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RESEARCH ARTICLE

AGRO-CHEMICALS USE PATTERN OF TOMATO GROWERS IN CONTROLLING INSECT-PESTS AND DISEASES IN HOOGHLY DISTRICT OF WEST BENGAL

***Hiralal Jana**

Department of Agricultural Extension, College of Agriculture, BCKV, Agricultural Farm-713101, Burdwan, West Bengal, India

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ABSTRACT

During post green revolution, indiscriminate use of chemicals in agriculture and their adverse effect on soil health and environment has created an alarming situation. A situation has resulted which urgently demands an environmentally safe, sustainable and simultaneously, economically viable production system. This indeed is essential for optimizing production and the same time to minimize threat to environment. Considering the importance of the study, the objective, to portray the agro-chemicals use pattern of tomato growers in controlling insect-pests and diseases was undertaken. The study was conducted in Hooghly district of West Bengal. For the selection of area and respondents of the present investigation, multi-stage random sampling technique and universe method were adopted. The study indicates that majority of the respondents were literate (85%), majority of the respondents (58%) had 1.1 to 4.0 bigha of own cultivable land, majority of respondents (60%) had 0.6 to 2.0 bighas of vegetable cultivable land, majority of respondents (65%) were related with vegetable cultivation up to 20 years, majority of respondents (66%) had up to 20 years of experience on application of agro-chemicals on vegetable crops. Generally, leaf eating caterpillar, fruit borer, mealy bug and white fly were seen on tomato cultivation. In case of disease, the main diseases were-seedling rot, late blight, fruit rot and leaf curl. The respondents used various brands of various chemicals with several doses to control the insect-pests and diseases. Mainly infestation of insect-pests and diseases was seen on mature stage of the crop. In seedling stage the respondents applied 30-40 litres of water for spraying chemicals whereas at mature stage, it was 80-100 litre of water. Majority of the respondents (70%) applied chemicals 2-7 days interval whereas the spraying was most preferred method of application of agro-chemicals (100%). Respondents got information regarding use of agro-chemicals mainly from agricultural input retailers at the time of purchasing of chemicals. Therefore, on the basis of the present investigation, the various extension agencies those are working in the study area should reorient their extension strategies accordingly.

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INTRODUCTION

Agriculture is one of the largest economic sectors and it plays an important role in the overall socio-economic progress of India. It provides livelihood to about 64 percent of the labour force, contributes nearly 27.4 percent of gross domestic product and accounts for about 18 percent share of the country's exports. It supplies bulk of wage goods required by the non-agricultural sector and raw material for a large section of industry. Agriculture serves food for survival in the nature for human beings. In the modern times, agriculture has expanded its range from only serving food. It is looked upon as the source of money and employment that has a secured future.

****Corresponding author: Hiralal Jana,***
Department of Agricultural Extension, College of Agriculture, BCKV, Agricultural Farm-713101, Burdwan, West Bengal, India.

India has already achieved the first position in fruit production in the world and in vegetable production; India's position is second in the world (Gayathri, 2014). Food production in India increased from 51 million tonnes in 1950 to 235 million tonnes in 2010-2011 with the use of high yielding genotype seeds, increased application of chemical fertilizers and irrigation water and development of appropriate technologies for crop production made the country from food security to food self-sufficiency. Fertilizer contributed to 50 percent growth in agricultural production during post-green revolution era. India witnessed a significant increase in crop productivity and cropping intensity till 1980s, thereafter new challenges caught up to slow down the agricultural growth rate. An agrarian country like India where population growth rate outstrips agricultural productivity, the need to produce more and more food compels the people to meet new challenges so as to

maintain food security intact (Patil *et al*., 2012). In the new millennium, the challenges in the agricultural sector are quite different from those met in the previous decade. The enormous pressure of produce more food from less land with shrinking natural resources is a tough task for the farmers. While agriculture held an important place in the national economy, its' efficiency remained at low level. Among the all measures to raise the productivity level, plant protection is in central position. Plant protection is a basic exercise in any crop for control of insect-pests, diseases, weeds etc. to avoid economic losses. Over dependence on chemical pesticides has led to problems like development of insecticidal resistance, residue in food chain, degradation in quality of ecosystem, human health and adverse effect on beneficial micro-biota.

