*Original Research Article*

Assessing the Awareness and Constraints in Adoption of Integrated Pest Management Technology by Chickpea Growers in Zone Ib of Rajasthan, India

.

ABSTRACT

|  |
| --- |
| **Aims:** This research attempts to analyze and explore the level of awareness and constraints in adoption among the chickpea growers under IPM technology.**Study design:** A descriptive and exploratory research design was utilized in this study.**Place and Duration of Study:** This research, conducted during 2016–20, was confined to Zone Ib comprising of Sri Ganganagar and Hanumangarh districts of Rajasthan.**Methodology:** Researchers collected primary data from 30 IPM farmers using structured schedules and secondary data from agricultural organizations. The study assessed farmer awareness of 14 key IPM components using a three-tiered awareness scale and analyzed constraints in IPM adoption using Kendall's W statistic.**Results:** IPM is a complex, yet adaptable, system emphasizing need-based pest management. While farmers showed high awareness in areas like water management and neem formulations, knowledge gaps in pest-defender ratio and economic threshold levels were significant. Major constraints to IPM adoption included scarcity of skilled labor, unavailability of inputs (including traps and bio-fertilizers), and lack of knowledge regarding chemical pesticide use and friendly insects. These findings highlight the need for targeted training and support to improve IPM implementation.**Conclusion:** In this research, the recommended components of IPM technology for Chickpea were identified and were then asked to the respondents for analyzing their awareness level about IPM technology. The constraints faced by the chickpea farmers in adoption of IPM technology were identified, as a result of which, this paper presented a clear picture of the prevailing situation of IPM technology in the study area.  |

*Keywords: IPM technology; Chickpea; Awareness; Constraints*

**1. INTRODUCTION**

**1.1. Background of the Study**

India is the world's leading producer of chickpeas, produced over 12.2 million metric tons in 2023, accounting for 70% of the global production. Worldwide, chickpea production was nearly 18.1 million metric tons during 2023 [1]. About 98 percent of gram production of the country are produced by states of Madhya Pradesh, Rajasthan, Maharashtra, Gujarat, Uttar Pradesh, Karnataka, Andhra Pradesh, Jharkhand, Chhattisgarh and Telangana [2]. In 2023–24, Rajasthan produced 19.38 lakh hectares of chickpeas, making it a major chickpea-producing state in India. Rajasthan's chickpea production is significantly high, with the state contributing a considerable share to the national chickpea production. [3]. Chickpea, a major protein source in the Indian subcontinent, faces significant challenges in its production and productivity. Pests, especially diseases, are a major culprit, sometimes causing complete crop loss, further exacerbated by environmental factors and nematode infestations. Recognizing the limitations of chemical pesticides, India's National Agricultural Policy champions Integrated Pest Management (IPM). This eco-friendly, socially acceptable, and economically viable strategy is key to unlocking chickpea's full potential by effectively minimizing pest-related losses [4]. Integrated pest management, is defined as a sustainable and scientific decision-making process integrating various cultural, physical, biological, chemical practices, and other management techniques for minimizing pests and threats to the environment, human health as well as the economy. IPM was meant to involve knowledge about the pest biology and hosts, with several techniques involved in environmental and biological supervision to minimize pest related problems [5]. With the advent of new developments in agricultural technology, modern communication technologies, varying customer needs, increased consciousness for sustainably formed food systems and globalization of trade and travel, there was a need for change in IPM model relevant to modern scenario. The new model based on previous models could be extended and revamped to include aspects of business, management and sustainability with emphasis on research and extension. The pest control options, the awareness and resources to build up management strategies, information management and timely decisions making, and the dissemination of information were said to be the four components of management aspects of IPM. The business aspects were said to consider the producer, consumer and seller, whereas the aspect of sustainability were said to address matters relating to environmental safety, social acceptability, and economic viability [6]. IPM technology and organic farming are found to be similar in approaches to agricultural production. Both practices are found to be based on use of biological measures, reducing pesticide use for its adverse impacts and other cultural and mechanical practices. Growers and researchers needed to come forward, to overcome their reluctance and should work together for the betterment of the sustainable system [7].

