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Toxic and deterrent effects of natural products against *Cnaphalocrocis medinalis* (*Guenee*) (Lepidoptera: Crambidae)

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The inhibitory and lethal effects of natural pest management products were observed against rice leaf folder, *C. medinalis,* during 2022 and 2023, under both laboratory and field conditions at the Department of Organic Agriculture and Natural Farming, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. *Agniastra*, *Brahmastra*, *Darekastra*, *Dashparni ark*, and *Neemastra* were the products which were made and used for pest management studies. The LC_{50} values ranged from 26.56 (*Dashparni ark*) to 62.13% (*Brahmastra*). *Dashparni ark* showed the highest repellent activity with a repellence index (RI) of 0.48 and the highest feeding deterrence with a feeding deterrence index (FDI) of -70.01 at 40% concentration. When given a choice, *Neemastra* was least preferred by *C. medinalis* for oviposition, in the choice test at all concentrations compared to when no choice was given. Field evaluations data of two years, further confirmed the efficacy of *Dashparni ark* by reducing *C. medinalis* infestations by 62.82 and 66.49% over untreated controls in both years, respectively. These findings suggest that natural products, especially *Dashparni ark* and *Neemastra*, could be effective and eco-friendly alternatives to chemical pesticides for managing *C. medinalis* in rice cultivation.

Keywords: *Dashparni ark,* Feeding deterrence, Inhibitory, Lethal, Oviposition, Repellence

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Rice (*Oryza sativa* L.) is an essential food for about half of the world's population. It plays a significant role in food security and is cultivated across temperate, tropical, and sub-tropical regions worldwide. India ranks at second position in terms of rice production, by growing the crop on 46.38 million hectares and yielding 130.29 million tonnes[1]. In Himachal Pradesh, rice is being cultivated over 67.30 thousand hectares, achieving a production of 130.05 thousand tonnes[2].

The rice ecosystem is very diverse with a record of more than 800 insect species, causing direct as well as indirect type of damage through disease transmission[3]. In India, a variety of insect pests have been identified to cause damage to different parts of rice plants. More than 175 insect pest species are known to infest rice at various growth stages[4]. Notable pests include *Scirpophaga incertulas* (Walker), *Sogatella furcifera* (Horvath), *Nilaparvata lugens* (Stal.), *Sesamia inferens* (Walker), *Nephotettix virescens* (Distant), *Scirpophaga innotata* (Walker), *Chilo suppressalis* (Walker), *Cnaphalocrocis medinalis* (Guenee), *Orseolia oryzae* (Wood-Mason), *Nymphula depunctalis* (Guenee), *Hydrellia philippina* (Ferino), and *Leptocorisa acuta* (Thunberg)[5]. Other than these regular pests, rice hispa (*Dicladispa armigera*), *Mythimna separata* (Walker), grasshoppers, skippers, mealybugs, thrips, aphids, caseworms and termites are emerging threats in rice-growing states of the country[6,7].

Overall, the insect-pests in rice are able to cause yield loss to an extent of 25%[8]. Among chewing pests, leaf folder (*C. medinalis*) is one of the regular pests of rice, which causes an estimated crop loss of 30 to 80%[9]. This pest 1[st] folds the leaf, and then feeds on it by scraping the leaves from within, causing longitudinal white stripes and membranous patches on the leaf surface. At 1[st], the young larval instars feed together inside the folded leaves, but as they grow old they start to infest the rice leaves individually[10].

In modern pest management, the most commonly employed practice is using chemical pesticides. But there are some disadvantages to this practice *viz*., pest resurgence, resistance development *etc*., which necessitates the use of alternative management practices like "Natural farming". In this farming

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system traditional or natural products are used which are a combination of plant-based and cow-derived compounds, which achieve pest management through diverse mechanisms. Cow urine just not only provides plant immunity through different nutrients, salts and amino acids, but it is also known to exhibit pesticidal properties[11]. It is effective alone and can also give additive effects when combined with other products[12]. Among plants, neem (*Azadirachta indica*) and darek (*Melia azedarach*) are most commonly used in pest management as they act as feeding deterrent and limonoids found in neem can also interfere with the physiological processes of insect[13]. Also, darek extracts make the pupal stage of insect less viable and cause deformities in pests like tobacco caterpillar[14,15]. *Agniastra*, has a strong repellent property due to presence of garlic (diallyl disulfide) and chilli (capsaicin), which also interferes with insect's nervous systems and reduce their egg laying capacity[16]. In *Dashparni ark*, *Datura* plant containing scopolamine is also added, which has been reported to give control against onion thrips, rice ear-cutting caterpillars, grasshoppers and aphids[17]. These natural products provide sustainable alternatives for integrated pest management.

As there is a dearth of information on the use of these natural products on rice leaf folder, this study was conducted to include these in effective, economical, and efficient pest management strategies in terms of lethal toxicity, feeding deterrence, and ovipositional deterrence under laboratory and reduction in infestation over untreated check (UTC) in field conditions.

Materials and Methods

The study evaluated traditional Indian bioformulations- *Agniastra*, *Brahmastra*, *Neemastra*, *Dashparni ark*, and *Darekastra*, widely used in organic and zero-budget natural farming (ZBNF) for their efficacy in controlling *C. medinalis*. In this study, both laboratory and field trials were conducted. A one-time laboratory experiment was performed to test the effectiveness of these products on the second instar larvae of *C. medinalis*. In addition, two years of field trials (2022-2023) were carried out at the Research Farm of the Department of Organic Agriculture & Natural Farming, CSKHPKV Palampur, to assess the efficacy of these treatments under field conditions.

These formulations have been documented in indigenous pest management systems and require scientific validation to support their integration into modern sustainable agriculture[18,19]. Details of these products are provided in Table 1.

