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ADOPTION AND IMPACT OF INTEGRATED PEST MANAGEMENT IN TOMATO CULTIVATION IN LALITPUR AND BHAKTAPUR NEPAL

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ABSTRACT

This study evaluates the knowledge, adoption attitudes, practices, and challenges of Integrated Pest Management (IPM) in controlling insect pests in tomato cultivation in two districts of Kathmandu Valley, Nepal. Conducted between May 25 and June 30, 2024, in Bhaktapur and Lalitpur districts of Bagmati Province, the research involved 90 commercial tomato farmers selected through purposive random sampling. Data were collected using semi-structured questionnaires and interviews. The findings revealed that 82% of farmers in Lalitpur and 89% in Bhaktapur lacked adequate knowledge and awareness of IPM principles. Limited access to resources (39%) and high initial costs (33%) were significant obstacles, alongside regulatory and policy challenges (26%). The study also identified key pests, with Tuta absoluta being the most damaging (36%), followed by Bemisia tabaci (29%), Helicoverpa armigera (19%), and Aphis gossypii (13%). The results highlight the urgent need for targeted IPM training, improved resource access, and stronger policy support to promote sustainable pest management in tomato farming.

Keywords: Adoption, agricultural challenges, Farmer's knowledge, Pest management, Tomato

INTRODUCTION

Agriculture is the backbone of Nepal's economy, providing livelihoods, income, and employment to a significant portion of the population (Shrestha, 2012). Within the agricultural sector, horticulture plays a key role, with vegetable cultivation contributing over Rs. 36 billion to the national economy. Among the various vegetable crops, solanaceous crops—particularly tomatoes and potatoes—account for 13.57% of the country's total vegetable production. Tomatoes are cultivated on 17,273 hectares, yielding approximately 232,897 tons annually. The Kathmandu Valley, along with Lalitpur and Bhaktapur districts, is central to tomato production in Nepal (Durbar, 2014).

Tomatoes are a high-value crop with substantial market potential. Increasingly, tomatoes are cultivated year-round, particularly through the use of plastic houses that enable off-season production (Ghimire et al., 2017). They thrive in warm, dry climates, with an optimal temperature range of 20-24°C, and are predominantly grown in winter. Popular varieties in Nepal include Abinash, Trishul, Sirjana, and Pusa Ruby. Farming tomatoes in plastic houses offers significant financial benefits, generating a net profit of NPR 85,400 (~700 USD) per ropani annually—2–3 times more profitable than open-field farming (Budhathoki, 2006).

Despite its economic importance, tomato cultivation faces challenges, primarily related to the use of agrochemicals for pest and disease management. Inappropriate pesticide use has led to chemical residues in tomatoes, which pose health risks to consumers and the environment (Karungi et al., 2011). Globally, tomatoes are among the most pesticide-treated vegetables (Gatahi, 2020). Conventional tomato farming practices, including intensive irrigation, weeding, pruning, and pest control, are labor-intensive and contribute to these challenges (Jones et al., 2012).

Integrated Pest Management (IPM) offers a solution by minimizing the reliance on chemical pesticides and promoting more sustainable farming practices. IPM is an environmentally sensitive approach that combines biological, cultural, and chemical methods to manage pests effectively (EPA, 2020; Burlakoti & Rajbhandari, 2016). Although IPM adoption has grown globally, particularly in the United States and Europe, its uptake in Nepal has been slow. The market for IPM-grown vegetables is still in the early stages, and there is a lack of comprehensive market data (Bhatta et al., 2008). However, there is an emerging trend among urban consumers demanding safer and healthier produce, which could help accelerate the adoption of IPM in Nepal.

This study aims to provide valuable insights into the adoption and effectiveness of Integrated Pest Management (IPM) practices in tomato cultivation in the Lalitpur and Bhaktapur districts of Nepal. By assessing farmers' knowledge and awareness of IPM, and evaluating its impact on managing key insect pests such as *Tuta absoluta*, *Bemisia tabaci*, and *Helicoverpa armigera*, the research seeks to identify the challenges and potential benefits of IPM. The findings will contribute to the development of sustainable pest management strategies that can boost tomato production while minimizing the environmental and health risks associated with excessive pesticide use.

MATERIALS AND METHODS

The study was conducted from May 25 to June 30, 2024, in Lalitpur and Bhaktapur districts, specifically focusing on the Godawari and Mahalaxmi municipalities in Lalitpur, and the Changunarayan and Suryabinayak municipalities in Bhaktapur. A total of 90 commercial tomato farmers were selected, with 45 respondents from each district. Semi-structured questionnaires were designed to collect data on demographic characteristics, cultivation practices, pest management strategies, and pest control methods.

Primary data were gathered through direct interviews with farmers, supplemented by personal interviews and field observations. Secondary data were sourced from books, journals, research papers, reports from the Nepal Agricultural Research Council (NARC), Ministry of Agriculture and Livestock Development (MoALD), and other relevant publications. Descriptive statistics, including percentages and frequencies, were applied for data analysis. The findings were presented using Microsoft Excel in the form of tables, pie charts, and bar diagrams.

