Economics of Pesticide consumption and Pest control in Kashmir valley: focus crop Apple

[1]Arshad Bhat, [2]G. M. Bhat, [3]Iqra Qureshi, [4]Abid Qadir, [5]M. M. Kachroo, [6]Shabeer A. Ganaie, & [7]Aamir Qureshi

[1]Rajiv Gandhi Chair in Contemporary Studies on Livelihood and Food Security, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar-190025, [2]Department of Economics, Central University of Kashmir Srinagar-191201, [3]Central Institute of Temperate Horticulture, Rangreth Srinagar-190007, [4]Department of Environmental Sciences, The Glocal University, U.P. 247121, [5]School of Agricultural Economics and Horti-Business Management, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar-190025, [6]KVK, Anantnag- Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar and [7]Department of Management Studies, University of Kashmir, Srinagar-190025.

Abstract

Kashmir is having a legacy of producing juicy fruits and is therefore very rich in producing globally acknowledged qualitative fruits of numerous species. Traditionally the fruits are produced through organic means and very few chemicals and pesticides used for its cultivation, but after green revolution the use of chemicals and pesticides has increased tremendously in every aspect of agriculture including horticulture and same was the tale of the apple cultivation as well. Over the years, the growers are spraying the pesticides on apple of and on and are using the dosage beyond the recommended level resulting into high chemical residues in the apple and which in turn resulted into the adverse effects on both the quality of apple, environment and human health. Therefore, the study aims to determine the amounts and types of pesticides used in apple orchards, and to analyze the economic loss accrued by the growers on farm-level. The study utilises the date collected in 209-20 from 600 apple producers of the three regions of the Kashmir valley. The results revealed that average area under apple production was 1.49 ha with 12061.259 kg ha−1. The average cost of apple production was found out to the tune of Rs.79964 ha−1. The results revealed that excessive use of pesticides was observed in the apple production of sampled area, which resulted into an average economic loss of 20.48 per cent in just a g/ml/100 lt. of water.

Keywords: Pesticide use, economic loss, overutilization, chemical residues, gain threshold.

Introduction

Apple a commercial economic activity carried out all over the world and in Kashmir valley, almost 80 per cent of people are associated with this activity either directly or indirectly. Globally, about 69 million tonnes of apples were grown in 2019-20, with China producing almost half of this total (45%). The European Union, with more than 20 per cent of world production is the second-leading producer. Other important global players are United States (7.34%), Turkey (4.36%), Iran (4.07%) and India (3.34%). The export of apples in

China in the year 2019-20 was 1 million tones but it was little affected due to price inflation. (FAO, 2019-20).

In India, Jammu and Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh are the major apple producing states. Jammu & Kashmir and Himachal Pradesh accounts for 96.57 per cent of the total production and about 89.16 per cent of the total area under apple. As far as productivity of apple is concerned Jammu & Kashmir has the highest productivity (12.25 tonnes/hectare) followed by Himachal Pradesh (4.45 tonnes /hectare) and Uttarakhand (2.70 tonnes/hectare) (NHB, 2019). The annual apple production in Jammu and Kashmir was recorded 20.01 lakh MT in 2019-20 (National Horticulture Board, 2019).

The capacity of pesticides production in the country is more than 1,39,000 tonnes per annum. The production of pesticides in India has shown 1.71 per cent increase in growth rate during the 2006-2016 periods, while their imports show a varying trend. Indian pesticide scenario seems to be more export-oriented, as their exports have been increasing over the years (Indiastat, 2019-20).

Apple industry in Jammu and Kashmir is facing many challenges and insects, pests and diseases are the prime among them. In Kashmir, the most important pests attacking apple are Scab, Sooty Blotch and Flyspeck, Sanjose Scale, European Red Mite, Codling Moth, Frog eye leaf spot, black rot & smoky canker etc. The growers face many economic losses also due to some prominent diseases on apple (Verma and Sharma, 1999; Zaki *et al.*, 2010, Qazi, 2015). To combat with these diseases, the Horticulture Development Department in coordination with the agricultural University and its extension units (KVK's) have recommended fungicides such as Carbendazim, Mancozeb, Myclobutamil and Fenarimol Dimethoate, Phosphamidon, Ethion, Endosulphon, Malation and Carbaryl etc. against scab and arthropod pests respectively (Qazi, 2015). In Jammu and Kashmir pesticides, fungicides and like Chlorpyriphos, Dimethoate, Quinalphos, Thiocloprid, Malathion etc., Bitertanol, Captan, Hexaconazole, Carbendazim, Mencozeb, Chlorothalonil, Difenaconazole, Flusilazole, Zirametc and Dicofol, Fenazaquin, Ethion etc. are mostly used by apple growers (Qazi, 2015). The pesticide use though recommended by the concerned agencies is not followed letter and spirit, in place a desired dose of these pesticides is used by the growers. The over-dose of these pesticides not only are pressing a negative impact on the human health and environment around, but also resulted into huge economic loss of the apple growers in the region. It is in this backdrop, a study of

economics of pesticide use in Kashmir valley with focus crop apple was carried out to ascertain the quantum of loss that growers are facing.

