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Adoption level and constraints of IPM technology in chickpea growers of Raebareli district of Uttar Pradesh

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Abstract
Chickpea is one of the most important pulse crops grown in India and its production in highly influenced by insects and diseases infestations at different plant growth stages. These biotic stresses can be managed by practicing the components of IPM. The level of adoption of IPM technology in chickpea was studied during 2018-19 among 80 respondents through Krishi Vigyan Kendra, Raebareli at five selected villages. It was found that 65.00% respondents belonged to low adoption level of integrated plant protection practices followed by medium (35.00%) and high level (10.00%). Practice wise adoption level was reported that, 81.25% respondents were adopted timely sowing followed by mixed and intercropping with linseed/mustard (68.75%), crop rotation (43.75%), deep summer ploughing and destruction of stubbles (15.00%), selection of disease and insect resistant varieties (5.00%), and line sowing (3.75%) while application of neem cake/ground nut cake were not adopted by the respondents. 17.50 per cent respondents were adopted weed management practices while 8.75 per cent respondents were accepted hand removal of pest and disease affected plants/plant parts. Only 5.00 per cent respondents were adopted installation of pheromone trap and erection of T shaped sticks for bird perches and none of them applying putting of heaps of grasses for insect management. 16.25 per cent respondents practicing bio-fungicide i.e. *Trichoderma viride*, *T. harzianum* as seed treatment for management of wilt and collar rot while 2.50% respondents implementing bio-insecticide i.e. NPV, Bt and NSKE for insect management. Under use of recommended chemical pesticides, 17.50 per cent respondents were adopted recommended chemical pesticides for pest management while 11.25 per cent respondents were using their proper doses with timely application interval. Under situational constrains, the 88.75% respondents faced difficulties about unavailability of bio-insecticides i.e. NPV, Bt and NSKE at local market for eco-friendly management followed by unavailability of skilled labour and unavailability of quality seed in time, high rate of wages, high cost of pesticides, availability of safe pesticides at local markets. Under technical constraints, 100% respondents also faced difficulties regarding lack of awareness of friendly insects, lack of knowledge about economic threshold level and economic injury level followed by lack of knowledge about identification of harmful insect-pests and diseases, lack of knowledge about safe pesticides, lack of timely information and technical guidance and use of appropriate time of pesticides.

Keywords: Adoption level, IPM practices, constraints, chickpea growers

Introduction
Chickpea (*Cicer arietinum* L.) is one of the most important food grain legumes in the world with production of 14.78 million tons from an area of 14.56 million hectares and productivity of 1014.60 kg/ha in 2017 (FAOSTAT, 2019) [11]. It is an important source of energy, protein and soluble and insoluble fiber. Mature chickpea grains contain 60-65 per cent carbohydrates, 6 per cent fat and between 12 to 31 per cent protein, which is higher than any other pulse crop. Chickpea is also good source of vitamins (especially Vitamins B) and minerals like potassium, phosphorous, calcium, magnesium, iron and zinc. Chickpea plays a significant role in improving soil fertility by fixing atmospheric nitrogen and the crop meets up to 80 per cent of the soil nitrogen needs from symbiotic biological nitrogen fixation, so farmers have to apply less nitrogenous fertilizer than they do for other non-legume crops.
India is the world's leading producers of chickpea accounting for 11.23 million tons from the 10.56 million hectares with a productivity of 1063 kg/ha in 2017-18 (Agricultural Statistics at a Glance, 2018) [1]. In India, it is grown throughout the country excepting on high altitude of northern and north eastern regions and coastal peninsula. Madhya Pradesh (4.60 million tons), Maharashtra (1.78 million tons), Rajasthan (1.67 million tons), Karnataka (0.72 million tons), Andhra Pradesh (0.59 million tons), Uttar Pradesh (0.58 million tons), Gujrat (0.37 million

tons), Chhattisgarh (0.32 million tons), Jharkhand (0.29 million tons) and others (0.32 million tons) are the major chickpea producing states sharing over 95% area. In Uttar Pradesh, chickpea crop is cultivated over an area of 0.50 million hectare with an annual production of 0.58 million tones and productivity of 1156 kg/ha (Agricultural Statistics at a Glance, 2018) [1]. In 2017-18, district Raebareli produced 499.90 metric tons production from 541.70 thousand hectares area with average productivity of 9.00 q/ha (DES, 2019) [7].