Laboratory studies

Rearing and maintenance of C. medinalis

A laboratory culture of *C. medinalis* was maintained on 20-25 day-old paddy seedlings grown in pots. Adults collected from rice fields were introduced into ovipositional cages with potted plants and provided a 10% honey solution as feed. Egg-laden plants were transferred to separate cages for hatching and larval development, ensuring a continuous supply of insects for experiments.

Lethal toxicity

Natural products were prepared as 100% stock solutions, with working concentrations obtained through serial dilution in distilled water. Preliminary tests identified concentrations causing 20-80% mortality. Potted rice plants were treated with different concentrations and an untreated control (UTC) was included. After drying for 30 min, 10 second instar larvae were released per treatment (three replicates).

Table 1 — Composition of the natural products used in pest management

Natural products	Composition
Agniastra	Cow urine - 10 L, Crushed and ground leaves of Darek- 5 kg, Tobacco powder - 500 g, Chilli powder - 500 g, Crushed garlic - 500 g
Brahmastra	Cow urine - 4 L, Leaves of five plants - 200 g each, (darek, papaya, castor, mango and dhatura)
Neemastra	Neem leaf/fruit powder - 5 kg, Cow urine - 5 L, Cow dung - 5 kg, Water - 100 L
Dashparni ark	Cow urine - 4 L, Cow dung - 400 g, Turmeric powder - 100 g, Ginger paste - 100 g, Asafoetida (heeng) - 500 g, Water - 40 litres, Tobacco powder - 200 g, Green chilli powder - 200 g, Garlic paste - 100 g, Darek leaves - 400 g, Leaves of any 10 plants - 400 g, (castor, dhatura, papaya, mango, guava, arjuna, bana, basuti, turmeric, ginger)
Darekastra	Darek branches with leaves - 5 kg, Cow urine - 5 L, Cow dung - 1 kg, Water - 100 L
Beejamrit	Cow dung - 5 kg, Cow urine - 5 L, Burnt lime - 50 g, Uncontaminated soil - 5 g, Water - 20 L
Jeevamrit	Cow dung - 10 kg, Cow urine - 10 L, Gram flour - 2 kg, Jaggery - 2 kg, Uncontaminated soil - 100 g, Water - 200 L
Ghanjeevamrit	Cow dung - 100 kg, Cow urine - 5 L, Gram flour - 1 kg, Jaggery - 1 kg, Uncontaminated soil - 500 g

All formulations were tested at recommended concentrations and found non-phytotoxic to rice plants.

Mortality of larval stage was observed at 24, 48, and 72 h post-treatment, and corrected mortality was calculated using Abbott's formula[20]. LC_{50} values were determined through Probit analysis[21].

Repellent activity

Five concentrations (2.5, 5, 10, 20, and 40%) of natural products were tested for repellence using potted plants. After shade drying, treated plants and UTC were placed in separate cages, with 10 third instar larvae released per plant (three replicates). Larvae movement was recorded hourly for three hours, and repellence was calculated using a formula. The data were expressed in the form of per cent repellence (PR) by using the following formula:

$$\text{Repellence (\%)} = \frac{\text{(Insects (\%) repelled in treatment)} - \text{(Insects (\%) repelled in untreated control)}}{100 - \text{Insects (\%) repelled in untreated control}} \times 100$$

Repellence index (RI) was also calculated using the equation[22]:

$$RI = \frac{2T}{(T + C)}$$

Where, T is the number of insects on treated plants and C is the number of insects on the UTC. When RI = 1, indicated attractiveness of *C. medinalis* to the treated plants compared with the UTC.

Feeding deterrence/antifeedant activity

The antifeedant effect of natural products was tested at five concentrations on rice plants with three larvae per plant that were pre-starved for 12 h (three replicates). After 48 hours, the leaf area consumed was measured using a leaf area meter, and the Feeding Deterrence Index (FDI) was calculated. FDI values range from -100 (complete deterrence) to +100 (attraction).

$$FDI = \left(\frac{(T - C)}{(T + C)}\right) \times 100$$

Oviposition deterrence

Choice and no-choice tests were conducted to evaluate the oviposition deterrence of natural products. In the choice test, insects chose between UTC and treated plants (five treated, one UTC), while in the no-choice test, UTC and treated plants were placed in separate cages. Thirty mated females were released (five per plant) and oviposition was recorded after 48 h. The Oviposition Deterrence Index (ODI) was calculated, with positive values indicating attraction and negative values indicating repellence[23].

$$ODI = \left(\frac{(T - C)}{(T + C)}\right) \times 100$$

Where, T represents number of eggs oviposited on treated plants and C denoted number of eggs oviposited on UTC. Products were categorized based on repellence, feeding deterrence, and oviposition deterrence at the field-recommended dose (10%)[18].

Categorization of insecticidal activities of natural products

Category	Observed mortality/ deterrence (%)	Category score
Very low	1.0-20.0	1
Low	20.1-40.0	2
Moderate	40.1-60.0	3
High	60.1-80.0	4
Very high	80.1-100.0	5

Observations were recorded up to 3 h (for repellency) and 48 h (for feeding deterrence and ovipositional deterrence) post-treatment. Statistical analysis was performed using a completely randomized design (CRD), with appropriate transformations to assess the effects of natural products at different concentrations on *C. medinalis*.

Field evaluation of natural products

An experiment was conducted at the Research Farm of the Department of Organic Agriculture & Natural Farming, CSKHPKV Palampur in 2022 and 2023 to evaluate natural products against rice insect pests. The HPR 2880 variety, chosen for its susceptibility to rice pests to allow effective evaluation of treatments, was transplanted in the second week of July, following standard agronomic practices without plant protection measures (Table 2). The study included 11 treatments with 4 replications, using 3 m × 2 m plots with 20 cm × 15 cm plant spacing. Four sprays were applied, and natural farming inputs were sourced from the Zero Budget Natural Farming Research Farm, CSKHPKV, Palampur, Himachal Pradesh, India. Natural products were applied starting at 58-61 days after transplanting

(DAT), with four sprays at 10-day intervals. Leaf infestation by the rice leaf folder was recorded on ten randomly selected hills per plot before each spray and 5 and 10 days after spray. The per cent reduction over control in leaf infestation was calculated using the final observed infestation data.