**1.2. Review of Literature**

In India, the prevalence of more than 300 varieties of pests and insects in pigeon pea, 50 varieties of pests in chickpea and 45 varieties of pests in urad/mungbean, serve as the major reason behind the high infestation of insects and pests in pulses, right from seedling to maturity and storage. IPM strategy was described to be the combination and utilization of appropriate pest management techniques, like adoption of pest resistant varieties, modification of agronomic practices, various biological and other such control measures with need based and judicious utilisation of chemical pesticides, aiming towards keeping the pest populations below economic threshold level [8]. IPM is proved to be beneficial for small scale farmers in lowering production costs and improving yield, with difference in quantity of pesticide application between IPM adopter and non-adopters of chickpea [9]. Studies show the overall adoption index and the overall knowledge index about IPM in chickpea to be 50.83 percent and 63.83 percent, respectively. IPM practices like, field sanitation, seed treatment was mostly adopted by the chickpea growers of that area. Significant positive correlations have been found between variables like annual income, land holding size, contact with extension agencies and that of knowledge level regarding IPM practices in chickpea with adoption at one percent significance level. It also revealed that factors like non-availability of bio-agents, inputs like bio-pesticides, traps, lack of technical knowledge, proper training, and lack of knowledge regarding appropriate use of inputs at appropriate time, served as major constraints in the adoption of IPM practices in chickpea [10]. The major constraints in adoption of IPM technology are found to be inadequate availability of bio-agents, inadequate availability of required Inputs at required time, lack of proper training on IPM technology by extension agencies and personnel, lack of information about proper input use at right time, lack of media exposure, lack of technical knowledge on IPM practices, non-availability of tolerant varieties, high input cost, lack of knowledge about identification and proper application of weedicides and insecticides as the major obstacles faced by them in the adoption of IPM [10], [11], [12], [13]

**1.3. Justification and Scope of the Study**

Rajasthan, one of the major chickpea producing states, normally contributes more than 15 percent to the total production of our country. This crop grows comparatively well in good condition in irrigated fields. Chickpea being the prime crop of the Zone Ib for *Rabi* seasons their sustainability is a matter of concern for the study area. The problem of pest resistance has compelled the farmers to use more of pesticides in these major crops and has led to the over reliance of conventional farmers on chemical pesticides. IPM has been proven as an effective measure for pest management. The purpose of the study is to study the recommended practices of IPM for Chickpea; farmers’ level of awareness and constraints in adoption of IPM technology in Chickpea crop. The outcome of the study will facilitate the stakeholders in planning and designing the dissemination of the IPM technology in a better way for the benefit of the farmers.

**2. MATERIALS AND METHODS**

The research was based on both descriptive and exploratory research designs. Zone Ib, known as the granary of Rajasthan was purposively selected for the study which comprises of two districts namely, Sri Ganganagar and Hanumangarh. It was evident that, Zone Ib covered a considerably higher area and production chickpea, as compared to other regions of the state. Multistage stratified random sampling technique was followed for the study. Based on the PPS (Probability Proportional to Size) method, 30 IPM farmers from two villages viz. 22 GG village of Burzwali Gram Panchayat under Sri Ganganagar tehsil and 25 RWD village of 25 RWD gram panchayat under Rawatsar tehsil were selected for the study. With the help of structured schedules, primary data was collected from the sample farmers, whereas secondary data for the recommended practices for IPM technology were gathered from reports of CIPMC, Sri Ganganagar, Agricultural Research Station, Sri Ganganagar and Agriculture Technology Management Agency (ATMA), Hanumangarh, etc.