Maintaining the productivity in a sustainable manner with sound resource management would be key issue in the coming decades (Aswal and Sha, 2011). Among the crops, it is observed that vegetables are the one of the major users of plant protection chemicals. Farmers' use behaviour of agro-chemicals in vegetables is so dynamic which requires regular research. So, collection of reliable information and knowledge about agro-chemicals use behaviour of the vegetable growers becomes crucial for wide range of stakeholders. Considering the importance of the study, the objective to portray the agro-chemicals' use pattern of tomato growers in controlling insect-pests and diseases was undertaken.

MATERIALS AND METHODS

The study was undertaken in the state of West Bengal. For the selection of area and respondents of the present study, multi-stage random sampling technique and universe method were adopted. At the first stage of sampling, Hooghly district was selected among the 18 agricultural districts of the state purposely based on its' comparatively higher area coverage in tomato cultivation. Out of 16 blocks of Hooghly district, one block (i.e. Singur) was randomly selected at the second stage of sampling. In the selected block (Singur) a relatively homogeneous field cultivated with tomato crop was chosen on the basis of the opinion of the agricultural input retailers. The farmers who were growing tomato in that field were selected as respondents of the study through total enumeration. Thus total 400 hundred farmers ultimately considered as respondents of the present investigation. Personal interview method was adopted to collect data by using local language (Bengali) for getting their response exactly. Statistically, simple percentage method was used for analysis of data to reach at meaningful results and conclusion.

RESULT AND DISCUSSION

The data collection was done in Hooghly district of West Bengal. The district is famous for potato cultivation. Other main crops except potato were rice, banana and vegetables. Among the vegetable crops most identifiable ones were tomato, cauliflower, ladies finger and brinjal. The study area covered the villages of Nasibpur, Dashi, Sundarpur, Bhanderda, Jaminberia, Ratanpur, Mallikpur, Berh, Purusottampur and Rasulpur.

Education level of respondents

The study revealed (Table 1) that majority of respondents (37%) had upto primary level of education whereas, at the lowest 8 percent of respondents had the education of graduate level and above. Approximately, one third of respondents (30%) had secondary level of education and 10 percent of respondents had higher secondary level of education and remaining 15 percent of vegetable growers were illiterate.

Own cultivable land

At the most 33 percent of respondents (Table 2) had the own cultivable land between 1.1-2.0 bigha whereas at the lowest 7 percent of vegetable growers had 4.1-6.0 bigha of land. One fourth of respondents (25%) had 2.1 -4.0 bigha of own cultivable land and 27 percent of respondents had upto 1 bigha of land, they were mainly the marginal farmers whereas remaining 8 percent of cultivators had the more than 6.0 bigha of land, they were mainly considered as big farmers by the local people.

Vegetable cultivable land

The Table 3 clearly indicates that at the most 31 percent of respondents had 0.6 to 1.0 bigha of land under vegetable cultivation whereas at the least 2 percent of respondents had more than 4.0 bighas of land under vegetable cultivation. More than one-fourth percent of respondents (29%) had 1.1 to 2.0 bigha of land under vegetable cultivation whereas 27 percent of respondents had upto 0.5 bigha of land under vegetable cultivation. Remaining 11 percent of respondents had 2.1 to 4.0 bigha of land under vegetable cultivation. Previously, the area was known as vegetable growing area though recently the farmers are coming back to rice, jute and other traditional crops.