RESULTS AND DISCUSSIONS

Major Tomato Pest Species

The study identified the key insect pests affecting tomato crops in both Lalitpur and Bhaktapur districts. The most damaging pest was *Tuta absoluta* (Meyrick), which caused significant damage to tomato crops, accounting for 36% of the pest occurrences. Other major pests included *Bemisia tabaci* (Gennadius) (whitefly), which contributed to 29% of the pest damage, and *Helicoverpa armigera* (Hubner) (tomato fruit borer), which caused 19% of the damage (Table 1). Aphis gossypii (Glover) and *Spodoptera litura* (Fabricius) were less prevalent, causing 13% and 3% of the damage, respectively. These findings are consistent with previous studies, such as that by Lamsal et al. (2018), which highlighted *T. absoluta* as the most devastating pest, leading to substantial crop losses in the absence of proper pest management.

Adoption of IPM Practices

The adoption of Integrated Pest Management (IPM) practices varied between districts. In Lalitpur, 25% of respondents used botanical pesticides like Jholmal, while in Bhaktapur, 27% of respondents used them. The use of pheromone traps such as TLM lure and Helilure was reported by 33% of respondents in Lalitpur and 27% in Bhaktapur. Yellow sticky traps, a common method for controlling aphids and whiteflies, were used by 45% of respondents in Lalitpur and 50% in

Bhaktapur. Chemical pesticides were still widely used, with 81% of respondents in Lalitpur and 79% in Bhaktapur relying on them for pest control (Table 2).

Table 1. Major Tomato Pest Species

Pest Name	Local Name	Scientific Name	f, %
South American Tomato Leaf Miner	Paat Khane Kira	*Tuta absoluta* (Meyrick)	36
Tomato Fruit Borer	Gabaroo	*Helicoverpa armigera* (Hubner)	19
Whitefly	Seto Jhinga	*Bemisia tabaci* (Gennadius)	29
Aphid	Lahi	*Aphis gossypii* (Fabricius)	13
Tobacco Caterpillar	Surti Ko Paat Khane Kira	*Spodoptera litura* (Glover)	3

(Source: Field survey, 2024)

These findings align with the study by Joshi et al. (2017), which reported the widespread use of both chemical and biopesticide methods, including botanicals and pheromones, for managing pests like *T. absoluta* and *Helicoverpa armigera*.

Table 2. Adoption of IPM Practices

Practices	Target insect pests	Respondents in			
		Lalitpur		Bhaktapur	
		f	%	f	%
Botanicals (Neemazin, Jholmol)	Aphids, Tomato leaf miner	23	25	24	27
Pheromones such as TLM lure, Helilure	*Tuta absoluta* (Meyrick), Tomato fruit borer	30	33	24	27
Yellow sticky trap	Aphids, whiteflies	41	45	45	50
Cow urine	Whitefly	12	13	11	12
Chemical method	Tomato leafminer, Tomato fruit borer, whitefly, aphids	73	81	71	79

(Source: Field survey, 2024)

Effectiveness of IPM Components in Pest Reduction

The effectiveness of various Integrated Pest Management (IPM) components was demonstrated by significant reductions in pest populations. Biological control, such as using *Coccinellidae* and *Trichogramma* species, reduced tomato fruit borer larvae from 90-100 per 100 plants to 20 (Table 4). Neem-based botanical pesticides reduced whiteflies from 1000 to 150-200, while pheromone and yellow sticky traps decreased pest larvae of *Tuta absoluta*, *Helicoverpa armigera*, aphids, and whiteflies from 120-150 to 20-30 per plant. Mechanical controls like hand-picking reduced aphid and *Tuta absoluta* larvae from 250-300 to 50-60 per acre (Table 3). These results suggest that IPM components, particularly biological control and the combination of pheromone and sticky traps, effectively reduce pest populations and, consequently, the need for chemical pesticide use.

Table 3. Effectiveness of IPM Components in Pest Reduction

IPM Components	Pest Species Targeted	Initial pest Populations (Before IPM)	Final Pest Populations (After IPM)
Biological control (E. g: Coccinellidae, Trichogramma species)	Tomato fruit borer	90-100 larvae per 100 plants	20 larvae per 100 plants
Botanical pesticides (Neem)	Whitefly	Around 1000 Whiteflies	150- 200 whiteflies
Pheromone Traps (E. g: TLM lure, Helilure) and Yellow sticky traps	*Tuta absoluta* (Meyrick), *Helicoverpa armigera* (Hubner), Aphids and whitefly	120-150 larvae/plant	20-30 larvae/plant
Mechanical control (Hand-picking)	Aphids, *Tuta absoluta* (Meyrick)	250-300 larvae/acre, 500-600 aphids/acre	50-60 larvae/acre, 100 aphids/acre

(Source: Field survey, 2024)