Research Methodology

A random sampling was followed through a pretested questionnaire for data collection from the baseline stakeholders (growers) and the pesticide dealers operating in sampled area. An extensive survey was carried out in the region and 600 respondents (growers) of three different zones; North. South and Central Kashmir were personally interviewed. For data collection three zones were further divided into blocks and 6 blocks viz; Shadimarg & Zainpora, Nagam & Harwan and Zainageer & Rafiabad and inaddtion 100 pesticides dealers were also selected from whom the data was collected. Two villages from each block were selected because of having almost 100 per cent of their area under apple fruit. After successful collection of requisite data from the respondents in sampled area, mean average, standard deviation, percentages, frequencies were utilised. To calculate the economic losses accrued due to over-utilisation pesticides the following model was employed;

Where:

DROUP: difference resulting from overdose used pesticide

APAIU: amount of pesticide active ingredient used (g ha−1)

APAIR: amount of pesticide active ingredient recommended (g ha−1)

EL: Economic losses (Rs. ha−1)

PPUPT: Price of pesticide used by pesticides type (l/Rs.)

Inaddtion, gain threshold was also estimated for apple production. Gain thresholds are a simple way to determine the relationship between the pesticide and pesticide application costs and the value of the harvested crop. Gain thresholds are simply the pesticide and pesticide application costs per area divided by the value per unit of harvested crop. Therefore, the gain threshold can be calculated with the following formula (Pedigo 1996; Engindeniz 2006; Yilmaz et al 2015). The gain threshold was obtained by using the model as;

$$\textbf{Gain threshold (Kg/ha}^{-1}\textbf{)} = \frac{\textbf{Pesticide and pesticide application costs (Rs./ha}^{-1}\textbf{)}}{\textbf{Average apple price (Rs/kg}^{-1}\textbf{)}}$$

Result and Discussion

Socio-economic and demographic features of respondents

From the analysis of table it can be ascertained that average age of the farmers in the sampled area was 53.71 years and similarly average experience of farmers was 28.67 years. The average number of family members was found out to be 7.72 people. Likewise, farmers' average

education in years were found out 0.56. From the table, it is evident that 42.5 per cent of farmers use agricultural credit for apple growing in the sampled area. Furthermore, in an average 1.49 ha of area is under apple cultivation.

Table 1: Technical, socio-economic, information usage and farmers awareness indicators in agricultural chemical use in apple production

Indicators	Average	Standard deviation	%
Farmer's age (years)	53.71	16.138	-
Education of farmer's (years)	0.56	0.496	-
Farm Experience (years)	28.67	14.172	-
Family size (No.)	7.72	5.023	-
Membership of farmers to agricultural cooperative (%)	-	-	76.6
Family members associated with crop production	3.4	1.121	-
Family members associated with non-agricultural activity	-	-	34.3
Farmer having access to agricultural credit	-	-	42.5
Area under apple (hectare)	1.49	0.881	-
Farmers who want to produce by using the environmentally friendly techniques (%)	-	-	91.9
Farmers who listens radio programmes related to agriculture (%)	-	-	79.7
Farmers who watches TV programmes related to agriculture (%)	-	-	86.4
Farmers who use internet for agricultural purposes (%)	-	-	32.6
Farmers participated in any extension programmes related with plant protection (%)	-	-	43.5
Farmers aware about useful insects (%)	-	-	54.7

Regarding extension services, the farmers use TV, Radio and other internet sources to acquaint themselves regarding new and other scientific practices related agriculture. There are (86.4 %), per cent of growers who use TV as a medium for acquiring knowledge and update about agricultural activities, similarly, (79.7%) growers listened the agricultural related programs on radio and (32.6%) growers used internet as a medium for agricultural updates. Similarly, the rate of farmers aware about useful insects were 54.7 per cent in sampled area of Kashmir valley (Table 1). Presently due to revolution in information and communication technology, there are various media available for a grower/farmer to get useful information about the agricultural pursuits, but still the farmers are not following the recommendations in totality and they use their own brain with regard to these decisions.