Per cent reduction over control (%) =
(% infestation in control)
– (% infestation in treatment)
----------------------------------- × 100
% infestation in control

Table 2 — Details of natural products used in insect-pest management

Treatments	Natural products	Concentrations (%)
T_1	*Agniastra*	10
T_2	*Agniastra*	20
T_3	*Brahmastra*	10
T_4	*Brahmastra*	20
T_5	*Darekastra*	80
T_6	*Darekastra*	100
T_7	*Dashparni ark*	5
T_8	*Dashparni ark*	10
T_9	*Neemastra*	10
T_{10}	*Neemastra*	20
T_{11}	Untreated control	-

Results

Laboratory studies

Lethal toxicity

In the present study, the relative toxicity data of different natural products revealed that LC_{50} values ranged from 26.56 to 62.13%, with the minimum and maximum values corresponding to *Dashparni ark* and *Brahmastra*, respectively (Table 3). When compared to *Brahmastra*, *Dashparni ark* was 2.34 times more toxic to 2nd instar larvae followed by *Neemastra* (2.07 times).

Repellent activity

The natural product *Dashparni ark* showed the highest average repellence, followed by *Neemastra* and *Agniastra*, which were at par with each other. *Brahmastra* had the lowest repellent activity, significantly differ from the other products. The repellence index (RI) established for five natural products presented in (Fig. 1) showed all the evaluated products resulted in values less than unity depicting them to exhibit repellent effect to 3rd instar larvae of *C. medinalis* at all the tested concentrations. *Dashparni ark* exhibited the lowest RI values, indicating maximum repellence at all evaluated

Table 3 — Relative toxicity of different natural products to 2nd instar larvae of *C. medinalis*

Treatment	LC_{50} (%)	SE (LC_{50})	Regression equation	95% CI (%)	Slope (b)	Heterogeneity ($\chi 2$)	Relative toxicity
Agniastra	35.50	±6.68	2.49+1.63 X	22.42 - 48.59	1.63	0.12	1.75
Brahmastra	62.13	±11.88	1.87+1.78 X	38.79 - 85.47	1.78	0.28	1.00
Darekastra	43.48	±8.31	2.32+1.65 X	27.17 -59.79	1.65	0.25	1.43
Dashparni ark	26.56	±4.91	2.64+1.66 X	16.94 - 36.18	1.66	0.07	2.34
Neemastra	29.99	±5.76	2.65+1.60 X	18.69 - 41.30	1.60	0.04	2.07

χ^2_{cal} (p=0.05) < χ^2_{tab} (7.815) in all the cases
LC_{50} values, 95% confidence intervals, and standard errors were estimated using probit analysis; non-overlapping CIs indicate statistically significant differences at p<0.05.

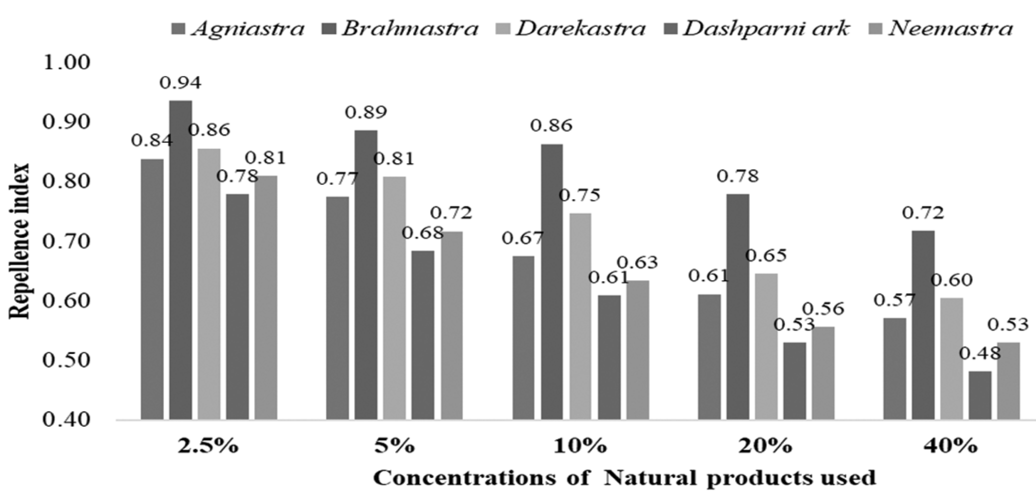

Fig. 1 — Repellence index of natural products to 3rd instar larvae of *Cnaphalocrocis medinalis*

concentrations, with the highest repellent activity observed at 40.0% (0.48). The subsequent effective treatments in terms of repellence, were found to be *Neemastra* and *Agniastra* (Fig. 1).

Feeding deterrent activity

The data on feeding deterrent activity of natural products showed that lowest leaf area of 2.67 cm^2 was consumed in plants treated with *Dashparni ark* at 40.0% concentration as compared to *Brahmastra* which showed maximum leaf area consumed (12.27 cm^2) at 2.5% concentration. The feeding deterrence index (FDI) calculated for natural products, indicated that all the products exhibited feeding deterrent activity against 3rd instar larvae of *C. medinalis* as indicated by the negative index values. The feeding deterrence activity shown in (Fig. 2), revealed *Dashparni ark* as the most efficacious feeding deterrent product, with deterrence increasing at higher concentrations, reaching its peak at 40.0% concentration (-70.01).