For collection of data based on the review of literature, schedules containing both open and closed ended questions were formed for farmers. During the analysis of the data, suitable statistical tools and techniques were applied to represent the data in a systematic manner to interpret the results. For the analysis of the compiled data for all the objectives, softwares like, Microsoft Office (MS 2021), and Trial version of Statistical Package for the Social Sciences (SPSS 29) were used. For assessing awareness level, 14 major IPM components were identified for chickpea farming. Farmers were asked about their awareness regarding the components. Three levels of awareness were set based on the experts’ opinion and researcher’s acumen viz. low, medium and high were formed based on ‘meaning’, ‘meaning + purpose’ and ‘meaning + purpose + technicality’ regarding IPM components, respectively. For constraints in adoption of IPM technology, Kendall’s W statistic (also called as the coefficient of concordance), a non-parametric statistic was used.

The formula for the W statistic is:

$$W= \frac{12S}{m^{2}\left(n^{3}-n\right)}$$

Where:

‘S’ is the sum of squared deviations,

‘m’ is the number of judges (raters),

‘n’ is the total number of objects being ranked.

$$S= \sum\_{i=1}^{n}(R\_{i}-\overbar{R})^{2}$$

Where,

$R\_{i}$ = Ranking of the subject $i$

$\overbar{R}$ = Mean of the $R\_{i}$

**3. RESULTS AND DISCUSSION**

**3.1. Objective 1: To Identify Major Components of IPM Technology and their Recommended Use for Chickpea**

**Table 1 Recommended components of IPM technology for chickpea**

|  |
| --- |
| **a. Cultural practices** |
| **i. Land preparation:*** Deep summer ploughing
* Destruction of stubbles, just after harvesting
 |
| **ii. Cropping system:*** Inter crop of linseed/ mustard/ wheat/ coriander/ maize/ sorghum
* Crop rotation with non-leguminous crop to reduce soil-borne diseases such as wilt and root rot
* Sow marigold as trap/ disease indicator crop on border or in between the crop rows.
* Avoid growing solanaceous crops like potato, tomato, etc. during Kharif in the root knot nematode prone areas.
 |
| **iii. Seed management:*** Use recommended tolerant/resistant varieties as per Zone Ib
* Spacing with 30 cm or 45 cm in case of seed drilling
* Seed rate is 60 kg/ha for certified seeds and 100 kg/ha for large size seeds
* Depth of sowing should be 7-8 cm
* Follow early and timely sowing i.e. 25th October to 5th November
 |
| **iv. Nutrient management:*** Application of well decomposed FYM or neem cake 500 kg/ha in nematode prone area
* Follow recommended fertilizer (nitrogen 20 kg and phosphorous 40 kg in drilling before sowing)
 |
| **v. Water management:*** 1st irrigation 50-55 DAS, 2nd irrigation 100 DAS if required. In case of one-time irrigation, it is 60-65 DAS.
* In case of sprinkle irrigation, 1st irrigation 60 DAS and 2nd irrigation 110 DAS.
* Depth of water in the field should be 60 cm at each time of irrigation.
* Mild irrigation at the time of disease incidence under stress condition to minimize the soil temperature
 |
| **vi. Other inter cultural operations:*** Detopping or nibbing wherever possible at 30 days after sowing to reduce pest occurrence and induce branch initiations
* The crop should be maintained weed free initially for 6-8 weeks. Removal of weeds at the flowering stage of the crop.
