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Overview of Pesticide Use in Vegetable Cultivation: Ground Truth

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ABSTRACT

Pesticides are turned to be the potent weapon to wipe away the enmassed pest population in agriculture crops, specifically when other measures fail. A deep understanding of the field practices in pesticide application is required to establish the soundness of human health and environmental safety. The study was an attempt to unravel field realities in vegetable cultivation through the prism of good pesticide practices in application. Vegetable fields of National Capital Region (NCR)'s two sub regions Uttar Pradesh (UP) and Haryana were selected for conduct of the study. About 200 farmers growing cabbage, cauliflower, brinjal and bitter gourd were selected as the respondents. This study revealed that the prevailing pest management method was application of plant protection chemicals wherein, farmers gave least consideration for Economic Threshold Level (ETL). Farmers were neither aware of ETL nor following it. Likewise, was the most approached source of information on pesticides was the fellow farmers followed by input dealers. Field practices further indicated that vegetable fields were seldom managed by integrated pest control principles, only invisible percentage of the farmers used bio-pesticides in the fields. The commercial motives, fear of losing market demand and strive for good production in consumer appealing forms are apparent from the farmer's practices of keeping separate chemical pesticide free plot for production of vegetables for domestic consumption. In sum, farmers' practices were seldom compliant with the recommended practices of pesticide handling, at the core of which is their lack of awareness about safety practices and its need.

Key Words: Field Practices, Good Pesticide Practices, Pest Management, Pesticides, Vegetables.

INTRODUCTION

Vegetables contribute important vitamins, minerals, antioxidants, and fiber (Fresco and Baudoin, 2002) to support a healthy body and help to lower the risk of developing certain chronic diseases, and are especially important to growing children (CDC, 2013).In India per capita consumption of vegetables is 230g as against 300g recommended dietary allowance (RDA) (Kodandram *et al*, 2013). This is apparent in the youth and student diet with only 2.97 servings per day and 2.94 servings a day or around 234 g/d, respectively (Mukherjee and Dutta, 2016). This is high time to increase the production and consumption of quality fruits and vegetables to produce a healthy young population who materializes the nation's developmental dreams.

However, attack of various pests and diseases in vegetables stands as a roadblock in vegetable production (Kaur *et al,* 2016). To overcome the menace, farmers resort various pest control tactics, chemical control being a major strategy among them. Contamination of vegetables by chemical pesticides, causing various ailments, resulted in a shift in demand for organically grown vegetables, for which the urban people are willing and able to pay more. Fruits and vegetable occupy three per cent of total cropped area but consume 13 per cent of the total pesticides in the country (Nigam and Murthy, 2000) and thus the people are served with a heavy load of harmful chemicals in their plate. On an average 46 per cent of area grown under vegetables is pesticide treated (Anonymous, 2015). Ministry of agriculture report says, vegetables

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accounted for over 56% of the samples which had more MRL than the limit set by the food regulator. The major culprits were green chilli, cauliflower, cabbage, brinjal, okra, tomato, capsicum and coriander leaves, according to the annual report on Monitoring of Pesticide Residues at National Level during 2014-2015 (Anonymous, 2016). This situation made consumers perplexed, would they go for nutritionally rich foods or would it be better to keep away from pesticide loaded platter? Some relevant studies quote that pesticides are safe to be used until it confirm to the approved practices. Yet, the high level of residue above the permitted levels in food and environment is a serious cause for concern and can be attributed to unscientific use of pesticides. All these facts need a deeper understanding of the current scenario of pesticide use at the farm level. Hence the present study was conducted with an objective to undermine the field practices and common approaches followed in pesticide applications in vegetable fields.

MATERIALS AND METHODS

The current state of pest management practices in vegetable crops was compared with recommended practices to identify the practice gap. The studied followed an interview method of data collection with a pre-tested and standardized interview schedule as the survey instrument. The schedule items were made according to FAOs Good Pesticide Practices in ground application .The study was conducted in National Capital Region (NCR). The locale has been selected purposively since NCR has the largest consumer base (Census, 2011). From NCR two sub-regions, Uttar Pradesh (U.P.) and Haryana were selected purposively, because pesticide consumption in vegetable crops is maximum in U.P.(Indiastat,2012), while the highest number of vegetable samples exceeding Maximum Residue Levels (MRL) of pesticide has been reported from Haryana (Anonymous, 2015).

