Eco friendly management of pest and diseases in Cauliflower through front line demonstrationat farmer's field in Doddaballapur taluk, Bengaluru Rural District, Karnataka, India.

Abstract

A study on eco-friendly management of pests and diseases was carried atDoddaballapur taluk by ICAR-KVK, Bengaluru Rural District, through front linedemonstration during 2022-2023. The results indicated that infestation of diamondback moth and black rot was observed both under farmer's practice plots and front-line demonstration plots. The infestation of DBM was 7.36 % and 29.32 % in FLD plots and farmer's practice plots, respectively. Similarly, black rot incidence was 5.21 % and 16.62 % in demonstration plots and farmer's practice plots, respectively. The weight of curd and total yield obtained under front line demonstrationwas maximum (2.234 kg/ plant and 26.29 t/ha) and was minimum under farmer's practice plots (1.258 kg/plant and 22.98 t/ha). The analysis of cost economics revealed that higher gross and net returns and BC ratio were obtained in FLD plots (4,73,220 Rs/ha, 2,87,043.20 Rs/ha, and 2.54, respectively); low gross and net returns and BC ratio were obtained under farmer's practice plots (4,13,640 Rs/ha, 2,45,588.20 Rs/ha, and 2.46, respectively). Theanalysis of gaps: total yield gap, technological gap, extension gaps and extent of adoption after FLD revealed that there is a need to bridge the gaps through proper training, methoddemonstration, dissemination of technological interventions, instilling coordinationand removal of circumstantial differences between the farmers, researchers, andscientists, and convincing the farmers to adopt improved practices for management of diamondback moth and black rot in cauliflower.

Keywords:cauliflower, diamondback moth, black rot, front line demonstration, Bengaluru Rural District.

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Introduction

In India, vegetables occupy every part of our country under varied agro-climatic and soil conditions in plains and hilly regions. 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 [1]. Indian vegetables present numerous opportunities for export [2]. Crucifers are a novel group of vegetables that occupy a major space in the Indian vegetable basket. Cruciferous vegetables are temperate crops, which include cauliflower, cabbage, kale, garden cress, bok choy, broccoli, Brussels sprouts, mustard plant, collard greens, horseradish, kale, kohlrabi, radish, rutabaga, turnips, water cress, arugula, and wasabi.

Cauliflower is a commercially important vegetable cultivated or curd; curd is the edible part, which consists of the shoot with short internodes, branches, bracts, and apices. The name cauliflower is derived from two Latin words, 'caulis' means stem and 'floris' means flowers [3,4]. Cauliflower, *Brassica oleracea* var. *botrytis* (2n=18) of the family Cruciferae [4] has high quality proteins and is special in the stability of vitamin C after cooking. Cauliflower has high nutritional value due to high levels of "phytochemicals," such as antioxidant compounds, glucosinolates, vitamins, carotenoids, and phenolic compounds. Integrating phytochemicals in our daily diet has profound beneficial effects on our health, which will slow down the development of chronic diseases (various types of cancer and coronary heart disease) [5]. It is rich in vitamin B complex (B1, B2, B3, B5, B6, folic acid), vitamin C, E, K, omega-3 fatty acids, dietary fiber, and minerals (potassium, phosphorus, magnesium, manganese, and iron). Cauliflower is the richest source of Indole-3-carbinol and sulforaphane, which are anti-inflammatory and anticancerous in nature [6]. White-curded cauliflower cultivars are popular, and there are other commercially available types; green, purple, and orange curds, with enhanced synthesis of chlorophylls, anthocyanins, and carotenoids, respectively [7]. Cauliflowers are widely used as a dish or an ingredient of soups or salads, consumed both as raw and cooked [8].

Cauliflower is a commercial crop in India; it occupies an area of 486 ha with 9536 mt of production [9] and it contributes tremendously to GDP of India [10]. India is the second largest producer of cauliflower in the world [11]. The major cauliflower producing states are West Bengal(26 %), Bihar (17 %), Madhya Pradesh (10 %),

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Orissa (10 %), Gujarat (8 %), Haryana (7 %), Assam (6 %) and Maharashtra (3 %). Karnataka's cauliflower production is about 120.28 tons [12]. In Bengaluru Rural District, cauliflower accounts for 195 ha area, 3329 t of production, and 17.07 t/ha of productivity.

