respondents did not use any safety measures where 21% of the vegetable growers covered their body and faces. Jamali *et al.*, (2014) in a study conducted at Lower Sindh of Pakistan reported that 50% of the farmers did not follow safety measures during application of pesticide. The study conducted by Chowdhury *et al.* (2019) in seven districts namely, Bogura, Rajshahi, Jashore, Narsingdi, Cumilla, Jamalpur and Gazipur revealed that 75% of the farmers took protective measure during insecticide spray. Mahantesh *et al.* (2009) reported that farmers did not follow adequate safety measures during pesticide application. Nguyen *et al.* (2017) reported that many types of pesticides like Cypermethrin, Permethrin, Cartap, Imidacloprid, Copper hydroxide and Paraquat belonged to highly toxic pesticides (WHO class II) Inadequate safety measures and knowledge may create various health problems, such as headache, eye and nose irritations, dizziness, and nausea were common among the growers.

From the above discussion, it was observed that 44.44 per cent of the total respondent farmers did not take any protective measures during the application of pesticides which was very much threatening to the human health. It might be due to the ignorance of farmers about the negative impact of pesticides to human health. The pesticides might cause several diseases to human being like respiratory diseases, skin diseases, lungs disease, heart disease, problem in eyes and so on. To get rid of such problems the farmers should strictly follow the protective norms during the application of pesticides in their crop field.

CONCLUSION

Vegetables are very important food for our day to day life; but our discussion revealed that the farmers were using more quantity of chemical fertilizers and insecticides in their vegetable crops. Due to more application of the agricultural chemicals, the products might become unsuitable for human consumption. Some literature revealed that due to higher dose of application of pesticides might cause some problems like respiratory problem, heart disease, cancer and so on. It even effects on the soil health and to the environment as a whole. One most important thing was that the high dose of application of the chemicals caused economic loss to the farmers. Moreover, most of the farmers did not protect

themselves from the chemicals during its spray in the field. To get rid of these problems, the awareness programme amongst the farmers on judicious use of agricultural chemicals, taking of safety/ protective measures during spray should be made. The farmers should also be made aware for the adoption of integrated nutrient management and integrated pest management practices. The government should take initiative to establish some laboratories to test for the agricultural chemical residues available in the farm products.

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