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Adoption of Integrated Pest Management (IPM) Technologies and Major Constraints in Pigeonpea Production in Amravati District, Maharashtra, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study evaluated the impact of Integrated Pest Management (IPM) technology on pigeonpea [*Cajanus cajan* (L.) Millsp.] production conducted in Amravati district of Maharashtra during 2024. Primary data were collected from 120 farmers across six villages using a multistage random sampling technique. Analytical tools such as the Technology Adoption Index and Garrett's ranking method were applied. The study revealed that the overall adoption of IPM practices were 48%, with adoption indices of 0.25, 0.51, and 0.74 among low, medium, and high adopters, respectively. Major constraints in adoption included lack of awareness (ranked 1st), higher cost of IPM components, non-availability of bioagents, and shortage of skilled labour. The findings shows that IPM significantly improves profitability and sustainability in Pigeonpea cultivation by reducing chemical dependency, enhancing yields, and ensuring eco-friendly crop protection. Wider dissemination and farmer training related to IPM practices are essential to increase adoption and maximize benefits.

Keywords: Pigeonpea; IPM; level of adoption; constraints; composite adoption Index.

1. INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millspaugh], a significant leguminous crop, plays an important role in global agricultural systems, especially in the tropical and subtropical regions. Its high protein content and adaptability to diverse environmental conditions make it indispensable in addressing food security and nutritional needs. Globally, pigeonpea ranks among the top grain legumes, although it occupies a smaller area compared to crops like chickpea and beans. Its utility extends beyond human consumption to include livestock feed, fuel wood, and green manure, underscoring its multifaceted contributions to agriculture and sustainability. (Mishra *et. al.* 2025). India is the largest producer of the crop, contributing approximately 77% of the area and 73% of the tonnage of global production over the last decade (FAO 2024). India stands as the global leader in pigeonpea production, contributing nearly 77.61% of the world's output. The crop is integral to the country's agricultural landscape, particularly due to its prominence in the Indian diet as dal. (Kumari *et. al*. 2021). The division contributes significantly to the total area and production of pigeon pea in the region. Within the Amravati division, **AMRAVATI** has the maximum area **116630 ha** and production **158616 tonnes**, where as has the highest productivity **1360 kg/ha** during year 2024-25 (https://krishi.maharashtra.gov.in). Pigeonpea has other applications and uses in farming systems. Many smallholders use harvested pigeonpea stems as thatching or for fuel and it can be used as a forage for grazing livestock due to its ratooning ability. The pigeonpea intercrop crop fixes atmospheric nitrogen which benefits the cereal, along with providing other agronomic and yield benefits (Volp et al., 2025). The incidence of insect pests is one of the major yield reducers in pigeon pea crop, which is the main source of protein in India. Because of this high incidence of pests, the use of chemical insecticides increased rapidly, leading to its indiscriminate use and the consequent development of resistance by the pod borer *Helicoverpa armigera*. This increase was also responsible for the higher cost of cultivation and chemical residues creeping into the food. Since the crop is grown by resource-poor small-scale farmers in the rainfed regions, there is also a need to develop and transfer cheaper and safer pest management strategies to the farmers cultivating the crop. Emphasis has thus been given to the promotion of integrated pest management (IPM) methods. (Rao *et. al*. 2011). Chemical controls are the only strategy being currently adopted by the farmers and rely on synthetic organic insecticides to manage the insect-pests in pulse crops. This increases the risk of environmental contamination, loss of biodiversity and development of insecticide resistance in pod borer complex, pod fly and other pests. To overcome the present crisis, the farmer to be paid more attention to integrated approach for pest management. Keeping this in view, recommended production technologies with integrated pest management (IPM) strategies of pulse crops were conducted under cluster front line demonstrations programmne for sustainability of production and farmers income. (Singh *et. al*. 2022). Integrated Pest Management is the integrated use of pest control strategies in a way that not only reduces pest population to satisfactory level but is sustainable and non-polluting. IPM strategies focus on an appropriate mixture of eco-friendly practices. It includes eco-friendly practices which are grouped as cultural, mechanical, biological and environmentally safe chemical. A wide gap exists between the available techniques and its actual application by the farmer which is reflected through poor yield in the farmers' fields (Panda & Biswas, 2025; Rao et al., 2025). Many factors responsible for low yields of pigeonpea in India, insect pests are the major ones. Though the pest spectrum of pigeonpea crop includes 200 insects and mites, in which gram pod borer (*Helicoverpa armigera*), spotted pod borer (*Maruca vitrata*), pod fly (*Melanogromyza obtusa*) has been the major pest as they reduces yield by feeding the reproductive parts and pods of plants. (Wadaskar et al. 2013) recorded 15.9 % pod damage due to lepidopteron borers and reported 2.6 %, 9.7 % and 5.3 % per cent pod damage by *H. armigera*, *M. vitrata* and *M. obtusa*, respectively. A number of insecticides have been found reported to be effective for controlling insect pests on pigeonpea However, in the wake of widespread resistance and cross resistance to chemical insecticides the need of integrated pest management (IPM) is increasingly felt. In recent time integrated pest management (IPM) is possible way to reduce the yield losses due to insect pest complex and it will also eliminate other ill effects of pesticides in pigeon pea. Most of the farmers are not aware about the benefit of IPM technology, (Maurya *et. al*. 2017). in this regard, the present study was conducted to validate the IPM technology for the management of major insect pests of pigeonpea in amravati district of Maharashtra.