Oviposition deterrent activity

The data pertaining to oviposition deterrence of natural products, assessed against five mated females of *C. medinalis* in both choice and no-choice tests. The Oviposition Deterrence Index (ODI) revealed that *Neemastra* exhibited the highest deterrent activity, followed by *Dashparni ark*, *Agniastra*, *Darekastra*, and *Brahmastra* at all concentrations in both choice and no-choice tests, as indicated by negative ODI values (Fig. 3 & Fig. 4). When given a choice, *Neemastra* followed by *Dashparni ark* and *Agniastra* were least preferred by *C. medinalis* for oviposition, as shown by the higher deterrence exhibited by these products compared to no choice. On the other hand, *Brahmastra* and *Darekastra* were less effective in deterring egg-laying in the choice test at lower concentrations. However, at higher concentrations, both products exhibited slightly higher oviposition deterrence in the choice test than in the no-choice test. *Brahmastra* and *Darekastra* were less effective in deterring egg-laying at lower concentrations, likely due to insufficient levels of bioactive compounds to trigger a strong behavioral response in the insects. However, at higher concentrations, the increased presence of deterrent compounds enhanced the avoidance behavior, resulting in slightly higher

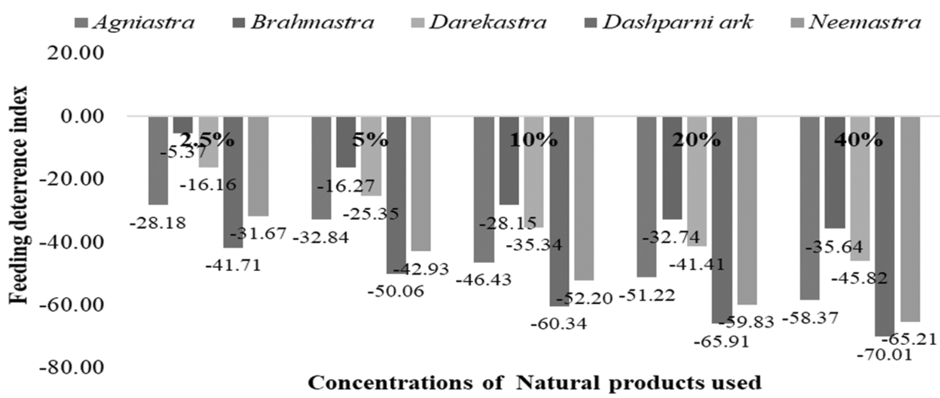

Fig. 2 — Feeding deterrence index of natural products to 3rd instar larvae of *Cnaphalocrocis medinalis*

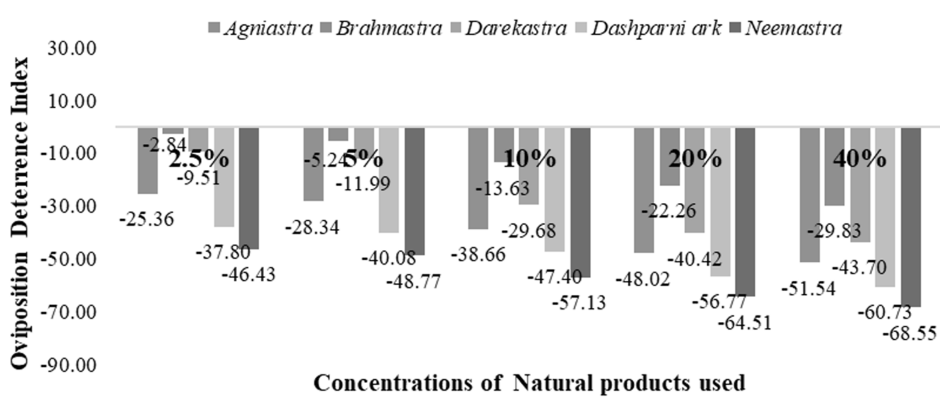

Fig. 3 — Oviposition deterrence index of natural products against *Cnaphalocrocis medinalis* in choice method

oviposition deterrence in the choice test compared to the no-choice test.

Insecticidal activity of natural products at recommended field dose

The assessment of natural products against *C. medinalis* at the recommended field dose (10%) showed varied insecticidal activities. Repellent activity ranged from 24.07% to 55.09%, with *Brahmastra* showing the lowest and *Dashparni ark* the highest. Feeding deterrence in *Dashparni ark*-treated plants was comparable to *Neemastra* and *Agniastra*, which were significantly higher than *Darekastra* and *Brahmastra*. In the no-choice test, the order of oviposition deterrence was *Neemastra* > *Dashparni ark* > *Agniastra* > *Darekastra* = *Brahmastra* (Table 4).

The insecticidal properties of five natural products at recommended field dose, revealed *Dashparni ark* and *Neemastra* to exhibit moderate level of repellence. These findings support traditional agricultural wisdom, where farmers have long used cow urine, neem, and other botanicals to deter pests without harming beneficial organisms. While these formulations are generally cost-effective and made from locally available ingredients, their preparation is labor-intensive, and some ingredients may not be available year-round. Therefore, both efficacy and practical feasibility should be considered when recommending these products for natural farming systems.

Field evaluation of natural products against *C. medinalis* during 2022 and 2023

Two-year field trials showed that *Dashparni ark* (10%) was found most effective against leaf folder infestation, showing significantly lower infestation levels compared to *Neemastra* (20%), which was the next best treatment in both years. *Brahmastra* was the least effective, with the highest infestation at both concentrations. All treatments significantly reduced leaf infestation compared to the untreated control at 40 DAS. In 2022, *Dashparni ark* (10%) achieved the highest reduction (62.82%), followed by *Dashparni ark* (5%), *Neemastra* (20%), with reductions of 61.46%, 57.19%, 55.15%, and 53.75%. A similar trend was observed in 2023, with *Dashparni ark* (10%) achieving a 66.49% reduction (Fig. 5).

