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Yogendra Kumar Mishra
Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, India

Amit Kumar Sharma
Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Muni Pratap Sahu
ICAR-Directorate of Weed Research, Jabalpur, Madhya Pradesh, India

Manoj Kumar Ahirwar
Central Arid Zone Research Institute KVK, Pali, Rajasthan, India

Vikash Singh
ICAR-Directorate of Weed Research, Jabalpur, Madhya Pradesh, India

Narendra Kumar
ICAR-Directorate of Weed Research, Jabalpur, Madhya Pradesh, India

Corresponding Author:
Yogendra Kumar Mishra
Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, India

Efficacy of fermented botanical extracts against incidence of *Helicoverpa armigera* (Hubner) in chickpea

Yogendra Kumar Mishra, Amit Kumar Sharma, Muni Pratap Sahu, Manoj Kumar Ahirwar, Vikash Singh and Narendra Kumar

Abstract
In the present scenario, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) is a major constraint to the cultivation of chickpea in India, and its management has faced considerable challenges due to climate change and resistance development by using more synthetic insecticides. In this context, the experiment was initiated with the objective to evaluate the effectiveness of fermented botanical extracts against the incidence of *H. armigera* in chickpea under field conditions. The results revealed that Treatment, T_6 (Buttermilk @ 15 litres/ha + Neem leaves @ 625 gm/ha + Datura leaves @ 625 gm/ha + Black pepper @ 625 gm/ha + Mustard @ 625 gm/ha) was most effective in reducing *H. armigera* larval populations (0.13 larvae/mrl), pod damage (2.58%) with increased subsequent yield (2322.32 kg/ha) as compared to other treatments. Accordingly, locally to be have botanical extracts would greatly significantly advantage to the marginal farmers in chickpea production. Future research attention and issues as a part of IPM strategies in pest management are important.

Keywords: Fermented botanical, *Helicoverpa armigera* (Hubner), chickpea

1. Introduction

In recent times, *H. armigera* management facing huge challenges in many crops around the world (Li *et al*., 2018; Patil *et al*., 2017; Singh *et al*., 2014) [17, 21, 29]. *H. armigera*, a highly polyphagous and wide range of host plants (Attique *et al*., 2000; Pande *et al*., 2000; Sarwar, 2012) [5, 20, 30], is a serious pest of chickpea (*Cicer arietinum* L.) (Fite *et al*. 2018; Patil *et al*., 2017; Sarwar *et al*., 2012) [12, 21, 30]. It is able to cause 21 to 36% chickpea yield losses in India (Dinesh *et al*., 2017) [10]. The demand of pulse crop is high for an increasing world population (Chichaybelu *et al*., 2018; Singh *et al*., 2014) [8, 29]. Although numerous non-chemical techniques, related to transgenic crops (Das *et al*., 2017; Singh *et al*., 2018) [9, 28], cultural (Jallow *et al*., 2004) [15] and biological methods (Reddy & Manjunatha, 2003; Revathi *et al*., 2011) [23, 24], to behave as a part of the integrated pest management (IPM) strategies, however its management is basically based on huge use of synthetic insecticides. The adaptability of chemical method to insect pest control is leading to economic yield losses with elevated bad result to surrounding environment is a fateful to the modern agriculture (Ahmad *et al*. 2019; Bird, 2017; Li *et al*., 2018; Mironidis *et al*., 2013) [3, 6, 17, 18]. Due to the increasing facet consequences of synthetic insecticides, there may be increasing demand and interest for botanical pesticides global (Ali *et al*., 2017) [4]. *H. armigera* is diagnosed as an ability insect pest for resistance development to a huge range of synthetic chemicals, along with Bt. in various crops global (Ahmad *et al*., 2019; Alvi *et al*., 2012; Hussain *et al*. 2015; Li *et al*., 2018) [3, 33, 13, 17]. In India, farmers are facing complication to manage this resistant insect pest as maximum of the synthetic insecticides in chickpea ineffective under field situation. Consequently, in order to reduce the negative impact of synthetic chemicals, the use of naturally occurring botanical extracts as a part of IPM would be an alternative technique for successful management of *H. armigera*. Several researches have been conducted on using botanical extracts, crucial oils and other compounds (Koul, 2016; Ali *et al*., 2017; Younas *et al*., 2016; Junhirun *et al*., 2018) [16, 4, 32, 14] as promising insect pest management strategies. Several botanical products have been examined to act as oviposition and feeding deterrents, ovicidal, and larvicidal agents against various insect pests (Silva *et al*., 2015; Ahmad *et al*., 2015) [26, 2]. Moreover, they have no adverse effects on beneficial organisms and to the environment (Begg *et al*., 2017) [7]. Botanicals are cheaper and easily available for insect pest management and they are eco-friendly. Furthermore, marginal farmers in developing countries cannot have enough money to use chemical insecticides due to much more prices.

