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Bio-efficacy of Mineral Oil against Yellow Mite in Dark Jute (*Corchorus olitorius* L.) under Terai Region of West Bengal

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted during pre-kharif season of 2016 and 2017 to determine the efficacy of relatively cheaper, safer horticultural mineral oil on yellow mite (*Polyphagotarsonemus latus).* The experiment was laid out in randomized block design with seven treatments [T_1- mineral oil @ 3 ml/litre at 35 and 50 days after sowing, T_2- mineral oil @ 6 ml/litre at 35 and 50 DAS, T_3- mineral oil @ 9 ml/litre at 35 and 50 DAS, T_4-Neem oil @ 3 ml/litre at 35 and 50 DAS, T_5- mineral oil @ 3 ml/litre + neem oil @ 3 ml/litre at 35 and 50 DAS and T_6- Control] replicated four times. Two scheduled spraying of each treatment was done on standing jute crop at 15 days interval. The effect of treatments was significant on post treatment mite population recorded after spray for both the cropping season. Among the treatments, T_5 was found to be the most effective combination. The post treatment observation during 2016 and 2017 at 7 days after treatment indicated significantly less number of mites i.e. (1.08 and 0.84 mites cm^{-2}) and (0.83 and 0.41 mites cm^{-2}) respectively in the treatment T_5. Within the treatments, maximum plant height (216.92 and 206.64

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cm) and yield (34.68 and 28.28 q ha^{-1}) were also observed in treatment T_5. Considering the effectiveness against mite on jute as well as the environmental safety, mineral oil might be suggested as biorational component of IPM for effective management of yellow mite.

Keywords: Yellow mite; bio-efficacy; mineral oil; neem oil.

1. INTRODUCTION

Jute, *Corchorus* spp. (Malvaceae) is an important renewable natural fibre crop next to cotton [1]. It is mainly cultivated in India and other South East Asian countries i.e. Bangladesh, China, Nepal and Thailand [2]. In India jute cultivation is restricted to West Bengal, Bihar, Assam, Andhra Pradesh, Orissa, Meghalaya and some parts of Nagaland [3]. West Bengal alone contributes 80% of national jute production [4]. Jute fibre is utilised for making bags, decorative, textiles and geotextiles. It is superior over synthetic materials and eco-friendly to the environment. Jute production and productivity is hampered by number of abiotic and biotic stresses [5]. Among the biotic constrains yellow mite, *Polyphagotarsonemus latus* (Banks) (Acari: Tarsonemidae) is devastating in nature and often causing yield losses [6]. Yellow mite is the most common economically important pest of jute causing downward leaf curl through sucking cell sap from epical tender leaf [7]. The pest is reported from almost all the growing countries of jute affecting both the cultivated species with estimated fibre yield loss of 42% [8].

Inappropriate pests management practices with indiscriminate use of synthetic pesticides to ensure higher yield have adversely affected both biological and physical environment, leading to the pollution of biosphere and rapid build-up of resistance and resurgence of pests and diseases [9]. The damage is caused due to high toxicity and non-biodegradable nature of synthetic pesticides and left over residues in soil, water and crops that ultimately affect human health [10].

