Original Research Article

Management of gram pod borer, *Helicoverpaarmigera*Hub.,~~on~~in chickpea in Saran District, Bihar, India

Abstract:

Field experiment was conducted for management of gram pod borer in chickpea during *rabi* season in 2019-20 and 2020-21. Two technologies, namely two times spray of profenophos 50% EC, and the use pheromone trapat flowering time and spay of spinosad 45 SC @ 50% pod formation stages were ~~tested~~ compared with the farmer's practice of spraying quinalphosion eight8 farmers'~~s~~ field using~~on~~ variety "BG-372". ~~In technology I two spray of profenophos 50% EC @ 1.5 ml/liter of water at 50% flowering time and 50% pod formation time, and technology II use of pheromone trap @ 20/ha at flowering time and spray of sponosad 45 SC @ 0.3ml/liter of water at time of 50% pod formation with compare of farmer's practices spray of quinalphose @ 2ml/liter of water at time of pod formation.~~ The results of two years pooled data revealed that the use pheromone trap at flowering time and spraying of spinosad 45 SC @50% pod formation~~technology option II~~ were~~as~~the most effective against gram pod borer management. The least~~Minimum~~ percent pod infestation (1.75%) was recorded ~~(1.75%)~~ in these technologies~~y option II~~ followed by the percent pod infestation recorded (2.74%)in two times spray of profenophos 50% EC at 50% flowering and pod formation stages. The highest pod infestation record (782%) was recorded in farmers'~~technology option I (2.74%) compare with farmer's~~ practices ~~(782%)~~. Similarly, ~~the significantly~~ maximum grain yield (14.84 q/ha) was recorded in using pheromone trap at flowering and spraying spinosad 45 SC @50% pod formation stages followed by the yield record in spraying profenophos 50% EC (12.26 q/ha) and the yield record in farmers' practices (9.42 q/ha).~~technology option II i.e. 14.84 q/ha followed by technology option I and farmer's practices i.e. 12.26 q/ha and 9.42 q/ha, respectively.~~The cost benefit ~~The impact~~ analysis showed that ~~pooled data~~ the net return and benefit cost ratio was also higher in using pheromone trapand sprayingspinosad 45 (₹ 52763/ha and ₹ 2.48:1) than the net return and benefit cost ratio in the farmers' practices (₹ 28544/ha and ₹ 1.55:1)~~technology option II in compared to farmer's practices which was ₹ 52763/ha and 2.48:1, ₹ 28544/ha and 1.55:1~~,respectively. ……

Comment [G1]: 2019/20, 2020/21 looks better, check other reputable papers

Comment [G2]: Numbers below 10 are usually written in word

Comment [G3]: Be sure whether this figure is 78.2% OR 782%?

Comment [G4]: Is 'q/ha' the SI unit of mass? I think 'Kg' or 'ton' sounds better, Check it up!

Comment [G5]: Is '₹ ' the SI unit to report scientific papers? I think can work for local report; '$' sounds better in research language!

Comment [G6]: Would please add a conclusion?

Keywords: Management, Gram pod borer, ~~chickpea~~ Chickpea

Introduction:

Gram commonly known as "Chickpea' or Bengal gram is the most important pulses crop of India. In India, chickpea accounts for about 45% of total pulses production. Similar to the case of other pulses, India is the major chickpea producing country and contributing for over 75% of total world chickpea production. The chickpea production in the country has gone up from 3.65 to 9.53 million tons between 1950-51 and 2013-14, registering a modest growth. During the period, while the area has also gone up from 7.57 to 9.93 million ha, the yield has steadily increased from 482 kg/ha to 960kg/ha (Maurya and Kumar, 2018). There is steady decline in the area, production and productivity of the crop. The farmers are losing the ground due to heavy losses from pests and disease. Gram pod borer, *Helicoverpaarmigera*(Hub.), is the most damaging pest in most of areas where chickpea~~this pulse crop~~ is grown. *H. armigera*is a charismatic and one of the most dominant insect pests in agriculture, accounting for half of the total insecticides usage in India for protection of crops (…). This pest damages the chickpea plants from seedling stage to crop maturity stage and its larvae can thrive on leaves, tender twigs, flowers and pods. After pod formation, the larvae bore into the pods and feed on the seed inside and cause considerable loss to seed yield. Its caterpillars feed on young pods by making holes and eat the developing seeds by inserting the half portion of their body inside the pod.Chickpea ~~It~~ is attacked by more than 250 species of insect, of which pod borer *Helicoverpaarmigera*Hubner is themajor pest in most parts of the country (Shanower *et al.*, 1999). Excessive and indiscriminate use of pesticides to control thisesepest~~s~~ has resulted in undesirable ecological changes (Mahappatro and Gupta, 1998). About 20-30% of the chickpea yield can be reduced due to ravages of pod borer (Sarwar, 2012).In view of the above, management of gram pod borer through different chemicals in holistic manner incorporating judicious use of newly introduced modern pesticides seem to be best alternative. Hence, the present investigation was carried out to Management of gram pod borer, *Helicoverpaarmigera* Hub. on chickpea in Saran District,Bihar.

