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Pesticides Usage and Handling by the Tomato Growers in Ramanagara District of Karnataka, India – An Analysis

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A B S T R A C T

A study was conducted to analyze the perception and pesticides usage practices by the small tomato growers in Ramanagara district of Karnataka using the pretested questionnaire and field observations. Detailed Information was obtained from 129 tomato growers wherein the information related to extent and types of pesticides used, knowledge about pesticides and their effectiveness was collected. Most of the respondents (98.44%) were male and most commonly farmers use 25 pesticides in tomato ecosystem. The major source of information for the small growers about the use of pesticides was the local pesticides dealers (55%) followed by Krishi Vigyan Kendra (33.3%). A good number of farmers (55%) used pesticides upon noticing the pest or disease incidence in tomato as curative measure. A great majority of the farmers (87.59%) used knapsack sprayers to apply pesticides. However, it is astonishing to observe that 83.72% of the growers used no or partial personal protection measures to spray the chemicals. Over 48% of the farmers expressed that they did not consider the wind direction (pesticide drift) during spraying due to which 87% of the farmers reported symptoms of pesticides poisoning after spraying. Most of the farmers (88.37%) enter into their farms within 48 hours after spraying while many farmers (83.72%) did not follow commonly recommended guidelines for safe use of pesticides including using personal protection measures. The study revealed that the tomato growers in the district are suffering since they are highly exposed to pesticides due to inadequate knowledge about safe and judicious use of pesticides. Education is essential to reduce pesticides application and encourage farmers to adopt integrated pest and diseases management practices along with safe use of pesticides through capacity building programmes.

Introduction

The tomato (*Solanum lycopersicum*) is one of the most widely grown vegetable in the world (Ganeshan and Chethana, 2009). India is the second largest tomato growing country after China in area (8.65 lakh ha) and production (168.26 lakh tons). In India, Karnataka is the second largest producer after Andhra Pradesh (National Horticulture Board, 2011). The tomato is known for its nutritive value and combined in many different dishes and eaten in different ways as a fresh vegetable or made into soup or sauce. It is a low calorie vegetable, low in fat, has no cholesterol and is an excellent source of anti-oxidants, dietary fiber, minerals, potassium and vitamins. Dieticians and nutritionists often recommend tomatoes in cholesterol controlling and weight reduction diet programs. Eating tomatoes has been promoted as helping to prevent some human diseases (cancer and heart diseases) and improving the immune system response (Ntonifor *et al.,* 2013). Ramanagara which is near to the Bengaluru, is one of the main district of Karnataka where tomato is widely grown among all the vegetables. In this district more than 80% tomato growing farmers are smallholders. Tomato is of great importance to the smallholders in the district in terms of income generation and local consumption. The farmers grow tomatoes all-round the year in the district due to which the crop is greatly affected by insect pests and diseases. This problem has prompted farmers to use several pesticides injudiciously as a means to control pests and diseases and to improve the productivity. In due process, farmers are often exposed to health risks in terms of mixing chemicals, application and disposal of pesticides or their containers. This type of exposure to hazardous chemicals can lead to pesticide poisoning causing short and or long term health effects. According to The World Health Organization (WHO), approximately 20% of the pesticide poisoning cases from farm use lead to death (WHO, 1986). In this milieu, the present study was conducted to determine the degree and types of pesticide usage & its effects as well as to provide a basis for developing effective intervention to promote safe pesticides usage. This study also aims to fill the gap in knowledge about pesticide handling practices of smallholding tomato growing farmers in Ramanagara District.