Grain yield and IOIR

Two-year field trials showed that *Dashparni ark* (10.0%) consistently provided the highest grain yield

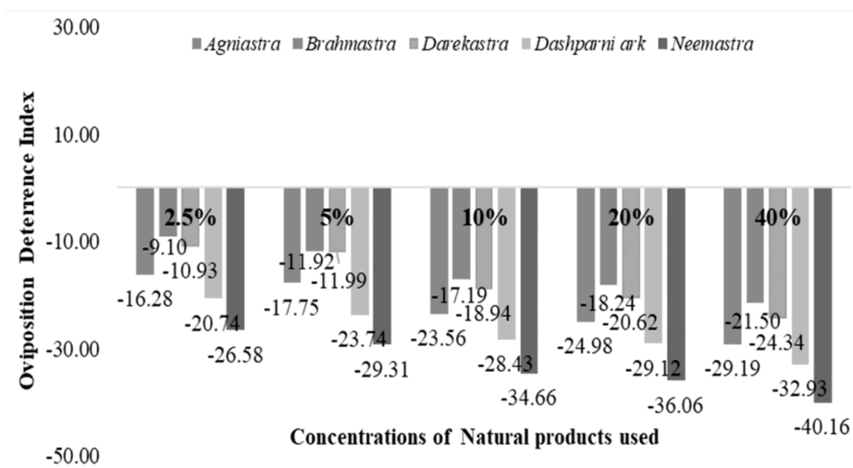

Fig. 4 — Oviposition deterrence index of natural products against *Cnaphalocrocis medinalis* in no-choice method

Table 4 — Comparative insecticidal activity (%) of natural products against *Cnaphalocrocis medinalis* at recommended field dose

Natural products	Repellence* (%)	Feeding deterrence** (%)	Ovipositional deterrence** (%)
Agniastra (10%)	47.22 (43.39)	63.22 (52.69)	38.12 (38.11)
Brahmastra (10%)	24.07 (29.37)	43.91 (41.48)	29.25 (32.68)
Darekastra (10%)	39.35 (38.84)	51.43 (45.84)	31.82 (34.32)
Dashparni ark (10%)	55.09 (47.91)	75.01 (60.12)	44.26 (41.69)
Neemastra (10%)	51.39 (45.78)	68.58 (55.89)	51.38 (45.78)
CD (p = 0.05)	(1.87)	(8.07)	(3.74)

Figures in parentheses are the arc sine transformed values
*3 h after treatment
**48 h after treatment

(35.01 q/ha in 2023) and IOIR (3.53), followed by *Neemastra* (20.0%) with a yield of 34.86 q/ha and IOIR of 2.71 (Fig. 6). *Dashparni ark* (10.0%) and *Neemastra* (20.0%) were significantly superior to other treatments. *Dashparni ark* (5.0%) with 32.51 q/ha and *Neemastra* (10.0%) with 29.08 q/ha were significantly at par with each other, and also significantly superior to *Agniastra* (10.0%) and (20.0%) with yields of 26.88 q/ha and 28.94 q/ha, respectively. These treatments were the most cost-effective, yielding substantial increases over the untreated control (22.77 q/ha in 2023).

Discussion

Natural products serve as potent biological insecticides, employing mechanisms like toxicity, antifeedant activity, growth inhibition, and reduced fertility to combat pests[19]. Botanical insecticides not only give effective control against various pests but are safer to natural enemies or non-target pests[7]. Cow urine and dung are also ecofriendly alternatives which are being used in various studies for managing insect-pests in agriculture[24].

In the current study, *Agniastra* showed moderate insecticidal activity against *C. medinalis*, likely due to its compounds such as garlic and tobacco, which have insecticidal properties against certain insect-pests[7]. The effectiveness of garlic is due to the presence of sulfurous compounds such as diallyl disulfide, allicin and ajoene, which interfere with insect's nervous system and repel it or prevent its feeding. Tobacco has nicotine, an important toxin that disrupts the functioning of acetylcholine receptors, resulting in paralysis and death in many insect species. The moderate efficacy observed in this study may be due to the relatively lower concentration of these active compounds in the formulation or their reduced stability under field conditions. A number of studies

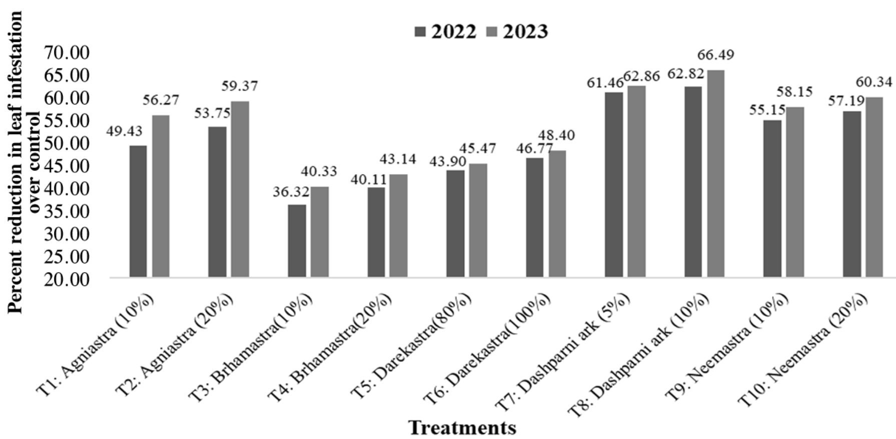

Fig. 5 — Reduction in leaf infestation of *Cnaphalocrocis medinalis* by natural products over untreated control during 2022 and 2023