The study followed stratified random sampling procedure and was conducted in four districts of Uttar Pradesh and Haryana. The districts selected for the study were Faridabad (brinjal), Hapur (cabbage), Sonepat (cauliflower) and Ghaziabad (bitter gourd). A random sample comprising 50 farmers each from the districts were selected from the study area. Observations recorded were: category of pesticide applicator, initial source of information on pesticide, intensity of pesticide use (kg/ha), method of pest management practices, frequency of pesticide spray (no./season), pre-harvest intervals (no. of days), cultivation for home consumption and commercial sales, time of application of pesticide, re-entry period, frequency of use of pesticide equipment, stages of crops, expenditure incurred on pest management, source of pesticide, average hours exposure to pesticides, method of preparing pesticide solution, occupational health hazards experienced by farmers after their acquaintances with chemical pesticides. The obtained data were analyzed using descriptive statistics like frequency and percentage, arithmetic mean, median and mode.

RESULTS AND DISCUSSION

The major pest management method followed by the vegetables farmers was chemical control. Cultural practices of pest control; specifically crop rotation was commonly practiced in all the farms; but without knowing its benefit in keeping pest population at bay. Mechanical and biological methods were rarely practiced in vegetable fields. It was observed that farmers strongly believed that a stage had been reached where only chemicals can protect them from economic losses, all other methods, specifically; biological methods seemed to be child's play, which those having time and money can experiment with. The dominance of chemical pesticides was reported by Jeyanthi and Kombairaju (2005), Devi (2010), Gay (2012), and Kodandaram *et al*. (2013).

The farmers were applying chemicals without giving any consideration for Economic Threshold Level (ETL). Neither the farmers were aware of ETL nor following it. From the knowledge test, it was perceptible that a large number of them (82%) suggested applying pesticides at the first

Table 1. Pesticide applicator category and initial source of information about pesticide (n=200)

Crop	Pesticide applicator	Initial information about pesticide (% of farmers)		
		Input dealer	Government extension agent	Fellow farmers/ family members
Cabbage	Men (100)	34	16	50
Cauliflower	Men (100)	30	4	66
Brinjal	Men (100)	8	14	78
Bitter gourd	Men (100)	20	12	68

appearance of pest. Besides, they had scanty idea about the pesticides they were using. None of them could completely explain the meaning of color codes. About 28% were able to tell what do red and green color codes signify. But all of them were equally ignorant about the meaning of blue and yellow; most of them perceived blue to be most dangerous after red, and yellow the moderate toxic. The case was more or less similar for input dealers and extension personnel.

Pesticide application was the job of men. Neither women nor children were engaged in this activity of crop production (Table 1), which is a welcoming sign, because vulnerability of females and children is much pronounced to pesticide effects (Ali, 2001; Atreya, 2007). It was observed that, in all the four crops, the initial introduction of pesticides to the farmers was mostly done by fellow farmers or the family members, which account as source for more than half of farmers. This can be attributed to the nature of farming occupation, for large number of the farmers it was continuation of family occupation and they started farming since childhood with the initial lessons learnt from elders of the family.

Only less than 20 per cent of farmers of all the groups obtained initial information about pesticides from government agents (table 1). That was because of local presence of input dealers catering to their information and input needs, whereas Government agents rarely reach the individual farmers (Sabur and Molla, 2001).

The average chemical pesticide (technical grade) consumption in cabbage was 5.1 kg/ha. It ranged from 2.5 kg to 8.75 kg/ha. Eighty six percent of the cabbage farmers used 2.5-7.5 kg/ha and 7.5-10 kg/ha was the usage in 14 per cent of fields whereas, the average bio-pesticide consumption was 1.25 kg/ha, a meager quantity. In case of cauliflower more than half of the farmers applied 5 kg or less than that of chemical pesticide in hectare. However, six percent of the farms consumed chemical pesticides at the rate of 10-12.5 kg/ha. The average chemical use was 4.5 kg/ha and it ranged from 0.75 to 11.25 kg. The average bio-pesticide consumption was not impressive in cauliflower farms, which was only 250g.