Experience

Number of years related with vegetable cultivation

The Table 4 expresses that at the most 39 percent of respondents were related with vegetable cultivation in the range of 11 to 20 years and only 7 percent of growers reported that they had knowledge about cultivation of vegetables above 40 years. Over one-fourth of respondents (26%) were related with vegetable cultivation upto 10 years and 15 percent of growers were related with vegetable cultivation in range of 21-30 years and remaining 13 percent of respondents had the knowledge about vegetable cultivation in the range of 31-40 years.

Number of years related with application of agro-chemicals (Table 4)

Nearly half of respondents (40 percent) had the 11-20 years of experience and 26 percent of growers had the experience upto 10 years. It was seen that 20 percent of vegetable growers had the experience about application of agro-chemicals in the range of 21-30 years whereas remaining 14 percent of respondents had above 30 years of experience about application of agro-chemicals on the vegetable crops for protecting the crops from attack of insect-pests and diseases.

Table 1. Level of education (N=400)

Level of Education	Number of respondents	Percentage of respondents
Illiterate	60	15
Primary level	148	37
Secondary level	120	30
Higher secondary level	40	10
Graduate and above level	32	8

Table 2. Own cultivable land (N=400)

Land (Bigha)	Number of respondents possessed	Percentage of respondents possessed
Upto 1.0	108	27
1.1-2.0	132	33
2.1-4.0	100	25
4.1-6.0	28	7
Above 6.0	32	8

Table 3. Vegetable cultivable land (N=400)

Land (Bigha)	Number of respondents possessed	Percentage of respondents possessed
Upto 0.5 bigha	108	27
0.6 to 1 bigha	124	31
1.1 to 2.0 bigha	116	29
2.1 to 4.0 bigha	44	11
Above 4.0 bigha	8	2

Table 4. Experience of respondents (N=400)

Number of years related with vegetable cultivation	Number of respondents	Percentage of respondents	Number of years related with application of agrochemicals	Number of respondents	Percentage of respondents
Upto 10	104	26	Upto 10	104	26
11-20	156	39	11-20	160	40
21-30	60	15	21-30	80	20
31-40	52	13	Above 30 years	56	14
Above 40 years	28	7			

Table 5. Various insect-pests of tomato (N=400)

Insect-pests	Number of respondents reported	Percentage of respondents reported
Leaf eating caterpillar	360	90
Fruit borer	304	76
Mealy bug	92	23
White fly	148	37

Table 6. Agro-chemicals used to control leaf eating caterpillar (N=400)

Brand Name	Agro-chemicals	Number of respondents adopted	Percentage of respondents adopted	Dose(per litre of water)
Ripcord	Cypermethrine	160	40	1-3ml
Thiodan	Endosulfon	84	21	1-3ml
Nuvan	Dichlorvos 76% E.C.	76	19	1.5-3ml
Challenger	Cypermethrine	36	9	1.5-3ml
Cyperin	Cypermethrine	44	11	1.5-3ml

Table 7. Agro-chemicals used to control fruit borer (N=400)

Brand Name	Agro-chemicals	Number of respondents adopted	Percentage of respondents adopted	Dose (per litre of water)
Thiodan	Endosulfon	100	25	1-3ml
Sevin-50	Carbaryl	80	20	1.5-3.0gm
Ripcord	Cypermethrine	100	25	1-3ml
Suquin	Quinalphos	40	10	1-3ml
Sumidon	Phosphamidon	80	20	2-4ml

Table 8. Agro-chemicals used to control mealy bug (N=400)

Brand Name	Agro-chemicals	Number of respondents adopted	Percentage of respondents adopted	Dose (per litre of water)
Monocil	Monocrotophos	84	21	1.0-3.0ml
Sumidon	Phosphamidon	76	19	2.0-4.0ml
Rogor	Dimethoate	160	40	2.0-4.0ml
Metasystox	Methyl Demiton 25%	80	20	2.0-4.0ml

Table 9. Agro-chemicals used to control white fly (N=400)

