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Management of mites and thrips in capsicum under polyhouse through front line demonstration in Bengaluru rural district, Karnataka, India

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Abstract
Mites and thrips are critical pests infesting capsicum crop. It causes economic losses of 50%. A study on management of these pests was conducted at Doddaballapur taluk by ICAR-KVK, Bengaluru Rural district, through front line demonstration during 2022-2023. The results indicated that the mites and thrips infestation under front line demonstration was 62.72% lower than the actual plots under farmer's practice. The marketable yield obtained under front line demonstration was maximum (37.49 t/ha) and was minimum under farmer's practice plots (27.21 t/ha). The analysis of cost economics revealed that the net returns (5,96,431.80 Rs/ha) and B:C ratio (2.74) were maximum under front line demonstration plots and were lesser in farmer's practice plots (3,94,476.00 Rs/ha and 2.38, respectively). The analysis of gaps: total yield gap, technological gap, extension gaps in the study revealed that there is a need to bridge the gaps through proper training, method demonstration, dissemination of technological interventions, instilling coordination and removal of circumstantial differences between the farmers, researchers, and scientists, and convincing the farmers to adopt improved practices for the commercial production of capsicum.

Keywords: Capsicum, mites, thrips, demonstration, gaps

Introduction

India is a hub of fruit and vegetable cultivation; vegetables occupy every corner of our country under varied agro-climatic and soil conditions. India holds second place in the production of vegetables across the world (200.30 million metric tons); our countries vegetable production is totally concentrated on ginger and okra production (Anon., 2024) [4]. Indian vegetables present numerous opportunities for export (Vishal *et al*., 2017) [40]. Capsicum is one of the commercial vegetables cultivated for consumption as a vegetable and also for export purposes. India contributes one fourth of world production of capsicum, with an average annual production of 0.9 MT from an area of 0.885 million hectares (Kumar *et al*., 2016) [14]. In India, it is intensively cultivated in Karnataka, Maharashtra, Tamil Nadu, Himachal Pradesh, and hilly areas of Uttar Pradesh (Sunitha and Narasamma., 2017) [38].

Capsicum, also called pepper, is a major vegetable cum spice crop. It is cultivated all over the world for fresh, dried, and processing products (Pasquale and Sanjeet., 2019) [21]. It belongs to the Night Shade family 'Solanaceae' and originated in Tropical South America (Pramanik *et al*., 2020) [22]. The genus Capsicum comprises five domesticated species: *C. annuum*, *C. frutescens*, *C. chinense*, *C. baccatum*, and *C. pubescens*; these species are mainly grown for consumption (Pramanik *et al*., 2020) [22]. Capsicum is known as sweet pepper, bell pepper, or shimlamirch (Manjeet *et al*., 2017) [17], pimiento (Spanish), red pepper and pepper (English), pepper (Italian), piment (French), and paprika (German and other northern European languages). The color of the capsicum can be green, red, yellow, orange, and more rarely white, purple, blue, brown, and black, depending on time of harvest and the type of cultivar (Sunitha and Narasamma., 2017) [38]. The term "chili pepper" refers to varieties with small and spicy fruits, whereas "sweet pepper" refers to varieties with larger fruits and little or no spice (Pasquale and Sanjeet., 2019) [21]. Capsicum is an interesting and fascinating crop, extremely versatile, and suitable for innumerable uses such as food and non-food products and is commercially cultivated in India

(Manjeet *et al.*, 2017) [17]. Nowadays, progressive farmers are accepting protected cultivation of high value vegetables and flowers at a commercial scale (Maitra *et al*. 2020 and Sagar *et al*., 2020) [15 & 30]. Protected structures are utilized to cultivate several vegetables such as tomato, brinjal, chilli, capsicum, broccoli, cabbage, cauliflower, radish, carrot, spinach, coriander, lettuce, cucumber, bottle gourd, and bitter gourd, which have a great demand in the market due to their ample nutrients that have grasped the market by their availability in different seasons (Basabadatta *et al*., 2020) [7]. Protected cultivation of horticulture crops can be considered as a precise, progressive, parallel horticulture involving almost every aspect of cultivation, additionally subjected to extra supervision (Ramana *et al*., 2013) [29]. Similarly, capsicum cultivation under protected structures serves our farmers with better income compared to open field cultivation (Rakesh *et al*., 2024) [28]. It creates a suitable microclimate and controlled environmental conditions for cultivation, allowing for crop production to occur year round or only during certain periods of the year (Mahendra and Satyendra., 2024) [16]. Cultivation of capsicum during off season under shade net gives better yield as compared to open field conditions (Ghosal and Das., 2012) [10].