Management of mite has become difficult due to wide host range and gradual changing of climatic conditions. Application of chemicals also helps to develop pesticide-resistant strains of mite. Thus, due to the importance of pest and difficulty of its control through prevalent methods, it seems that there is urgent need for the development of suitable alternative that are effective and eco-friendly in nature. Biorational insecticides like azadirachtin and petroleum spray oils (PSO) can compensate the limitation, which antecedently proved to be effective against mite control [11]. Azadirachtin is plant extracted botanical insecticide acquired from neem tree, which act as growth regulator, repellant and antifeedant against insects [12]. Mineral oil is petroleum-derived oil. It is highly refined, parrafinic oils that is used to manage pests and diseases of plants. Mineral oil helps to block the air holes (spiracles) through which insects breathe, causing them to die for asphyxiation. Also, the spread of oil through the respiratory pores and block the insect's trachea which leads to death. In some cases oil create a thin layer on the surface of insect eggs where it stops the gaseous exchange [13]. Mineral oil has several advantages over the majority of the synthetic pesticides employed to control pests. It is safe on the different environmental elements and the natural enemies. Oil is easy to apply with the existing spray equipment and compatible with many other pesticides to enhance their efficiency [14,15]. Less in costs as compared to the traditional methods and quickly dissipate through evaporation leaving little residue. Still pests are unable to develop population resistance against mineral oil [16]. These biorational insecticides are cost effective, durable and free from environment pollution. Therefore, an attempt has been made to evaluate the efficacy of horticultural mineral oil (HMO) and plant derived bio pesticide, neem oil against yellow mite in jute.

2. MATERIALS AND METHODS

Field experiment was conducted for bio-rational management of yellow mite infecting *Corchorus olitorius* (dark jute) during pre-kharif season of 2016 and 2017 at instructional farm of Uttar Banga Krishi Viswavidyalaya (UBKV), Cooch Behar in randomized block design (RBD) with four replications. Jute variety JRO-204 (Suren) was used in the study. Plot size was 3 m × 4 m and within the plots, 30 cm × 8 cm spacing were adopted. During cultivation, standard package of practice for jute was followed. Different integrated treatments include: T_1- mineral oil @ 3 ml/litre at 35 and 50 days after sowing (DAS), T_2- mineral oil @ 6 ml/litre at 35 and 50 DAS, T_3- mineral oil @ 9 ml/litre at 35 and 50 DAS, T_4-

Neem oil @ 3 ml/litre at 35 and 50 DAS, T_5- mineral oil @ 3 ml/litre + neem oil @ 3 ml/litre at 35 and 50 DAS and T_6- Control (no spray). After natural population (infestations) build up in the field, at 35 and 50 DAS plots were treated with the respective treatments and control plots were left untreated. The spraying of treatment was done with the help of a knapsack sprayer attached to hollow cone nozzle. Yellow mite infestation was recorded from young second unfolded leaf of 10 randomly selected plants per plot, as yellow mites are commonly found on the lower surfaces of young apical leaves and flowers, where they lay their eggs. Pre-treatment observations were taken from all the plots before application of treatment at 35 and 50 DAS. Post-treatment observations for mite population were recorded after both the spray (35 and 50 DAS) at 4 and 7 days after treatment. The number of mite irrespective of different stages per cm^2 leaf was counted with 10x magnifying lens and stereo binocular microscope. Plant height (cm), basal diameter (cm), green biomass (q ha^{-1}) and fibre yield (q ha^{-1}) were also recorded.

Percent reduction of mite population under field condition was recorded using the formula given by Rahman et al. [17].

$$(\%)\ \text{Reduction} = (N-N_1 /N) \times 100$$

Where,

N = Number of mite infested plant in control plot

N_1 = Number of mite infested plant in treated plot

2.1 Statistical Analysis

Experimental data were processed with square root transformed prior to statistical analysis for the test of significance. Significant differences between treatments means were determined through Duncan's multiple range test. Statistical analysis and interpretation of results were done by calculating values of critical difference (CD) at 5% level of significance through analysis of variance technique (ANOVA) as described by Gomez and Gomez [18].