Furthermore, a lack of awareness on botanical extracts for the proper using of IPM strategies in chickpea is crucial in improving the livelihoods of marginal farmers. It is apparent that there's required to develop biological alternatives for management of *H. armigera* in chickpea. The demand for natural botanical insecticides is increasing to replace the adverse effects on beneficial insect and environment. Thus, locally available botanical extracts would greatly benefit to marginal farmers in chickpea production. Future research attention and considerations as a part of IPM tools, in pest management, are crucial. Therefore, the objective of this study was to evaluate the efficacy of fermented botanical extracts against the incidence of *H. armigera* in chickpea under field conditions.

2. Materials and Methods

2.1 Experimental site and layout

A field trial was conducted during rabi season in the year 2019-2020 with JG-14 chickpea variety in the field at Panna district of Madhya Pradesh. The experimental site lies between 23° 48′ N latitude and 80° 40′ E longitude, and 440.80 m above mean sea level. The experiment was laid out in randomized block design, with three replications and eight treatments including an untreated control with a plot size of 4 x 3.60 m each and spacing of 30x 10 cm^2. The treatments were randomly allocated in each replication.

2.2 Preparation of treatments

Treatment combination were T_1 (Buttermilk @ 15 litres/ha), T_2 (Buttermilk @ 15 litres/ha + Neem leaves @625 gm/ha), T_3 (Buttermilk @ 15 litres/ha + Neem leaves @625 gm/ha), T_4 (Buttermilk @ 15 litres/ha + Black pepper @ 625 gm/ha + Mustard @ 625 gm/ha), T_5 (Buttermilk @ 15 litres/ha + Neem leaves @ 625 gm/ha + Datura leaves @ 625 gm/ha), T_6 (Buttermilk @ 15 litres/ha + Neem leaves @ 625 gm/ha + Datura leaves @ 625 gm/ha + Black pepper @ 625 gm/ha + Mustard @ 625 gm/ha), T_7 (Emamectin benzoate 5% SG @ 200 gm/ha) and T_8 as untreated control. These treatment materials were filled in 20 litres container and kept in the sun for 15 days to fermentation. Then after all treatment extracts were filtered and mixed with 500 litres of water and sprayed per hectare.

2.3 Observation procedure

Observations of larval population have been recorded at 24 hours earlier than remedy and 3rd, 7th and 10th days after 1st and 2nd application of botanical extracts on one metre row length (1mrl) at five distinctive places in every plot. The seed yield was recorded for every treatment and computed for hectare in kg/ha. The percent of pod damage was computed by means of using the following formula:

$$\text{Pod Damage (\%)} = \frac{\text{No. of damaged pods}}{\text{Total no. of pods}} \times 100$$

2.4 Data analysis

Statistical analysis was performed to test the variation of yield with different treatments. The data recorded on different observations were tabulated and analyzed statistically using the techniques of analysis of variance (ANOVA) by online software OPSTAT.