Capsicum fruits with mild pungency, medium size, tetra lobed fruits, longer shelf life, eye catching colour, and superior taste are suitable for the export market, but, the supply is inadequate in capsicum due to low productivity (Pramanik *et al*., 2020) [22]. This might be due to climate change, limited natural resources, diminution of cultivable land, higher input costs, shortage of man power, market price fluctuation, pest and disease infestation and hesitation among youth to choose farming as a career (Pramanik *et al*., 2020) [22].

Thrips and mites are destructive pests of capsicum and are major constraints in its production which limits growth, yield and quality. Thrips pierce and collapse the plant cells resulting in the formation of deformed flowers, leaves, stems, shoots, and fruits, besides causing the greatest threat to many other crops, through the thrips vectored tomato spotted wilt virus (TSWV) (Pramanik *et al*., 2020) [22]. The mites are commonly found on the upper part of the plant, feeding on the apical shoots and the abaxial side of young leaves (Abhishek and Radadia., 2018) [1]. Mites are considered to be cell feeders, feeding of these mites will lead to downward curling of leaves, elongation of petioles on older leaves and clustering of tender leaves at the tip of the branches. The growth of the plant is arrested and the entire plant look like a leaf curl plant (Gupta *et al*., 2021) [11]. Mites and thrips are detrimental (Figure 1), which causes an overall yield loss of 50 per cent if not controlled. Hence, to manage these pests, appropriate measures have to be adopted. Therefore, an FLD was conducted to manage mites and thrips in capsicum under protected cultivation.

The primary objective of front line demonstrations are to demonstrate the recently released or newly released crop production and protection technologies, crop management techniques in the farmer's field under various agro climatic regions and farming situations. The FLD's enable to persuade farmers and extension agents to collaborate on the dissemination of capsicum production technologies on a larger scale. The impact of FLDs must be evaluated in light of an efficient expansion technique of front-line demonstrations for diffusion of capsicum production technology. The current study was therefore carried out with the particular objectives

1. To assess the technologies for management of mites and thrips in capsicum under polyhouse as package of practices under front-line demonstration.
2. To study the yield gap identified in capsicum production in BRD district.
3. To study the yield and economics of capsicum production before and after front line demonstration.

Material and Methods

Capsicum growing farmers were identified and selected for demonstrating FLD on management of thrips and mites in capsicum under polyhouse. A random sample survey was carried out by Participatory Rural Appraisal (PRA) by ICAR Krishi Vigyan Kendra, Bengaluru Rural District (Swapnil., 2014) [39] to select respondents, and the data was collected before and after front line demonstration by personal interview. The front line demonstration on management of mites and thrips in capsicum under polyhouse was conducted at 10 selected farmer's fields of each 300 m^2 area at Turuvanahalli, Doddaballapura Taluk, Bengaluru Rural District, Karnataka state, during the year 2022-23 under ICAR-KVK Bengaluru Rural District.