3. RESULTS AND DISCUSSION

Study outcome from consecutive two years were analysed to conclude the results of applied treatments for management of yellow mite. All the pesticide treatments were superior over control (Tables 1 and 2). Significant reduction of mite population with respect to untreated control was observed at 4 and 7 day after application of the pesticides i.e. on 35 DAS and 50 DAS in both the year. In terms of mite population suppression, all the treatments were close to each other. Four day after first spray highest reduction of mite population was observed in treatment T_5 (mineral oil @ 3 ml $litre^{-1}$ + neem oil @ 3 ml $litre^{-1}$ at 35 and 50 DAS) followed by T_3 (mineral oil @ 9 ml $litre^{-1}$ at 35 and 50 DAS). Likewise same trend of pesticide efficacy continued up to seven day after first and second application of treatments. Highest reduction of infested mite population was found after 7 days of second spraying with the treatment T_5, causing a reduction of 96% and 91% mite in jute plant for two seasons respectively. Similar mode of mite reduction was also observed after 7 days of first spraying in treatment T_5 with 86% and 84% reduction in mite population compared to control.

Previously effective control of red mite on apple was achieved through three application of horticultural mineral oil @ 2 and 3% by Agnello et al. [11]. In another study, mineral oil star oil showed a considerable reduction of 99% soft scale insect (*Pulvinaria psidii* Maskell) infesting guava trees [16]. Anil et al. [19] found that, mahogany and karanja oil was effective to minimise the damage of jute leaves by *Polyphagotarsonemus latus*. Sridharan et al. [15] recorded 2 percent concentration of mineral oil + neem oil was superior and effective against leaf hopper with 93.3% mortality. Yellow mite infestation in present experiment was recorded 0.70 -10.18 and 0.18-4.98 mites cm^{-2} with various treatments in 2016 and 2017 respectively. Previous report of mite infestation was 0.50 to 1.83% in 2001–2002 with various IPM treatments as compared to 6.07–12.97% in 2000–2001 [20]. Significant variation was observed in plant height and fibre yield for both the jute growing seasons. The results revealed that within the treatments highest plant height was observed in treatment T_5 (216.92 and 206.64 cm). Highest fibre yield (34.68 q ha^{-1} and 28.28 q ha^{-1}) was also recorded in the plots treated with treatment mineral oil @ 3 ml/litre + neem oil @ 3 ml $litre^{-1}$ at 35 and 50 DAS, followed by T_3 (27.56 and 33.78 q ha^{-1}). Babu et al. [21] recorded significant reduction of yellow mite population on jute and maximum yield after application of mineral oil @ 3 ml $litre^{-1}$. Yeasmin et al. [22] observed that application of neem oil increased 24.64% plant height, 27.87%

Table 1. Bio-efficacy of different treatments against yellow mite population in jute and their effect on fibre yield during 2016

Treatment	Mean number of mite /cm^2 on second unfold leaf at different days						Plant height (cm)	Yield (q ha^{-1})
	Pre- treatment (35 DAS)	4 day post application (39 DAS)	7 day post application (42 DAS)	Pre- treatment (50 DAS)	4 day post application (54 DAS)	7 day post application (57 DAS)		
T_1	5.65 (2.38)	3.62 (1.90)^{b}	2.37 (1.54)^{c}	3.73 (1.93)^{e}	2.62 (1.61)^{b}	2.15 (1.46)^{b}	211.19	29.92^{b}
T_2	5.76 (2.40)	3.34 (1.83)^{c}	2.46 (1.57)^{bc}	4.40 (2.10)^{c}	2.70 (1.64)^{b}	1.36 (1.17)^{c}	213.91	32.96^{a}
T_3	5.89 (2.43)	2.39 (1.54)^{e}	1.20 (1.09)^{d}	3.68 (1.92)^{e}	1.86 (1.36)^{c}	1.04 (1.02)^{d}	215.67	33.78^{a}
T_4	5.84 (2.42)	3.07 (1.75)^{d}	2.57 (1.60)^{b}	4.70 (2.17)^{b}	2.74 (1.65)^{b}	1.46 (1.21)^{c}	211.51	30.48^{b}
T_5	5.80 (2.41)	1.85 (1.36)^{f}	1.16 (1.08)^{d}	4.17 (2.04)^{d}	1.34 (1.15)^{d}	0.70(0.84)^{e}	216.92	34.68^{a}
T_6	6.65 (2.58)	10.18 (3.19)^{a}	8.16 (2.86)^{a}	6.57 (2.56)^{a}	7.43 (2.72)^{a}	7.72 (2.78)^{a}	203.21	28.70^{b}
SEm (±)	NS	0.020	0.016	0.006	0.016	0.018	0.024	0.053
$CD_{(P=0.05)}$		0.060	0.049	0.017	0.050	0.054	0.072	0.161