3. Result and Discussion

3.1 Population of *H. armigera*

The data given in table 1 indicated the larval population of *H. armigera* in chickpea one day before and at 3, 7 & 10 days after application of fermented botanical extracts. The results revealed no significant differences in injury level in the pre-treatment observations. After spraying, significantly lowest larval population of *H. armigera* (0.22 larvae /mrl) were found at 3 days after application, T_6 (Buttermilk @ 15 litres/ha + Neem leaves @ 625 gm/ha + Datura leaves @ 625 gm/ha + Black pepper @ 625 gm/ha + Mustard @ 625 gm/ha) which was at par with the treatment T_7 (Emamectin benzoate 5% SG @ 200 gm/ha) (0.26 larvae /mrl). Similarly, results were also noted at 7 and 10 days after application of the treatments. On the basis of overall mean of the treatments significantly reduced larval population of *H. armigera* as compared to untreated control. Among the various treatments T_6 (Buttermilk @ 15 litres/ha + Neem leaves @ 625 gm/ha + Datura leaves @ 625 gm/ha + Black pepper @ 625 gm/ha + Mustard @ 625 gm/ha) was found the most effective as it recorded lowest mean of larval population (0.13 larvae/mrl) followed by T_7 (Emamectin benzoate 5% SG @ 200 gm/ha) (0.17 larvae/mrl), T_5 (Buttermilk @ 15 litres/ha + Neem leaves @ 625 gm/ha + Datura leaves @ 625 gm/ha) (2.29 larvae/mrl,) respectively.This finding supported with previous reported by some scientist. Combining botanicals with different modes of actions have been reported to be more effective than using them singly which is in correspondence with the previous reports of (Sharma *et al*., 2007; Younas *et al*., 2016) [25, 32]. Mode of actions and the mechanism of botanicals vary especially when they are combined depending on the type of compound and ingredient contents (Esmaeili & Asgari, 2015) [11] so that maximum plant protection will be achieved by having synergic effect due to the multiple modes of actions. Osipitan *et al*., (2013) [19] reported that this implies that the extract of Datura metel could effectively manage the population of termites on the field. Rahman *et al.*, (2020) [22] reported that emamectin benzoate more effective against caterpillar.

3.2 Pod Damage

In comparison to the control plot, the lowest pod damage was observed in the treatment applied plot with fermented botanical extracts (Figure 1). Revealed that, the maximum pod damage was recorded from the control plot (24.33%) and minimum was from the T_6 (Buttermilk @ 15 litres/ha + Neem leaves @ 625 gm/ha + Datura leaves @ 625 gm/ha + Black pepper @ 625 gm/ha + Mustard @ 625 gm/ha), (2.58%) which was at par with the T_7 (Emamectin benzoate 5% SG @ 200 gm/ha) (3.10%). Some previous reports indirectly supporting here, Neem Seed Kernel Extract (NSKE 5%) greatly reduced the pod borer population in chickpea (Hussain *et al*., 2016) [13]. Abbasipour *et al*., (2011) [1] observed that the results can be compared with other studies on *Datura stramonium* and larvicidal effects of *Datura stramonium* against *T. castaneum* were also observed.

3.3 Seed yield (Kg/ha)

In response to lower larval population and pod damage the treatments had significant effect on the seed yield of chickpea. The lowest yield was recorded in the untreated control (1343.45 kg/ha), while highest yield was obtained in the treatment, T_6 (Buttermilk @ 15 litres/ha + Neem leaves @

625 gm/ha + Datura leaves @ 625 gm/ha + Black pepper @ 625 gm/ha + Mustard @ 625 gm/ha), (1343.45 kg/ha) followed by T_7 (Emamectin benzoate 5% SG @ 200 gm/ha) (2230.27 kg/ha). Similarly, Shabozoi *et al*., (2011) [27] also obtained a higher yield with application of a neem-based botanical extract compared to synthetic insecticides in managing insect pests of pigeon pea. Tilahun and Azerefegne (2013) [31] also reported that higher maize yields were obtained from maize plots treated with aqueous crude seed extracts *M. ferruginea* 5% against *B. fusca*.

Table 1: Overall mean of two spraying (1st and 2nd spray) for *H. armigera* in chickpea

Treatment's code	Treatments details	Dose (gm or ml per ha)	Mean larval population /mrl					% Pod damage	Yield (kg/ha)
				Days after spraying**					
			Pre treatment	3	7	10	Overall mean		
T1	Buttermilk	15 litre	6.32 (2.61)	5.07 (2.36)	5.39 (2.43)	5.38 (2.42)	5.28 (2.40)	19.41 (26.12)	1440.66
T2	Buttermilk + Neem leaves	15 litre + 625 gm	5.81 (2.51	4.14 (2.15)	3.88 (2.09)	3.93 (2.10)	3.98 (2.12)	12.06 (20.30)	1876.49
T3	Buttermilk + Datura leaves	15 litre + 625 gm	8.2 (2.95)	4.09 (2.14)	3.95 (2.11)	4.01 (2.12)	4.01 (2.12)	14.26 (22.17)	1788.14
T4	Buttermilk + Black pepper+ Mustard	15 litre + 625 gm + 625 gm	5.63 (2.48)	4.71 (2.28)	4.84 (2.31)	4.44 (2.22)	4.66 (2.27)	16.01 (23.56)	1620.41
T5	Buttermilk + Neem leaves+ Datura leaves	15 litre + 625 gm + 625 gm	6.51 (2.65)	2.26 (1.75)	2.37 (1.69)	1.94 (1.56)	2.29 (1.67)	10.07 (18.46)	1924.88
T6	Buttermilk+ Neem leaves + Datura leaves+ Black pepper+ Mustard	15 litre + 625 gm + 625 gm + 625 gm + 625 gm	5.40 (2.43)	0.22 (0.85)	0.12 (0.79)	0.04 (0.74)	0.13 (0.79)	2.58 (9.19)	2322.32
T7	Emamectin benzoate 5 % SG	200 gm	7.14 (2.76)	0.26 (0.87)	0.17 (0.82)	0.09 (0.76)	0.17 (0.82)	3.10 (10.01)	2230.27
T8	Untreated control		6.78 (2.70)	7.48 (2.82)	6.26 (2.60)	7.08 (2.75)	6.94 (2.73)	24.33 (29.53)	1343.45
SE±				0.05	0.05	0.06	0.03	0.77	25.734
C.D. (P=0.05)				0.17	0.15	0.18	0.09	2.36	78.812