 |
| **b. Mechanical practices** |
| **i. Manual methods:*** Manual destruction of insects/infected plants timely
* Heaps of grasses on bud encourage congregation of larvae which should be mechanically destroyed.
 |
| **ii. Mechanical traps:*** Erection of 20 bird perches/ha and to be removed just after maturity/harvesting of the crop.
* Pheromone traps 5/ha, 1 foot above plant canopy have to be installed for each species
* Set up light traps 1 trap/acre, 15 cm above the crop canopy for monitoring and mass trapping insects. Time of operation is 6 PM to 10 PM and 4.00 AM upto sunrise).
 |
| **c. Biological practices** |
| **i. Bio-control agents:*** Conserve campoletis, lady bird beetles, chrysopa, stinkbugs, reduviid bug, predatory wasps, spiders other natural enemies by avoiding indiscriminate use of pesticides.
 |
| **ii. Bio-fertilizers and bio-pesticides:*** Seed treatment with effective strain of trichoderma viride 4g/kg of seed
* Incorporation of trichoderma viride 5kg/ha multiplied on decomposed FYM 100kg/ha under moist soil condition in wilt/root rot affected areas
* Spray Bacillus thuringiensis var. kurstaki against pod borer 1 Kg/ha.
* Spray Beauveria bassiana 1% WP 3kg/ha
* Spray HaNPV 2.0% AS 250 LE/ha + 0.5 per cent Jaggery + 0.1 per cent fabric whiteners (tinopal, blue etc)/ha on noticing 1st instar larvae or eggs of pod borer (3 sprays at weekly intervals in evening hours)
 |
| **iii. Neem based pesticides:*** Spray crude NSKE 5% or azadirachtin 0.03% (300 ppm), neem oil based WSP 2500 to 5000 ml/ha at pre-flowering stage at 15 days interval.
 |
| **d. Chemical practices** |
| **i. Economic threshold level:*** Cut worm: ≥1 larvae/ sq mt.
* Termite: ≥5 damaged plants/ sq mt.
* White grub: ≥5 grubs/ sq mt.
* Gram pod borer: ≥5 to 8 eggs or 2 early instar /10 plants or one mature larvae (more than 1cm in length)/10 plants or 1 meter row.
* Semilooper ≥2 larvae/10 plants
* Wilt and root rot ≥5-10 per cent plants infested
* Rodents ≥25 live burrows/ha
* Nematodes ≥1-2 larvae/g of soil
 |
| **ii. Sprays above ETL (Recommended pesticides as per Zone Ib)**Pod borer* Quinalphos 1.5% DP 24 kg/ha
* Methyl parathion 2% DP 24 kg/ha
* Quinalphos 25% EC 1000 ml/ha
* Triazophos 40% EC 1500 ml/ha
* Indoxacarb 14.5% SC 400 ml/ha
* Fenvalerate 20% EC 400 ml/ha
* Profenophos 50% EC 1000 ml/ha
* Spinosad 45% SC 130 ml/ha
* Emamectin benzoate 5% SG 200 gm/ha
 |
| **iii. Other measures*** For application rate and dosage, see the label and leaflet of the particular recommended pesticide.
* It is advisable to check the output of the sprayer (calibration) before commencement of spraying under guidance of trained person.
* Clean and wash the machines and nozzles and store in dry place after use.
* It is advisable to use protective clothing, face mask and gloves while preparing and applying pesticides.
* Do not apply pesticides without protective clothing and wash clothes immediately after spray application. Do not apply in hot or windy conditions.
* Operator should maintain normal walking speed while undertaking application.
* Do not smoke, chew or eat while undertaking the spraying operation
* Operator should take proper bath with soap after completing spraying
* Do not blow the nozzle with mouth for any blockages. Clean with water and a soft brush.
 |

