Awareness and Constraints in the Adoption of Integrated Pest Management Technology among Chickpea Growers of Rajasthan, India

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ABSTRACT

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| **Aims:** This research aims to analyze and explore the level of awareness and constraints in adoption among the chickpea growers following 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:** Guided by experts of Central Integrated Pest Management Centre (CIPMC) and the Agricultural Research Station (ARS), Sri Ganganagar, and considering the availability of IPM farmers, a sample size of 30 was finalized. Researchers identified 30 chickpea farmers practicing IPM technology and collected primary data by using structured schedules. Secondary data, especially the recommended IPM practices for chickpea for the zone, was sourced from the same institutions. The multistage stratified sampling method and Probability Proportionate to Size (PPS) method were followed to ensure the sample's representativeness. 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:** The study revealed a very high level of awareness (100%) in water management as well as neem-based formulations among the chickpea growers. Growers’ awareness regarding other IPM components varied, and was especially low in pest-defender ratio (20%) and economic threshold level (10%). It also explored key constraints in adoption in IPM technology which included: scarcity of skilled labour, unavailability of essential inputs like traps, biofertilizers and bio-pesticides, lack of knowledge about ETL and the perceived complexity of IPM itself.**Conclusion:** These findings highlight the urgent need for interventions, including regular training to IPM farmers and improved access to the necessary resources, to accelerate the dissemination of the technology in an effective manner. |

*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 per cent 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. Chickpea production in Rajasthan 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 as well as productivity. Insects and diseases sometimes cause complete crop loss, aggravated by other environmental factors. Because of the limitations of chemical pesticides, India's National Agricultural Policy promotes Integrated Pest Management (IPM) technology. This eco-friendly and economically viable technology is key to chickpea's full potential production [4]. IPM, 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 technologies, changing customer preferences, increased consciousness for healthy food and globalization, there was a need for change in IPM model. 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 [6]. Growers and researchers need to come forward, to 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].

Recent studies show that IPM practices like, field sanitation, seed treatment are mostly adopted by the chickpea growers. 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 per cent significance level [10], [11]. One Study in Maharashtra also revealed that IPM farmers (around 48 per cent of respondents) had medium level of awareness about use of yellow traps, application of bio-pesticides, etc. [12]. Similar type of research was conducted in Gujarat which explored that majority of the respondents (71.67 per cent) were from medium level knowledge group with respect to recommended chickpea production technology, followed by 15.83 per cent and 12.50 per cent of the respondents were in high and low knowledge group, respectively [13]. In Chhattisgarh also a study revealed that most of the respondents (45.84%) had medium level of knowledge [14].

regarding recommended chickpea production technology.

Studies 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 [11]. 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 [15], [16]. Another recent study explored major constraints in IPM adoption in chickpea. Situational challenges primarily included the unavailability of bio-insecticides and skilled labour, issues in seed quality and high labour costs. Technical constraints included the lack of awareness regarding beneficial insects and economic threshold levels (ETL) and economic injury levels (EIL) [17].

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

Rajasthan, one of the major chickpea producing states, contributes more than 15 per cent to the total country’s production. Chickpea is the major crop of the Zone Ib for *Rabi* seasons. The problem of pest resistance has compelled the farmers to use more of chemical pesticides in this major crop and has led to the over reliance of farmers on chemical pesticides. IPM has been proven as an effective measure for pest management. The purpose of the study is to assess the level of awareness among chickpea farmers practicing IPM technology in the study area. This research also identifies major constraints in the process of the adoption of the technology. The outcome of the study will facilitate the stakeholders in planning and designing the effective the dissemination of the IPM technology. The objectives of the research are as follows:

* To Identify Major Components of IPM Technology and their Recommended Use for Chickpea
* To Analysis the Awareness of Farmers regarding Use of IPM Practice for Chickpea
* To Classify Constraints Faced by Farmers in Adoption of IPM in Cultivation of Chickpea

**2. MATERIALS AND METHODS**

**Sampling procedure and schedule development :**

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. Guided by experts of Central Integrated Pest Management Centre (CIPMC) and the Agricultural Research Station (ARS), Sri Ganganagar, and considering the availability of IPM farmers, a sample size of 30 was finalized. Researchers identified 30 chickpea farmers practicing IPM technology and collected primary data by using structured schedules. Secondary data, especially the recommended IPM practices for chickpea for the zone, was sourced from the same institutions. The multistage stratified sampling method and Probability Proportionate to Size (PPS) method were followed to ensure the sample's representativeness 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. A structured schedule was developed based on literature review and experts’ advice. 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. Based on experts’ advice, 14 major IPM components were identified for chickpea farming for assessing awareness level. 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 analysing constraints in adoption of IPM technology, Kendall’s W statistic (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**

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

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| --- |
| **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.
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| **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.
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*Source: CIPMC chickpea booklet, Sri Ganganagar, 2020*

It is clear from the findings that IPM involves an integration of practices for 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. The findings were in accordance with respect of literature reviewed [18].

**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*

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 per cent) and ‘neem based formulations’ (100.00 per cent) followed by ‘intercultural operations’ (93.33 per cent), ‘bio-fertilizers and bio-pesticides’ (93.33 per cent), ‘land preparation’ (90.00 per cent), ‘nutrient management’ (90.00 per cent), ‘mechanical traps’ (90.00 per cent), ‘recommended dosage of pesticides’ (80.00 per cent), ‘cropping system’ (76.67 per cent), ‘safety parameters of using pesticides’ (73.33 per cent), ‘seed management’ (66.67 per cent), ‘bio-control agents’ (56.67 per cent), ‘pest defender ratio’ (20.00 per cent) and ‘economic threshold level’ (10.00 per cent). It has been observed that farmers following IPM technology have low 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. The findings were in moderate accordance with respect of literature reviewed [12], [13], [14].

**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 per cent level of probability*

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

It can be observed 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].

The findings were in accordance with respect of literature reviewed [15], [16], [17].

**4. CONCLUSION**

It is evident that IPM involves a strategic integration of different practices that emphasizes the need-based adoption of the IPM components.

Chickpea farmers showed high level of awareness in water management and neem-based formulations. There is a critical knowledge gap persist among the farmers particularly in pest-defender ratios and ETL. This finding highlights the urgent need for regular trainings for effective dissemination of IPM technology.

Farmers in the process of adoption of IPM technology also encounter various constraints. These include scarcity of skilled labour, non-availability of mechanical traps non-availability of bio-fertilizers/bio-pesticides, lack of knowledge about ETL for chemical pesticides and the perceived complexity of IPM itself. These constraints coupled with a lack of associated institutional guidance significantly hinder the widespread adoption of the technology.

Future interventions must prioritize improving farmers' knowledge regarding the ecological principles of IPM technology. Also, efforts should be made by the stakeholders to ensure the availability of the necessary IPM inputs at the nearby markets. Both Institutional support and community approach may be promoted to foster sustainable chickpea production.

**Disclaimer (Artificial intelligence)**

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

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