Gram pod borer (*Helicoverpa armigera* (Hubner), gram semiloper (*Autographa nigrisigna),* termite (*Odontotermes obesus* Ramb. and *Microtermes obesi* Heomgr), cutworm (*Agrotis ipsilon* Rott), aphid (*Aphis craccivora* Koch), wilt (*Fusurium oxysporum* f. sp. *ciceri*), collar rot (*Selerotium rolfsii* Sacc.), black rot (*Rhizoctonia solani*), stem rot (*Sclerotinia sclerotiorum* (lib.) Mass.), ascochyta blight (*Ascochyta rabiei* Pases Labr) and botrytis grey mould (*Botrytis cinerea* Pers. Ex. Fr.) are major biotic stresses in the region. Among these biotic stresses, wilt/root rot causes yield loss in chickpea about 20-25 per cent (Chandrashekar *et al.*, 2014) [5] and gram pod borer is a major pest accounting for 21 per cent yield losses and 50-60 per cent pod damage in the crop (Kambrekar, 2012) [12]. Chemical controls are the only strategy being currently adopted by the farmers and rely on synthetic organic insecticides to manage the insect-pests in chickpea. This increases the risk of environmental contamination, loss of biodiversity and development of insecticide resistance in pod borer, pod fly and other pests. Integrated plant protection measure, uses a combination of management practices among which cultural, mechanical, biological and chemical means of pest control are important but the farmers are not aware to these management technologies. To overcome the present crisis, farmers need to be pay more attention to integrated approach for pest management. Therefore, the present study was undertaken with a point of view to determine extent of present adoption pattern and constraints of integrated pest management (IPM) in chickpea by the farmers in Raebareli district of Uttar Pradesh.

Materials and Methods

The present study was conducted based on personal interview with the help of interview schedule in the selected villages of Raebareli district of Uttar Pradesh. Five villages *viz.* Bairampur Sidhauna, Andhawa, Tharuya and Tajpur of Amawna block of district Raebareli were selected randomly. The farmers of this village had small and marginal chickpea growers. The total numbers of respondents were 80, out of these, 16 respondents were chosen at random separately from each selected village and different recommended components of integrated pest management (IPM) practices were selected to study the adoption level. The integrated pest management practices were classified into four major categories, viz., cultural, mechanical, biological and chemical practices and seven, four, two and two parameters were included in each category, respectively for study purpose. The adoption level of integrated pest management practices was estimated in terms of acceptance of technology within the respondents. The adoption was categorized into three levels viz., full (High), partial (Medium) and non-adoption (Low). These were assigned the score 2, 1 and 0, respectively. The total score of all parameters was considered as adoption score of individual respondents. The existing constraints in adopting the IPM technology were grouped as situational, and technical in this study. The investigation data were sampled into different constraints group through difficulty or problem faced by the respondents in adopting the recommended components of IPM practices (Singh *et al.*, 2014) [20].

Results and Discussion

Overall adoption level of IPM technology

Data presented in the table-1 indicated that majority of respondents (65.00%) had low level of adoption of IPM technology. Only 10.00 per cent of the respondents had high level of adoption towards the recommended components of IPM technology while 35.00 per cent respondents were found to be medium adoption of IPM practices. Similar findings were reported by Singh *et al.*, 2013 [24] and 2014 [20].

Practice wise adoption of IPM practices by the respondents

The practices wise adoption level of the respondents on the recommended components of IPM practices were assessed and results are presented in table 2.