In brinjal, the chemical pesticide use had shown wide variation, it varied from 2.5kg to 18.75 kg/ha with an average of 5.25, the highest among crops. The farms consumed more than 10 kg/ha constituted 25 per cent. Bio-pesticide use was only 750g average, with 92 percent of the farmers not applying bio-pesticide. In the bitter gourd fields average chemical pesticide use rate was 4.37 kg/ ha, ranging from 3 kg to 15 kg. It can be observed that more 50 percent of the farms consumed 2.5-5 kg/ha. Bio-pesticide consumption was minimal with an average use rate of 108g. Only six per cent of the bitter gourd farmers were applying bio-pesticides in their fields.

In cabbage, 78 per cent of the field constituted the category with 5-10 sprays a season. The average spray frequency in cabbage farm was 6. About 10 per cent of cabbage farms reported to have sprayed more than 10 times. The average spray frequency in cauliflower was 6.8. It varied

Table 2. Frequency of pesticide sprays under various crops in a season (n=200).

Pesticide use frequency (number of sprays)	Cabbage (% of farmers)	Cauliflower (% of farmers)	Brinjal (% of farmers)	Bitter gourd (% of farmers)
>5	12	4	0	0
5-10	78	68	48	4
11-15	10	18	6	28
16-20	0	10	36	68
21-25	0	0	10	0
Average	6.3	6.8	12.7	17.5
Range	4-12	4-20	5-25	9-20

between 4 and 20 sprays (Table 3). Highest number of sprays was reported from brinjal which was 25 sprays a season. The average number reported in a season was 13. The bitter gourd farms reported to spray most frequently than the other three crops. The crop has highest minimum of 9 sprays and a maximum of 20. The majority (68%) of them were concentrated in a range of 16 to 20 sprays, while the average frequency was 17.5 sprays. Jeyanthi and Kombairaju (2005) reported average application frequency in cauliflower and brinjal were 15 each, average frequency in agricultural crops according to Van-Drooge *et al* (2001) was 10-20; and Jallow *et al*(2017) reported two times a month up to once a week in vegetables.

Pre-harvest intervals are different for various pesticide products. A major observation made from the study area was that the farmers were unaware of pre-harvest interval for the crops and pesticides they sprayed. Neither this information was available on the labels, a serious deviation from the labeling norms while many other countries clearly specified both pre-harvest intervals and re-entry periods on the label, for instance, USA and Canada. The average number of days kept before harvest of cabbage and final spray of pesticide in the study area was 12. The range of pre-harvest intervals in cabbage was 8 to 20 days. Pre-harvest interval was highest in cauliflower, since majority of the farmers reported 14 and more days were given before the harvest. The average days followed was 17, with minimum of 12 days and maximum of 20 days. The observed pre-harvest intervals were not intentionally followed by the farmers; it was the situation which necessitated them to do so. For instance, the cabbage and cauliflower farmers reported that the pest incidence is more concentrated in the vegetative stage and early head/curd formation stage. Consequently, less number of sprays were required towards the maturity. Similarly, pest attack is minimum during winter months, thus the pesticide requirement was least.

The pre-harvest interval observed in brinjal was one of the lowest with an average of 2 days and a good number of farmers (40%) did not leave even two days. The number of days varied between one and four. Bitter gourd exhibited the similar trend of pre-harvest interval, with an average of two days; ranging from 1 to 5 days. Wide ignorance and farmers non-compliance of pre-harvest interval were reported by other studies as well (Dinham, 2003; Adjrah *et al*,2013; and Halimatunsadiah *et al*, 2016).

Cost of cultivation was apparent from table 4 that highest cultivation cost was incurred for bitter gourd, followed by other three crops with equivalent cost. It was again bitter gourd, which had the highest expenditure for pest management. Minimum pest management cost was for cabbage, which takes only 11.5 per cent of total cost. This can be substantiated by the relative incidence of pest and disease in these crops and the season of

Table 3. Cultivation expenditure of vegetable crops for a season (n=200)

Crop	Stages		
	Average production cost (Rs.)	Average cost incurred on pest management (Rs.)	% expenditure for pest management to total cost
Cabbage	33,000	3800	11.5
Cauliflower	30,000	8300	27.6
Brinjal	30,000	13,000	43
Bitter gourd	45,000	19,500	43.3