MATERIALS AND METHODS

Comment [G7]: 'Keyword' is written as a single word

Comment [G8]: Avoid using words in the TILTE as keywords. And, add more/at least three keywords which are not in the TITLE

Comment [G9]: Is this way of writing sounds better? Better if written as '1950/51 and 2013/14???

Comment [G10]: In all lines, check the SI units and the way they are written. In this case, 'Kg' not 'kg!'

Comment [G11]: This is the STATISTICS data that should be written from the statistics source during the time of conducting the research, not from published paper which is even older at to justify this research…replace it!

Comment [G12]: When was this decline happened, was it since 2013/14 or…? Since the statement is too sensitive, it should be clearly stated with reference!

Comment [G13]: Using pronoun after too long statements or parag's is misleading.

Comment [G14]: reference

Comment [G15]: caterpillar is the larva of Lepidopterans, use either 'larvae' or 'caterpillar' consistently, don't mix up!

Comment [G16]: Words like 'damage', 'devour', 'bore'…sounds better in this case

Comment [G17]: See the above comment

Comment [G18]: Use this statement as a JUSTIFICATION for the steady decline of chickpea production…..take it above!

Comment [G19]: Are you referring many pests or '*H. armigera*' only? Don't copy and use other works as they are, restate them!

Comment [G20]: Too old reference to use it for your justification

Comment [G21]: This last justication part should be rewritten with the concept that the pesticides used in this trial are safer than the ones recommended for the insect mgt. so far, and they are lacking in the areas concerned. Abbreviating '*Helicoverpaarmigera* Hub 'as '*H. armigera*' after its first use sounds better. Be consistent in using it throughout the paper…

The on farm trails wereconducted ~~at~~ ineight farmers~~'s~~ field of Saran District,~~(~~Bihar,~~)~~ for two consecutive years of 2019/20~~-20~~ and 2020/21~~-21~~. The trials were laid out in randomized complete block design with eight replications. Chickpea crop was sown in last week of October 2019 and 2020. All the agronomical practices recommended for the crop were~~to raise the good crops~~ followed. Two technologies, namely~~were tested on 8 farmer's field on variety "BG 372". In technology I~~ two times spray of profenophos 50% EC @ 1.5 ml/liter of water at 50% flowering time and 50% pod formation time, and ~~technology II~~the use of pheromone trap @ 20/ha at flowering time and spray of spi~~o~~nosad 45 SC @ 0.3ml/liter of water at time of 50% pod formation were ~~with~~ compared with farmers' practice of spraying quinalphos @ 2ml/liter of water at time of pod formation in eight farmers' field using the chickpea variety 'BG-372'. ~~of farmer's practices spray of quinalphose @ 2ml/liter of water at time of pod formation.~~After treatments application, observations were made and data on ~~related problem addressed to average~~ numbers of infested pods/m^2 ~~per square meter area~~, percent pod infestation,weight (g) of harvested grain/m^2~~per square meter (gram)~~ and ~~calculate of~~ total yield/ha ~~per ha~~ were recorded. Gross return (Rs./ha), net return (Rs./ha) and cost-benefit ratios were also calculated. Data analysis was carried out on the ~~Two~~ two years data, and~~were pooled and~~ percent pod infestation ~~and its reduction due to various treatments were~~was transformed to Arc Sine.

