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RESEARCH PAPER

Evaluation of different plant products against pod borer, *Helicoverpa armigera* (Hubner) infesting chickpea under certified organic farming system

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Abstract: Pest management under organic farming is a challenging task, wherein, ecofriendly approaches against insect pest were accomplished through the use of appropriate strategies which promotes manipulation and alteration of agro-ecosystem. In this view, an experiment was laid out in Randomized Block Design with JG-11, a chickpea variety sown during *rabi* of 2021-22 and 2022-23 at certified organic block (certified since 2006), Bio-Resource Farm, Institute of Organic Farming, University of Agricultural Sciences, Dharwad. The analysis of pooled data for two seasons revealed that, among various plant products evaluated the plots treated with NSKE @ 5% found superior with significantly least larval population of *Helicoverpa armigera* (0.72 larvae/m row), with minimum per cent defoliation (12.02%) as well as significantly lower pod damage (11.75%) which was followed by *Vitex negundo* @ 5%. Similarly, statistically higher chickpea yield was noticed under plots sprayed with NSKE @ 5% with (825.40 kg/ha) with B:C ratio (1.77) during 2021-22, and (788.36 kg/ha) with B:C ratio of (1.69) during 2022-23, compared to untreated check with 161.02 kg/ha and 195.77 kg/ha during 2021-22 and 2022-23, respectively. However, in comparison with inorganic check, organically treated plots documented, relatively higher population of major natural enemies of chickpea ecosystem such as *Campoletis chlorideae* and coccinellids which was on par with untreated control.

Key words: Chickpea, Certified organic farming system, *Helicoverpa armigera,* Insecticidal plant extracts

Introduction

Organic farming as a holistic production management system that encourages and improves health and biodiversity of agro-ecosystem. Pest management in organic farming is accomplished through the use of appropriate cropping techniques, biological control, and natural pesticides (biorationals), which promotes manipulation and alteration of agro-ecosystem. The main strategy to combat harmful insect herbivores and to build up a population of beneficial insects. Chickpea (*Cicer arietinum*) [Fabaceae] is an important annual legume crop in India, Mediterranean and Middle Eastern region. India is the largest producer of chickpea in the world, accounting for 70 per cent of global production in 2019 (Anon., 2020). Chickpeas are a nutrient-dense food, providing rich content (20% or higher of the Daily Value) of protein, dietary fiber, folate, and certain dietary minerals, such as iron and phosphorus in a 100-gram reference amount. In particular, the Calcium content in chickpea leaves was over three times higher than that in spinach and over six times higher than that in cabbage leaves (Ibrikci *et al.,* 2003) and also these are used as energy and protein source as animal feed (Bampidis and Christodoulou, 2011). Presently, there is enormous potential for increasing chickpea productivity, which is severely hampered by insect pests with annual losses estimated to be 15 per cent. Despite several plant protection interventions, more than 200 species of insects live and feed on chickpea and major losses worldwide due to pod borer, *Helicoverpa armigera* Hubner alone (Rao *et al*., 2013). Because of the current state of pesticide use, insects have become resistant and more challenging to control, particularly in chickpea production with negative impact on health of other non-target organisms and environment. Therefore, alternative and environmentally safe ways are crucial to overcoming these obstacles successful insect pest management. As a result, current study is being conducted on cent percent organic land to assess key plant components for managing *H. armigera* in chickpeas.

Material and methods

Experiment was laid out in Randomized Block Design in three replications with a plot size of 4.20 × 3 m^2, leaving a gangway of 1m all around the plots. Plots were sown with JG-11, a chickpea variety sown during *rabi* of 2021-22 and 2022-23. Timely agronomic practices were carried out throughout the cropping season except for insect control. The required amount of fertilizer was supplied through the application of suitable organic source (especially 'P' requirement was met for pulses) as suggested under organic package of practice, UAS, Dharwad (Anon. 2020). To compare the results of each experiment a standard organic check and an inorganic check (chemical check) were laid out separately at inorganic block, UAS, Dharwad in three replications. Plant samples (leaves or seeds) were collected and extracted by standard extraction protocols mentioned as below. For preparing neem seed kernel extract and pongamia extract, 50 g of dried and smashed neem/ pongamia seeds were soaked overnight in 1 lit. of distilled water, squeezed through muslin cloth and diluted with distilled water to get 5 per cent concentration of the suspension. Similarly, for

Table 1. Effect of different plant products on *Campoletis chlorideae* population in chickpea ecosystem during 2021-22 and 2022-23