*Source: CIPMC chickpea booklet, Sri Ganganagar, 2020*

It is clear from the findings that, IPM involves an integration of practices for the pest management. As IPM technology is comprised of several components and practices, it is perceived to be a complex technology by farmers, but it does not necessarily mean to follow each practice under each component of IPM. It rather emphasizes on need based adoption of suitable practices under different components of IPM technology, taking the economic and the ecological aspects of pest management into consideration.

**3.2. Objective 2: To Analysis the Awareness of Farmers regarding Use of IPM Practice for Chickpea**

Based on the collected data regarding chickpea, the total numbers of responses were compiled together for the analysis of level of awareness, regarding 14 selected major recommended components of IPM technology.

**Table 2 Awareness Level of farmers following IPM technology in chickpea**

|  |  |
| --- | --- |
| **Major** **components** **of IPM** | **Responses of chickpea farmers (N=30)** |
| **Low level of awareness** | **Medium level of awareness** | **High level of awareness** |
| **F** | **%** | **F** | **%** | **F** | **%** |
| Water management | - | - | - | - | 30 | 100.00 |
| Neem based formulations | - | - | - | - | 30 | 100.00 |
| Intercultural operations | - | - | 2 | 6.67 | 28 | 93.33 |
| Bio-fertilizers and bio-pesticides | - | - | 2 | 6.67 | 28 | 93.33 |
| Land preparation | - | - | 3 | 10.00 | 27 | 90.00 |
| Nutrient management | - | - | 3 | 10.00 | 27 | 90.00 |
| Mechanical traps | - | - | 3 | 10.00 | 27 | 90.00 |
| Recommended dosage of pesticides | - | - | 6 | 20.00 | 24 | 80.00 |
| Cropping system | - | - | 7 | 23.33 | 23 | 76.67 |
| Safety parameters of using pesticides | - | - | 8 | 26.67 | 22 | 73.33 |
| Seed management | - | - | 10 | 33.33 | 20 | 66.67 |
| Bio-control agents | - | - | 13 | 43.33 | 17 | 56.67 |
| Pest-defender ratio | 5 | 16.67 | 19 | 63.33 | 6 | 20.00 |
| Economic threshold level | 5 | 16.67 | 22 | 73.33 | 3 | 10.00 |

*F: Frequency, %: percentage*

*Source: Researcher’s computation from field data*

**Figure 1 Awareness among chickpea farmers following IPM technology**

*Source: Researcher’s computation from field data*

All 30 chickpea farmers following IPM technology were asked about their awareness regarding recommended practices of 14 major components of IPM technology for chickpea. It can be observed from the Table 2 and Figure 1 that, farmers following IPM technology in chickpea in the study area possess high level of awareness in ‘water management’ (100.00 percent) and ‘neem based formulations’ (100.00 percent) followed by ‘intercultural operations’ (93.33 percent), ‘bio-fertilizers and bio-pesticides’ (93.33 percent), ‘land preparation’ (90.00 percent), ‘nutrient management’ (90.00 percent), ‘mechanical traps’ (90.00 percent), ‘recommended dosage of pesticides’ (80.00 percent), ‘cropping system’ (76.67 percent), ‘safety parameters of using pesticides’ (73.33 percent), ‘seed management’ (66.67 percent), ‘bio-control agents’ (56.67 percent), ‘pest defender ratio’ (20.00 percent) and ‘economic threshold level’ (10.00 per cent). It has been observed that farmers following IPM technology have medium level of awareness in ‘pest-defender ratio’ and ‘economic threshold level’. The results suggest for focus to be emphasized on imparting knowledge and conducting trainings and awareness programs on economic threshold level and pest defender ratio for better dissemination and implementation of IPM technology.

**3.3. Objective 3: To Classify Constraints Faced by Farmers in Adoption of IPM in Cultivation of Chickpea**

**Table 3 Constraints in adoption of IPM technology in chickpea**

|  |  |  |  |
| --- | --- | --- | --- |
| **Class** | **Constraints** | **Mean** **Rank** | **Test** **Statistics****(N=30)** |
| Cultural | Scarcity and high wage of skilled labour | 1.07 | W: 0.89\*\*χ2: 80.20 |
| Unavailability of required farm inputs | 1.93 |
| Lack of assured irrigation | 3.30 |
| Lack of knowledge on balanced use of fertilizers | 3.70 |
| Mechanical | Non-availability of traps in market | 1.57 | W: 0.37\*\*χ2: 33.56 |
| Time consuming and laborious method of mechanical practice | 2.13 |
| Insignificance of mechanical practice | 3.07 |
| High cost of mechanical practices | 3.23 |
| Biological | Unavailability of Bio fertilizers and Bio pesticides | 1.23 | W: 0.68\*\*χ2: 61.28 |
| Lack of knowledge about friendly insects | 2.37 |
| High cost of biological practices | 2.57 |
| Ineffectiveness of Neem based formulations | 3.83 |
| Chemical | Lack of knowledge about ETL for using chemical pesticides | 1.63 | W: 0.46\*\*χ2: 41.12 |
| High cost of plant protection chemicals | 1.97 |
| Poor quality of pesticides available in the local market | 2.83 |
| Impracticality of following safety measures | 3.57 |
| Others | Complexity of IPM | 1.63 | W: 0.61\*\*χ2: 55.24 |
| Lack of Institutional Guidance | 1.77 |
| Lack of community approach | 2.80 |
| Lack of separate marketing facility for remunerative pricing | 3.80 |