Adoption of cultural practices

Cultural practices may be defined as management of pests and diseases by slight variation and introduction of farm practices which are normally adopted in the cultivation of a crop. The data illustrated in the table-2 indicated that only 15.00 per cent respondents adopted deep summer ploughing. It is recommended that cultural practice like deep summer ploughing is essential for pest management. Deep ploughing should be done in the last week of May and first week of June where the temperature above 40ºC (Mishra *et al.* 2005) [18]. Selection of suitable varieties is very important for getting higher yield. The recommended resistant/tolerant varieties of chickpea are L-550, Pusa-1003, Radhey, K-850, Pusa-256, Awarodhi, KPJ-59 and Pusa-372, JAKI 9218, GNG 1581, RSG 963 etc. All the varieties are resistant/ tolerant to wilt, root rot and blight. The use of improved chickpea varieties assists in yielding capacity (Singh and Singh, 2013; Singh *et al.*, 2019 and Singh *et al.*, 2020) [26, 27, 28]. Only 5.00 per cent of the respondents were adopted recommended varieties in their cultivation practices. Lower adoption of the recommended disease resistant varieties was due to non-availability of seeds in time and lack of knowledge about importance of recommended varieties. Dwivedi *et al.* (2011a & 2011b) [8, 10] reported adoption of production and protection technology pulse crops.

The recommended time of sowing of chickpea crop is second fortnight of October. Timely sowing to avoid peak infestation period of pod borer (*Helicoverpa armigera*) and another pest in chickpea crop. Table 2 indicated that 81.25 per cent respondents sown timely their crop because they were much concerned about importance of timely sowing. Peak infestation period of pod borer and other pest in chickpea can be avoided by timely sowing (Ali and Mishra, 2000) [3].

Line sowing is beneficial over broadcast as it ensures uniform distribution of seeds, placement of seeds at proper depth, better plant stand, easy in cultural operation and also improved drainage. The chickpea crop may be sown by seed drill or local plough at a row spacing of 30 and 45 centimeter as per the late rain fed situation and timely irrigated situation, respectively. The seed should be placed 6 cm deep because the shallow sown crop is more liable to be damaged by wilt. Proper sowing method reduces the insect pest population and diseases also. It may be sowing by broadcasting method

resulted poor germination and plant population. It could be seen from the table-2 that only few respondents (3.75 per cent) were adopting recommended method of sowing and majority of the respondents are not using this practice due to lack of knowledge about importance of recommended sowing method. Reed *et al.* (1987) [22] and Singh *et al.* (2019) [27] also found that plant spacing, time of sowing, intercropping and soil operations such as ploughing have potential to reduce the damage caused by *H. armigera.*

Intercropping is a very important cultural practices for reducing pod borer and wilt incidence. Planting of linseed, and mustard on borders/mixed to conserve natural enemies; it reduces the incidence of pod borer and wilt. Table-2 indicates that 68.75 per cent were adopted intercropping pattern in their chickpea field. The respondents were much concerned about importance of timely sowing. Planting of linseed and mustard on borders/mixed to conserve natural enemies; it reduces the incidence of pod borer and wilt (Mehta *et al.* 1990, Mishra *et al.* 2005) [17, 18].

Use of oil cakes as manures has been known to Indian Agriculture since long back. It is used as amendments of the soil are known to reduce the incidence of root rot, wilt, root knot etc. It happens mainly through the decomposition of organic matter attack by organism. During this process, increases the activity of saprophytic organism (*Pythium, Rhizoctonia, Sclerotium, Aspergillus, Penicillium, Rhizopus)* in a flush which result in the abundant liberation of Co_2 as a result of respiratory activity of microorganism. The pathogen sensitive to CO_2 are inhibited. Due to rapid multiplication of microorganism in the soil, the available nitrogen in the soil is rapidly utilized by the fast-growing saprophytes. This results in acute nitrogen scarcity which adversely affects the growth of the deleterious pathogen. As per recommendation of neem cake @ 2 q/ha and groundnut cake @ 10 q/ha should be apply at the time of field preparation for the management of insect-pest and wilt of chickpea, respectively. The reason of not using recommended dose of neem cake and groundnut cake were mostly attributed by the farmers to the lack of knowledge behind the use of organic amendments in the pulse crop. Neem cake manage the termite, resting stage of pod borer etc. and groundnut cake manage the wilt pathogen. Groundnut cake mostly increase the activity of plant growth promoting rhizobacteria (PGPR) i.e. *Bacillus subtillis* bacteria in the soil which reduces the inoculums of wilt pathogen by the antibiosis process. Nobody is using neem cake as per recommendation of neem cake @ 2 q/ha and groundnut cake @ 10 q/ha at the time of field preparation for the management of insect-pest and wilt of chickpea was also reported by Asthana, 1999 [4]; Mishra *et al.* 2005 [18], and Raghu *et al.* 2008 [21]. Nikam *et al.* (2007) [19] also reported that the maximum wilt reduction with use of groundnut cake followed by neem seed and castor cake in chickpea.