Treatments	*Campoletis chlorideae* cocoons per plant								
	2021-22			2022-23			Pooled data		
	30 DAS	60 DAS	Mean	30 DAS	60 DAS	Mean	30 DAS	60 DAS	Mean
T_1: NSKE (5%)	1.22** (1.31)^{a}	2.47 (1.72)^{a}	1.85	1.15 (1.28)^{b}	2.40 (1.70)^{a}	1.78	1.18 (1.29)^{a}	2.44 (1.71)^{a}	1.81
T_2: *Vitex negundo* (5%)	1.20 (1.30)^{a}	2.40 (1.70)^{a}	1.80	1.13 (1.28)^{b}	2.33 (1.68)^{a}	1.73	1.17 (1.29)^{a}	2.37 (1.69)^{a}	1.77
T_3: *Adathoda vesica* (5%)	1.19 (1.30)^{a}	2.39 (1.70)^{a}	1.79	1.12 (1.27)^{b}	2.32 (1.68)^{a}	1.72	1.16 (1.29)^{a}	2.36 (1.69)^{a}	1.76
T_4: *Pongamia glabra* (leaf extract) (3%)	1.20 (1.30)^{a}	2.50 (1.73)^{a}	1.85	1.13 (1.28)^{b}	2.43 (1.71)^{a}	1.78	1.17 (1.29)^{a}	2.47 (1.72)^{a}	1.82
T_5: *Pongamia glabra* (seed extract) (3%)	1.23 (1.31)^{a}	2.48 (1.73)^{a}	1.86	1.19 (1.30)^{b}	2.41 (1.71)^{a}	1.80	1.21 (1.31)^{a}	2.45 (1.72)^{a}	1.83
T_6: *Vinca rosea* (5%)	1.18 (1.29)^{a}	2.50 (1.73)^{a}	1.84	1.20 (1.30)^{b}	2.43 (1.71)^{a}	1.82	1.19 (1.30)^{a}	2.47 (1.72)^{a}	1.83
T_7: Standard organic check	1.25 (1.32)^{a}	2.38 (1.68)^{a}	1.82	1.18 (1.30)^{b}	2.31 (1.66)^{a}	1.75	1.22 (1.31)^{a}	2.35 (1.68)^{a}	1.79
T_8: Untreated check (UTC)	1.31 (1.34)^{a}	2.51 (1.73)^{a}	1.91	1.79 (1.50)^{a}	2.49 (1.73)^{a}	2.14	1.55 (1.42)^{a}	2.50 (1.72)^{a}	2.03
T_9: Inorganic check (RPP)	0.53 (1.01)^{b}	1.24 (1.31)^{b}	0.89	0.64 (1.07)^{c}	1.23 (1.31)^{b}	0.94	0.65 (1.07)^{b}	1.24 (1.31)^{b}	0.95
S. Em. (±)	0.07*	0.11	-	0.09	0.11	-	0.08	0.11	-
C.V. (%)	7.17	8.24	-	8.11	8.16	-	7.31	8.12	-

DAS: Days after Sowing Standard organic check: *Metarhizium anisopliae* (2g/lit.) RPP: Recommended Package of practice
*Significant @ 5% **Figures in parentheses are √x+0.5 transformed values
Means denoted by same alphabet in vertical column do not differ significantly (P=0.05) by DMRT

preparation of leaf extracts, fresh plant materials were collected and washed thoroughly (3-4 times) with tap water and finally with distilled water. Later, they were chopped into small pieces with a sharp knife. Five grams of chopped material were macerated in pestle and mortar and extracted with a small quantity of distilled water. The extracts were squeezed through muslin cloth and made up to 100 ml with distilled water. The filtrate was cold stored in clean reagent bottles for further use. The concentration of the suspension so prepared works out to be 5 per cent. The treatments were imposed 10-15 days after seedlings emergence and subsequent sprays were taken at 10 days' interval based on intensity of pest damage (need based spray).

Further, observation on incidence pod borer (*H. armigera*), per cent defoliation and pod damage was recorded regularly both at vegetative and reproductive stages of crop. Observation on larval population in terms of number of larvae per meter row length was recorded at 3 and 7 days after each spray, wherein, treatments were imposed based on the infestation level and a total of five spray were taken. Likewise, chickpea yield parameters and observation on abundance of beneficial insect fauna were documented as well.

Results and discusion

In the current study, different plant products were evaluated against chickpea pod borer (*H. armigera*) during *rabi* 2021-22 and 2022-23, and results of pooled data for two seasons were presented hereunder (Fig. 1). Among various plant products evaluated in chickpea, plots sprayed with NSKE @ 5% proved to be statistically superior with 0.72 larvae/m row, which was followed by *Vitex negundo* @ 5% with (1.14 larvae/m row). Remaining all the treatments found on par to each other. However, significantly lower population was recorded under inorganic check (0.13 larvae/m row) and higher under untreated check (9.74 larvae/m row). Similarly, plots treated with NSKE @ 5% found superior and effective against *H. armigera* damage which recorded lower defoliation of 12.02 per cent and lower pod damage (11.75 %). However, significantly higher defoliation was registered under untreated check (UTC) with 24.44 per cent, whereas, inorganic check documented statistically least defoliation (9.49%) among all the treatments. Similar trend was continued till fifth week of crop growth, wherein, the mean value throughout the crop stage showed that, minimum