Brand Name	Agro-chemicals	Number of respondents adopted	Percentage of respondents adopted	Dose (per litre of water)
Rogor	Dimethoate	96	24	2.0-4.0ml
Metasystox	Methyl Demiton 25%	100	25	2.0-4.0ml
Metacid	Methyl Parathion	48	12	1.5-3.0ml
Phorate	Phorate	104	26	5-10gm/plant
Furadon	Carbofuran	52	13	5-10gm/plant

Table 10. Diseases of tomato (N=400)

Diseases	Number of respondents reported	Percentage of respondents reported
Seedling rot	132	33
Late Blight	148	37
Fruit rot	204	51
Leaf curl	108	27

Table 11. Agro-chemicals used to control seedling rot (N=400)

Brand Name	Agro-chemicals	Number of respondents adopted	Percentage of respondents adopted	Dose (per litre of water)
Captan	Captan 50%W.P.	48	12	1.0-3.0gm
Fytolan	Copper Oxychloride	88	22	2.0-4.0gm
Indofil-M 45	Mancozeb	208	52	2.5-3.0gm
Cyvistin	Carbendazim	56	14	2.0-4.0gm

Table 12. Agro-chemicals used for controlling late blight disease (N=400)

Brand Name	Agro-chemicals	Number of respondents adopted	Percentage of respondents adopted	Dose (per litre of water)
Uthane M-45	Mancozeb	228	57	2.5-3.0gm
Captan	Captan 50%W.P.	76	19	1.0-3.0gm
Derosal	Carbendazim50%W.P.	52	13	2.0-4.0gm
Fytolan	Copper Oxychloride	44	11	2.0-4.0gm

Table 13. Agro-chemicals used to control fruit rot disease of tomato (N=400)

Brand Name	Agro-chemicals	Number of respondents adopted	Percentage of respondents adopted	Dose (per litre of water)
Complex-M 45	Mancozeb	140	35	2.5-3.0gm
Bavistin	Carbendazim50%W.P.	116	29	2.0-4.0gm
Blue copper	Copper Oxychloride	60	15	4.0-6.0gm
SAAF	Carbendazim12%+ Mancozeb 63%	84	21	2.0-3.0gm

Table 14. Agro-chemicals used to control leaf curl disease of tomato (N=400)

Brand Name	Agro-chemicals	Number of respondents adopted	Percentage of respondents adopted	Dose (per litre of water)
Rogor	Dimethoate	192	48	0.5ml
Metasystox	Methyl Demiton 25%	132	33	2.0-4.0ml
Metacid	Methyl Parathion	40	10	1.5-3.0ml
Furadon	Carbofuran	36	9	5-10gm/plant

Table 15. Attacking stages of insect-pests and diseases and water requirement for spraying

Insect-pests and diseases	Attacking stages of crop	Amount of water used for spraying per bigha of land
Insect-pests		
Leaf eating caterpillar	All stages	30-40 litre (seedling stage) 80-100 litre
Fruit borer	Mature stage	80-100 litre
Mealy bug	Mature stage	80-100 litre
White fly	All stages	80-100 litre
Diseases		
Seedling rot	Seedling stage	30-40 litre
Late Blight	All stage	80-100 litre
Fruit rot	Fruiting stage onwards	80-100 litre
Leaf curl	Mature stage	80-100 litre

Table 16. Interval of application and method of application of agro-chemicals (N=400)

Days of interval	Number of respondents followed	Percentage of respondents followed	Methods of application of agro-chemicals	Number of respondents followed	Percentage of respondents followed
1	40	10	Spraying	400	100
2-3	80	20	Dibbling	184	46
4-7	200	50	Dusting	68	17
8-15	48	12			
Above 15	32	8			

Table 17. Source of information regarding use of agro-chemicals (N=400)

Source	Number of respondents collected information	Percentage of respondents collected information
Retailers	400	100
Big farmers	208	52
Fellow farmers	312	78
Neighbours	132	33
Relatives	84	21
Others	44	11

Insect-pests

Various insect-pests of tomato as reported by respondents are given below in the following Table (5)

Majority of respondents (90%) had the problem of leaf eating caterpillar which damaged the crop mostly and at the lowest 23 percent of the vegetable growers reported about mealy bug and its' nature of damage. Fruit borer was a very common insect-pest of tomato crop and it was reported by more than three-fourth percent of respondents (76%) whereas 37 percent of the tomato growers reported about presence of white fly on their cultivated crop.