Diseases and pests faced by apple growers

In the sampled area Apple Scab, Wooly Apple Aphid, Apple Stem Borer, Alternaria Leaf Blotch, Tent Caterpillar, Bark Beetle, Powdery Mildew, Marssonina Blotch, Apple leaf miner,

Sooty Blotch and Flyspeck, Frog eye leaf spot, black rot & smoky canker, other diseases, Sanjose Scale, European Red Mite, Codling Moth and Indian Gypsy Moth are the main diseases of apple trees (Blommers 1994; Ohlendorf 1999). These pests and diseases, mainly Sanjose Scale, apple scab, European Red Mite and codling moth, cause economical losses in majority of apple orchards in sampled area. Therefore, to combat and control the havoc created by these pests and diseases, application of pesticides works as prime method (Karaca et al. 2010). Table 2 presents the picture of major pests and diseases which pose serious threat to the apple quality and in turn resulted into huge economic loss in the sampled area. From the table it is evident that majority of the apple growers face many diseases in the ranking order like; apple scab, sooty blotch and flyspeck, Sanjose Scale, European Red Mite etc. (Table 2). Among the pests and diseases, the most commonly encountered in apple growing in the study area are apple scab, Sanjose Scale, Sooty Blotch and European Red Mite. These four pests and diseases accounted for over 74.095 per cent in apple growing in the study area.

Table 2: The major pests and diseases encountered by farmers in apple growing in research area

Diseases and Pests	No.	%	Rank
Apple Scab	460	76.66	I
Alternaria Leaf Blotch	251	41.83	X
Powdery Mildew	241	40.16	XI
Marssonina Blotch	195	32.5	XIII
Sooty Blotch and Flyspeck	452	75.33	II
Frog eye leaf spot, black rot & smoky canker	351	58.5	VI
Other diseases	280	46.66	IX
Sanjose Scale	441	73.06	III
European Red Mite	428	71.33	IV
Codling Moth	392	65.33	V
Indian Gypsy Moth	283	47.16	VIII
Wooly Apple Aphid	311	51.83	VII
Tent Caterpillar	191	31.83	XIV
Apple Stem Borer	172	28.66	XVI
Bark Beetle	212	35.33	XII
Apple leaf miner	182	30.66	XV

Pesticides used by growers

Table 3 shows an overview of all types of the pesticide used by the farmers in apple growing in Kashmir valley. Among the 600 apple growers, 51 different types of pesticide were used. The insecticides commonly used by the farmers were identified as Dodine 65% WP (92.16 %), Captan 70% + Hexaconazole 5% WP (93.83 %), Noor (9682 kg) (95.5 %), Indofil M-45 (167610 kg) (95.0 %), Contaf plus (8638 ltr) (87.17 %), Captan 70% + Hexaconazole 5% WP

(93.83 %) and Ziram 80% WP used by 89.5 % of the farmers.

Table 3: Pesticides used by growers in sample area

Chemical component	Trade name	Number of farmers	Percentage
Mancozeb 75% WP	Kohinoor-M-45 (105234 kg)	531	88.5
Dodine 65% WP	Superstar (99727 kg)	553	92.16
Ziram 80% WP	Z-78 (37727 kg)	537	89.5
Captan 50% WP	Kohicap (32960 kg)	432	72.0
Herbex 4 Kg	Herbex (26080 kg)	43	7.16
Propineb 70% WP	Filprostar (20660 kg)	213	35.5
Ziram 27% SC	Zirex L (14890 kg)	541	90.16
Captan 70% + Hexaconazole 5% WP	Wave (13091 kg)	563	93.83
Chlorpyriphos 20% EC	Kohiban (12842 lt)	412	68.66
Ethion 50% EC	Tope (12738 lt)	321	53.5
Covert (74301 kg)	Carbendazim 12% + Mancozeb 63% WP	182	30.33
Luzem (56570 kg)	Mancozeb 75% WP	12	2.0
Rogor (49150 ltr)	Dimethoate 30% EC	459	76.5
Miracle GR (327240 kg)	Tricontanol 0.5%	211	35.16
Aceso (32040 kg)	Hexaconazole 4% WP +Zineb 68% WP	23	3.83
Durmet (23000 ltr)	Chlorpyriphos 20% EC	32	5.33
Miracle Liquid (12010 ltr)	Tricontanol 0.1%	11	1.83
Sway (4500 kg)	Propineb 70% WP	112	18.67
Nurocombi (3030 ltr)	Chlorpyriphos 50% EC + Cypermethrin 5% EC	12	2.0
Hemtop (966 kg)	Metiram 55% + Pyraclostrobin 5%	31	5.16
Captaf (219727 kg)	Captan 50% WP	431	71.83
Tata M-45 (105267 kg)	Mancozeb 75% WP	429	71.5
Blitox (26845 kg)	Copper Oxychloride 50% WP	354	59.0
Tafethion (24219ltr)	Ethion 50% EC	12	2.0
Contaf (13366 ltr)	Hexaconazole 5% EC	523	87.16
Contaf plus (8638 ltr)	Hexaconazole 5% EC	521	86.83
Taqat (8100 kg)	Captan 70% + Hexaconazole 5% WP	234	39.0
Ergon (5070 ltr)	Kresozim methyl 44.3 SC	312	52.0
Tafgor (3534 ltr)	Dimethoate 30% EC	13	2.16
Koranda 505 (2796 ltr)	Chlorpyriphos 50% EC + Cypermethrin 5% EC	5	0.83
Indofil M-45 (167610 kg)	Mancozeb 75% WP	570	95.0
Indofil Z-78 (88585 kg)	Zineb 75% WP	453	75.5