The demonstrated package of practices (NBAIR & IIHR, Bengaluru, 2020) and farmers practices followed for management of mites and thrips in capsicum under polyhouse in Bengaluru Rural district are presented in Table 1. Proper skill training and capacity training was provided to the respondents. The demonstration of various methods on adopted technologies was carried out to encourage the farmers to utilize the recently released technologies. The critical inputs were supplied to the farmers (Figure 4) and applied as per the package of practices for the capsicum crop for management of mites and thrips recommended by the National Bureau of Agricultural Insect Resources (NBAIR) and the Indian Institute of Horticulture Research (IIHR), Bengaluru, Karnataka, 2020. The crop was sown during rabi season under the supervision of scientists, ICAR-KVK, Bengaluru Rural District. The farmers were guided, and FLD fields were monitored regularly by Scientist, KVK, Bengaluru Rural District, from sowing to harvest, followed by marketing (Figure 5). The recommended package of practices was adopted regularly after the establishment of the crop. The technologies suggested by NBAIR and IIHR were adopted and followed for the crop growth and management of mites and thrips in capsicum under polyhouse. The crop growth, development, and total performance were observed periodically, and farmers were supervised by the scientists of ICAR-KVK, Bengaluru Rural district.

The data on pests and disease incidence was collected from both the demonstration fields and farmer's practice fields. The demonstrated plot yield was obtained from front line demonstrations conducted in the farmer's field under the close supervision of scientists from Krishi Vigyan Kendra, Bengaluru Rural District. Further, information on actual yield obtained by the farmers on their farms under their own management practices was collected.

The total yield gap, technology gap, extension gap and technology index were worked out as per the formula suggested by Samui *et al*. (2000) [31] and Dayanand and Mehta (2012) [8] as given below:

1. Total yield gap = Potential yield - Farmer's practice yield
2. Technology gap = Potential yield - Demonstration yield.
3. Extension gap = Demonstration yield - Farmer's practice yield.
4. Total yield index = (Potential yield - Farmer's practice yield) ×100 /Potential yield.
5. Technology index = (Potential yield - Demonstration yield) ×100 /Potential yield.
6. Extension index = (Demonstration yield - Farmer's

practice yield) x 100/ Demonstration yield.

Per cent increase in yield is another important aspect that determines the actual difference between the yield in demonstrated plots and farmer's practice plots. It is determined by the formula given below

per cent increase in yield = (Demonstration yield - Farmer's practice yield / Farmer's practice yield) × 100.

The cost economics of capsicum cultivation in polyhouse under demonstration and farmer's practice was calculated as per the formulas given below:

1. Gross returns (Rs/ha) was calculated based on total yield/ha and prevailing market price of capsicum (25 Rs /Kg). This was expressed as total income per hectare.
2. Net Return = Gross Return – Cost of cultivation
3. Benefit/ Cost Ratio = Net Return / Cost of Cultivation x 100

Fig 1: Mites and thrips infestation in capsicum under polyhouse

Fig 2: Capsicum cultivation under front line demonstration

Fig 3: Healthy capsicum fruits under front line demonstration

Fig 4: Distribution of inputs to capsicum FLD farmers in Bengaluru Rural District

Fig 5: Supervision of capsicum crop in polyhouse under FLD by ICAR-KVK BRD Scientist

Table 1: The demonstrated package of practices (NBAIR & IIHR, Bengaluru, 2020) and farmers practices followed for management of mites and thrips in capsicum under polyhouse in Bengaluru Rural district

Sl. No.	Package of practice	Front line demonstration (Demonstrated package)	Farmers practice	Gaps
1.	Seedling treatment	Spraying Imidacloprid (0.3 ml/l)	Not in practice	Full gap
2.	Transplanting	Transplanted at 60 x 30 cm on raised beds	Transplanted at 60 x 30 cm on raised beds	No gap
3.	Application of manures	FYM at 5.0 kg/m^2 along with neem cake at 200 g/m^2	FYM: 3 kg/m^2	Partial gap
4.	Application of nutrients	NPK-150:150:150 kg/ha supplied by water soluble fertilizers through fertigation during entire crop growth period of 6-8 months.	Imbalance and inadequate application of nutrients, and some farmers have resorted to application of only urea.	Full gap
5.	Irrigation	Irrigation at weekly intervals	Irrigation at weekly intervals	No gap
6.	Earthing up	Light earthing up after 30 and 45 DAT	Light earthing up at 45 DAT	Partial gap
7.	Weeding	Hand weeding through out entire crop duration	Carried once in entire crop duration	Partial gap
8.	Training	Capsicum plants are trained to retain 2-4 stems per plant.	Adopted to some extent	Partial gap
9.	Application of vegetable special	Foliar spray of vegetable special 75 g + 15 L water + 1 lemon + 1 shampoo (Rs. 1) at 25-30 DAT and at 20-25 days after first spray	Not in practice	Full gap
10.	Plant protection measures to manage mites and thrips	Spraying of Shatpada All Rounder – 20g/L at 20, 30, 40 & 50 DAT	Farmers have no information about this bio formulations	Full gap
		Installation of blue sticky cards – 10 no.s/acre	Adopted to limited extent	Partial gap
		Spraying of Spinosad – 0.25ml/L	Irrespective of occurrence of pests, farmers have adopted spraying of various plant protection chemicals	Full gap
		Spraying of abamectin – 0.5 ml/L	Indiscriminate pesticide application	Full gap
11.	Harvesting	Manual harvesting of fruits at right stage	Manual harvesting of fruits at right stage	No gap