1.1 Objective

To examine the extent of adoption of IPM technology in pigeon pea cultivation.

To analyse the constraints faced by pigeon pea growers for adoption of IPM Technology.

2. MATERIALS AND METHODS

Area of Study: The Amravati district of Maharashtra State was purposively selected for the study.

2.1 Data Collection

Primary data was collected from 120 randomly selected Pigeonpea farmers across six villages in the Amravati and Nandgaon (kh) tehsils of Amravati district. Data was gathered through personal interviews and structured questionnaires covering specific information related to cost of cultivation, inputs used and yields obtained, adoption of different IPM technology and constraints.

2.2 Sampling Technique

Amravati district was selected for the impact of IPM technology for pigeonpea production.In Amravati district two tehsil namely Amravati and Nandgaon Kh. were selected. In Amravati. tehsil, three villages namely Walgaon, Reosa, and Gopalpur were selected and from Nandgaon Kh. tehsil three villages namely Jawara, Januna, and Mohali chor were selected for the study. From each village, randomly twenty Pigeonpea farmers were selected for the collection of primary data which included general information like age, education, sex, and family details, as land information like area, irrigation facility, cropping pattern, livestock, and capital assets, and information related to the cost of cultivation of pigeonpea.

Period of Study: The study was based on primary data pertained for the year 2024.

2.3 Analytical Tools for Data Analysis

Extent of adoption: Technology adoption index was calculated, to know the extent of adoption of the improved technology. Technology adoption index was calculated as per methodology proposed by (Kumar *et. al.* 2004). In his research study on Adoption pattern of improved maize technology in Northern India: Impact on farm earning and trade. The technology adoption index (TAI) was estimated by the following formula.

$$TAI = 1/K\ [AX_1/RX_1 + AX_2/RX_2 \ldots AX_K/RX_K] \times 100$$

Where,

TAI = Technology adoption index.
K = No. of technologies
AX_1= Actual use of selected technology.
RX_1 = Recommended use of selected technology

2.4 Principle Component Analysis

The principle component analysis (PCA) approach was used for developing composite index. The principle components based on 11 x

11 correlation matrix of 11 component of technology were computed. A set of 11 principle component explaining 100 per cent of total variations of all components of recommended technology were considered. For example, consider 11 Eigenvectors in the form of 11X11 matrix where rows represent variables and columns represent Eigen vectors from which weight (wi) coefficient of component of technology say ∑ is determine as,

$$Wi = Mi/\sum Mi$$

Where,

Wi = Weight
Mi = Maximum element in ith raw.
∑Mi = Sum of maximum element in ith row.

The required linear function for deriving composite index is,

$$S_i = W_1 X_1 + W_2 X_2 + \dots\dots\dots\dots\dots\dots + W_{11} X_{11}.$$

This provides adoption index (of all components of technologies) for each cultivator. The composite index obtained in the process lie in between 0 to 1, classified the farmers into low, medium and high adopters based on equal interval classification.

2.5 Constraint Analysis

The constraints faced by Pigeonpea growers in adoption of IPM technology were analysed using Garrett's ranking technique. The ranks given by each respondent were converted into percent position by using formula.

$$\text{Percent position } = \frac{100 \times (Rij - 0.5)}{Nj}$$

Where,

R_{ij} = Rank given to i^{th} constraint by the j^{th} individual.
N_j = Number of constraints.

The estimated per cent positions were converted into scores using Garrett's table. The mean of score was estimated for each constraint and these means score was arranged in a descending order. The constraint with highest mean score value was considered as the most important and ranked as one and remaining mean scores have given rank in descending order.

3. RESULTS AND DISCUSSION

3.1 Extent of Adoption of IPM Technology

Distribution of farmers according to composite adoption index: The Table 1., indicate that the farmers whose adoption index was obtained below 0.34 were distributed into low adoption group. The farmers whose adoption index was between 0.34-0.66 were distributed into medium group. Similarly the farmers with composite adoption index more than 0.66 were categorized among the high level of adopters. Out of 120 selected farmers, 19 farmers had high level of adoption with composite adoption index above 0.66, 69 farmers had medium level of adoption with composite adoption index 0.34-0.66, while 32 farmers had low level of adoption with composite adoption index of below 0.34.

