IPM Strategies for Chickpea Production

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The Bundelkhand region of Uttar Pradesh is a water-scarce, rainfed semi-arid zone. The region comprises 14 districts, with seven districts each in Uttar Pradesh and Madhya Pradesh, and is well known for pulse cultivation, often referred to as mini pulse bowl of the country. Further, Bundelkhand region is a major chickpea-producing region of Uttar Pradesh, contributing approximately 69% of the state's total chickpea production and covering about 0.43 million hectares. The average chickpea productivity in Bundelkhand (1.43 t ha^{-1}) is relatively higher than the national average of 1.26 t ha^{-1} (2021–22), yet it remains significantly below the potential yield of 2.0 t ha^{-1}. However, chickpea production in the region is constrained by several biotic and abiotic stresses affecting plant growth and yield. Among the biotic constraints, soil-borne diseases and pod borer infestation cause substantial yield losses. Diseases such as collar rot (*Sclerotium rolfsii*), Fusarium wilt (*Fusarium oxysporum* f. sp. *ciceris*), and dry root

rot (*Rhizoctonia bataticola/Macrophomina phaseolina*) can result in yield losses of up to 100%, while pod borer (*Helicoverpa armigera*) infestation may reduce yields by up to 24.8%. Chickpea growers in the region have limited awareness of scientific pest management practices and largely rely on chemical pesticides. Therefore, the present initiative aimed to disseminate Integrated Pest Management (IPM) strategies among chickpea farmers in the Jalaun and Jhansi districts, in collaboration with KVKs of the region under Banda University of Agriculture and Technology, Banda, Uttar Pradesh.

In addition, chickpea cultivation in the area is constrained by several other factors, including water scarcity, imbalanced fertilizer use, and low adoption of improved cultivation practices such as pest-tolerant/resistant and high-yielding varieties,. However, it was found that the districts of Jalaun, Jhansi, Hamirpur and Mahoba in Uttar Pradesh possess considerable potential for pulse production. Baseline information collected from six villages revealed that approximately 45% of resource-poor farmers were unable to afford costly agricultural inputs, while 56% lacked technical knowledge related to Good Agricultural Practices. Accordingly, a farmer-participatory IPM programme was initiated in October 2018. Three villages viz. Ragauli, Ragauli, and Kukargaon were adopted under KVK Jalaun, while Chokari, Tejpura, and Bilati villages were selected under KVK Jhansi for the implementation of IPM strategies. During the 2018–19 cropping season, the IPM programme was validated over an area of 135 ha, which was subsequently expanded to 710 ha during 2018–21 for large-scale promotion and dissemination of IPM strategies.

IPM module

Adult *H. armigera* (male) trapped in pheromone traps

The chickpea crop was severely damaged by pod borer (*Helicoverpa armigera*) and wilt complex caused by *Sclerotium rolfsii*, *Fusarium oxysporum* f. sp. *ciceris*, and *Macrophomina phaseolina*/ *Rhizoctonia bataticola*, podborer Other crop-damaging pests such as termites, cutworms, Ascochyta blight, and root-knot nematode were observed, but they did not pose an economic threat. The IPM module for the management of soil-borne diseases included the selection of disease-resistant varieties (JG 14, BG 3062, GNG 1320, etc.) and seed treatment with *Trichoderma harzianum* (NRIIPM strain) at 8–10 g kg^{-1} seed. For the management of pod borer, installation of pheromone traps (12 ha^{-1}) and bird perches (50 ha^{-1}), along with foliar application of neem formulation (1500 ppm @ 5 ml L^{-1}) and *Bacillus thuringiensis* (2×10^8 CFU ml^{-1} @ 2.0–3.0 ml L^{-1}, applied thrice at 10–15 day intervals from the initiation of flowering). Need-based foliar applications of emamectin benzoate (5% SG @ 3.0 ml L^{-1}) or indoxacarb (14.5% SC @ 0.8 ml L^{-1}) for pod borer management. In contrast, non-IPM practices (FP) involved the cultivation of local varieties without seed treatment and without the use of pheromone traps, bird perches, neem formulations, or other IPM components.

Insect-pests and disease scenario

The IPM strategies were found to be effective in suppressing pod borer infestation below the economic threshold level (ETL) of 0.2 larvae m^{-1} row length, whereas infestation in FP fields was recorded above the ETL (1.2 larvae m^{-1} row length). At harvest, pod damage was limited to 11.6% in IPM fields compared to 28.4% in FP fields. Collar rot incidence was observed 20–30 days after sowing, while Fusarium wilt and dry root rot incidences occurred during flowering and pod formation stages, respectively. Implementation of the IPM module resulted in significantly lower disease incidence (9–12%) in IPM fields, whereas FP fields recorded 30–40% disease incidence. Infestations of other pests such as termites, cutworms, aphids, and Ascochyta blight remained negligible. The number of pesticide sprays were reduced from six to two under IPM practices. Consequently, IPM farmers achieved significantly higher returns, 23.6% yield increase over FP fields with benefit–cost ratios of 3.61 and 2.52, respectively. The IPM module was validated at both KVKs for two consecutive cropping seasons (2018–19 and 2019–20), covering an area of 135 ha. Subsequently, a group of progressive and potential farmers from the adopted villages was selected for large-scale dissemination and implementation of the IPM programme. During 2020–21, the IPM implementation programme was extended to 16 villages, covering 580 ha. The findings revealed relatively lower pod borer infestation in IPM fields, with pod damage of 9.5%, similar to the previous year, whereas FP fields recorded 32.6% pod damage at harvest. Likewise, disease complex incidence was recorded at 12.5% in IPM fields compared to 33.6% in FP fields.

Collar root disease incience

Economic impact of IPM

The number of pesticide sprays were further reduced from six to three. As a result, IPM growers again achieved attractive returns with a 24.5% higher yield over FP fields, with B:C ratios of 4.61 and 2.82 in IPM and FP fields, respectively. Extension activities such as regular field monitoring, scientist–farmer interactions, training on mass multiplication of microbial bioagents, and distribution and use of IPM inputs were carried out. Farmers showed keen interest in the programme and ensured continued adoption of IPM strategies for sustainable chickpea production. Several farmer field days were conducted during IPM implementation for crop protection, and demonstrations on mass multiplication of microbial bioagents were provided to enable farmers to produce bioagents on their farms for future use. Overall, the implementation of the IPM module significantly minimized disease complex incidence compared to FP fields. Based on the performance of IPM strategies, the programme was further extended to 24 villages, covering approximately 710 ha during 2021–22. Around 70% of the farmers adopted the IPM module for chickpea cultivation in these villages.

They installed pheromone traps (12 traps ha^{-1}) for mass trapping of *H. armigera* (112 ± 24.6 moths per standard meteorological week), used bird perches (50 ha^{-1}) to encourage predatory birds, applied neem formulations against pod borer, and utilized microbial bioagents (*T. harzianum* and *B. thuringiensis*) as effective alternatives to chemical pesticides. IPM fields consistently recorded higher yields compared to FP fields, with B:C ratios of 4.45 and 3.60 in IPM and FP fields, respectively. Hence, farmers adopted IPM strategies for chickpea cultivation, and follow-up activities continued with groups of participating farmers.