Materials and Methods

Ramanagara is predominantly a dry farming district which lies in geographic position of North latitude between 12^{o} 33' to 12^{o} 58' and east longitude 77^{o} 13' to 77^{o} 25'. The district fall under Zone-5 of Agro-climatic zones of Karnataka comprising four taluks viz., Magadi, Ramanagara, Channapatna and Kanakapura with a total of 18 hoblies. Tomato is the main vegetable that is cultivated in the district over an area of about 1120 ha. Though the crop is cultivated in all the four taluks during rabi season, it is cultivated during all the seasons in Magadi and Channapatna taluks. Majority of small and marginal farmers cultivating tomato are unaware of improved and eco-friendly cultural practices. The major problems that the farmers facing in tomato cultivation are pest and diseases related problems. Among insect pests, fruit borer, *Helicoverpa armigera*, Leaf miner, *Liriomyza trifolii*, Pin worm, *Tuta absoluta* and thrips (vectors for bud necrosis and population are severe in summer). The major diseases are bacterial wilt, fungal wilt and blight (early and late) diseases predominantly during November to February. Most of the tomato growers in the district lack knowledge about specific insecticides / fungicides / bactericides and integrated pest and diseases management practices. Pesticides are usually applied by male farmers or workers using knapsack sprayer (Farmers personal communication). For the purpose of the study, observations

noticed from January 2014 to December 2017 were considered. A standardized and pretested questionnaire and field observations were used to collect necessary information. The questionnaire consisted of queries that mainly addressed the demographic characteristics, application of pesticide and management, storage of pesticides, disposal of used containers, sources of information about the type of pesticide to be used, signs and symptoms of acute pesticide poisoning after spraying, personal and life style factors, number of pesticide sprays applied in each season and major insect pests and diseases observed by the small tomato growers. For the purpose of the study, 129 small tomato growers were selected purposefully. These respondents were the one who visited the KVK for advisories from 2014 to 2017 and also such of the small tomato growers to whose field the KVK scientists visited for diagnostic visits and personal requests from the farmers. The simple non-parametric statistical stools like mean, range and percentage were used to quantify the response of tomato growers selected for the study.

Results and Discussion

The farmer's demographic information is presented in Table 1. Most of the tomato growing farmers were male (98.44%) and 80.62% were married. The farmer's average age was 42 years ranging from 22-67 years. Most of the farmers (62.79%) had primary school of education and had spent on an average of seven years in tomato cultivation (range 2-9 years). All the farmers were having own land. Farmers have been applying pesticides more frequently with the hope of acquiring higher yields. Farmers (95%) lack knowledge about the appropriate techniques and management of pesticides or alternative ways to control pests which could be addressed by instituting agricultural extension service programmes.

It was revealed and identified that the tomato growers in the district commonly used 25 pesticides (Table 2). Fungicides (48%) were most frequently used by the growers followed by insecticides (44%) and acaricides (8%). Majority (95%) of the farmers said that they were dependent upon chemicals for control of pests and diseases of tomato. Farmers' dependency on chemicals was encouraged and supported by easy access to pesticides with more than 80% of them purchasing from local pesticides / input dealers, followed by Farmers Produce Organization (FPO's). Small scale tomato growing farmers know different formulations and combination of pesticides as the major means to control pests and diseases in their farms. According to farmers major hindrance for tomato production in the area was due to the incidence of fruit borer (*Helicoverpa armigera)* and leaf miner (*Liriomyza trifoli)* during summer season and late blight (*Phytophtora infestans)* during rabi season. Farmers in this region are very much aware of the damages caused by these pests and diseases to tomato production which has led to almost all tomato growers to use pesticides as the major means to control them. Unfortunately many farmers was unable to identify the suitable choices of pesticides and their proper application or alternative measures for management of pests and diseases than exclusively depending only on pesticides.

The major source of knowledge on pesticides use by farmers was local pesticides dealers (55%) followed by Krishi Vigyan Kendra (33.3%) located at Chandurayanahalli, Kalya (Post), Magadi Tq., Ramanagara District. Farmers also obtained information about pesticides usage from progressive farmers / friends (8.53%) and Farmers Produce Organization (FPO's, 14.7%) which were established since two years in the district. The pesticides were available in liquid formulations with packing range of 100ml to

one liter and also in powder form in sachets of 100 g to 1 Kg. Many farmers don't have formal training on safe and correct pesticides usage and hence many farmers use the pesticides incorrectly and unsafely.