Agro-chemicals used to control leaf eating caterpillar (Table 6)

Leaf eating caterpillar (*Spodoptera litura*)

The caterpillars feed voraciously on the leaves, shoots and fruits at night and become isolated at the later stage of the growth. The pest is confined to nursery beds and is also classed as cutworm. The moth is greyish brown with white markings on the forewings and hind wings with irradiantly white with a brown border. The thorax and abdomen are light brown and display a tuft of hairs in the end. At the most 40 percent of respondents applied Ripcord to control leaf eating caterpillar @ 1.0-3.0ml/litre of water whereas at the lowest 9 percent of growers sprayed Challenger @ 1.5-3.0 ml/litre of water. Over one-fifth of respondents (21%) applied Thiodan @ 1.0 -3.0 ml/litre of water, Nuvan applied @1.5-3.0ml/litre of water by 19 percent of respondents and Cyperin @ 1.5-3.0ml/litre of water was applied by 11 percent of respondents to control the caterpillar.

Agro-chemicals used to control fruit borer (Table 7)

Fruit borer

(*Heliothis armigera*): This is also known as gram caterpillar. The caterpillars after hatching feed on the vegetable parts. They cut holes into the fruits and make burrows. The infected fruits are unfit for consumption and marketing. The moths are brown to yellowish brown and measure about 4 cm. in length with slight stripes. The caterpillars are greenish with dark brown grey lines along the side of the body. At the most 25 percent of respondents applied Thiodan and Ripcord @ 1.0-3.0ml/litre of water whereas one-fifth percent of respondents (20%) applied Sevin-50@ 1.5 -3.0gm per litre of water and Sumidon @ 2.0-4.0ml per litre of water to control fruit borer of tomato crop.

Only 10 percent of respondents applied Suquin@1.0-3.0ml per litre of water for the same purpose.

Agro-chemicals used to control mealy bug (Table 8)

Mealy bug (*Pseudococcusvirgata*)

The damage is caused by both the nymphs and adults. They cover the top of the shoot near the leaf petioles and suck the sap of the plants resulting in checking of growth and malformation of leaves. In case of heavy attack, the internodes are swollen, the leaves arising from the attacked region become deformed giving a bushy appearance. The nymphs and adults are elongate, oval, soft bodied, light coloured with distinct segmentation and covered with mealy cottony wax secretion. Female bugs have well developed legs and antinae. Males are apterous with two long caudal wax filaments and are usually smaller than the females. At the most 40 percent of respondents applied Rogor@2.0-4.0ml/litre of water whereas at the lowest 19 percent of respondents applied Sumidon@ 2.0-4.0ml/litre of water for controlling mealy bug. More than one fifth percent of respondents (21%) applied Monocil@ 1.0-3.0ml/litre of water and 20 percent of respondents applied Metasystox@2.0-4.0ml/litre of water for controlling mealy bug.

Agro-chemicals used to control white fly (Table 9)

White fly (*Bemisia tabaci*)

They are very small white insects and suck the sap of the plants. The insect transmits the leaf curl virus disease of tomato. At the most 26 percent of respondents applied phorate @5-10gm/plant whereas at the lowest 12 percent of respondents applied Metacid @1.5-3.0ml/litre of water to control white fly. One fourth percent of respondents (25%) applied Metasystox @2.0-4.0ml/litre of water, 24 percent of respondents used Rogor @2.0-4.0ml/litre of water and 13 percent of respondents used Furadon @ 5-10gm/plant to control the fly.