Results and discussion

The perusal of data presented in Table 2, depicts that the plant height was maximum (178.702 cm) under demonstration plots whereas the plant height was lower (122.17 cm) under farmer's practice plots. Similarly, the number of branches per plant produced was maximum (8.70) under demonstration plots and was minimum (6.20) under farmer's practice plots. This is due to the suitableness of environmental conditions inside polyhouse, which facilitated vigorous cell division and enlargement in the terminal plant parts that enhanced plant height, more leaves per plant, more branches per plant and overall plant growth. The number of branches per plant is an important attribute of productivity and quality in capsicum, higher number of branches will improve yield by inducing bigger, quality fruits by better supply of nutrients, penetration of light and air (Pramanik *et al.*,2021) [23]. The infestation of mites and thrips was 9.04% in demonstration plots and 24.30% in farmer's practice plots that is 62.79% less infestation in demonstration plots.

The yield and marketable (Table 2 and Figure 2) obtained under front line demonstration were higher (40.27 t/ha & 37.49 t/ha, respectively) compared to the actual yield obtained under farmer's practice plots (32.33 t/ha & 27.21 t/ha). The number of fruits per plant obtained under demonstration plots was 15.49 and the number of fruits per plant obtained by the farmers on their farm with their own resources and management practices was 10.52. This depicts that, the yield of capsicum under FLD plots was improved by 37.78%. This is due to the adoption of improved package of practices during capsicum cultivation under FLD plots (Figure 2 and 3). Manjeet *et al.* (2017) [17] experiment on capsicum under polyhouse is the best example that supports the current results. The results reported by Prasanta *et al.* (2014) [24], Shamsher *et al.* (2014) [32], Dhaka *et al.* (2015) [9], Mansoor *et al.* (2018) [18], Balkaran and Nirmaljit (2019) [6], Kamal *et al.* (2020) [13], Ashok *et al.* (2020) [5], Rai *et al.* (2020) [25], Shivran *et al.* (2020) [33], Singh *et al.* (2020) [37], Ambreen *et al.* (2021) [3], Narendar *et al.* (2023) [19] and Singh *et al.* (2023) [34] lend support to the present findings. Thus, it is evident that the performance of the demonstrated technology was found to be better than the farmer's practice under the same environmental conditions. The plant height, number of primary branches, number of fruits per plant and yield per hectare were high in demonstration plots. This is because the mites and thrips infestation was lower (62.72%) because of application of the Shatpada All Rounder (20 g/L) at 20, 30, 40 and 50 DAT, spraying of Spinosad (0.25 ml/L), spraying of abamectin (0.5 ml/L) and installation of blue sticky cards (10 no's/acre) as recommended by NBAIR and IIHR (2020). These technologies have assisted the crop to gain healthy growth, overcome mites and thrips infestation to maximum extent and to yield better. The fruits obtained were sold which has met consumer satisfaction.