Comparison of Yield and Pest Damage with and without IPM

The study reveals that Integrated Pest Management (IPM) significantly improves tomato yields and pest control in Lalitpur and Bhaktapur. IPM-treated fields outperformed non-IPM fields, with yields in Lalitpur ranging from 50,000-80,000 kg/ha, compared to 25,000-50,000 kg/ha in non-IPM fields (Table 5). In Bhaktapur, IPM-treated fields yielded 50,000-75,000 kg/ha, while non-IPM fields ranged from 20,000-45,000 kg/ha. Marketable yields were also higher in IPM fields (80-90%) versus non-IPM (60-80%). Additionally, pest damage was lower in IPM-treated fields, with damage in Lalitpur (10-20%) and Bhaktapur (15-20%), compared to 30-50% in non-IPM fields (Table 5). These findings demonstrate that IPM practices not only boost yield but also reduce pest damage, highlighting its effectiveness as a sustainable and economically viable pest management strategy. However, the low adoption rate of IPM training among farmers calls for greater educational efforts to expand its use.

Cost-Benefit Analysis of IPM Strategies in Lalitpur and Bhaktapur

The cost-benefit analysis of IPM strategies in both Lalitpur and Bhaktapur districts highlights the profitability and effectiveness of various IPM components. In Lalitpur, biological control demonstrated the highest potential for profit, with net profits ranging from Nrs. 95,000 to 300,000, although at a higher cost (Nrs. 18,000-30,000/ha). Botanical pesticides and mechanical control were also cost-effective, generating net profits of Nrs. 1,340,000 and 1,450,000, respectively (Table 5).

Table 4. Comparison of Yield and Pest Damage: (IPM vs. Non-IPM Fields)

District	Field Type	Average Yield (Kg/ha)	Marketable Yield (%)	Crop Damage by Pests (%)	Increase in Yield (IPM vs. Non-IPM)
Lalitpur	IPM Treated	50,000-80,000	80-90	10 – 20	(10 –15) % But, can vary widely
	Non- IPM Treated	25,000-50,000	60-80	30 – 50	Depends on variety and local pest pressures
Bhaktapur	IPM Treated Fields	50,000-75,000	80-90	15-20	(8 –15) % But, can vary widely
	Non- IPM Treated Fields	20,000-45,000	50-80	35-50	Depends on variety and local pest pressures

(Source: Field survey, 2024)

Table 5. Table-Cost-Benefit Analysis of IPM Strategies in Lalitpur district

IPM Components	Cost (Nrs/ha)	Yield (Kg/ha)	Gross Income (Nrs/ha)	Net Profit (Nrs/ha)
Biological control	18,000-Nrs. 30,000	50,000-70,000	2,500,000	95,000 - Nrs. 300,000
Botanical Pesticides	1000-Nrs. 10,000	45,000-80,000	1,350,000	1,340,000
Pheromone Traps	2000- Nrs. 9000	30,000-80,000	900,000 - 150,000	1,40,000
Mechanical Control	5000- Nrs. 8000	20,000-60,000	600,000 - 1,500,000	1,450,000

(Source: Field survey, 2024)

Table 6. Table-Cost-Benefit Analysis of IPM Strategies in Bhaktapur district

IPM Components	Cost (Nrs/ha)	Yield (Kg/ha)	Gross Income (Nrs/ha)	Net Profit (Nrs/ha)
Biological control	15,000-Nrs. 30,000	50,000-75,000	2s,500,000	80,000- . 2,470,000
Botanical Pesticides	1000-Nrs. 12,000	40,000-80,000	2,000,000	1,988,000
Pheromone Traps	2000- Nrs. 10,000	30,000-70,000	1,500,000	1,490,000
Mechanical Control	4000- Nrs. 8000	30,000-60,000	1,500,000	1,492,000

(Source: Field survey, 2024)

In Bhaktapur, biological control showed impressive returns with net profits reaching up to Nrs. 2,470,000, while other methods, such as botanical pesticides and mechanical control, also yielded strong profits (over Nrs. 1.9 million) (Table 6). Overall, the data suggests that while biological control and botanical pesticides are costly, they offer substantial returns, making them favorable options for farmers. This emphasizes the viability of IPM in enhancing both productivity and profitability across districts.

CONCLUSION

This study evaluated the adoption and effectiveness of Integrated Pest Management (IPM) practices for controlling insect pests in tomato farming in Lalitpur and Bhaktapur districts. While traditional pesticide-based methods predominated, some farmers unknowingly practiced IPM techniques, such as using traps and lures, which showed significant reductions in pest populations and crop damage. IPM-treated fields demonstrated higher yields, better marketable produce, and less pest damage compared to non-IPM fields. Despite these positive outcomes, the adoption of IPM remains low due to a lack of awareness, training, and limited access to necessary resources. The cost-benefit analysis revealed that although IPM methods like biological control and botanical pesticides involved higher initial costs, they were profitable in the long run.

The findings highlight the effectiveness of IPM in improving yield and reducing pest damage but also point to the need for greater awareness and education among farmers. Overcoming barriers such as high initial costs and resource limitations will require targeted training, policy support, and stronger research and extension services. By addressing these challenges, IPM adoption can be expanded, ensuring sustainable and economically viable pest management for tomato farmers in these districts.

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