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Research Article

EFFECT OF DIFFERENT COMMERCIAL AND CRUDE NEEM FORMULATIONS ON GROWTH PARAMETERS AND FECUNDITY OF DIAPHANIA PULVERULENTALIS (HAMPSON) (LEPIDOPTERA: PYRALIDAE) INFESTING MULBERRY

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Abstract: An experiment was conducted under laboratory condition, at the Department of Sericulture, UAS, GKVK, Bengaluru, wherein six neem formulations *viz*., Neemark, Nimbecidine, Solarneem, Limonool, Neem oil and NSKE were screened against larvae of *D. pulverulentalis* at the concentrations of 0.5, 1.0, 2.0, 4.0 and 8 percent each. Among these treatments, NSKE at 0.5, 1.0, 2.0 and 4.0 percent, recorded significantly lowest larval weight of 0.03, 0.02, 0.02 and 0.01 g, respectively, whereas in NSKE treatment at 8.0 percent the larvae did not survive indicating its significant superiority. The four concentrations of NSKE *viz*., 1.0, 2.0, 4.0 and 8.0 percent were on par with each other with respect to the larval weights. However, significantly maximum larval weight was recorded in untreated control (0.16 g). The pupal weight was recorded to be significantly maximum in untreated control (0.09 g), whereas, it was 0.01 g at 0.5 percent concentration of NSKE. However, the pupae did not survive in any of the other concentrations of NSKE that were tested. The moth emergence was lowest (10.00 %) at 0.5 percent concentration of NSKE. The maximum moth emergence (83.33%) and fecundity (110.00) was recorded in case of untreated control whereas the pest did not survive at 0.5, 1.0, 2.0, 4.0 and 8.0 percent concentrations of NSKE. The findings clearly demonstrated the superiority of NSKE over other neem formulations for the suppression of *D. pulverulentalis* on mulberry.

Keywords: *Neem Formulations, D. Pulverulentalis*

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Introduction

Mulberry leaves serve as the sole food for silkworm, *Bombyx mori* L. From the economic point of view, moriculture coupled with silkworm rearing remains a highly labour intensive activity providing vast scope for employment. However, there are several factors that hinder the productivity as well as quality of mulberry leaves, among them incidence of pests and diseases act as major bottlenecks. In mulberry, 300 insect and non-insect pest species have been reported to infest mulberry crop [1,2]. Insect pests of mulberry can be classified as sap feeders, root feeders, stem borers and defoliators. Among the defoliators, the leaf roller, *Diaphania pulverulentalis* (Hampson) (Lepidoptera: Pyralidae) is causing serious damage to mulberry in South India [3]. Botanicals mostly act as antifeedants besides having ovicidal and phytoecdysonal activity. Several reports suggest the utility of Neem oil application to manage lepidopteran pests in field crops [4,5]. Therefore, the current investigations explore the efficacy of neem formulation on the life history parameters of *Diaphania pulverulentalis* infesting mulberry.

Materials and Methods

Four commercial materials neem-based formulations like Nimbecidine, Neemark, Solarneem and Limonool, in addition to Neem oil (Crude) and Neem Seed Kernel Extract (NSKE) at different concentrations, namely 0.5, 1.0, 2.0, 4.0, and 8.0 percent each were prepared to know their efficacy as feeding deterrents against the mulberry leaf roller. All the four commercially available neem formulations and Neem oil were procured from the market and then evaluated; however, NSKE was prepared under laboratory conditions as per the standardized procedure as detailed below and then evaluated. Neem seeds which were healthy, bold and free from moulds were procured and the seed coat was removed mechanically and these kernels were soaked in water overnight (12 h). Later the kernels were ground in a mixer-grinder for 10 minutes. The known quantity of ground seeds were tied in a muslin cloth and then suspended in known volume of water. The suspension of NSKE was squeezed through a muslin cloth, filtered and diluted to achieve the required concentration for the experimental purpose. The spray suspension of the commercial neem based formulations; Neem oil and NSKE were prepared in the laboratory. The desired concentrations of each formulation were obtained by dilution, subsequently each formulation was sprayed on mulberry leaves with the help of atomizer, at five different concentrations *i.e*., 0.5, 1.0, 2.0, 4.0 and 8.0 percent each. One day old third instar larvae of *D. pulverulentalis* were placed in a plastic container, measuring 10 cm height and 6 cm diameter and the top portion of the plastic container was covered with muslin cloth in order to avoid the escape of the larvae from the plastic container. Three replications were maintained for each of the seven treatments. The different formulations at pre-determined concentrations (as indicated above) were sprayed on the fresh mulberry leaves. The leaves were then provided to the *D. pulverulentalis* larvae enclosed in each plastic container which were labelled appropriately. An untreated control was also maintained for the purpose of comparison between treatments. Observations were recorded on a daily basis until moth emergence.

