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Influence of frontline demonstration of plant protection on the yield and quality of apple in dry temperate zone of Himachal Pradesh

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Abstract

For the effective transfer of improved agricultural innovation to the farming community, front-line demonstration is the most suitable means. Krishi Vigyan Kendra, Lahaul and Spiti II at Tabo, Himachal pradesh have conducted a front line demonstration as plant protection technologies and management practices in the farmers' apple orchard under cold desert region during 2019-20 to 2021-22, in all 30 demonstrations on the management of woolly apple aphid in apple. With the timely application of plant protection measures, the apple fruit yield was 13.78% higher than that of farmers (295 q/ha). Thus, the average technology gap, extension gap, and technology index of 64.33 q/ha, 40.67 q/ha and 16.08 percent, respectively were obtained between demonstration and farmer practices.

Keywords: Woolly apple aphid, frontline demonstration, technology gap, technology index

Introduction

The Spiti Valley, located in the western Himalayan region of India, is an integral part of the Indian cold deserts. It lies between latitudes 31042' to 32058' N and longitudes 77021' to 78035' E and occupies an area of 5,582 km^2 (Fig. 1). It is bounded by Tibet in the northeast, Kinnaur in the southeast, Kullu in the west, and Ladakh in the north, with an average elevation of 4000 m. As a part of the cold desert, the area is characterized by harsh climatic conditions, such as dry and cold weather, low temperature, heavy snowfall, and low annual rainfall. The area is characterized by harsh climatic conditions such as dry and cold weather, low temperatures, heavy snowfall, and low annual rainfall. According to the 2011 Census of India, Spiti's total population is 12457 with 2583 number of households (www.censusindia2011.com/himachal-pradesh/lahul-spiti/spiti-population.html). Total of 1284 farmers/farm women are dependent on agriculture; among them, only farmers from four major villages in lower Spiti are commercial apple growers.

Apples are considered an important source for improving the economy of farmers in this tribal area. Therefore, traditional agricultural crops and arable land have been replaced by apple orchards in the lower Spiti area, adjoining the Kinnaur region. Apple orchards occupy 154.6 ha of the Spiti Valley (Kumar *et. al*., 2008) [3]. Although apple orchards occupy a very small area compared with other apple-producing areas in the state, they are comparatively younger. Apple orchards are confined to a small area, mainly within Poh and Hurling.

Owing to changing climate scenarios and increasing areas under apple cultivation in Spiti, orchardists are facing problems pertaining to insect and disease attacks in their orchards. The establishment of these pests and the subsequent losses caused by them are alarming to fruit growers. These pests can cause both direct and indirect damage. Direct losses include fruit damage, quality, and quantity of apples, while indirect losses are the costs incurred for their management. Owing to the lack of well-organized and precise quarantine systems for insect pests of apples in India, exotic pests are of major concern. Woolly apple aphid (*Eriosoma lanigerum* Hausmann) and phytophagous mites (European Red Mite (*Panonuchus ulmi* Koch) and Two Spotted Spider Mite (*Tetranychus ulmi* Koch)) are the major insect pest problem of approximately 80% orchards in Spiti.

Being a tribal area and tough to reach apple growers in Spiti, they have very limited knowledge about plant protection measures that need to be applied in their orchards. Before the establishment of Krishi Vigyan Kendra at Tabo (Spiti), farmers generally performed plant protection measures on the recommendations of pesticide sellers from Rampur and Reckong Peo, and more than 80% of the recommendations were generally recommended for non-recommended pesticides in cotton, paddy, and vegetables with incorrect doses of application. Krishi Vigyan Kendra Lahaul and Spiti II at Tabo is established in the year 2017-18, and with its establishment, apple growers of Spiti are using its facilities as technical guidance in plant protection.

Frontline Demonstration is a form of applied research through the ICAR/SAU system on the latest notified/released varieties along with a full package of practices on selected farmers' fields with a view to demonstrate the potential of the technologies to (a) participating farmers, (b) neighboring farmers and other agencies, (c) to analyze the production, and (d) the performance of the technologies for scientific feedback. KVK L&S II at Tabo also performs several front-line demonstrations (FLDs) in the farmer's field to educate them about the identification, life cycle of insect pests, and their management without harming the biodiversity or ecosystem of Spiti Valley with judicious and timely use of pesticides.

Materials and Methods

A frontline demonstration (FLD) of pest management in apples was conducted by Krishi Vigyan Kendra, Lahaul, and Spiti II at Tabo, Himachal Pradesh, from 2019 to 2022 in different villages such as Lari, Tabo, Poh, and Maane (Table 1) of Lahaul and Spiti, subdivision Spiti. Thirty demonstrations were conducted in four villages. In general, the soil in the study area was loose, gravel, and sandy, with a low fertility status.