Crop rotation is one of the most frequently recommended methods of control of insect-pest and soil-borne diseases. Continuous cultivation of same crop leads to the perpetuation of pathogenic soil-borne pathogens and gradually increases in the intensity of the disease and in regarding insects if a similar crop is grown year after year on a large area the insects of that crop predominant as they are getting continuous food. A perusal of the data in Table-2 indicated that the 43.75 per cent respondents adopted crop rotation in chickpea cultivation. 3 to 4 years crop rotation follows in the less productive field helps to manage many soil-borne diseases and pests. The above findings were also similar to the findings of Singh *et al.*, 2013 [24] and 2014 [20].

Adoption of mechanical practices

Mechanical practices are an important tool of IPM practice under such types of methods involve hand removal and destruction of insect-pest and disease affected plants/plant parts or its stages of life cycle, installation of pheromone trap and T-shaped sticks for bird perches and weed management putting of heaps of grasses. Table 3 revealed that only 8.75 per cent respondents were adopted hand removal of insect pest and disease affected plant/plant parts. The most of the respondents were not aware the importance of collection and destruction of affected plants /plant parts due to lack of knowledge. Removal and destruction of disease and pests affected plants/plant parts reduces the incidence of diseases and pest population (Raghu *et al.* 2008) [21]. Singh *et al.* (2011 & 2014) [23, 20] and Dwivedi *et al.* (2011a & 2011b) [8, 10] also reported similar results pulse crops.

The putting heaps of grasses are an important mechanical practice of management of pod borer and gram cutworm (Raghu *et al.* 2008) [21] where the congregated larvae can be killed in the morning. Nobody followed this technique in the present study due to lack of knowledge. Singh *et al.* (2014) [20] also reported similar findings in their study of adoption of IPM practices in chickpea crop.

Installation of pheromone traps @ 12-15/ha and erection of T-shaped sticks @ 70-80/ha for bird perches are used in the chick pea field for the management of pod borer (Asthana, 1999, Raghu *et al.* 2008) [4, 21]. It is most important mechanical practices for the management of insect-pest of chick pea but very few respondents (5.00 per cent) followed this technique due to lack of knowledge about importance pheromone trap and installation of bird perches.

Weed competes with the crop plants for various production resources such as nutrients, moisture, sun light, space and consequently reduces yield. The degree of yield loss by weeds depends upon the nature and magnitude of weed infestation, known as critical crop weed competition period. This period varies in different pulse crops. In Chickpea, it is 30-60 days and crop suffer from a sever weed infestation which causes in drastic reduction in yield. Therefore, it is advisable to keep the field free from weeds and weed free condition may be achieved by giving one hand weeding after 30 days and second if needed after 60 days of sowing of the crop. Where hand weeding is not possible, use of pendimethalin @ 1 kg a.i./ha as a pre-emergence (Ali and Mishra, 2000, Mishra *et al.* 2005) [3, 18]. Weed also provides shelter for insect pest and diseases which affects yield losses. The data presented in table-3 reveals that majority of the respondents were not adopted weed management practices. Only 17.50 per cent respondents were adopted weed management practices. The reason of not using recommended weed management practices were mostly attributed by the farmers to the lack of knowledge behind the importance of weed management practices. Pulse crop treated as secondary crop by the farmers. The findings were in accordance with respect of Dwivedi *et al.* (2010) [9] and Singh *et al.* (2014) [20].