Diseases (Table 10)

More than half of respondents (51%) reported about the fruit rot disease of tomato, 37 percent reported about late blight disease, 33 percent of respondents reported about seedling rot and at the lowest 27 percent of respondents reported about the leaf curl disease of tomato.

Agro-chemicals used to control seedling rot (Table 11)

Seedling rot (*Pythium* spp.)

Actually it is damping off of seedling. Pre-emergence damping off of seedlings consists of killing of seedlings from initial stages of seed germination to time of emergence above the soil due to rotting of seeds or radicle and plumule coming out of

the seed. In case of post emergence damping off the seedlings may topple over any time after the emergence from the soil due to rapid shrinking and darkening of cortical tissues of the hypocotyl. The infested tissues appear soft and water soaked. With the progress of the disease the stems become constricted at the base and the plants fall down. The fungi are soil inhabitant and survive there in the form of oospores and sclerotia. More than half of respondents (52%) applied Indofil M-45 @2.5-3.0gm/litre of water to control seedling rot. At the lowest 12 percent of respondents applied Captan @ 1.0-3.0gm/litre of water, 22 percent of respondents used Fytolan @2.0-4.0gm/litre of water and remaining 14 percent of respondents applied Cyvistin @ 2.0-4.0gm/litre of water to protect the crop from seedling rot.

Agro-chemicals used for controlling late blight disease of tomato (Table 12)

Late blight disease of tomato (*Phytophthora infestans*)

The disease can attack any ground part of the plant at any stage of the crop growth. Water soaked brown to purple black lesions develop at any point on leaflet, rachis, petiole, stem or leaf. These lesions advance rapidly to cause a severe blight under warm and humid conditions. In times of low humidity, the lesion growth is checked. On the lower side of the leaves, white fructification of the fungus appears at the joining point of pale and purple areas. On tomato fruits, dark olivaceous, greasy-appearing spots are formed. These may enlarge to cover the entire fruit. In very moist weather, a white weft of fungus growth develops on the invaded areas. The fungus survives on other host plants and on the potato refuse. The fungus also lives in soil. Potato and tomato both are infected at the same time. The different chemicals those were applied to control late blight disease, their dose and number of respondents applied are the following-Uthane M-45 @2.5-3.0gm/litre of water (57%), Captan@1.0-3.0gm /litre of water (19%), Derosal @2.0-4.0gm /litre of water (13%) and Fytolan @2.0-4.0gm /litre of water (11%).

Agro-chemicals used to control fruit rot disease of tomato (Table 13)

Fruit rot disease of tomato (*Phytophthora parasitica*)

The disease appears on the lower fruits in the form of spots. The spots are pale brown with concentric rings.

These spots may be small or they may cover a major portion of fruit surface. If the green fruits are attacked, they show brownish circular spots at the blossom end, shrink and get mummified. The symptom appears mostly at the point of contact between fruit and soil. The disease is more prevalent in wet weather. The disease is soil borne and the fungus survives in the soil. Agro-chemicals used to control fruit rot disease, their doses and number of respondents applied are the following: -

Complex-M 45@2.5-3.0gm/litre of water (35%), Bavistin@2.0-4.0gm/litre of water (29%), Blue copper @4.0-6.0gm/ litre of water (15%) and SAAF @2.0-3.0gm/ litre of water (21%).

Agro-chemicals used to control leaf curl disease of tomato (Table 14)

Leaf curl disease of tomato (Tobaccovirus 16 or Necotiana virus 10; Geminiviruses group)

The characteristic symptom is the severe stunting of plants with downward rolling and crinkling of the leaves. The newly formed leaves show chlorosis. The older, curled leaves become leathery and brittle. The infected plants look pale and produce more lateral branches giving a bushy appearance. The diseased plants are partially or completely sterile in case of severe infection. The disease is more severe during rainy season. The virus is transmitted by white fly, *Bemisia tabaci*. Even a single viruliferous white fly is able to transmit the virus. Leaf curl disease of tomato is a viral disease and spread out by vector. To control the vector, the chemicals applied, their doses, and number of respondents adopted are the following:-

Rogor@ 0.5ml /litre of water (48%), Metasystox @ 2.0-4.0ml /litre of water (33%), Metacid @ 1.5-3.0ml /litre of water (10%) and Furadon @ 5-10gm/plant (9%).