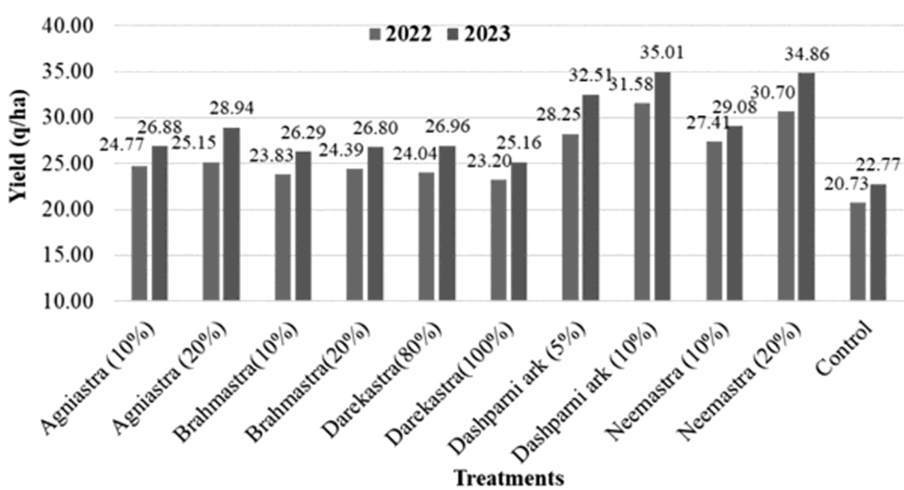

Fig. 6 — Grain yield in different treatments evaluated against insect-pests of rice during 2022 and 2023

supporting the result of current study have shown *Agniastra* causing mortality rate of 81.67% against *Sciara orientalis*[25], cutworm[26] (LC_{50} = 11.19%), and *Leucinodes orbonalis* (LC_{50} = 29.79%).

Darekastra showed low insecticidal activity in this study. It has been found effective as an antifeedant, because of the presence of limonoids like azadirachtin and meliartenin in Darek (*M. azedarach*)[14]. These limonoids interfere with the insect's hormonal system, inhibiting molting and metamorphosis, disrupting digestive enzyme activity, and causing reduced nutrient absorption, which ultimately leads to stunted growth, delayed development, and increased mortality. Its ability to reduce larval weight, increase mortality, and suppress pupation in pests was further confirmed by researchers[27,28]. Its moderate activity were observed against red spider mites[18,27,29], with some studies showing significant repellency and mortality[25,30].

In the present study, *Brahmastra* demonstrated a very low level of insecticidal efficacy and was found to be the least effective against *C. medinalis*. This could be attributed to its known effectiveness primarily against sucking pests[31] as *Brahmastra*, applied at a concentration of 20%, exhibited high effectiveness in suppressing sucking pests in cotton, including aphids, leafhoppers, thrips, and whiteflies, resulting in the highest seed cotton yield of 27.74 q/ ha with no adverse effects observed on natural enemies. Additionally, *Brahmastra*, sprayed at a concentration of 5%, remained effective for up to seven days' post-application, demonstrating a good residual effect against pests such as whiteflies, mites, aphids, leafhoppers, and fruit borers in okra[32].

Neemastra showed moderate insecticidal efficacy against *C. medinalis*, particularly in oviposition deterrence. Its effectiveness is attributed to its impact on plant morphology, texture, and colour, making it less conducive for egg-laying and feeding. Neem, containing the triterpenoid azadirachtin, is a well-known bio-pesticide, effective against over 450 insect species[33]. Azadirachtin induces antiperistaltic movement in larvae, causing vomiting and cessation of feeding[34]. Studies have shown neem oil's effectiveness in managing *Nilaparvata lugens*[35] and inhibiting growth in *C. medinalis*. Azadirachtin was found effective against *Plutella xylostella*, supporting the current findings[36]. *Dashparni ark* proved to be the most effective natural product against *C. medinalis*, demonstrating strong antifeedant, repellent, and mortality effects. Its unique composition, including cow dung, cow urine, and ten plants, enhance its insecticidal activity. *Dashparni ark* has been found highly effective against cutworm, *A. ipsilon*, showing maximum rate of antifeedance and lethal toxicity[37]. It has also shown its effectiveness against different insect pests *viz*., leafhopper, leaf folder and thrips[38] and in one of the studies, its efficacy was tested at different concentrations and was found best at 0.025%[39].

Dashparni ark, *Neemastra*, and *Agniastra* were highly effective against *C. medinalis* in rice, aligning with a study in which *Dashparni ark*'s efficacy against leaf folder, leafhopper, and thrips was reported[38]. Neemastra was also found effective in current study and was supported by many previous reports[34,40]. *Agniastra* was also found effective in this study which also gets support from a report in which reduced infestations and higher yields were observed after using *Agniastra* or the raw material present in it[40,41]. Natural products such as *Agniastra*, *Beejamrit* and *Neemastra* have been tested for the management of rice pests[35,42]. The crop yield was found maximum with *Dashparni ark* and *Neemastra*, at different concentrations with differences in yield being statistically significant.

The natural farming practice may appear very easy, but there are some challenges in the preparation and usage of these products as these are a combination of cow based and plant based compounds. To collect these products high number of infrastructure, labour and time is required, also the life of the products is another concern, as their effectiveness is mostly seen only for 6 months with 1st three months being the best. Although a detailed account on benefit cost ratio has not been given, but according to the observations it can be concluded that the locally sourced products such as *Dashparni ark* and *Neemastra* are effective and economical due to low material and preparation costs.

Conclusion

This study was conducted to evaluate the effectiveness of potent biopesticides, specifically *Dashparni ark* and *Neemastra*, in managing *C. medinalis*. Laboratory evaluations (lethal toxicity, repellence, feeding deterrence and ovipositional deterrence) of natural products *viz*., *Agniastra*, *Brahmastra*, *Darekastra*, *Dashparni ark* and *Neemastra* revealed *Dashparni ark* and *Neemastra*, to have moderate insecticidal activity against

C. medinalis. Field evaluations further confirmed the results of laboratory tests with *Dashparni ark* causing 62.82% reduction in infestation during 2022 and 66.49% during 2023, respectively. The specific mode of action of these products is still not known; therefore the future studies should be focused more on evaluating the effects of these products on crop plants and target pest population. Development of commercial formulations of these natural products can reduce the overreliance on chemical pesticides and can also benefit the environment and other beneficial insects.