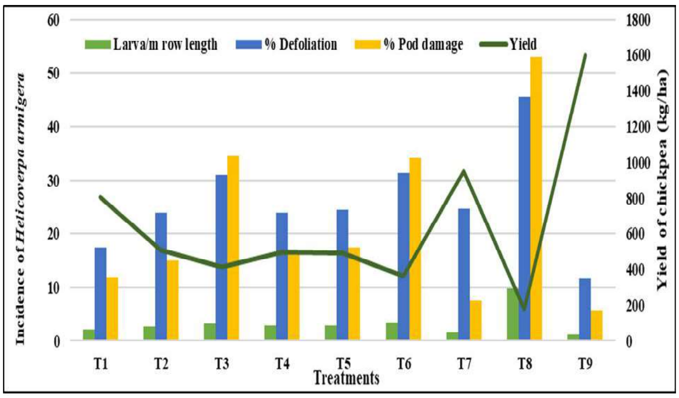

Fig. 1. Effect of different plant products against Helicoverpa armigera infesting chickpea during 2021-22 and 2022-23

T1: NSKE (5%); T2: *Vitex negundo* (5%); T3: *Adathoda vesica* (5%); T4: *Pongamia glabra* (leaf extract) (3%); T5: *Pongamia glabra* (seed extract) (3%); T6: *Vinca rosea* (5%); T7: Standard organic check; T8: Untreated check (UTC) and T9: Inorganic check (RPP)

Table 2. Effect of different plant products on coccinellid population in chickpea ecosystem during 2021-22 and 2022-23

Treatments	Coccinellids per plant								
	2021-22			2022-23			Pooled data		
	30 DAS	60 DAS	Mean	30 DAS	60 DAS	Mean	30 DAS	60 DAS	Mean
T_1: NSKE (5%)	1.04** (1.23)[b]	2.11 (1.62)[ab]	1.58	1.38 (1.36)[b]	2.44 (1.71)[b]	1.91	1.21 (1.30)[b]	2.28 (1.67)[b]	1.75
T_2: *Vitex negundo* (5%)	1.05 (1.23)[b]	2.14 (1.62)[ab]	1.60	1.36 (1.35)[b]	2.47 (1.72)[b]	1.92	1.20 (1.30)[b]	2.31 (1.67)[b]	1.76
T_3: *Adathoda vesica* (5%)	1.07 (1.24)[b]	2.10 (1.59)[ab]	1.59	1.37 (1.36)[b]	2.43 (1.71)[b]	1.90	1.22 (1.30)[b]	2.27 (1.66)[b]	1.75
T_4: *Pongamia glabra* (leaf extract) (3%)	1.08 (1.25)[b]	2.09 (1.61)[ab]	1.59	1.41 (1.37)[b]	2.42 (1.70)[b]	1.92	1.24 (1.32)[b]	2.26 (1.66)[b]	1.75
T_5: *Pongamia glabra* (seed extract) (3%)	1.08 (1.25)[b]	2.02 (1.59)[ab]	1.55	1.42 (1.37)[b]	2.35 (1.68)[b]	1.89	1.25 (1.31)[b]	2.18 (1.64)[b]	1.72
T_6: *Vinca rosea* (5%)	1.09 (1.25)[b]	2.03 (1.59)[ab]	1.56	1.43 (1.38)[b]	2.36 (1.69)[b]	1.90	1.26 (1.32)[b]	2.20 (1.64)[b]	1.73
T_7: Standard organic check	1.08 (1.24)[b]	2.02 (1.59)[ab]	1.55	1.42 (1.37)[b]	2.35 (1.68)[b]	1.89	1.25 (1.31)[b]	2.19 (1.64)[b]	1.72
T_8: Untreated check (UTC)	1.71 (1.47)[a]	2.77 (1.80)[a]	2.24	2.57 (1.75)[a]	3.75 (2.05)[a]	3.16	2.14 (1.62)[a]	3.26 (1.92)[a]	2.70
T_9: Inorganic check (RPP)	0.62 (1.05)[c]	0.86 (1.16)[b]	0.74	0.83 (1.15)[c]	0.92 (1.19)[c]	0.88	0.73 (1.11)[b]	0.89 (1.18)[c]	0.81
S. Em. (±)	0.08*	0.11	-	0.10	0.11	-	0.10	0.11	-
C.V. (%)	8.34	8.49	-	8.26	8.26	-	9.36	8.25	-

DAS: Days after Sowing Standard organic check: *Metarhizium anisopliae* (2g/lit.) RPP: Recommended Package of Practice
*Significant @ 5% **Figures in parentheses are $\sqrt{x+0.5}$ transformed values
Means denoted by same alphabet in vertical column do not differ significantly (P=0.05) by DMRT

defoliation was observed under NSKE @ 5% treated plots, followed by *Vitex negundo* @ 5%. However, UTC documented maximum defoliation with mean value of 38.79 per cent and higher pod damage with mean value of 52.95 per cent.