Insect-pests and diseases, their attacking stages and amount of water used for spraying (Table 15)

The table indicates that the tomato crop was mainly attacked by insect-pests and diseases at mature stage. Tomato growers used amount of water for spraying per bigha of land at mature stage was 80-100 litre whereas at seedling stage they sprayed only 30-40 litres of water for one bigha of land.

Interval of applying agro-chemicals and method of application of agro-chemicals (Table 16)

Interval of application of agro-chemicals

At the most 50 percent of respondents applied chemicals at the interval of 4-7 days whereas at the lowest 8 percent of respondents applied chemicals above 15 days interval. Another interval of days of application was 1 days (10%), 2-3 days (20%) and 8-15 days (12%).

Methods of application of agro-chemicals

Surprisingly, all the respondents in the study area applied agro-chemicals through spraying method whereas at the lowest 17 percent of respondents applied chemicals through dusting. Nearly half of respondents (46%) applied agro-chemicals through dibbling method. Jat *et al.* (2011) reported that majority of tomato growers had medium knowledge level about the recommended cultivation practices of tomato. Among the various aspects of different recommended cultivation practices, majority of the farmers also had knowledge about seed treatment, time for application of nitrogenous and phosphorus fertilizers. Only a few farmers had knowledge regarding dose of weedicides, application method of bio-fertilizers and time of application of bio-fertilizers. Jat *et al*. (2012) who reported the major constraints in improved tomato production technology as perceived by the tomato growers were- high cost of high yielding varieties, high cost of

fertilizers and chemicals, lack of knowledge about disease resistant varieties, lack of knowledge about proper application methods of chemical fertilizers, lower prices at harvesting time, lack of knowledge of seed treatment and lack of knowledge and skills about proper method of tomato production.

Source of information regarding use of agro-chemicals

All the respondents (100%) collected information regarding use of agro-chemicals from agricultural input retailers whereas at the lowest 11 percent of respondents gathered information from other sources. Over-three fourth percent of respondents (78%) collected from fellow farmers, 52 percent of respondents collected from big farmers, 33 percent of respondents collected from neighbours and 21 percent of respondents collected from relatives. Patel, *et al.* (2013) who reported that among the several constraints of tomato production, higher prices of plant protection materials (63.10%), lack of information about high yielding varieties and lack of marketing information were also the important constraints. Singh *et al.* (2014) reported that about one-third of the respondents (33.75%) and nearly one-fourth of the respondents (23.75%) had medium and high overall information seeking behaviour respectively. Private dealers, friends, kisan mela and PAU scientists were emerged as the main sources of seeking information.

The weed control, plant protection, recommended varieties and fertilizer applications were the major areas for seeking information regarding vegetable cultivation. Most of the respondents shared information with neighbours, friends, relatives and mode of sharing was verbal as stated by 100 percent of the respondents.

Conclusion

Cultivation of high yielding varieties and hybrids of cereals have put a great pressure on soil and water resources. Vegetable cultivation has aggravated this problem because intensive cultivation of these crops require heavy doses of fertilizers and various kind of agro-chemicals to protect the crops from insect-pests, diseases, weeds, nematodes and other pests. Therefore, to reduce the detrimental effects of these chemicals on environments, it is urgent to know the agro-chemicals use pattern of farmers for each crop. Considering these, the present investigation was carried out. Therefore, on the basis of the findings of the present investigation, the govt. extension agencies, agro-chemical companies and private extension agencies should reorient their extension programmes accordingly.

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