Table 2: Pest and disease incidence and yield of capsicum under FLD and Farmer's practice plots in Bengaluru Rural district

Sl. No.	Parameters	FLD plots	Farmer's practice plots
1	Mites & thrips incidence (%)	9.04	24.30
2	Plant height (cm)	178.70	122.17
3	No. of branches/plant	8.70	6.20
4	No. of fruits/plant	15.49	10.52
5	Yield (t/ha)	40.27	32.33
6	Marketable yield (t/ha)	37.49	27.21
7	Percent increase in yield	37.78	-

*10 farmer's fields mean

Economics of capsicum cultivation under FLD and Farmer's practice

The assessment of cost economics (Table 3) of capsicum cultivation under FLD and farmer's practice plots revealed that maximum gross and net returns were obtained in FLD plots (9,37,250.00 Rs/ha & 5,96,431.00 Rs/ha, respectively); low gross and net returns were obtained under farmer's practice plots (6,80,250.00 Rs/ha & 3,94,476.00 Rs/ha). The benefit cost ratio of recommended technology (2.74) was also higher than farmer's practice fields (2.38). The benefit cost ratio proved the economic feasibility and utility of the assessed technology. The reports by Ngullie *et al.* (2016) [20], Rajpoot (2020) [27], Singh and Sanjai (2020) [35] and Adhi *et al.* (2022) [2], lend support to the current findings.

Table 3: Economics of capsicum production under FLD and Farmer's practice plots in Bengaluru Rural district

Sl. No.	Items	FLD plots	Farmer's practice plots
1	Cost of cultivation (Rs/ha)	340818.20	285774
2	Gross return (Rs/ha)	937250.00	680250.00
3	Net return (Rs/ha)	596431.80	394476
4	B:C ratio	2.74	2.38

The analysis of gaps and percentage index of capsicum cultivation in polyhouse

The gaps presented in Table 4 indicate that, there was quite a difference between the farmers practice yield and the demonstrated plot yield. The total yield gap depicted that, the farmer's practice yield was less than the potential yield and the demonstrated yield. The total yield gap can be justified by the circumstantial differences between extension workers, and farmers' fields and farmers' unwillingness to adopt production technology. It can be attenuated through considerable coordination among the researchers, extension workers, and farmers. The adoption of improved technologies under demonstration plots, variations in soil fertility, and the whims of the environment in both the demonstration area and farmer's practice plots are responsible for the extension gap (Singh and Bisen. 2020, Narendar *et al.*, 2023) [36 & 19]. The disparity between the technologies adopted under FLD and farmer's practice plots under local weather conditions accounts for the technology gap. The technology index indicates the sustainability of the demonstrated technology, including the farmer's practice. To narrow the technological gap, it is necessary to suggest a location specific package of practices that deals with critical issues such as pests, diseases and cultivation aspects to increase production. The demonstrations proved to be a effective tool for spreading knowledge about the scientific production technology. It successfully raised awareness and inspired non-beneficiary farmers to fully embrace the technology by instilling confidence in them. The present findings of extension gap, technology gap and technology index are consistent with Hiremath and Hilli (2012) [12]., Ngullie *et al.* (2016) [20], Rai *et al.* (2020) [25] and Raja *et al.* (2022) [26].

Table 4: Analysis of gaps and percentage index in capsicum yield cultivated under polyhouse in Bengaluru Rural district

Sl. No	Particulars	Yield (t/ha)	Percentage index
1	Potential yield	60.00	-
2	Demonstrated yield	37.49	-
3	Farmer's practice yield	27.21	-
4	Total yield gap	32.79	54.65
5	Technological gap	22.51	37.51
6	Extension gap	10.28	28.22

Conclusion

Mites and thrips are important pests in capsicum, which cause crop and yield losses to a greater extent. The protection practices adopted by farmers have become outdated. The technologies recommended by NBAIR and IIHR (2020) will control mites and thrips, and in turn, reduce additional costs employed on unnecessary plant protection chemicals. The mites and thrips were managed to maximum level compared to farmer's practice plots and the yield obtained was higher in demonstration fields than in the farmer's practice fields. From this study, it was found that, proper technical support and training for the farmers is quite necessary for early adoption of technological interventions to produce high yield and quality fruits. Thus, the front line demonstration served as an effective method in persuading the farmers for the adoption of new technologies to manage mites and thrips in capsicum under polyhouse.

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