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Conflict of Interest

The authors have no conflicts of interests about publication of this paper.

Author Contributions

PKS contributed to the conceptualization, methodology, resource acquisition, supervision and validation. AKS and PCS contributed to the methodology and supervision. AS conducted the experiments, performed data analysis, curation, and was involved in the review, editing, and writing of the original draft. All authors have read and approved the final version of the manuscript.

Ethical Approval

All plant/cow based products have been collected with the necessary permissions and ethical standards of plant research were also kept in mind while conducting this study. The authors declare that all the guidelines (national/ international/ institutional) were followed.

Prior Informed Consent

There is no involvement of any community but traditional knowledge systems from where these natural products originate are acknowledged.

Data Availability

The research data sheets associated with this study are available with corresponding author and will be shared on request.

References

1 Anonymous, Area, production and yield of major crops, Annual Report 2022-23, Department of Agriculture and Family Welfare, 2023a.

2 Anonymous, Area and Production under Crops, Department of Agriculture, Himachal Pradesh, 2023b.

3 Agyen-Sampong M, Mangrove swamp rice production in West Africa. In: Dynamics and Uses of Mangrove in the Countries of the Southern Rivers (from Senegal to Sierra Leone); Cormier-Salem M C (Ed.), ORSTOM Éditions: Paris, France, 1994, pp. 185-188.

4 Sulagitti A, Raghuraman M, Reddy M S S & Sathua S K, Seasonal variation in major insect pest incidence on rice and impact of various abiotic factors on their incidence under Varanasi conditions, *J Entomol Zool Stud*, 5 (3) (2017) 1060-1063.

5 Rath P C, Bose L K, Subudhi H N, Lenka S & Jambhulkar N N, Biodiversity of insect pests of rice in India, *Int J Chem Stud*, 8 (1) (2020) 2998-3002. DOI: 10.22271/chemi.2020.v8.i1at.8726

6 Singh S & Kumari B, Roving survey of major insect pests of rice crop (*Oryza sativa* L.) in different blocks of Patna district of Bihar state, India, *J Entomol Zool Stud*, 8 (5) (2020) 1115-1120.

7 Soundararajan R P, Chandrasekaran M & Narayanasami C, Botanical plant products against insect pests of rice, In*: Cutting-edge Research in Agricultural Sciences*, Mohamed A M & Al-Naggar (Eds.), Vol. 1, (Book Publisher International, Egypt), (2021) 52-64.

8 Dhaliwal G S, Jindal V & Dhawan A K, Insect pest problems and crop losses: changing trends, *Indian J Ecol*, 37 (1) (2010) 1-7.

9 Gangwar R K, Life cycle and abundance of rice leaf folder, *Cnaphalocrocis medinalis* (Guénée) – A review, *J Nat Sci Res*, 5 (15) (2015) 103-105.

10 Dash L, Ramalakshmi V, Padhy D & Tripathy B, Breeding for resistance against leaf folder in rice, *Indian J Pure Appl Biosci*, 8 (6) (2020) 248-253. DOI: http://dx.doi.org/10.18782/2582-2845.8456

11 Prashith Kekuda T R, Vivek M N, Manasa M, Kambar Y, Noor-Nawaz A S, *et al.*, Antifungal effect of cow urine extracts of selected plants against *Colletotrichum capsici* isolated from anthracnose of chilli, *Int J Agric Crop Sci*, 7 (3) (2014) 142-146.

12 Mudigoudra S, Shekharappa & Balikai R A, Evaluation of plant products in combination with cow urine and panchagavya against sorghum shoot fly, *Atherigona soccata* Rondani, *Kar J Agric Sci*, 22 (2009) 618-620.

13 Benhamou N, Lafontaine P J & Nicole M, Induction of systemic resistance to *Fusarium* crown and root rot in tomato plants by seed treatment with Chitosan, *Am Phytopathol Soc*, 84 (12) (2012) 1432-1444.

14 Carpinella M C, Defago M T, Valladares G & Palacios S M, Antifeedant and insecticide properties of a limonoid from *Melia azedarach* (Meliaceae) with potential use for pest

management, *J Agric Food Chem*, 51 (2) (2003) 369-374. doi: 10.1021/jf025811w

15 Ayil-Gutiérrez B A, Sánchez-Teyer L F, Vazquez-Flota F, Monforte-González M, Tamayo-Ordóñez Y, *et al*., Biological effects of natural products against *Spodoptera* spp., *Crop Prot*, 114 (2018) 195-207. https://doi.org/10.1016/j.cropro.2018.08.032

16 Plata-Rueda A, Martínez L C, Santos H D, Fernandes F L, Wilcken C F, *et al*., Insecticidal activity of garlic essential oil and their constituents against the mealworm beetle, *Tenebrio molitor* Linnaeus (Coleoptera: Tenebrionidae), *Sci Rep*, 7 (2017) 46406. https://doi.org/10.1038/srep46406

17 Kuganathan N & Ganeshalingam S, Chemical analysis of *Datura metel* leaves and investigation of the acute toxicity on grasshoppers and red ants, *E-J Chem*, 8 (2011) 107-112. DOI:10.1155/2011/714538

18 Thakur S & Sood A K, Lethal and inhibitory activities of natural products and biopesticide formulations against *Tetranychus urticae* Koch (Acarina: Tetranychidae), *Int J Acarol*, 45 (6-7) (2019) 381-390. https://doi.org/10.1080/01647954.2019.1666920

19 Anees M M & Chandel Y S, Preparation and evaluation of cow-based insecticides against *Spodoptera litura* (Fab.) (Lepidoptera: Noctuidae), *J Pharm Innov*, 11 (12) (2022) 446-451.