*Figures in parenthesis are the ark sin transformed values and $\sqrt{X+0}$. ** Mean of two spraying

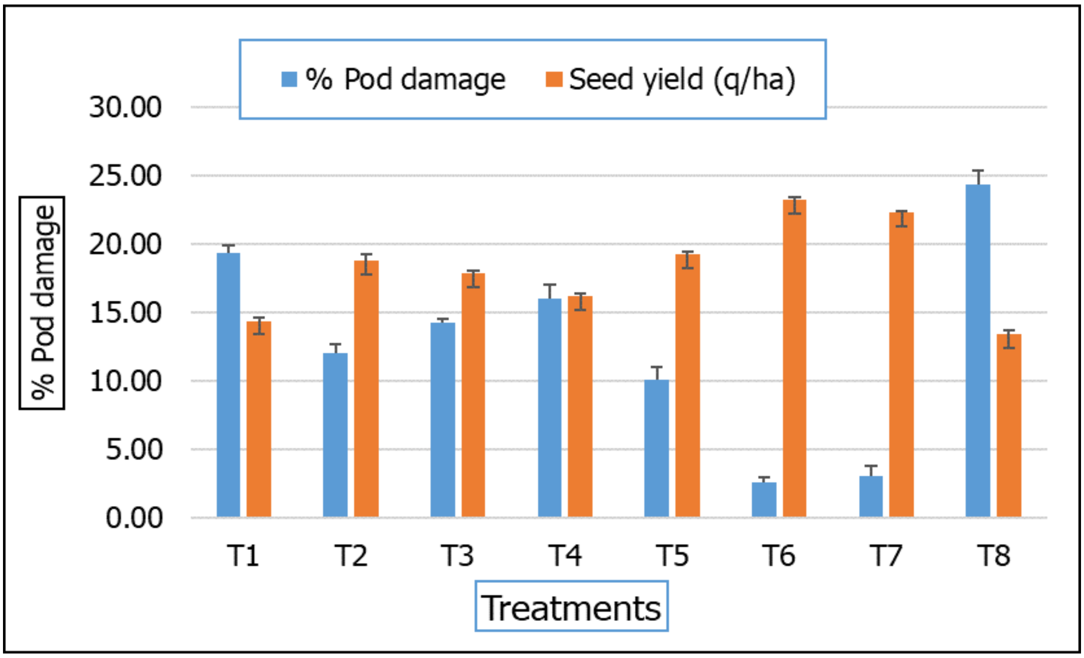

Fig 1: Percent chickpea pod damage due to *H. armigera* in the experiment

4. Conclusion

In conclusion, based on study, we recommend that sprays of T_6 (Buttermilk @ 15 litres/ha + Neem leaves @ 625 gm/ha + Datura leaves @ 625 gm/ha + Black pepper @ 625 gm/ha + Mustard @ 625 gm/ha) for the management of *H. armigera* in chickpea. this treatment combinations are totally natural products which can be made by the farmers at his home. These are very cheaper botanical products, ecofriendly, economical, safe to beneficial insect and very effective against the *H. armigera* in chickpea as compare to the chemical control. Fermented Botanical extracts can be a promising a part of IPM program for marginal chickpea farmers. consequently, future studies need to have attention on mechanisms in their mode of action, ease of product availability and repeat trials under different location.

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