*Ranks from 1-4 for each category have been evaluated for the analysis; 1 being major constraint and 4 being the least constraint*

*W: Kendall's Coefficient of Concordance*

*χ2: Chi-Square*

*\*\*: Significant at one percent level of probability*

*Source: Researcher’s computation from field data through SPSS*

It can be seen from Table 3 that in the cultural constraint category, ‘scarcity and high wage of skilled labour’ (mean rank: 1.07) was found to be the major constraint, followed by ‘unavailability of required farm inputs’ (mean rank: 1.93), ‘lack of assured irrigation’ (mean rank: 3.30), and ‘lack of knowledge on balanced use of fertilizers’ (mean rank: 3.70). For cultural constraints, the value of W and χ2 was significant at one per cent level of probability [W= 0.89, χ2(3)= 80.20, *P*= .01]. Under mechanical constraints category for chickpea grown with IPM technology, ‘non-availability of traps in market’ (mean rank: 1.57) was found to be the major constraint followed by, ‘time consuming and laborious method of mechanical practice’ (mean rank: 2.13), ‘insignificance of mechanical practice’ (mean rank: 3.07), and ‘high cost of mechanical practices’ (mean rank: 3.23). For mechanical constraints, the value of W and χ2 was significant at one per cent level of probability [W= 0.37, χ2(3)= 33.56, *P*= .01]. Under biological constraints category, ‘unavailability of bio fertilizers and bio pesticides’ (mean rank: 1.23) was found to be the major constraint, followed by, ‘lack of knowledge about friendly insects’ (mean rank: 2.37), ‘high cost of biological practices’ (mean rank: 2.57), and ‘ineffectiveness of neem-based formulations’ (mean rank: 3.83). For biological constraints, the value of W and χ2 was significant at one per cent level of probability [W= 0.68, χ2(3)= 61.28, *P*= .01]. Under chemical constraints category of chickpea grown with IPM, ‘lack of knowledge about ETL for using chemical pesticides’ (mean rank: 1.63) was found to be the major constraint, followed by ‘high cost of plant protection chemicals’ (mean rank: 1.97), ‘poor quality of pesticides available in the local market’ (mean rank: 2.83), and ‘impracticality of following safety measures’ (mean rank: 3.57). For chemical constraints, the value of W and χ2 was significant at one per cent level of probability [W= 0.46, χ2(3)= 41.12, *P*= .01]. Under other constraints for chickpea grown with IPM, the major constraint was ‘complexity of IPM’ (mean rank: 1.63), followed by ‘lack of institutional guidance’ (mean rank: 1.77), ‘lack of community approach’ (mean rank: 2.80), and ‘lack of separate marketing facility for remunerative pricing’ (mean rank: 3.80). For other constraints, the value of W and χ2 was significant at one per cent level of probability [W= 0.61, χ2(3)= 55.24, *P*= .01].

**4. CONCLUSION**

It is a well-known fact that, IPM is a technical aspect, which requires high level of awareness, high skill, timely availability of farm inputs and other IPM inputs viz. traps, and bio-based inputs, etc. IPM is known to be a labor-intensive technology, as it does not promote the application of chemical pest control measures in the field until the economic threshold level arrives. Therefore, the cost of labor has always been known to be a major problem. With lack of technical skills, farmers are not able to apply bio-control agents in the field, properly. Lack of knowledge also brings constraints in conservation of bio-agents. Lack of knowledge about ETL regarded as an essential component in IPM technology, is also found to be a major constraint. The costs of quality chemical pesticides are also very high and available pesticides in the market are found to be of, leading to several problems, when applied in the fields. In addition to this, IPM as a technology is perceived to be a complex process by the farmers, following IPM technology for the selected crop. Unavailability of separate marketing facility for remunerative pricing appeared to be a major constraint by farmers following IPM which suggest for adequate and effective steps to be followed, for effective dissemination of the technology, at the field level.