A Majority of the farmers (55%) use pesticides upon noticing the pests or diseases incidence in tomato as curative measure. Few farmers (35%) started using pesticides immediately after transplanting of tomato seedlings to prevent leaf miner, *Liriomyza trifoli* infestation. Pesticides used by tomato growers in Ramanagara District belonged to wide range of chemical groups. Most commonly used insecticides and fungicides were acephate, indoxacarb, chlorantraniliprole, metalaxyl +Mancozeb, Cymoxanil + Mancozeb and Copper Oxycloride (Table 2). Pesticides are expensive, especially for small scale farmers (Matthews *et al.,* 2003). The use of pesticides has been encouraged by pesticides dealers who suggest the farmers to use them in combination of 2-3 chemicals together. This practice is more worrisome for correct and safe use of pesticides which leads to environment pollution as well as consumers point of view. Many farmers anticipate pest infestation and disease incidence and started spraying the crop few days after transplanting.

This attitude of farmers leads to killing of many natural enemies of insect pests and other organisms like earthworms which benefit the ecosystem (Table 3). The interesting finding of the study is that many farmers used indiscriminate chemical combinations with repeated applications with a hope of getting rapid and improved results. Some of these chemical combinations at higher doses have been shown phytotoxic effects apart from facilitating the development of pest and disease resistance to the chemical. These findings were corroborated with findings of Ntonifor *et al.,* 2013.

A great majority of small farmers (87.59%) used knapsack sprayers (Table 4) to apply the pesticides with 83.72% using no or partial personal protection measures. Over 48% of farmers expressed that they did not consider the wind direction (pesticide drift) during spraying whereas only 37.98% farmers took sprays in wind direction. A good number of farmers (96.12%) washed their sprayers after spraying. Nearly 80 % of them disposed the water to wash knapsack sprayers to nearby fields / tank. Most of the farmers (88.37%) enter into their farms within 48 hours after spraying. It is clear from the Table 5 that 74.41% of farmers disposed the used pesticide containers on their farms. However, it is virtuous to note that a great majority of farmers (82%) do practice the safe methods of pesticide storage after procurement. Many of the farmers (87%) reported symptoms of pesticides poisoning after spraying (Table 6) with weakness (67.44%), dizziness/headache/ fever (27.90%), skin irritations (16.27%).

Most of the farmers do wash their farm cloths along with their family member's cloths which raises the possibility of cross contamination. Since knapsack sprayer was the main pesticide application equipment used by the farmers, it is important to keep knapsack sprayers in good and operating condition. Sprayers have been known to spill or leak, especially when farmers are using them for many years. An association has been shown between knapsack leakages and human health effects (Matthews *et al.,* 2003 and Palis *et al.,* 2006). Toxic residues on the skin and clothes can cause acute pesticide poisoning. All pesticide residues should be immediately removed from the skin with soap and water when spills and leak occurs. Most of the tomato growers mixed and sprayed pesticides injudiciously using knapsack sprayer without accurate measurement of chemicals leading to an incorrect estimation of pesticide strength and overdosing of the chemicals.

Table.1 Characteristics and distribution of tomato growers

Dimensions	Frequency, Mean, Per cent, Range
A. Demographic Characteristics	
Male	127 (98.44%)
Age (Years)	42.1 (Range: 22-67 years)
Female	2 (1.55%)
Age (Years)	36.5 (Range: 32-41 years)
Married	104 (80.62%)
B. Education level	
No formal Education	13 (10.07%)
Primary school	81 (62.79%)
Secondary school	16 (12.40%)
Above 10th standard	19 (14.73%)
C. Years as tomato growers	6.8 (Range: 2-9)

Table.2 Major pesticides used by tomato growers in Ramanagara District

Insecticides	**Chlorantraniliprole 18.5 SC**
	Imidacloprid 17.8%SL
	Acephate 50% + Imidacloprid 1.8% SP
	Deltamethrin 1% + Triazophos 35% EC
	Indoxacarb 14.5% SC
	Acephate 75% SP
	Fipronil 5% SC
	Flubendiamide 39.35% SC
	Profenophos 50EC
	Spinosad 2.5%EC & 45%SC
	Thiamethoxam 75% SG
Fungicides	Carbendazim 50% WP
	Copper Oxychloride 50% WP
	Diafenconazole 25% EC
	Dimethomorph 50% WP
	Mancozeb 75% WP
	Propineb 70%WP
	Thiaphenate methyl 70% WP
	Carbendazim 12% + Mancozeb 63% WP
	Cymoxanil 8% + Mancozeb 64% WP
	Metalaxyl 8% + Mancozeb 64% WP
	Copper hydroxide 77% WP
	Metalaxyl-M + Mancozeb 64% WP
Acaricides	Fenazaquin 10 % EC
	Propargite 57 EC