Avtar (78575 kg)	Hexaconzole 4% WP +Zineb 68% WP	109	18.16
Flash (42569 kg)	Quinalphos 25% EC	321	53.5
Noor (9682 kg)	Dodine 65% WP	543	95.5
Captra (7464 kg)	Captan 50% WP	311	51.83
Mitex (6732 kg)	Propergite 57% EC	43	7.17
Companion (6620 kg)	Carbendazim 12% + Mancozeb 63% WP	109	18.17
Dhan (4608 kg)	Propaconzole 25% EC	12	2.0
Sprint (3594 kg)	Carbendazim 25% + Mancozeb 50% WP	34	5.67
Merimain (135376 kg)	Captan 50% WP	21	3.5
Shamir (65270 ltr)	Tebuconazole 8% +Captan 32% SC	9	1.5
Macoban M-45 (36890 kg)	Mancozeb 75% WP	7	1.17
Proximain (26240 kg)	Propineb 70% WP	43	7.16
Macoban C (25225 kg)	Carbendazime 12% + Mancozeb 63% WP	23	3.83
Premain (18690 ltr)	Chlorpyriphos 20% EC	11	1,84
Premain Super (13385 ltr)	Chlorpyriphos 50% + Cypermethrin 5% EC	18	3.0
Orius (13300 ltr)	Tebuconazole 25.9% EC	6	1.0
Mainex (8100 ltr)	Hexaconazole 5% SC/EC	2	0.33
Olander (8010 ltr)	Difenoconazole 25%EC	3	0.5

Plant Protection Costs in Apple Production

Table 4 shows plant protection costs in apple production in the study area. Plant protection costs of items such as wages, uniforms, equipment of personnel engaged in plant protection and pesticides. In this study, average costs of apple production were determined to be Rs.343109/- ha−1. According to this study, the cost of plant protection (pesticide and pesticide application costs) per hectare was determined as Rs. 79964/- having the portion of 23.20 per cent of average production cost. In this study, average yield for apple was determined to be 12061.259 kg ha−1. In this study, pesticide and pesticide application costs and production costs were determined to be Rs.6.63/- kg−1.

Table 4: Pesticide and pesticide application costs in apple production

Indicators	Mean
A. Average yield (Kg/hectare)	12061.259
B. Average Pesticides + Pesticide application costs (Rs./ha)	79964
C. Average Pesticides + Pesticide application costs (Rs./kg) (C = B/A)	6.63
D. Average production costs (Rs./ha)	343109
E. Average apple production costs(Rs./ kg) (E = D/A)	28.44
F. The proportion of plant protection costs in average production costs (%) (F = (B/D)*100)	23.30

G. Economic loss due to overdose use of agricultural chemicals (Rs./ha)	41034
H. The proportion of economic loss in average plant protection costs (%) (H = (G/B)*100)	51.31

Estimation of gain threshold of pesticide use on apple production

Under this scenario the cost of pesticide per hectare in the sampled area was calculated to the tune of RS.69164/- and cost pesticide application per hectare was estimated as Rs. 10800/- considering two labours (family labour excluding) for a whole day can spray one hectare of area. Similarly, the average apple price per kilogram was calculated by considering 17 kgs of apple in a box and the rate per labour was fixed as 600 (because this labour is hired from early hours to late hours).