The component demonstration of frontline technology in apples comprised a filling gap in the lack of basic knowledge about insect pests and their time of appearance among fruit growers, avoidance of the indiscriminate use of pesticides, poor information on pest monitoring among orchardists, and timely application of the correct dose of insecticides against woolly apple aphids (Table 2). Total of 0.30 ha area was covered in three consecutive years. In the demonstration, one control plot was maintained where farmer practices were carried out. The FLD was conducted to study the technology gap between the potential and demonstrated yields, the extension gap between the demonstrated and demonstrated yields under existing practices, and the technology index. Yield data were collected from both demonstrations and farmers' practices using a random sampling method and analyzed using simple statistical tools. The extension gap, technology gap, and technology index (Samui *et al*., 2000) [6] were calculated using formula (Eq. 1–4) as follows:

$$\text{Percent increase in yield} = \frac{\text{Demonstration yield- Farmer's yield}}{\text{Farmer's yield}} \quad \text{(Eq. 1)}$$

$$\text{Technology gap} = \text{Potential yield - Demonstrated yield} \quad \text{(Eq. 2)}$$

$$\text{Extension gap} = \text{Demonstrated yield - Yield under existing practices} \quad \text{(Eq. 3)}$$

$$\text{Technology index} = \frac{\text{Potential yield – Demonstrated yield}}{\text{Potential yield}} \times 100 \quad \text{(Eq. 4)}$$

Field demonstrations with chlorpyrifos (at 0.05%) as foliar application July – August were also carried out in apple orchard at farmer's field at village Lari, Kurith, Tabo and Maane area during 2019-20 to 2021-22. The trials were laid in a randomized block design on 20-25 years old trees of variety 'Royal Delicious.' There were two treatments, including an untreated control, and each treatment was replicated three times, with a single tree as a replicate. Spraying was performed with a high-volume sprayer in July, with 10 litre of spray fluid per tree. The pretreatment counts on the number of woolly apple aphid colonies on ten randomly selected twigs were observed in each treatment one day before spraying, while post-treatment counts were made after 14 days of spraying. These data were statistically analyzed after subjecting them to a $\sqrt{n+1}$ transformation. The plants were also observed for any phytotoxic symptoms if present.

Results and Discussion

The yield of the frontline demonstration trials and the potential yield of the crop were compared to estimate the yield gap, which was further classified into technological and extension gaps (Table 2). A comparison of the productivity levels between improved plant protection in the demonstration trials is presented in Table 3. During the study period, it was observed that the adoption of improved plant protection technologies in demonstration trials increased yield compared to farmers' practices.

Crop yield

The data regarding the fruit yields of the apples are listed in Table 3. The increased fruit yield in demonstration over the farmers' practices was recorded during the three years of study. The recommended plant protection practices in Royal Delicious recorded an average higher yield of 335.67 q/ha as compared to the average farmers practice check (295.0 q/ha). The results indicated that the front-line demonstration had a positive impact on the apple farming community of Spiti, as they were motivated by the plant protection technologies applied in the FLD plots. The fluctuations in the overall apple yield from 2019-20 to to 2021-22 were due to the weather conditions in Spiti. The yield of the demonstrated plots over the check plots was 8.82% in 2019-20, 10.20% in 2020-21, and 22.33% in 2021-22. The average percentage increase in fruit yield over farmer practices was 13.78%. The increase in yield is due to the use of the recommended dose of pesticide and timely application, as integrated pest management technology has contributed to increased fruit yield over farmer practices. Along with the improvement in the quantity of apple production, quality is also improved with good shape and size, providing more economic value to farmers of their produce. The results indicate that the applied technology had a positive impact on the apple farming community in the locality, as they were motivated by the technology applied or demonstrated in the demonstration field.

Technology Gap

The technology gap showed a gap in the demonstration yield compared with the potential yield. From the data presented in Table 2, the average technological gap was recorded as 64.33 q/ha during all years of study, which needs to be minimized with the conduction of FLD/s. This technology gap may be attributed to the dissimilarity in soil fertility status, weather conditions, and lack of awareness of the recommended plant protection practices. In addition, more location-specific recommendations and precise use of technology in orchards are necessary to bridge the technological gap.

Extension gap

The extension gap showed the gap in the demonstration fruit yield over farmer's yield and it was 40.67 q/ha (table 2). This might be due to the lack of adoption of recommended plant protection measures. A larger extension gap indicates a strong need to motivate farmers to adopt recommended plant protection measures over their local practices. These results agree with those of Mukharjee (2003) [4], who stated that location-based problem identification and specific interventions might have great implications for the enhancement of crop productivity.