Results and Discussion

Six neem based formulations *viz*., Neemark, Nimbecidine, Solarneem, Limonool, Neem oil and Neem Seed Kernel Extract (NSKE) were evaluated against larvae of *D. pulverulentalis*. Each one of these neem formulations were evaluated at five different concentrations, namely 0.5, 1.0, 2.0, 4.0 and 8.00 percent. The results of these experiments are as described below and discussed in the light of earlier reports on the same lines.

Effect of Neemark

The V instar larval weight at 0.5, 1.0, 2.0, 4.0 and 8.0 percent concentration of Neemark was 0.07, 0.06, 0.04, 0.03 and 0.02 g, respectively. However, Neemark at 8.0, 4.0 and 2.0 percent were significantly superior and on par with each other with respect to reduction in larval weight of *D. pulverulentalis*. The maximum pupal weight was recorded in untreated control (0.09 g), whereas it was 0.03g each, at 0.5, 1.0 and 4.0 percent concentration of Neemark and 0.04g at 2.0 percent concentration, which were all on par with each other. The pupal weight at 8 percent concentration of Neemark, could not be recorded as the pupae failed to survive. Moth emergence was significantly more in untreated control (83.33%) whereas it was 23.33 percent each, in case of 0.5 and 1.0 percent, 20.00 and 13.33 percent at 4.0 and 2.0 percent respectively, all of which were on par with each other. Moth emergence was nil in case of 8 percent concentration of neemark. Fecundity of the moths showed significant differences with respect to the different concentrations of Neemark in comparison with untreated control. The maximum fecundity was recorded in case of untreated control (110.00). However, the same was 43.67, 42.00 and 38.00 at 0.5, 1.0 and 4.0 percent concentration of Neemark. Whereas, fecundity was nil in case of 2 and 8 percent concentration of Neemark [Table-1].

Effect of Nimbecidine

At 0.5, 1.0, 2.0, 4.0 and 8.0 percent concentrations of Nimbecidine, the larval weight was 0.07, 0.06, 0.06, 0.04 and 0.03 g., respectively. The concentration of 8.0 and 4.0 percent were significantly superior and on par with each other with respect to reduction in larval weight of *D. pulverulentalis viz*., 0.03 and 0.04 g, respectively. The maximum pupal weight was recorded in untreated control (0.09 g), whereas it was 0.04, 0.03 and 0.04 g at 0.5, 1.0, and 2.0 percent concentration of Nimbecidine, respectively which were all on par with each other. Significantly maximum moth emergence was recorded in case of untreated control (83.33%), whereas it was 30.00 percent and 33.33 percent, respectively in case of 0.5 and 1.0 percent, likewise it was 20.00 and 13.33 percent at 2.00 and 4.00 percent concentrations, both of which were found to be on par with each other. However, no moths emerged in case of 8 percent concentration of Nimbecidine. Fecundity of the moths showed significant differences with respect to the different concentrations of Nimbecidine in comparison with untreated control. The maximum fecundity was recorded in case of untreated control (110.00), whereas it was 46.33, 46.00 and 42.00 at 0.5, 1.0 and 2.0 percent concentration of Nimbecidine. However, fecundity of *D. pulverulentalis* was nil in case of 4.0 and 8.0 percent concentrations of Nimbecidine [Table-1].

Effect of Solarneem

At 0.5, 1.0, 2.0, 4.0 and 8.0 percent concentrations of Solarneem, the corresponding larval weights of *D. pulverulentalis* were 0.06, 0.06, 0.04, 0.04 and 0.03g, respectively. However, Solarneem at all concentrations was significantly superior than untreated control and all concentrations tested were on par with each other with respect to reduction in larval weight of *D. pulverulentalis*. Regarding the pupal weight, all the five concentrations of Solarneem were on par with each other by recording pupal weights of 0.03, 0.02, 0.02, 0.03 and 0.02 g. The maximum pupal weight was observed in case of untreated control (0.09 g). Significantly maximum moth emergence was recorded in case of untreated control (83.33%), whereas it was 43.33, 33.33, 23.33, 16.66 and 53.33 percent at 0.5, 1.0, 2.0, 4.0 and 8.0 percent respectively. However, 2.0 and 4.0 percent concentrations of solarneem recorded minimum moth emergence and both these concentrations were on par with each other. Fecundity of the moths showed significant differences with respect to the different concentrations of Solarneem in comparison with untreated control. The maximum fecundity was recorded in case of untreated control (110.00), whereas it was 50.00, 44.00, 48.00 and 44.00 percent at 0.5, 1.0, 2.0 and 4.0 percent concentrations of Solarneem, respectively. The moths failed to survive and deposit eggs at 8 percent concentration of Solarneem [Table-1].