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Comment [G22]: Consider the above comments

~~Pod damage analysis~~

~~Per cent p~~Pod damage (%) = $\frac{\text{No.of affected pods}}{\text{Total no. of pods}}$ x 100

Benefit Cost Ratio

Gross return was calculated by multiplying total yield with the market price of the produce. Cost of cultivation and cost of treatment imposition was deducted from the gross returns~~,~~ to calculate~~find out~~ net returns and cost benefit ratio by the following formula:

$$B : C = \frac{\text{Net returns}}{\text{Total cost of cultivation}}$$

Results and Discussion~~:~~

The results showed that the number of infected pods/m^2~~per square meter area~~ and per cent pod infestation ~~counted~~ by *H. armigera* on chickpea. The data pertaining to management of gram pod borer, *H. armigera*through different technology on chickpea crop during 2019-20 and 2020-21 in presented in table 1 and 2. The data revealed that use of technology were

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Comment [G23]: The sentence is incomplete…., What the results showed about the number of infected pods/m^2 and percent pod infestation due to H. armigera?

Comment [G24]: Be consistent with using the insect's name

Comment [G25]: So, what these data tell us? Too shallow statement…., what Table 1 and 2 tell about?

significantly superior in comparison ~~compression~~ to farmer's practices. The number of infected pods and percent pod infestation range from 47.12 to 153.50 per square meter area and 2.01 to 9.38 percent pod infestation in 2019-20 and 62.63 to 137.77 per square meter area and 1.49 to 6.26 per cent pod infestation in 2020-2, respectively.~~Pooled data showed that s~~Significantly minimum pod infestation~~cted~~ (54.88)/m^2~~per square meter in technology option II (~~was recorded in the use of pheromone trap @ 20/ha at flowering time and spray of spi~~o~~nosad 45 SC @ 0.3ml/liter of water at time of 50% pod formation~~)~~ followed by 81.37/m^2~~sq min technology option I (~~two times spray of profenophos 50% EC @ 1.5 ml/liter of water at 50% flowering time and 50% pod formation time~~)~~as ~~in~~ compared to~~(145.64 pod/sq m) with~~ farmers'~~s~~ practices of~~(~~spraying~~of~~ quinalphose @ 2 ml/liter of water at time of pod formation (145.64/m^2). Similarly, significantly minimum percent pod infestation showed in technology option II followed by technology option I compare with farmers'~~s~~ practices in both years i.e. 2.01% 3.33% and 9.38% during 2019-20 and 1.49%, 2.14% and 6.26% during 2020-21, respectively. ~~Pooled data was also observed in similar trend.~~ Moreover, significantly maximum grain weight was observed in technology option II followed by technology option I compared with farmer's practices in both respective years i.e. 128.81 g, 105.29 g and 89.48 g per square meter area and 168.57 g, 139.80g and 98.78 g per square meter area during 2019-20 and 2020-21, respectively. ~~In pooled data~~ The total yield per hectare was~~was~~ calculated in technology option II (14.84 q/ha) followed by technology option I (12.26q/ha) and farmer's practices (9.42q/ha). Overall, result farmer's practices was found less effective in checking pod and grain damage due to pod borer in comparison to new molecule insecticides. These results agree ~~are in conformity~~ with the report of Prasad and Jha (2014) that~~was found~~ minimum pod and grain damage and maximum yield ~~produce~~ was recordedin sprayingof spinosad 45 SC @0.33 ml/liter water. It was also ~~Rashid *et al.* (2003)~~ reported that spinosad 45 SC @ 0.33 ml/liter water gave the highest percentage of reduction of pod borer (Rashid *et al.*, 2003;~~and same results are supported by~~ Ahmed ~~*et al.*~~*et al.*,~~(~~2004;~~)and~~Nitharwal *et al.*,~~(~~2017).

While judging the utility of any technology in pest management programme, it is not only evaluated by its relative potency against the target pest and the period for which its application provides protection to the crop, but the economics of treatments also remained a major consideration. ~~Hence, the benefit cost ratio was also worked out in the present investigation~~. The data recorded that the technology option II gave maximum cost benefit ratio of 2.48:1 (Table -2).

Comment [G26]: Which technology? State separately
Take care wordings

Comment [G27]: Replace by m^2

Comment [G28]: which treatments resulted these figures?

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Comment [G29]: State the technologies

Comment [G30]: See the above comment

Comment [G31]: Restate

Comment [G32]: ???

Comment [G33]: ???

Comment [G34]: Restate

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Comment [G38]: Restate with the concept indicate

Comment [G39]: Restate using the concept of economic feasibility of the effective treatments, don't use other less important words here

Followed by technology option I (1.90:1) and farmer's practices (1.55:1). Gowda *et al.* (2007) who reported that the spinosad 45 SC recorded the highest yield and maximum cost benefit ratio. Nitharwal *et al.* (2017) also recorded most economical treatment of spinosad 45 SC (3.40:1).