Adoption of biological management practices

Biological control practices mean destruction or suppression of undesirable insects-pests and diseases by another organism. Under this practice the term 'Bio-pesticides' is usually used for all biological materials and organisms which is formulated for use as pesticides for pest management. These included

microorganisms such as fungi, bacteria, viruses as well as materials of plant origin such as Neem. Indiscriminate use of chemical pesticides creates several problems such as development of resistance in pests and diseases against pesticides, pest resurgence, toxic residue in food, water, air and soil, elimination of natural enemies and disruption of ecosystem. Some bio-pesticides i.e. *Trichoderma viride*, *Trichoderma harzianum*, Nuclear Polyhedrosis Virus (NPV), *Bacillus thuringienses* (Bt.) and Neem Seed Kernel Extract (NSKE) etc. are available in the market, but NPV and Bt both are not easily available in the local market because of the reason that most of the private dealers they don't have the storage facilities to sell bio-pesticides in remote areas of the villages.

Wilting and pod borer are the major pest problem in chickpea crop. To control wilt, it is recommended that the use of *Trichoderma* powder @ 5-10 g /kg of seed as seed treatment and for soil treatment it is used @ 5 kg along with 2-3 year well decomposed FYM @ 5 tones/ha (Kaur and Mukhupadhayay, 1992, Asthana, 1999, Khan *et al.* 2004, Mishra *et al.* 2005) [13, 4, 14, 18]. It should be applied at the time of last ploughing at evening time. The soil treatment technique is very effective for the management of wilt. Majority of the respondents did not adopt this practice. It is revealed from table 4 that 4.17 per cent respondents were adopting bio-fungicides as seed and soil treatment. The lower adoptions of this practice were due to lack of knowledge and lack of interest. The findings of the present study are similar to the result obtained by Singh *et al.* (2014) [20].

NPV, Bt and NSKE are very effective bio-insecticides in controlling pod borer as well as non-hazardous to living being and environmental degradation (Sharma *et al.* 1997, Ahmed *et al.* 2012) [25, 2]. A very few (2.50 per cent) of the respondents were adopted bio-insecticides and also none of them are aware of friendly insects in the field. Mandal *et al.* (2003) [16] reported effective management of *Helicoverpa armigera* on chickpea with use of bio-pesticides. Darling and Vasanthakumar (2004) [6] had also observed the medium level of knowledge and low level of adoption of farmers about biological pesticides. The similar results also reported by Dwivedi *et al.* (2010) [9]; Singh *et al.* (2013) [24] and Singh *et al.* (2014) [20].

Adoption of chemical management practices

This strategy of a good integrated plant protection practices advocates needs based use of pesticides (Singh *et al.* 2020a & 2020b) [31, 30]. As regarding plant protection practices the data in table-5 revealed that only 17.50 per cent respondents were adopted the use of recommended chemical pesticides while 11.25 per cent respondents adopted with timely proper doses and method of application. Majority of the respondents un-adopted chemical control practices because of due to lack of knowledge about safe chemical fungicide, insecticide and their doses. The present results are in agreement with the findings of Singh *et al.* (2013) [24] and Singh *et al.* (2014) [20].

Constraints in adoption of IPM practices

Situational constraints

The constraints faced by the respondents in adoption of recommended components of IPM practices of chickpea crop were studied and presented in table 6. It is obvious form the table-3 that it was observed under situational constraints, the 88.75% respondents faced difficulties about unavailability bio-insecticides i.e. NPV, Bt and NSKE at local market followed by unavailability skilled labour (81.25%), unavailability of quality seeds in time (61.25%), high rates of wages for labour (52.50%), high cost of pesticides (40.00%), unavailability of safe chemical pesticide (21.25%) and unavailability of bio-pesticide i.e. *Trichoderma viride*, *T. harzianum* and *Pseudomonas fluorescens* (6.25%). The findings of the present study are similar to the result obtained by Singh *et al.* (2013) [24] and Singh *et al.* (2014) [20] and Khare *et al.* (2013) [15].