Likewise, observation on abundance of natural enemy population (coccinellids and *Campoletis chlorideae*) was documented from chickpea fields (Table 1 and 2), which showed that, significantly lower number of coccinellids adults and *C. chlorideae* cocoons were documented under RPP with 0.73 and 0.65 per plant, respectively at 30 DAS and 0.89 and 1.24 per plant, respectively at 60 DAS. However, plots treated with plant products, standard organic check and UTC recorded significantly higher and statistically on par natural enemy population which ranged from 1.20-1.26 coccinellids/plant and 1.17-1.55 cocoons/plant at 30 DAS and 2.18-2.31 coccinellids/ plant and 2.35-2.50 cocoons/plant at 60 DAS. Similarly, at harvest, higher grain yield was noticed under NSKE @ 5% with (825.40 kg/ha) with B:C ratio (1.77) during 2021-22, and (788.36 kg/ha) with B:C ratio of (1.69) during 2022-23, followed by *Vitex negundo* @ 5%. However, yield under UTC was statistically least (161.02 kg/ha) and 195.77 kg/ha during 2021-22 and 2022-23, respectively. Whereas, among all the treatments, inorganic check (RPP) reported higher yield with B:C ratio of 2.24-2.91.

Among different botanicals, neem based extract (NSKE) found very effective might be due to properties of neem in various forms helps in inhibiting growth and development of insect pests, which also hinders oviposition with reduced egg laying and adult emergence with reduction in insect survival. Neem also known to affect pest incidence and population density and show JH mimic, antifeedant, repellent and insecticidal activity against various group of insects which was documented in several reports (Debashri and Tamal, 2012). Wherein, botanicals like *Vitex negundo* and *Pongamia glabra* are also found affective after neem, which was due to their antifeedants, larvicidal and pupicidal activity which was confirmed by Rajput *et al.* (2018). Wherein, botanicals like *Vitex negundo* and *Pongamia glabra* are also found affective after neem, which was due to their antifeedants, larvicidal and pupicidal activity which was supported by Pandey *et al.* (2014) and Rajput *et al.* (2018). Reports of Ladaji (2004) have also suggested that the treatment with Pongamia and *Vitex* leaf extract were found very effective in management of lepidopteran pest especially *Helicoverpa armigera* in various crops. Similarly, findings of Sahayaraj (2011) and Suganthy and Sakthivel (2013) concluded that *Azadirachta indica*, *Vitex negundo* and *Pongiamia pinnata* successfully managed *S. litura* population and damage on different crops. Murugan and Ravi (2020) documented the effectiveness of aqueous extracts of *Vinca rosea* and *P. pinnata* against jasmine lepidopteran pests. Lulie and Raja (2012) observed that the antifeedant activity of neem extracts on the fourth instar larvae of *Helicoverpa* and found minimum chickpea pod damage (13.33%) as compared to untreated control which was recorded 100 per cent pod damage. The organically treated plots have recorded significantly higher and abundant population of beneficial natural enemy when compared to inorganic check. These findings were confirmed by the studies of Bharathi (2005) and Mudigoudra and Shekharappa (2009) suggested that, botanicals are safer to natural enemies and their aqueous extracts of neem, pogamia, vitex, adathoda and periwinkle (*Vinca rosea*) did not affect activity of natural enemies (coccinellids, predatory mites and spiders) much but recorded next best to untreated control under various agro ecosystems. from the present study it was evident that yield under inorganic check was statistically higher compared to organic treatments. However, plots treated with NSKE @ 5% registered significantly maximum yield among organics with higher B:C ratio, which was next best to inorganic check. Rajput *et al.* (2018) have also observed that NSKE @ 5% treated plots obtained highest mean yield of 781 kg/ha and similar results concluded by Anandhi and Ambethgar (2022), documented NSKE 5% with significantly more grain yield (1869.55 kg/ ha) and cost benefit ratio (1:1.95) than other treatments.

Conclusion

The use of plant products with diverse mode of action not only improves herbivore management but also lowers the cost of plant protection which will intern benefit small and marginal farmers with improved plant and soil health. The present research, special emphasis was placed on hundred per cent organic production system which promotes human and livestock health-safety through pesticide-free organic pest management. In addition, it supports conservation agriculture, notably the biocontrol agents (natural enemies) which accelerates the insect pest management.

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