Table: 4. Percentage distribution of farmers based on source of obtaining information on pesticide volume required . (n=200)

Source	Cabbage	Cauliflower	Brinjal	Bitter gourd
Expert recommendation	20	4	2	2
Input dealer	18	56	58	64
Fellow farmer	30	4	6	2
Label	12	2	2	2
Own experience	20	34	32	30

cultivation. As reported by farmers, pest incidence was concentrated in summer and rainy season, on the other hand, winter season witnesses insignificant pest and disease. Furthermore, the cropping season for brinjal and bitter gourd is summer and rainy season, with higher probability of pest attack, while cole crops were cultivated only in winter months.

The source of information regarding pesticide use is an important factor deciding the farmers' safe pesticide practice. The major source of information to cabbage farmers on pesticide volume/dose required was fellow farmers (table 5). Input dealers had been sought by 18 per cent of them. In cauliflower more than 50 per cent of farmers obtained advice from input dealers for pesticide use. Similar was the case of brinjal and bitter gourd farmers, majority were dependent on input dealers for pesticide use information. Very scanty percent of cauliflower, brinjal and bitter gourd farmers obtained expert advice or followed label instructions for pesticide volume required, the most desired but least followed. Reliance of farmers on pesticide retailers as important source of information for pesticide use was reported by Rao *et al* (2009), Devi (2010), Al-Zaidi *et al* (2011), Saha *et al* (2015), Jin *et al* (2017), Devi *et al* (2017) and Vijayakumari (2017).

The acquaintance of farmers with pesticides sometimes culminates in short as well as long term health hazards. Since the long term hazards are outcome of chronic poisoning, it is difficult to attribute pesticides as the main cause. Regardless of this, the short term health effects can easily be noticed by farmers themselves and they can attribute the reason more accurately. Here, an attempt has given to understand these short term occupational health hazards experienced by farmer while applying pesticides or immediately after that (table 6). More than 70 per cent of the respondents agreed that they had experienced head ache after exposure to pesticides. The symptom confronted the most by nearly everyone irrespective of crop categories was skin irritation, followed by eye irritation. In addition to these three symptoms, nausea, dizziness, fatigue and weakness were the next common symptoms they had. The least contracted symptom was muscle cramps, which was reported only by bitter gourd farmers. Farmer respondents in similar studies also

Table 5. Percentage of farmers experienced occupational health hazards while/after applying pesticide (n=200)

Symptom	Cabbage	Cauliflower	Brinjal	Bitter gourd
Headache	78	88	72	92
Fatigue	66	20	36	88
Weakness	66	32	46	40
Dizziness /Unconsciousness	60	50	36	84
Nausea /Vomiting	62	58	54	24
Cough	22	8	0	32
Excessive sweating	0	0	38	2
Muscle cramps	0	0	0	4
Diarrhoea	0	0	8	2
Breathing difficulty	78	16	6	20
Stomach cramps	34	4	10	6
Soreness in joints	10	2	10	8
Skin irritation	96	86	92	98
Eye irritation	98	78	78	96
Irritation of the nose and throat	66	22	36	28

experienced these set of symptoms frequently. (Rola and Pingali, 1993; Devi, 2010; Khan *et al*, 2010; Hu *et al*, 2015 and Gesesew *et al*, 2016). In particular, more cases from cabbage growing areas were reported to have experienced many of the enlisted health hazards than the other farmer groups.

CONCLUSION

With the soaring environmental hazards, natural calamities and climate change consequences, both in frequency and intensity, the world attention has been drawn to devise strategies for regaining environmental health. Parallelly, deteriorating human health and regular occurrence of newer diseases have stirred the concern over quality and safety of the food we eat. Several studies have suggested that indiscriminate use of plant protection chemicals is a prime factor behind the degrading environmental and human health. Now, the study made an attempt to figure out the present status of adoption of good practices of ground application of pesticides in vegetables. The study revealed a grim picture of field realities in pesticide application, which indirectly impacts the soundness of health and environment aspects of the nation. Frequent campaigning must be undertaken with immediate alacrity to wipe away the unawareness and casual attitude of farm producers in application of agri-chemicals.

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