Table.3 Sources of farmer's knowledge of pesticide use

Indicator	Frequency of respondents N (%)
Pesticide / input dealers	71 (55.03%)
Progressive farmers/friends	11 (8.53%)
Farmers Produce Organization (FPO)	19 (14.72%)
Krishi Vigyan Kendra	43 (33.33%)
Pesticides labels	13 (10.07%)
Media/ other sources	5 (3.87%)

Table.4 Application of pesticides and management

A. Practice of personal protection	Frequency of respondents N (%)
Near complete protection	21 (16.27%)
No or partial protection	108 (83.72%)
B. Equipment use	
Knapsack sprayer	113 (87.59%)
Power sprayer	16 (12.40%)
C. Method of spraying	
In wind direction	49 (37.98%)
No consideration	62 (48.06%)
Against the wind	18 (13.95%)
D. Timing of pesticide application	
Immediately after transplanting	45 (34.88%)
Upon presence of pests/ disease	71 (55.03%)
Increased degree of pest infestation	13 (10.07%)
E. Field re-entry after spraying	
Less than 48 hrs	114 (88.37%)
48-72 hrs	9 (6.97%)
72 hours and greater	7 (5.42%)
F. Wash sprayer	
Yes	124 (96.12%)
No	5 (3.87%)
G. Disposal of wash water from sprayer	
On farm	38 (29.45%)
On nearby fields/tank	91 (70.54%)

Table.5 Storage of pesticides and disposal of used containers

A. Storage after purchase	Frequency of respondents N (%)
Safe practices	106 (82.17%)
Unsafe practices	23 (17.82%)
B. Disposal of used pesticide containers	
Discard on farms	96 (74.41%)
Take home and washed for reuse	3 (2.32%)
Buried on the farm	7 (5.42%)
Discarded on neighborhood fields	4 (3.10%)
Burned on farm	19 (14.72%)

Table.6 Signs and symptoms of pesticide poisoning after spraying

Indicator	Frequency of respondents N (%)
Weakness	87 (67.44%)
Dizziness, headache and/or fever	36 (27.90%)
Skin irritations	21 (16.27%)
Blurred vision and/or eye itching	9 (6.97%)
Vomiting and stomach discomfort	6 (4.65%)
None	17 (13.18%)

Table.7 Number of pesticide sprays applied in each season among small scale tomato grower's in Ramanagara District

Season	Month	Number of sprays	Mean of spray intervals (days)	% of respondents
Kharif	July - October	12-13	7	35.65
Rabi	November - February	16-17	5	87.59
Summer	March -June	9-10	10	60.46

Table.8 Major pests and diseases of tomato perceived by farmers

Insect Pests					
Sl. No	**Common name**	**Scientific Name**	**% respondents**		
			Kharif	**Rabi**	**Summer**
1.	Fruit borer	*Helicoverpa armigera*	24.03	42.63	87.59
2.	Leaf miner	*Liriomyza trifoli*	39.53	62.79	92.24
3.	Pin worm	*Tuta absoluta*	17.82	72.09	67.44
4.	Tobacco caterpillar	*Spodoptera litura*	14.72	52.71	10.85
5.	Thrips	*Thrips tabaci Frankliniella schultzei*	19.38	29.45	95.34
Diseases					
6.	Early blight	*Alternaria solani*	92.24	93.79	48.83
7.	Late blight	*Phytophtora infestans*	11.62	87.59	6.20
8.	Bacterial wilt	*Ralstonia solanacearum*	32.55	13.17	83.72
9.	Fungal wilt	*Fusarium oxysporum* f. sp. *Lycopersici*	20.93	68.21	25.58
10.	Tomato bud necrosis	Tomato spotted wilt virus	27.90	34.88	83.72
11.	Bacterial canker	*Clavibacter michiganensis* sub sp. *michiganensis*	34.10	21.70	8.52

Although fungicide usage is said to have little effects on humans, studies have shown that there is high risk of cancer with long term use of Mancozeb, a carbamate fungicide (Ngowi *et al.,* 2007). Farmer's health risks were increased because they were not aware of the need to consider wind directions while spraying pesticides. Less than one fifth of farmers expressed that they use personal protection measures (long sleeve shirts, pants, gloves, masks etc.) while 83.72% of the farmers are taking no or partial personal protection measures. This type of exposure increase the risk of pesticide poisoning and possible health effects. This was supported with the present findings that 87% of farmers reported signs and symptoms of acute pesticide poisoning after spraying.