Comment [G40]: See the above comments, many misleading statements, refine them

Conclusion ~~:~~

The present finding ~~clearly~~ indicated that the new generation insecticide~~s,like~~ spinosad,was effective against gram pod borer, *Helicoverpaarmigera*~~along~~ with good ~~an increased levelof~~ yield return. Furthermore, the benefit cost ratio was also more with the~~technology option II (~~use of pheromone trap @ 20/ha at flowering time and spray of spi~~o~~nosad 45 SC @ 0.3ml/liter of water at time of 50% pod formation~~)~~. Hence, it is suggested that the effective technology may be alternated in order to avoid the development of resistance.

Comment [G41]: See the above comments please

Comment [G42]: Which is that technology?

Comment [G43]: Please, put clear conclusion based on the findings

…….

References ~~:~~

Maurya Omprakash and Kumar Hemant (2018). Growth of chickpea production in India. Journal of Pharmacognosy and Phytochemistry. 7(5): 1175-1177.

Sarwar M. (2012). Competency of Natural and Synthetic Chemicals in Controlling Gram Pod Borer, *Helicoverpaarmigera*(Hubner) on Chickpea Crop International Journal of Agricultural Sciences. 2 (4):132-135.

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Gowda DKS, Patil BV, Yelshetty S. 2007.Evaluation of comparative efficacy of dusts and emulsifiable concentration formulations against gram pod borer in chickpea ecosystem, Karantaka Research., 20(2):276-278.

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Prasad Surendra and Jha, RK. 2014. Effect of different chemicals for management of *Helicoverpaarmigera*(Hubner) in pigeonpea. Journal of Hill Agriculture, 5 (2): 171-173.

Shanower, TG, Romeis, J. Minja, EM. 1999. Insect pests of pigeonpea and their management. Annual Review of Entomology, 44: 77-96.

Mahapatro, GK and Gupta, GP, 1998. Pesticides induced resurgence, Pestology, 22(12): 14-20.

Nitharwal, RS, Kumar, A., Jat, SL., and Chula, MP. 2017. Efficacy of newer molecules against gram pod borer, *Helicoverpaarmigera*(Hubner) on chickpea (*Cicer arietinum* L.). Journal of Pharmacognosy and Phytochemistry. 6(4): 1224-1227.

Comment [G44]: This part should be written following the JOURNAL STYLE and it must be uniformly written; don't mix up different reference writing styles

Table 1: Incidence of gram pod borer, *Helicoverpaarmigera*Hub. on chickpea crop during *rabi* 2019-20 and 2020-21

Treatments	No. of infected pod /sq m^2			Pod infestation (%)			Weight of grain/sq m^2 (g)			Yield q/ha		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Farmers practice	153.50	137.77	145.64	9.38 (17.83)	6.26 (14.49)	7.82 (16.16)	89.48	98.79	94.14	8.95	9.88	9.42
Technology* option I	72.87	89.86	81.37	3.33 (10.51)	2.14 (8.41)	2.74 (9.46)	105.29	139.80	122.55	10.53	13.98	12.26
Technology option II**	47.12	62.63	54.88	2.01 (8.16)	1.49 (7.00)	1.75 (7.58)	128.81	168.57	148.69	12.82	16.86	14.84
SEm±	12.66	13.18	12.92	1.49	0.55	1.02	9.35	10.69	10.02	0.90	1.07	0.99
CD at 5%	27.04	28.28	27.66	3.20	1.17	2.19	19.35	22.93	21.14	1.92	2.29	2.11

Figures in parenthesis are the Arc sine.

Table 2: Economic viability of different technology option in chickpea crop during *rabi* 2019-20 and 2020-21

Treatments	Gross return (₹ /ha)			Cost of cultivation (₹ /ha)			Net return (₹ /ha)			Benefit Cost Ratio		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Farmers practice	43631	50388	46982	18859	18017	18438	24772	32371	28544	1.31	1.80	1.55
Technology option I	51334	71298	61147	21368	20777	21072	29966	50521	40074	1.40	2.43	1.90
Technology option II	62498	85986	74015	21546	20957	21251	40952	65029	52763	1.90	3.10	2.48

Not : The sale price of grain was considered as Rs. 4875/q in 2019-20 and Rs. 5100/q in 2020-21.

Comment [G45]: See the previous comments

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Comment [G48]: Use footnote and explain what the technologies are

Comment [G49]: ??