Therefore, the gain threshold has been calculated as;

$$\textbf{Gain threshold (Kg/ha}^{-1}\textbf{)} = \frac{\textbf{Rs. 69164/-+ Rs. 10800/- (Rs./ha}^{-1}\textbf{)}}{\textbf{Rs. 35/- (Rs/kg}^{-1}\textbf{)}} = \frac{\textbf{Rs. 79964}}{\textbf{Rs. 35/-}}$$

$$= \textbf{Rs. 2284.69/-}$$

Therefore, the gain threshold was calculated to Rs. 2284.69/-

Excessive pesticide use and economics losses

The amounts of agricultural chemicals used by farmers with the amount of agricultural chemicals recommended by extension units and economic lose which caused by excessive use of agricultural chemicals were given in Table 5. It was determined that there is a significant difference in the dose recommended and the dose utilised in the sampled area. It was found that the recommended dose for Mancozeb was 300 **(**g/ml/100 lt) but the actual usage was 330 (g/ml/100 lt) accruing loss of Rs.23.1 in just 100 ltrs. Similar was the case with other pesticides used in the sampled are as shown in table 5. The same situation was observed by (Demircan and Yilmaz 2005) and (Kızılay and Akcaoz 2009). It was determined that farmers used more pesticide than the recommended by extension units. This situation shows that farmers have not sufficient knowledge on the pesticide using. Farmer's major problems belonging to pesticide applications were high pesticide prices, inefficient pesticides, lack of the pesticide subsidy, low education level, insufficient and ineffective extension services, low apple prices and income. It said that, training programs could play a crucial role in pest control decisions, providing farmers with the technical knowledge that is necessary for the selection of appropriate pest management methods and for safe, effective and economic pesticide use.

Table 5: Dominant agricultural chemicals recommended amounts and used in apples and economic losses

Fungicide	Recommended dosage (g/ml/100 lt)	Expanses on recommended dose (Rs.)	Unit cost (Rs/kg/lt)	Dosage used	Expanses on used dose (Rs.)	Difference	Economic loss (Rs. g/ml/100 lt)
Mancozeb	300 g	99	330/kg	370g	122.1	70g	23.1
Captan 70% + Hexaconazole 5%	50 g	70	1400/kg	60g	84	10g	14
Difenaconazole	30 ml	126	4200/ltr	45ml	189	15g	63
Ziram 80 WP	200 g	106	530/kg	230g	121.9	30g	15.9
Zineb 68% + Hexaconazole 4%	75 g	15.75	210/kg	95g	19.95	20g	4.2
Myclobutanil 10WP	50 g	23.5	470/kg	70g	32.9	20g	9.4
Chlorothalonil 75WP	150 g	37.8	250/kg	175g	44.1	25g	6.3
Mineral Oil spray	2.0 Litres	250	125/lt	2.5Lt	312.5	.5lt	62.5
Chlorpyriphos	100 ml	42.5	425/ltr	115ml	48.88	15ml	6.38
Dimethoate	100 ml	52	520/ltr	120ml	62.4	20ml	10.4
Summer spray oil	750 ml	93.75	125/lt	830ml	103.75	80ml	10

Conclusion

Apple one of the commercially grown fruit throughout the globe is very cost and climate sensitive. The fruit incurs cost in thousands of rupees but is very remunerative as well than other crops in the Kashmir region and that is the reason of conversion of agricultural land to the horticultural purpose over the past two decades. Even the farmers easily get loan from the banking and non-banking institutions if they are having a fruit orchard as mortgage. Though being high labour and capital intensive venture, still farmers prefer to cultivate this crop in the region Pesticide use is usually associated with social, economic and educational set-up the people. Pesticide exposure occurred through various channels like; dermal exposure, oral exposure and exposure through inhalation. The pesticide market in India has grown at 12-13 per cent per annum to reach $6.8 billion (2017) of which the domestic demand growth was at the rate of 8-9 per cent and export demand at 15-16 per cent. In apple orchards, pesticides are used to eradicate pests which are harmful to the quality of the apple. Although it is found that overall intensity of pesticide used in the study area is low as compared to other developed regions of the world. From the study it can be concluded that in Jammu and Kashmir the use of pesticides is very high and therefore, the residues found are at a higher side. Majority of the growers though aware about recommended dosage of the pesticides, but still they use their own desired dose for curbing the diseases and pests with the result the growers in the area are facing huge economic losses be it direct or indirect.

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