The crop is found to be affected by pests and diseases, mostly by diamondback moth (DBM) and black rot which cause 50 % crop loss. The crop damage by the diamondback moth is due to larval feeding. The larvae typically feed on theunderside of the leaves, rasping the epidermis except the leaf veins and generating a characteristic "window panning" or 'perforations' or "shot-holes'' appearance. The appearance of whitishpatches on leaves can be seen as a result of the scraping by the young larvae. Webbing can be observed on the undersides of leaves, leaf axils, or growing tips. The larvae cause damage to the crowns or growing points of young plants, leading to growth stunting. Feeding on heart leaves before heading can affect flower production and yield in certain cruciferous crops. The presence of frass or excrement of the larvae on the leaves or often near the feeding sites can be observed. The presence of larvae in the curds of cauliflower will result in rejection of the produce. The larvae are small and be numerous, they damage seedlings, and may disrupt head formation in cabbage, broccoli, and cauliflower.

Brassicaceae vegetables are susceptible tonumerous fungal and bacterial pathogens. *Xanthomonascampestris* pv. *campestris* (*Xcc*) [13] is a black rot (BR) causing pathogen and is one of the most destructive and yield-limiting diseases of Brassicaceae vegetables [14,15,16]. Seedborne *Xcc* can survive in crop debris or crucifer weeds. At temperatures between 25–30°C and with sufficient rainfall or heavy dew, *Xcc* enters the host plant vascular system through hydathodes or wounds caused by machinery or insects [14]. The typical symptoms ofbacterium infestation are vein blackening, leaf tissue necrosis, and V-shaped chlorotic lesions [17]. However, symptoms of BR may differ among different Brassicaceae vegetables. These symptoms reduce the quality and value of the Brassicaceae, a crop in which the leaves are the major commercial product [14]. Indeed, in some cases, Brassicaceae crops can be entirely lost to BR [18].

It was estimated that, diamondback moth (DBM) causes > 37 % crop loss, black rotcauses > 10 % crop loss. Other pests that cause damage to cauliflower are

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aphids, and leaf webber, rendering poor quality curds. To manage these pests and diseases, farmers are indiscriminately using pesticides, which is hazardous to human health. The crop has potential for performance; therefore, eco friendlymanagement of these pest and disease is need of the hour hence, a front line demonstration (FLD) was conducted on cauliflower in Bengaluru Rural District, Karnataka.

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Front line demonstration is an efficient way to introduce recommended technology among the farmers. The demonstration of the technologies developed at the agricultural universities and research stationsthrough research activities in farmer's fieldsthat are newly released crop production and protection technologies and their management practices under different agro-climatic regions and farming situations is demonstrated to farmers on their own field through FLDs. It is one of the most effective tools of extension because the new interventions will be propagated in front of the farmers so that they can have a practical experience of the technology and will adopt the same in their farming.

The objectives of the study were

1. To study the effectiveness of technological interventions in management of diamondback moth (DBM) and black rot in cauliflower
2. To study the extent of adoption of technologies for eco-friendly management of pest and diseases in cauliflower as package of practices before and after the conduct of a front line demonstration.
3. To study the yield gap identified in cauliflower production in Bengaluru Rural District
4. To study the yield and economics of cauliflower production before and after front line demonstration

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Material and methods

A front-line demonstration was conducted on eco-friendly management of pests and diseases in cauliflower at selected farmer's field in Bengaluru Rural District, Karnataka State during *rabi* 2022-23. The respondents were selected, and the data was collected by ICAR Krishi Vigyan Kendra, Bengaluru Rural District, through a random sample survey using participatory rural appraisal (PRA) [19] (Swapnil., 2014). The data was collected before and after front line demonstration by personal interview.

Ten cauliflower growing farmers were identified and selected for demonstrating the FLD in cauliflower at Sonnamaranahalli, Doddaballapura Taluk, Bengaluru Rural District under ICAR-KVK Bengaluru Rural District. The technological interventions and farmer practices adopted in front line demonstration fields and farmer's practice fields are presented in Table 1. Proper skill training, capacity training, and method demonstrations on adopted technologies were provided to the respondents. The critical inputs (Fig. 1) were supplied to the farmers and applied as per the package of practices for the cauliflower crop recommended by the University of Agricultural Sciences, GKVK, and the Indian Institute of Horticulture Research,Bengaluru, Karnataka, 2019. The crop was sown during the month of December, and the farmers were guided, and FLD fields were monitored regularly by Scientist, KVK, Bengaluru Rural District, from sowing to harvest, followed by marketing. After the establishment of the crop, timely adoption of the recommended package of practices and eco-friendly management of pests and diseases were followed. The crop growth, development, and total performance were periodically observed, and farmers were supervised by the scientists of KVK, Bengaluru Rural District.