Technical constraints

Under technical constraints depicted in table 7 it was found that 100% respondents faced difficulties regarding lack of awareness of friendly insects and lack of knowledge about economic threshold level (ETL) and economic injury level (EIL) period followed by lack of knowledge about identification of insect pest and diseases (91.25%), lack of knowledge about safe pesticide (81.25%), lack of knowledge about timely information and technical guidance (78.75%) and lack of knowledge about appropriate time of spraying of pesticides (70.00%). The findings were in accordance with respect of Dwivedi *et al.* 2010 [9]; Singh *et al.* 2012 [29] and Singh *et al.* (2014) [20].

Table 1: Distribution of the respondents in the adopter category (N=80)

SN	Category	Frequency	Percentage
1	Low	52	65.00
2	Medium	28	35.00
3	High	8	10.00

Table 2: Adoption of cultural practices (N=80)

SN	Cultural practice	Frequency	Percentage of adoption level
1	Deep summer ploughing and distribution of stubbles	12	15.00
2	Use of restraint varieties	4	5.00
3	Optimum time of sowing	65	81.25
4	Line sowing	3	3.75
5	Mixed and intercropping with linseed, mustard	55	68.75
6	Application of neem cake/groundnut cake	Nil	Nil
7	Crop rotation	35	43.75

Table 3: Extent of adoption of mechanical practices (N=80)

SN	Mechanical practices	Frequency	Percentage of adoption level
1	Hand removal of infected parts	7	8.75
2	Putting of heaps of grasses	Nil	Nil
3	Use of pheromone trap and erection of T-shaped sticks for bird perches	4	5.00
4	Weed management	14	17.50

Table 4: Extent of adoption of bio-control practices (N=80)

SN	Bio-control practices	Frequency	Percentage of adoption level
1	Seed treatment with bio-fungicide (*Trichoderma viride*, *T. harzianum*)	13	16.25
2	Use of bio-insecticide (NPV, Bt, NSKE)	2	2.50

Table 5: Extent of adoption of recommended chemical management practices (N=80)

SN	Chemical management practices	Frequency	Percentage of adoption level
1	Recommended chemicals pesticides	14	17.50
2	Time, dose and method of application	9	11.25

Table 6: Situational constraints faced by respondents in adoption of IPM practices in chickpea (N=80)

SN	Component of situational constraints	Frequency	Percentage
1	Unavailability of skilled laborer	65	81.25
2	Unavailability of quality seeds in time	49	61.25
3	Unavailability of safe pesticide in local market	17	21.25
4	Unavailability of bio-insecticide (NPV, Bt, NSKE) at local market	71	88.75
5	Unavailability of bio-fungicide i.e. *Trichoderma viride* and *T. harzianum* and *Pseudomonas fluorescens*	5	6.25
6	High cost of pesticides	32	40.00
7	High rate of wages	42	52.50

Table 7: Technical constraints faced by respondents in adoption of IPM practices in chickpea (N=80)

SN	Component of technical constraints	Frequency	Percentage
1	Lack of timely information and guidance	63	78.75
2	Lack of knowledge about spraying schedule	56	70.00
3	Lack of knowledge about diagnosis of pests and diseases	73	91.25
4	Lack of awareness of friendly insects	80	100.00
5	Lack of knowledge about safe pesticide	65	81.25
6	Lack of knowledge about ETL and EIL	80	100.00

Conclusion

On the basis of the findings of the study it can be concluded that the adoption of IPM practices by the growers in chick pea is still need to implement with recommended guide lines. The study correlate that the majority of respondents (65.00%) had low level of adoption of IPM practices followed by 35.00 per cent were in medium adoption and only 10.00 per cent had high level of adoption. Today many of the crop production level gone down therefore need to adopt the IPM strategies by using appropriate combination of cultural, mechanical, biological and chemical control methods. The major constraints like lack of knowledge about scientific plant protection measures to control various pest and diseases, lack of knowledge about seed treatments, non-adoption of improved technology by farmers and lack of proper guide line and training by various extension agencies expressed by the chickpea growers. Hence, it is suggested that to overcome these constraints more efforts need to be taken through demonstrations, trainings and by extension activities which will help to increase interest, focus and knowledge of farmers towards improved technology and production and productivity of the crops would be increase.

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