Effect of Limonool

At 0.5, 1.0, 2.0, 4.0 and 8.0 percent concentrations of Limonool, the corresponding larval weights of *D. pulverulentalis* were 0.07, 0.07, 0.06, 0.05 and 0.04 g, respectively indicating that all five concentrations were significantly different from each other and also superior than untreated control (0.16 g). Significant differences were observed between the five concentrations of Limonool with respect to the pupal weight, which was maximum in untreated control (0.09 g), whereas it was 0.02, 0.03, 0.04, 0.03 and 0.02 g each at 0.5, 1.0, 2.0, 4.0 and 8.0 percent of Limonool, respectively. All these five concentrations of Limonool were found to be on par with each other with respect to pupal weight. Significant differences were observed between the five concentrations of Limonool with respect to the moth emergence, which was maximum in case of untreated control (83.33%), whereas it was 33.33, 36.66, 30.00, 36.66 and 23.33 percent at 0.5, 1.0, 2.0, 4.0 and 8.0 percent concentrations of Limonool, respectively. Fecundity of the moths showed significant differences with respect to the varied concentrations of Limonool in comparison with untreated control. The maximum fecundity was recorded in case of untreated control (110.00) whereas it was 43.00, 42.00, 42.67, 38.00 and 36.00 percent at 0.5, 1.0, 2.0, 4.0 and 8.0 percent concentrations of Limonool respectively, of which 0.5, 1.0 and 2.0 percent concentrations were found to be on par with each other and 4.0 and 8.0 percent concentrations of Limonool were found to be on par [Table-1].

Effect of Neem oil

At 0.5, 1.0, 2.0, 4.0 and 8.0 percent concentrations of Neem oil, the larval weights were found to be 0.07, 0.06, 0.06, 0.05 and 0.03 g, respectively, indicating that all the five concentrations were significantly superior than untreated control (0.16 g) in reducing the larval weights. However, 8 percent concentration of neemoil recorded the significantly minimum larval weight (0.03 g). No significant differences were observed between the five concentrations of Neem oil with respect to the pupal weights, wherein it was 0.03, 0.04, 0.03, 0.03 and 0.02 g each at 0.5, 1.0, 2.0, 4.0 and 8.0 percent concentrations respectively. Further, significantly maximum pupal weight was recorded in case of untreated control (0.09 g). Significant differences were observed among the five concentrations of Neem oil with respect to the moth emergence, maximum being in case of untreated control (83.33%); whereas, it was 33.33 percent each in case of 0.5 and 1.0 percent concentrations of Neem oil which were on par with each other and also with 2.0 and 4.0 percent concentrations, which recorded moth emergence of 26.66 and 20.00 percent, respectively. However, at 8.0 percent concentration of Neem oil, the minimum moth emergence of 13.33 percent concentration was recorded, which was on par with that of 2.0 and 4.0 percent concentration of Neem oil. Fecundity of the moths showed significant differences with respect to different concentrations of Neem oil, with the maximum being recorded in case of untreated control (110.00), whereas it was 38.66, 40.00, and 38.00 percent at 0.5, 1.0 and 2.0 percent of Neem oil, which were all on par with each other. However, the moths did not lay eggs in case of both 4.0 and 8.0 percent concentrations of Neem oil [Table-1].

Effect of NSKE

At 0.5, 1.0, 2.0 and 4.0 percent concentrations of NSKE, the larval weight was 0.03, 0.02, 0.02 and 0.01 g, respectively. However, at 8.0 percent the larvae of *D. pulverulentalis* did not survive. The four concentrations of NSKE *viz*., 1.0, 2.0, 4.0 and 8.0 percent were on par with each other by recording 0.03 g, 0.02 g, 0.02 g, 0.0.01 g and 0.00 g, respect6ively with respect to the larval weights. However, significantly maximum larval weight was recorded in untreated control (0.16 g). Between the five concentrations of NSKE, the pupal weight recorded was significantly maximum in untreated control (0.09 g) whereas it was 0.01 g at 0.5 percent concentration of NSKE.

The pupae did not survive in case of 1.0, 2.0, 4.0 and 8.0 percent concentration of NSKE. The moth emergence was 10.00 percent at 0.5 percent concentration of NSKE, whereas, moths did not emerge in case of 1.0, 2.0, 4.0 and 8.0 percent concentration. The maximum moth emergence was 83.33 percent in untreated control. The maximum fecundity was recorded in case of untreated, control (110.00), whereas moths could not attain adult stage hence no fecundity could be recorded in case of 1.0, 2.0, 4.0 and 8.0 percent concentration of NSKE [Table-1]. Among different concentrations of NSKE, 1.0, 2.0, 4.0 and 8.0 percent adversely affected *D. pulverulentalis* development and survival to the maximum extent. Similar findings have been reported by earlier workers *viz*., Ravi (1998), who reported that NSKE (4%) was significantly effective in controlling the *D. indica* population in gherkin. Similarly, Viraktamath *et al*. (2003) also reported that neem products (Neemazal or Econeem plus @ 2ml/l) were most effective in the management of D. indica in gherkins. Likewise, Ravikumar *et al*. (2010) reported that spraying of Neem oil at 1, 2 and 3 percent concentration at 10 days interval gave a mean reduction of larval population of *D. pulverulentalis* to the extent of 14.43 percent.