The data on pests and disease incidence was collected from both the demonstration fields and farmer's practice plots. 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 and the information on actual yield obtained by the farmers on their farms under their own management practices was collected. A field day on eco friendlymanagement of pests and diseases was conducted in the FLD farmers field near to harvest of the crop (Fig.3). This is an important event that focuses on showcasing the latest technologies, creating a platform forfarmers, scientists, and extension workers to exchange knowledge and experiences. Farmers receive training on various aspects in horticulture (IPM, IDM, INM, organic farming techniques) and field days aim to disseminate sustainable technologies that emphasize on eco-friendly management practices, which helps farmers adopt methods beneficial for the environment and economically viable.

The total yield gap, technology gap, extension gap and technology index were worked out as per the formula suggested by Samui et al. (2000) and Dayanand and Mehta (2012) [20, 21] as given below:

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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

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Percent increase in yield: To determine the efficiency of front line demonstration, percentage increase in yield should be calculated. The higher the percentage yield the more efficient is the technologies adopted for raising the crop. Percentage increase in yield is determined by the following formula

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

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The cost economics of cauliflower cultivation under demonstration fields and farmer's practice fields are calculated as per the formulas given below:

1. Gross returns (Rs/ha)was calculated based on total yield/ha and prevailing market price of cauliflower curd (18 Rs./curd). 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

Results and discussion

The results obtained from the present investigation have been summarized as follows. A comparison of disease, pest infestation levels, and yield between demonstration and farmer's practice plots is shown in Table 2. It is evident from the results that, under the demonstrated plots, performance of cauliflower (yield) was higher than under farmer's practice in Bengaluru Rural District.

Pest and disease incidence in cauliflower plots

The diamondback incidence in cauliflowerdemonstration plots was 7.36 % which was less compared to farmer's practice plots, 29.32 %.Similarly, black rot incidence was

5.21 % and 16.62 % in demonstration plots and farmer's practice plots, respectively (Table 2).

Though aphid is another major pest on cauliflower in the district, there was no occurrence of aphid in both demonstration plots and farmer's practice plots during the demonstration period. This was due to the unfavourable climatic conditions for aphid infestation. The alternative management of DBM and black rot through eco-friendly practices (Table 1) has proved to be better technology compared to the traditional farmer's practice of resorting to non adoptionof integrated and eco-friendly plant protection methods; non adoption of need based cultivation practices, and excess/indiscriminate application of chemicals that have and will further harm the environment, health, and crop condition; [22,23,24,25].

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Yield analysis of cauliflower under front line demonstration and farmer's practice plots

The data presented in Table 2, depicts that the demonstration plot yield obtained through front line demonstration was 26.29 t/ha, and the actual yield obtained by the farmers on their farm with their own resources and management practices was 22.98 t/ha. The results indicate that, FLD plots recorded a mean production improvement of 14.40 % as compared to plots under farmer's practices (Table 3).Under FLD, the weight of curd per plant was 2.234 kg/plant, which was higher compared to farmer's practice (1.258 kg/plant) [26, 27, 28, 29, 30, 31, 32, 33, 25]. 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.

Economics of cauliflower cultivation under FLD and farmer's practice plots

Cost economics (Table 3) evaluation of cauliflower under FLD and farmers practice revealed that higher gross and net returns were obtained in FLD plots (4,73,220 Rs/ha & 2,87,043.20 Rs/ha, respectively); low gross and net returns were obtained under farmers practice (4,13,640 Rs/ha & 2,45,588.20 Rs/ha). The benefit cost ratioofrecommended technology (2.54)was alsohigherthanfarmer'spractice fields (2.46). The benefit cost ratioprovedthe economic feasibility and utilityoftheassessedtechnology [25, 34, 35, 36, 37, 38].

The analysis of gaps and percentage index of cauliflower cultivation

The extension gap depicted in the present studyTable 4 is attributed to improved technology adopted in the demonstration. It is also attributed to dissimilarities in soil fertility, erratic rainfall, and other vagaries of weather in the demonstration area [36, 39]. The technology gap is due to dissimilarity between the adopted technology under FLD and the technology practiced by the farmers under local weather conditions. The technology index shows the practicability of the demonstrated technology, including the farmer's practice. To reduce the technology gap, a location-specificpackage of practices addressing the issue of importance, such as pests, diseases, and cultivation aspects to obtain a higher yield, has to be recommended. The total yield gap is attributed tothe situational differences betweenextension workers and farmers fields and the adoption of production technology by the farmers. It can be reduced through appreciable coordination between researchers, extension workers, and farmers. The demonstrations proved to be an effective tool for spreading knowledge about the scientific production technology. It successfully raised awareness and inspired non-beneficiary farmers to fully embrace the technologyby instilling confidence in them. The present findings of extension gap, technology gap, and technology index are in accordance with [25, 37, 40, 41, 42].