Many farmers avoided medical care with an assumption that signs and symptoms of pesticides poisoning are a normal phenomenon and need no medical attention after spraying (Ajayi and Akinnifesi, 2007). This attitude of farmers broadens the risk of long term effects of pesticides poisoning. Many farmers articulated that they discarded the pesticides containers on the farm. This was confirmed during the farm visits where many empty pesticide containers could be seen in clusters. The disposal of used containers was further complicated because most of the tomato farms are located closer by where there is every chance of cattle chewing the poly ethylene cover sachet in which powder formulations of pesticides are packed. Further studies are needed to evaluate this possibility in order to put in place adequate measures to control such pesticides.

The tomato growing farmers in the district won't cultivate tomato in all three seasons (Table 7). The market demand for tomato also makes an impact on farmers to decide whether to cultivate or not to cultivate tomato during particular season. Most of the farmers (87.59%) in the district cultivate tomato during November-February (rabi season),

followed by March-June (summer season). During rabi, weather conditions are favourable for both tomato cultivation and as well as diseases incidence particularly late blight which demands more number (Average 16-17) of sprays. Farmers were of the view that it would be cost effective to cultivate tomato in summer season (average of 9-10 sprays). Farmers also get better price for tomatoes during summer in the market. Less than 36% of the farmers cultivated tomatoes in the rainy (kharif) season. The most commonly encountered tomato pests and diseases by the farmers during all the three seasons are listed in Table 8. Farmers do observe a decrease in pest population or disease incidence after using pesticides. The pesticides dealers emphasize this benefit and make pesticides more financially attractive by selling pesticides which are not having label claim. Labeling information is essential to making specific instructions for pesticide use available to all pesticide users. Every farmer expects immediate control of pests which is achieved only through chemical application. This practice does not encourage farmers to investigate other suitable non-chemical and environmental friendly approaches which are less expensive but offer good control of pests. Some of these methods include intercropping with trap crops like marigold and even the occasional use of plant based chemicals like Neem Seed Kernal Extract (NSKE 4%) or virus formulation Ha NPV (*Helicoverpa* NPV).

It was notice that many farmers did not follow commonly recommended guidelines for safe use of pesticides including using personal protection measures, hand washing with soap/bathing after spraying, not eating in the fields while spraying, not washing of work clothes with family members clothes and proper disposal of pesticide containers. These actions subject the farmers and their households to increased pesticide exposure and risk of pesticide poisoning. There is an obvious need for these farmers to be provided further education, especially on the safe use of pesticides. This sensitization can be successfully achieved by Krishi Vigyan Kendras. Most of the farmers cultivated tomatoes during rabi and summer seasons with an average frequency of sprayings being once in 5 days and 10 days, respectively until complete harvest of the crop. Those farmers who cultivated tomato during rabi season reported spraying more frequently than in the summer. An increase in spraying frequency during kharif and rabi season was attributed to frequent rainfall which would wash away the chemicals and favourable weather conditions for diseases outbreak, respectively. Nevertheless, many farmers prefer to cultivate tomato in rabi due to favourable weather conditions for better plant growth which helps in getting high yields. The study revealed that small farmers lack adequate knowledge on safe and judicious use of pesticides.

Therefore we must explore the most promising opportunities to increase benefits and reduce health and environmental risks of pesticide use. It is customary for all the stakeholders including Krishi Vigyan Kendra's to analyze and promote awareness about the risks associated with pesticides usage for all the tomato growers. Education is essential to reduce pesticides application and encourage farmers to adopt integrated pest and diseases management practices along with safe use of pesticides through capacity building programmes.

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