Technology index

The technology index shows the feasibility of the recommended plant protection measures in the fields of farmers. The lower the value of the technology index, the greater is the feasibility (Jeengar *et al*., 2006; Hiremath and Nagaraju, 2010; Sagar and Chandra, 2004) [2, 1, 5]. The technology index reported in Table 2 shows an average value of 16.08%.

Economic Analysis

The year-wise economics of apple fruit production under frontline demonstrations and farmers' practices were recorded and the results are presented in Table 2. The data revealed that the cost involved in the adoption of the recommended plant protection measures for apples varied and was more profitable. Higher net returns (1844885 q/ha) and benefit-cost ratio (4.25) were recorded in demonstrations than in local checks, where net returns (1276570 q/ha) and benefit–cost ratio (3.23) were recorded. The higher returns were due to the higher apple fruit production obtained using the demonstrated technology over check plots (farmers' practice).

Data on the number of woolly apple aphid colonies/twigs from 2019-20 to 2021-22 are presented in Table 4 and reveal that Chloropyriphos 20% EC is effective against woolly apple aphids. During 2019-20, after 14 days of spraying (DAS), the average aphid colonies/twig was recorded as 1.00 in the treated plants compared to 8.67 in the untreated control. Similarly, during 2020-21 and 2021-22, average aphid colonies/twigs were recorded as 1.00 and 0.33, respectively in treated plants whereas 7.33 and 9.67 among non-treated plants. Chloropyrifos 20%EC was found to be safe with no phytotoxic effects. The results of the present study corroborate earlier results on chlorpyrifos being highly effective (Thakur and Gupta, 1998; Khajuria *et al*., 2010). Singh and Bhardwaj (2018) reported higher toxicity of chlorpyriphos and thiamethoxam against the aerial form of woolly apple aphids.

Field days, diagnostic visits, and training programs were also organized at the farmer's orchard, where Frontline Demonstrations were conducted to improve farmers/farm women's information status regarding insect pests, and their influence over three years is shown in Fig. 2.

Table 1: Locations in Spiti where Frontline Demonstrations (FLDs) conducted

Sr. No.	Village	Location	Altitude (meter above mean sea level)	Apple variety
1	Lari	32º04‘51”N; 78º25‘15”E	3322	Royal Delicious
2	Tabo	32º05‘27”N; 78º22‘14”E	3298	Royal Delicious
3	Poh	32º03‘53”N; 78º20‘06”E	3369	Royal Delicious
4	Maane	32º02‘48”N; 78º13‘22”E	3502	Royal Delicious

Table 2: Differences between technological intervention and farmer's practices under FLD on plant protection in Apple

Particulars	Technological Intervention	Existing Practices	Gap
Information on pest monitoring	Provide knowledge about monitoring and surveillance of insect pest	Poor knowledge about monitoring of insect pests	Full gap
Basic knowledge about insect pest	Identification with specimens and photographs	Poor knowledge about life cycle and identification of insect pests	Full gap
Indiscriminate use of pesticides	Provide knowledge about recommended pesticides	Poor knowledge about pesticides	Full gap
Dose of pesticides	Recommended dose of pesticides	Poor knowledge	Full gap
Time of application	Timely application of pesticides	Poor knowledge	Full gap

Table 3: Gap in fruit yield production and economic impact of plant protection under FLDs

Year	Farming situation	Variety	No. of Demo.	Area (ha)	Average Yield (q/ha)		% Increase	Technology Gap (q/ha)	Extension Gap (q/ha)	Technology Index (%)	Net Return (Rs./ha)		BC Ratio	
					Demo	FP					Demo.	F.P.	Demo.	F.P.
2019-20	Irrigated	Royal Delicious	10	0.1	370	340	8.82	30	30	7.5	1844885	1276570	4.25	3.23
2020-21	Irrigated	Royal Delicious	10	0.1	270	245	10.2	130	25	32.5	1029885	914262	2.75	2.65
2021-22	Irrigated	Royal Delicious	10	0.1	367	300	22.33	33	67	8.25	1670079	1244262	4.14	3.24
Total Average			30	0.3	335.67	295	13.78	64.33	40.67	16.08				

*F.P. Farmer's Practice

Table 4: Efficacy of Chloropyriphos 20EC against woolly apple aphid (2019-2022)

Treatments	No. of woolly apple aphid colonies/ twig					
	2019-20		2020-21		2021-22	
	Pre count	14 DAT	Pre count	14 DAT	Pre count	14 DAT
Chloropyriphos (0.05%)	9.67 (3.10)	1.00 (1.00)[b]	6.00 (2.35)	1.00 (0.80)[b]	5.67 (2.37)	0.33 (0.33)[b]
Control (Water spray only)	6.67 (2.57)	8.67 (2.91)[a]	5.33 (2.27)	7.33 (2.68)[a]	9.00 (3.00)	9.67 (3.10)[a]
CD(p = 0.05)	NS	1.27	NS	0.82	NS	2.08