In this research, the recommended components of IPM technology for Chickpea were identified and were then asked to the respondents for analyzing their awareness level about IPM technology. The constraints faced by the chickpea farmers in adoption of IPM technology were identified, as a result of which, this paper presented a clear picture of the prevailing situation of IPM technology in the study area.

References

1. Shahbandeh, M. (2025). Volume of chickpeas produced worldwide 2023, by country, [https://www.statista.com/statistics/722203/chickpeas-production-volume-by-country-*worldwide*/](https://www.statista.com/statistics/722203/chickpeas-production-volume-by-country-worldwide/) retrieved as on 29.05.2025.
2. DPD (2025). Annual report 2023-24, Directorate of Pulses Development, Bhopal, Department of Agriculture and farmers welfare, Ministry of Agriculture & Farmers welfare, Government of India, retrieved from [*https://dpd.gov.in/Annual%20Report%20%202023-24%2014.01.2025.pdf*](https://dpd.gov.in/Annual%20Report%20%202023-24%2014.01.2025.pdf) as on 29.05.2025
3. NCIPM (2014). Integrated Pest Management Package for Chickpea. National Centre for Integrated Pest Management, Directorate of Plant Protection, Quarantine & Storage (DPPQ&S), Faridabad, retrieved from [*https://niphm.gov.in/IPMPackages/Chickpea.pdf*](https://niphm.gov.in/IPMPackages/Chickpea.pdf) as on 29.05.2025.
4. ANGRAU (2024). ANGRAU Crop Outlook Reports of Andhra Pradesh—Bengal gram–June to May, 2023–24, Center for Agriculture and Rural Development Policy Research (CARP), data retrieved from [*https://angrau.ac.in/downloads/AMIC/OutlookReports/2023\_24/bengalgram%20outlook%20-June-july-2023-24.pdf*](https://angrau.ac.in/downloads/AMIC/OutlookReports/2023_24/bengalgram%20outlook%20-June-july-2023-24.pdf) as on 29.05.2025
5. USDA-ARS (2018). A National road map for Integrated Pest Management. *United States Department of Agriculture-Agricultural Research Service Revised Report*: 1-17.
6. Dara, S. K. (2019). The new integrated pest management paradigm for the modern age. *Journal of Integrated Pest Management*, 10(1): 1-9.
7. Baker, B. P., Green, T. A., & Loker, A. J. (2020). Biological Control and Integrated Pest Management in Organic and Conventional Systems. *Biological Control*, 140: 1-9.
8. Saxena, H., & Shaw, S. S. (2015). Integrated pest management in pulses. *Pulses: Challenges & Opportunities, Under Changing Climatic Scenario, ICAR - Indian Institute of Pulses Research Kanpur*: 147-156.
9. Kerketta, M. (2015). *A study on adoption of Integrated Pest Management practices by Chickpea growers in Durg district of Chhattisgarh state* (M.Sc. Dissertation, Indira Gandhi Krishi Vishwavidyalaya Raipur): 45-76.
10. Singh, P. K., Singh, O. P., & Mohkar, M. K. (2019). Marketing cost and efficiency of arhar in Chhindwara district of Madhya Pradesh, India. *The* *Pharma Innovation Journal 2019*; 8(4): 197-201.
11. Panda, S., & Sharma, A. (2025). Analyzing the Factors Influencing the Adoption of Integrated Pest Management (IPM) Technology in Cotton in Rajasthan. *Indian Journal of Agricultural Research*, *59*(1): 147–152.
12. Panda, S., Sharma, A., and Biswas, S. (2023). Assessment of awareness level and constraints of cotton farmers following Integrated Pest Management (IPM) technology in Rajasthan, India. *The Pharma Innovation*, SP-12(10): 2037–2040.
13. Panda, S., Sharma, A., & Tyagi, S. (2022). Integrated Pest Management Technology as a Means to Cost Efficiency for Cotton Crop in Rajasthan, India. *Asian Journal of Agricultural Extension, Economics & Sociology*, 40(9): 53-63.