Conclusion

Six Neem formulations *viz*., Neemark, Nimbecidine, Solarneem, Limonool, Neem oil and NSKE were screened against larvae *D. pulverulentalis* under laboratory conditions at 0.5, 1.0, 2.0, 4.0 and 8.0 percent. Among these treatments NSKE (4%) was found to be significantly superior to rest of the treatments and also adversely affected *D. pulverulentalis* larval weight, pupal weight, moth emergence and fecundity development and survival to the maximum extent.

Table-1 *Effect of neem formulations at different concentrations on larval and pupal weights, moth emergence and fecundity of D. pulverulentalis*

Treatments	Concn. (%)	Larval weight (g)	Pupal weight (g)	Moth emergence (%)	Fecundity (No.)
Neemark	0.5	0.07^{f}	0.03^{bc}	23.33^{bcde}	43.67^{efg}
	1	0.06^{ef}	0.03^{bc}	23.33^{bcde}	42.00^{cdef}
	2	0.04^{cde}	0.04^{c}	13.33^{abc}	#
	4	0.03^{bc}	0.03^{bc}	20.00^{bcde}	38.00^{bc}
	8	0.02^{abc}	#	#	0.00^{a}
Nimbecidine	0.5	0.07^{f}	0.04^{c}	30.00^{cdefg}	46.33^{gh}
	1	0.06^{ef}	0.03^{bc}	33.33^{defgh}	46.00^{fg}
	2	0.06^{ef}	0.04^{c}	20.00^{bcde}	42.00^{cdef}
	4	0.04^{cde}	0.03^{bc}	13.33^{abc}	#
	8	0.03^{bc}	0.02^{abc}	#	#
Solarneem	0.5	0.06^{ef}	0.03^{bc}	43.33^{ghi}	50.00^{i}
	1	0.06^{ef}	0.02^{abc}	33.33^{defgh}	44.00^{efg}
	2	0.04^{cde}	0.02^{abc}	23.33^{bcde}	48.00^{h}
	4	0.04^{cde}	0.03^{bc}	16.66^{abc}	44.00^{efg}
	8	0.03^{bc}	0.02^{abc}	53.33^{ghi}	0.00^{a}
Limonool	0.5	0.07^{f}	0.02^{abc}	33.33^{defgh}	43.00^{efg}
	1	0.07^{f}	0.03^{bc}	36.66^{defgh}	42.00^{cdef}
	2	0.06^{ef}	0.04^{c}	30.00^{cdefg}	42.67^{cdefg}
	4	0.05^{def}	0.03^{bc}	36.66^{defgh}	38.00^{bc}
	8	0.04^{cde}	0.02^{abc}	23.33^{bcde}	36.00^{b}
Neem Oil	0.5	0.07^{f}	0.03^{bc}	33.33^{defgh}	38.66^{fcd}
	1	0.06^{ef}	0.04^{c}	33.33^{defgh}	40.00^{bcde}
	2	0.06^{ef}	0.03^{bc}	26.66^{bcdef}	38.00^{bc}
	4	0.05^{def}	0.03^{bc}	20.00^{bcde}	#
	8	0.03^{bc}	0.02^{abc}	13.33^{abc}	#
NSKE	0.5	0.03^{bc}	0.01^{ab}	10.00^{ab}	#
	1	0.02^{abc}	#	#	#
	2	0.02^{abc}	#	#	#
	4	0.01^{a}	#	#	#
	8	#	#	#	#
Untreated control		0.16^{g}	0.09^{d}	83.33^{i}	110.00^{i}
F. test		*	*	*	*
SEm ±		0.008	0.009	6.826	1.479
CD at 5%		0.022	0.024	19.30	4.180

Note:1. *Significant at 5 percent level of significance
2. Means followed by the same alphabet are not significantly different
3. (#) Individuals did not survive in that stage

Application of research: It facilitates the IPM of *D. pulverulentalis* in Mulberry through eco-friendly approaches

Research Category: Agricultural Entomology

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Study area / Sample Collection: Department of Sericulture, University of Agricultural Sciences, GKVK, Bengaluru, 560065, India

Cultivar / Variety name: Mulberry - *Morus indica* L. Victory-1(V-1)

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Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
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