Figures in the parenthesis are √x transformed values, NS= Non-significant, DAS= Days after sowing, Treatments with same alphabetical superscript within the column are not significantly different

Table 2. Bio-efficacy of different treatments against yellow mite population in jute and their effect on fibre yield during 2017

Treatment	Mean number of mite /cm^2 on second unfold leaf at different days						Plant height (cm)	Yield (q ha^{-1})
	Pre- treatment (35 DAS)	4 day post application (39 DAS)	7 day post application (42 DAS)	Pre- treatment (50 DAS)	4 day post application (54 DAS)	7 day post application (57 DAS)		
T_1	4.81 (2.19)	2.98 (1.73)^{b}	1.40 (1.18)^{b}	3.10 (1.76)^{b}	1.30 (1.14)^{b}	1.10 (1.05)^{b}	201.29	22.68^{cd}
T_2	4.77 (2.18)	2.86 (1.69)^{c}	1.08 (1.04)^{bc}	2.90 (1.70)^{bc}	1.18 (1.08)^{bc}	1.03 (1.01)^{b}	203.98	24.20^{c}
T_3	4.84 (2.20)	2.20 (1.48)^{e}	0.88 (0.93)^{c}	1.88 (1.37)^{d}	0.45 (0.67)^{d}	0.25 (0.50)^{c}	206.18	27.56^{ab}
T_4	4.79 (2.19)	2.64 (1.63)^{d}	0.94 (0.97)^{c}	2.73 (1.65)^{c}	1.08 (1.04)^{c}	0.90 (0.95)^{b}	204.28	25.12^{bc}
T_5	4.75 (2.18)	2.06 (1.43)^{f}	0.70 (0.83)^{c}	1.45 (1.20)^{e}	0.28 (0.52)^{e}	0.18 (0.41)^{c}	206.64	28.28^{a}
T_6	4.82 (2.19)	4.98 (2.23)^{a}	4.40 (2.09)^{a}	3.70 (1.92)^{a}	3.81 (1.95)^{a}	3.96 (1.99)^{a}	193.48	20.70^{d}
SEm±	NS	0.010	0.067	0.028	0.025	0.034	0.040	0.089
$CD_{(P=0.05)}$		0.029	0.202	0.084	0.075	0.102	0.120	0.268

Figures in the parenthesis are √x transformed values, NS= Non-significant, DAS= Days after sowing, Treatments with same alphabetical superscript within the column are not significantly different

Basal diameter over untreated control and resulted highest amount of fibre yield (2.68 t ha^{-1}). Present study and previous documentation indicated that mineral oils are cost effective and possess synergistic effect with the combination of bio-pesticides [15]. Moreover it is safe to environment, beneficial insects and mammals [23,24]. Hence, use of low dose of horticultural mineral oil, combined with neem oil seems to be best method for management of yellow mite without environmental pollution.

4. CONCLUSION

From the results of this two-year experiment, it was seen that yellow mite of jute caused by *Polyphagotarsonemus latus* is a major pest of jute (*C. olitorious*) in Terai region of West Bengal that results in economic losses. Very limited alternative and effective method is available to manage this mite in the field. So, it may be concluded that treatment with mineral oil @ 3 ml/litre + neem oil @ 3 ml/litre at 35 and 50 DAS was found to be effective and eco-friendly treatment in controlling of yellow mite in jute. As the horticultural mineral oil is safe by causing no harm to environment, natural enemies, plant morphology and mammals therefore it can be considered as biorational component of IPM for effective management of pests.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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