The adoption levels of package of practices in management of DMB and black rot in cauliflower at Bengaluru Rural District

After the front line demonstration, a survey on adoption percentage was conducted, and the results are presented in Table 5**.** The adoption percentage ranged from 22 to 71 % after the conduct of FLD for various management practices. The adoption level of new interventions is as follows: application of micro nutrients: Boric acid & Ammonium molybdate (54.29 %), vegetable special (62.86 %), sowing Mustard as trap crop (42.86 %), installation of WOTA-T traps (48.57 %), spraying of Neem Soap and Bt (71.43 %), Neem seed powder pellets (48.57 %) , use of blue Sticky cards (10 no./ acre) (40.00 %), spraying of Emamectin benzoate, Chlorfenapyr and Spinosad (37.14 %) , CoC + Streptocycline (60.00 %). The management practices for DBM and black rot were found to be effective as its practicability was experienced by the farmers, so that the adoption percentage for these practices increased gradually.

Conclusion

The adoption oftechnologies recommended by the University of Agricultural Sciences, GKVK, and the Indian Institute of Horticulture Research, Bengaluru (2019), forthe management of pests and disease in cauliflower through an eco-friendly approach has resulted in quality produce and increased productivity. Diamondback moth and black rot disease were managed to a maximum level compared to the farmer's practice field, and the yield obtained was greater in the demonstration fields than 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 quality yield.

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Table 1: The demonstrated package of practices (UAS, GKVK & IIHR, Bengaluru, 2019) and farmers practices for cauliflower crop management in Bengaluru Rural District

Sl. No	Package of practice	Front line demonstration (Demonstrated package)	Farmers practice	Gaps
1.	Soil testing	Carried out in all the FLD location	Not in practice	Full gap
2.	Variety	Dhaval	Dhaval	No gap
3.	Seedling treatment	Roots of seedlings are dipped in a solution of Bavistin (2 g/litre of water)	Not in practice	Full gap
4.	Transplanting	Transplanting in raised bed distance at 60 cm x 45 cm	Transplanted at 30 x 30 cm	Partial gap
5.	Gap filling	20-25 DAS to maintain the population and uniform growth.	Not in practice	Full gap
6.	Application of FYM and nutrients	FYM: 25 t/ha., RDF (120:80:80 kg/ha) Full dose of phosphorus and potash is applied during ploughing and field preparation. Half of nitrogen is applied at 7 DAT and the remaining half is top dressed after 30-35 DAT	FYM 10 t/ha, Imbalanced and inadequate application of nutrients, some farmers have resorted to application of only urea or complex fertilizers (17:17:17)	Full gap
7.	Irrigation	Drip or furrow method of irrigation at once in a week depending upon soil condition	Furrow method of irrigation once/twice in a week	No gap
8.	Earthing up	Carried at 30th day of planting	Not in practice	Full gap
9.	Weeding	Timely weeding at 30th and 45th day of planting.	Carried once in entire crop duration	Partial gap
10.	Application of micro nutrients	Spraying of Boric acid (0.3%) & Ammoniummolybdate (0.02%) 15 DAT @ 15 days interval (3 times)	Not in practice	Full gap

11.	Application of vegetable special	Spraying of vegetable special (5g/L) 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
12.	Sowing Trap crops	Inter-cropping with Mustard as trap crop (25:2)	Not in practice	Full gap
13.	Traps	Installation of WOTA-T traps (DBM traps) (Fig.2)	Have no knowledge about T traps	Full gap
14.	Application of neem based products	Spraying ofNeem Soap (10g/L) and Bt (2ml/L)	Not in practice	Full gap
		Spraying of Neem seed powder pellets (20g/L) @ 15 DAT and subsequent sprays at 8 days interval upto 70 DAT	Not in practice	Full gap
15.	Plant protection measures	Use of blue Sticky cards (10 no./acre)	Not in practice	Full gap
		Spraying of Emamectin benzoate 5SG (0.05%), Chlorfenapyr 10SC (0.1%) and Spinosad 2.5SC (0.15%)	* Indiscriminate pesticide application * Irrespective of occurrence of disease and pests, farmers have adoptedcombination spray of plant protection chemical with growth regulator without knowing the compatibility of chemicals * Pest and disease are not identified before spraying	Full gap
		Spraying of CoC + Streptocycline		Full gap
16.	Harvesting	Carried at right stage	Carried at right stage	No gap