The adoption index of IPM technology at different levels of adoption groups: The Table 2., Revealed that the total average adoption index in low level of adoption group was 0.25 revealed that only 25 per cent of recommended technologies were adopted by this group. The highest adoption index was observed for application of chemicals (0.71%) followed by ploughing (0.59%), while lowest adoption index was found for use of *trichogramma spp*, Use of HaNPV, collection and destruction of larvae (0.03 %). In medium level of adoption group, the total average adoption index was (0.51%). In this group the highest adoption was for chemical application (0.95%) followed by Seed treatment (0.79%). Collection and destruction of larvae were adopted low (0.18%). In case of high level of adoption group, the total average adoption index was the highest among all i.e. 0.74, indicating 74 per cent adoption of recommended technology. The adoption index for application of chemicals, Seed treatment and use of npk were observed to be high 94, 97 and 97 per cent, respectively. ploughing, spraying of botanicals, and use of *Trichogramma spp*. were also among the high adopted technologies. At the overall level, the total average adoption index was 0.48, indicating 48 per cent adoption of recommended technologies by all the 120 farmers. The adoption of ploughing, use of NPK and application of chemicals was high i.e. 75, 71, 89 per cent, respectively. The adoption of collection and destruction of larvae was observed to be low i.e.18 per cent. It is evident from this pattern that all groups rely more on chemical procedures while adopting biological and cultural activities at

Table 1. Distribution of farmers according to composite adoption index

Sr.NO	Level of Adoption	CAI	No. of farmers	Percentage of Total
1	Low	Bellow 0.34	32	26.67
2	Medium	0.34 - 0.66	69	57.5
3	High	Above 0.66	19	15.83
4	Overall		120	100

Table 2. The adoption index of IPM technology at different levels of adoption groups

Sr. No	IPM Practices	Adoption level groups			
		Low	Medium	High	Overall
1	Summer Ploughing	0.59	0.78	0.89	0.75
2	Use of resistant variety	0.15	0.50	0.78	0.45
3	Crop Rotation	0.06	0.38	0.60	0.33
4	Use of NPK	0.42	0.78	0.97	0.71
5	Collection And Destruction of Larvae	0.03	0.18	0.42	0.18
6	Installation Of Pheromone Trap and bird perches	0.18	0.38	0.63	0.37
7	Use of HaNPV	0.03	0.21	0.34	0.18
8	Spraying of Botanicals	0.07	0.36	0.86	0.37
9	Use of *Trichogramma Spp.*	0.03	0.39	0.81	0.36
10	Seed Treatment	0.48	0.79	0.97	0.74
11	Application Of Chemicals	0.71	0.95	0.94	0.89
	Total	0.25	0.51	0.74	0.48

Table 3. To analyze the constraints faced by farmers in Pigeonpea in adoption of IPM technology

Sr. No.	Constraints	Percent	Score	Average	Rank
1	Non availability of bioagents HaNPV, *Trichogramma spp.*	10	75	46.93	V
2	Identification of natural enemies and pest	30	60	48.13	IV
3	Lack of skill Labour	50	50	49.44	III
4	Comparatively higher price of IPM components	70	40	50.26	II
5	Lack of Awareness about IPM	90	24	54.22	I

relatively lesser rates. To encourage balanced and sustainable IPM adoption, concentrated efforts in capacity building, bio-input access, and farmer education are crucial.

3.2 Constraints in Adoption of IPM Technology

To analyse constraints faced by farmer in adoption of IPM technology was analyse by Garrett's ranking technique constaints is provided in Table 3., A number of knowledge-based and practical obstacles frequently prevent farmers from adopting Integrated Pest Management (IPM) methods. All the selected Pigeonpea growers were interviewed for the problems they are facing while adoption of IPM technology in pigeonpea. The information regarding the important problems faced by growers is presented in table reveal that, the problems faced by Pigeonpea growers while production were Non availability of bioagents, HaNPV, *Trichogramma*, Identification of natural enemies and pest, Lack of skill Labour, Comparatively higher price of IPM component and Lack of Awareness about IPM. Overall average percentage of these were 46.93, 48.13, 49.44, 50.26 and 54.22. Lack of awareness about IPM is major constraints in adoption of IPM technology. In summary, the information highlights the necessity of economical inputs, skilled labor, knowledge sharing, and better access to IPM resources in order to promote farmers' use of sustainable pest management techniques.

4. CONCLUSIONS

The study on "Impact of Integrated pest management technology for pigeonpea production", revealed that The adoption index of IPM technologies at different levels of adoption was 0.25, 0.51 and 0.74 for low, medium and high levels of adoption, respectively, indicating 25, 51 and 74 per cent adoption of recommended technologies by respective groups and overall adoption was 0.48 indicating 48 per cent of adoption of technology. The major constraints in the adoption of IPM technology in pigeonpea include lack of awareness about IPM (ranked 1st), higher costs, and shortage of skilled labour. Other challenges include difficulty in identifying natural enemies and pests, and non-availability of biocontrol agents like bioagents, HaNPV, and *Trichogramma spp*. In IPM technology the adoption from different practices only the application of chemical pesticide is used by farmers.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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