Figures in parentheses √ (n+1) transformed values; Each replication consisted of 10 twigs; Means followed by common letters do not differ significantly; DAT = Days after treatment

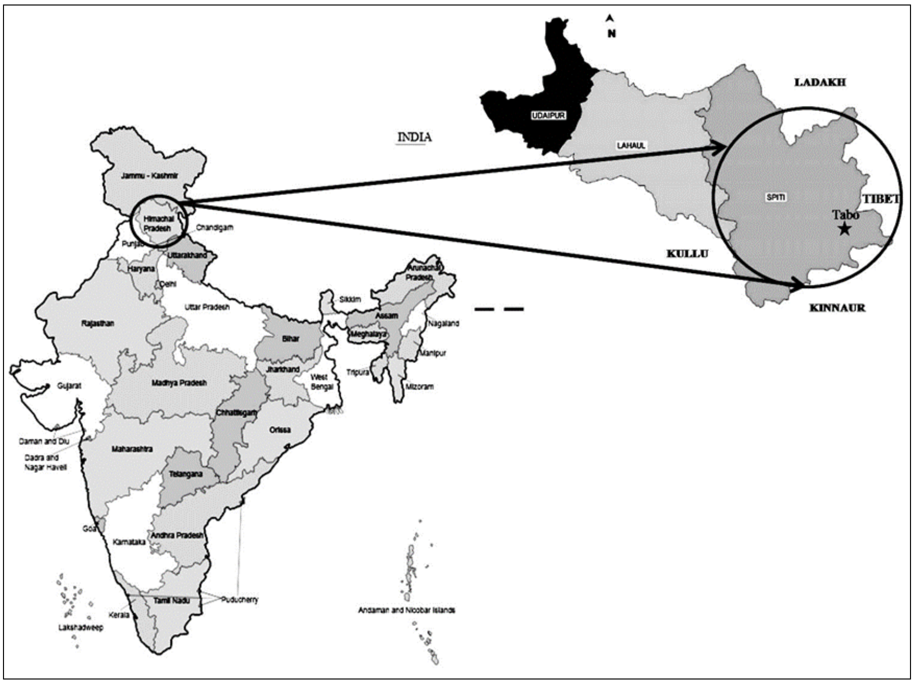

Fig. 1: The study area Spiti, Himachal Pradesh, India

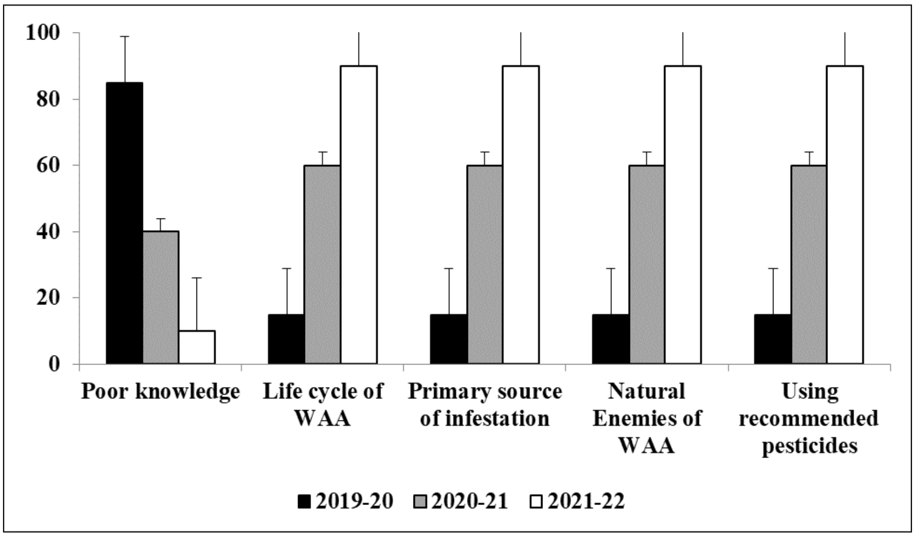

Fig 2: Gain in information about woolly apple aphid and its management among farmers (2019-2022)

Conclusion

A wide gap exists between the potential and demonstration yields in apples, mainly due to technology and extension gaps as well as the lack of awareness about plant protection measures in apples. Improved production technology has also shown the potential to increase apple yield. Timely application of the recommended dose results in the production of high-quality fruits with good texture, perfect size, and high juice content. It is further suggested that sincere extension efforts are required to educate farmers on the adoption of recommended plant protection measures besides strengthening improved technologies, so that resource-poor farmers can improve their livelihoods, provide employment to their local peoples, diversify their farming systems, and improve soil fertility.

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