Table 2: Pest and disease incidence and yield of cauliflower cultivation under FLD and farmer's practice condition

Sl No	Parameters	FLD plots	Farmer's practice plots
1	DBM incidence (%)	7.36	29.32
2	Black rot incidence (%)	5.214	16.62
3	Weight of curd per plant	2.234	1.258
4	Yield (t/ha)	26.29	22.98
5	Per cent increase in yield	14.40	-

*10 farmer's fields mean

Table 3: Economic analysis of cauliflower 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)	186176.80	168051.80
2	Gross return (Rs./ha)	473220.00	413640.00
3	Net return (Rs./ha)	287043.20	245588.20
4	B:C ratio	2.54	2.46

Table 4: Analysis of gaps and percentage index in cauliflower yield under FLD and farmer's practice plots in Bengaluru Rural District

Sl No	Particulars	Yield (t/ha)	Percentage index
1	Potential yield	48.00	-
2	Demonstrated yield	26.29	-
3	Farmers yield	22.98	-
4	Total yield gap	25.02	52.125
5	Technological gap	21.71	45.22
6	Extension gap	3.31	12.59

Table 5: The adoption level of package of practices in management of DMB and black rot in cauliflower at Bengaluru Rural District

Sl. No	Package of practice	Adoption(Before FLD)		Adoption(AfterFLD)		Increased adoption	
		No.	Per cent	No.	Per cent	No.	Per cent
1.	Soil testing	11.00	31.42	19.00	54.29	8.00	22.86
2.	Seedling root dip treatment with Bavistin (2 g/litre of water)	10.00	28.57	21.00	60.00	11.00	31.43
3.	Transplanting in raised bed distance at 60 cm x 45 cm	12.00	34.28	28.00	80.00	16.00	45.71
4.	Gap filling at 20-25 DAS	7.00	20.00	21.00	60.00	14.00	40.00
5.	Application of FYM and nutrients-FYM: 25 t/ha., RDF (120:80:80 kg/ha)	12.00	34.28	23.00	65.71	11.00	31.43
6.	Irrigation: once in a week	18.00	51.42	31.00	88.57	13.00	37.14
7.	Earthing up at 30th DAP	5.00	14.28	17.00	48.57	12.00	34.29
8.	Weeding at 30th and 45th day of planting.	12.00	34.28	23.00	65.71	11.00	31.43
9.	Application of micro nutrients: Boric acid (0.3 %) & Ammonium molybdate (0.02 %) 15 DAT @ 15 days interval	0.00	0.00	19.00	54.29	19.00	54.29
10.	Application of vegetable special (5 g/L)	5.00	14.28	27.00	77.14	22.00	62.86
11.	Sowing Mustard as trap crop (25:2)	2.00	5.71	17.00	48.57	15.00	42.86
12	Installation of WOTA-T traps (DBM traps)	5.00	14.28	22.00	62.86	17.00	48.57
13	Spraying of Neem Soap (10 g/L) and Bt (2 ml/L)	0.00	0.00	25.00	71.43	25.00	71.43
14	Spraying of Neem seed powder pellets (20 g/L) @ 15 DAT and subsequent sprays at 8 days interval upto 70 DAT	0.00	0.00	17.00	48.57	17.00	48.57
15	Use of blue Sticky cards (10 no./ acre)	9.00	25.71	23.00	65.71	14.00	40.00
16	Spraying of Emamectin benzoate 5 SG (0.05 %), Chlorfenapyr 10 SC (0.1 %) and Spinosad 2.5 SC (0.15 %)	7.00	20.00	20.00	57.14	13.00	37.14
17	Spraying of CoC + Streptocycline	5.00	14.28	26.00	74.29	21.00	60.00
18	Harvesting	15.00	42.85	30.00	85.71	15.00	42.86

*Total population: 35

Fig 1: Distribution of inputs to cauliflower FLD farmers in Bengaluru Rural District

Fig 2: Installation of DBM traps in cauliflower FLD plots in Bengaluru Rural District

Fig 3: Field day conducted in cauliflower FLD plot in Bengaluru Rural District