20 Abbott W S, A method of computing the effectiveness of an insecticide, *J Econ Entomol*, 18 (2) (1925) 265-267. https://doi.org/10.1093/jee/18.2.265a

21 Finney D J, *Probit Analysis*, 3rd ed., (Cambridge University, London), (1971) 33.

22 Baldin E L L, Crotti A E M, Wakabayashi K A L, Silva J P G F, Aguiar G P, *et al*., Plant-derived essential oils affecting settlement and oviposition of *Bemisia tabaci* (Genn.) biotype B on tomato, *J Pestic Sci*, 86 (2013) 301-308. https://doi.org/10.1007/s10340-012-0462-x

23 Hang Y-S, Schultz G W, Axelrod H, Kramer W L & Mulla M S, Ovipositional repellency of fatty acids and their derivatives against *Culex* and *Aedes* mosquitos, *Environ Entomol*, 11 (1982) 223-226. https://doi.org/10.1093/ee/11.1.223

24 Karkar D B, Korat D M & Dabhi M R, Evaluation of cow urine and vermiwash against insect pests of brinjal, *Kar J Agric Sci*, 27 (2014) 528-530.

25 Sharma A, Rana V K, Kumar R & Kumar S, Eco-friendly management of *Sciara orientalis* in *Agaricus bisporus* with *Agniastra*, seed kernel extracts of *Melia azedarach* and different colored sticky traps and light traps, *Res Rev JAAS*, 10 (2) (2021) 1-12.

26 Negi N, Sharma P C & Sharma P K, Relative toxicity of natural products and biopesticides against brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guenee), *HJAR*, 48 (2) (2022) 266-271.

27 Travis Lee M & Mix K, Evaluation of *Melia azedarach* as a botanical pesticide against beet armyworm (*Spodoptera exigua*), *ARPN J Agric Biol Sci*, 7 (11) (2012) 962-967.

28 Srinivasan R, Lin M-Y, Yule S, Huang C-C & Hsu Y-C, Effects of botanical extracts and formulations against fruit fly, fruit and pod borers on tomato and yard-long bean, *Biol Agric Hortic*, 31 (4) (2015) 254-264. https://doi.org/10.1080/01448765.2015.1013156

29 Thakur S & Sood A K, Foliar application of natural products reduces population of two-spotted spider mite, *Tetranychus urticae* Koch on parthenocarpic cucumber (*Cucumis sativus* L.) under protected environment, *Crop Prot*, 160 (2022) 106036. https://doi.org/10.1016/j.cropro.2022.106036

30 Sudeshna, Management of red spider mite using natural products in cucumber under protected environment, M Sc Thesis, Department of Entomology, CSK Himachal Pradesh Krishi Vishavidyalaya, Palampur, India, (2017) p. 106. https://krishikosh.egranth.ac.in/items/9dd670b2-cac0-4c58-a923-a34af8d74fec

31 Patel R D, Bharpoda T M, Borad P K, Bhatt N A & Mahida R D, Efficacy of different bio-pesticides against sucking pests of Bt cotton, *Agres*, 6 (1) (2017) 171-180.

32 Karthika C, Development of technologies for organic bhendi (*Abelmoschus esculentus* L. Moench) seed production, Ph D Thesis, Tamil Nadu Agricultural University, Coimbatore, India, 2013.

33 Schmutterer H & Singh R P, List of insect pests susceptible to neem products, In: *The Neem Tree Azadirachta indica A. Juss. and Other Meliaceous Plants*, Schmutterer H and and Weinhiem H (Eds), VCH Publications, Weinheim, (2002) 411-456.

34 Ananthi M, Selvaraju P & Sundaralingam K, Evaluation of seed bio-priming with biocontrol agents and biopesticides spraying on pests and its effect on seed yield and quality in chilli, *J Entomol Zool Stud*, 5 (4) (2017) 667-672.

35 Harini N, Veni C P, Sailaja A & Lata A M, Zero budget natural farming (ZBNF): A critical analysis on crop-wise practices, ZBNF models and cropping systems, *J Pharm Innov*, 10 (8) (2021) 105-109.

36 Kavita, Sharma S K & Sood A K, Repellent and deterrent effects of natural products against diamondback moth, *Plutella xylostella* (Linnaeus), (2023). https://doi.org/10.21203/rs.3.rs-2451189/v2

37 Joshi M J, Verma K S & Chandel R S, Feeding inhibition with bioformulations in cutworms *Agrotis ipsilon* (Hufnagel), *Indian J Entomol*, 82 (1) (2020) 134-138. DOI: 10.5958/0974-8172.2020.00030.

38 Kumawat N, Shekhawat P S, Kumar R & Sanwal R C, Formulation of bio–pesticides for insect-pests and diseases management in organic farming, *Pop Khet*, 2 (2014) 237-242.

39 Kumar T K, Rao B B, Dasu C S, Rao G & Ramana M V, Application of indigenous technical knowledge in organic fruit production, *Prog Res - An Int J*, 11 (2016) 4761-4765.

40 Mondal I H & Chakraborty K, Relative efficiency of some selected insecticide formulations on yellow stem borer, *Scirpophaga incertulas* (Walk.) in rice field at Murshidabad, West Bengal, India, *J Entomol Zool Stud*, 4 (6) (2016) 471-477.

41 Sood S, Sharma P C & Negi N, Efficacy of insecticides and some organic products against brinjal shoot and fruit borer *Leucinodes orbonalis* (Guenee), *Indian J Entomol*, 86 (1) (2024) 243-245. https://doi.org/10.55446/IJE.2023.630

42 Nishanthini K & Kandibane M, Efficacy of botanical extracts against rice stem borer *Scirpophaga incertulas* (Walker), *Indian J Entomol*, 84 (2) (2022) 363-367. DOI:10.55446/IJE.2021.105