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Toxicity of botanicals against two Spotted Red Spider Mite, *Tetranychus urticae* under laboratory conditions

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Okra (*Abelmoschus esculentus*) is a popular tropical and subtropical vegetable, grown on thousands of hectares in Pakistan, but yield is low due to a variety of factors, including the presence of insect pests and pathogen-borne illnesses. Among insect pests, two spotted red spider mite, *Tetranychus urticae* is a phytophagous mite that can affect plant physiological processes, causing severe economic losses of various agricultural and horticultural crops all over the world including Pakistan. An approximately, 30% of the total cost of pesticides used in some major crops. Chemical control is the most common strategy used to handle this pest on crops especially okra. Chemically manufactured acaricides, on the other hand, have a variety of drawbacks, including pest resistance, incompatibility with natural predators, phytotoxicity, pollution, and health hazards. There was need to adopt an alternative strategy such as botanicals to control this pest and to minimize environmental pollution in the country. To check the toxicity of plant-based products against *T. urticae*, the current study was conducted in laboratory during 2020. The order of ovicidal and adulticidal toxicity based on slope values and LC_{50} was neem *A. indica* > *N. tabacum* > *D. alba*. The lowest mortality (3.089 ± 0.0006) of adults was recorded by the application of *D. alba* while highest on *A. indica* (2.800 ± 0.0009). Mortality data and the slope values showed that the most toxic plant extract against eggs was *A. indica* (LC_{50} = 2.523%) followed by *N. tabacum* (LC_{50} = 3.789%) and *D. alba* (LC_{50} = 3.854%). The current ecofriendly technique can be manufacture at farm level by okra producers which minimize the mite attack on their crops

Keywords: *Abelmoschus esculentus*; *Tetranychus urticae;* Phytophagous; Plant extracts; Acaricides

INTRODUCTION

Okra, *Abelmoschus esculentus* belongs to family Malvaceae, commonly known as “Lady’s finger” or “Bhendi” is considered an important summer vegetable crop all over the world. One of the most prevalent pests of protected crop in greenhouses and interior plants capes is the two-spotted red spider mite (*Tetranychus urticae*) (Gore et al. 2013; Martin et al. 2015). The severe economic losses caused due to severe attack of mites (Williams 2012; Adamczyk et al. 2012; Van Leeuwen et al. 2010a; Kumar et al. 2010). More than 50-100 percent yield losses reported by (Clotuche et al. 2011; Naga et al. 2017). The losses can occur in different ways such as stunting of growth, loss of chlorophyll, webbing, stippling, leaf defoliation, leaf yellowing, leaf burning, reduce quality and quantity of fruits as well as deformed the fruits even death of plant occurred (Chiasson et al. 2004).

It's also found on berry, tea, okra, bean, tomato, potato, eggplant, pepper and fruit crops, as well as a variety of outdoor woody ornamentals such as roses (Natwick et al. 2012). Eggs are placed individually on the undersides of lower leaves that have silk threads covering

them. On the undersides of lower leaves, one larval instar and two nymphal instars can be seen. As mite concentrations rise, the population will migrate to younger leaves (Siddhapara and Virani, 2018). Mites may congregate in the top sections of the plants in large concentrations, where they are taken up by the wind and distributed through a silk strand (Murphy et al. 2014). The time from egg to adult is one to two weeks. The mouthparts of adults, larvae, and nymphs are piercing-sucking. Yellow dotting or stippling on the top surfaces results from feeding on the undersides of lower leaves. Leaves may become yellow to golden in colour, then dry out and fall off. To the untrained eye, damage may appear to be caused by nutritional shortages or plant disease (Haque et al. 2011; Naved 2012).

Several management strategies such as cultural, physical, mechanical, botanical, biological and chemicals have adopted by many farmers at small and large scale to control this polyphagous pest in okra producing countries of the world. This destructive pest is becoming serious problem in the country due to various factors such as polyphagous in nature, short life period, several generations per season, high reproductive potential and developing rapid resistance to several acaricides (Devine et al. 2001; Stumpf and Nauen, 2001). The reported data about mite control on various crops and ornamental plants is limited. There is need to develop an alternative strategy such as plant extracts (botanicals) which can prove ecofriendly and effective against pests especially mites. By keeping the importance of such strategy, the current study was conducted.

MATERIALS AND METHODS

Rearing of red spider mites

Mites were collected from different fields of okra and reared on okra leaves in Zoology lab by using procedure of various scientists (Roy et al. 2014b). The culture was maintained to three generations in growth chamber at 26 ± 5°C, 65 ± 5% RH and 14L: 10D.

Collection and preparation of plant extracts

The matured leaves of neem (*Azadirachta indica*), Tobacco (*Nicotiana tabacum*) and Datura (*Datura alba*) were collected from nearby areas of study area (lab). The collected leaves were brought to laboratory, washed thoroughly in flowing water, kept separately onto the cloth and dried under shade. The dried leaves were grinded by using an electric grinder. The ground products were soaked into water for 24 hours and in next day passed through a 20-mesh sieve. The filtered precipitates were kept into the bag and labelled accordingly. There were four treatments with three replications. Description of treatments with dosages is given below;

T1: Neem (*Azadirachta indica*) @ 3ml/l

T2: Tobacco (*Nicotiana tabacum*) @ 3ml/l

T3: Datura (*Datura alba*) @ 3ml/l

T4: Control (only water/untreated)

The botanicals extracts and method of preparations was made by following procedure of Dawar et al. (2010).

Collection of okra leaves and effect of plant extracts on adults and eggs

Matured okra leaves were collected from the field and cut leaf discs of 2 cm diameter from whole leaves. These were placed into petri dish of 9 cm diameter. Toxicological study was carried out on adults of mite. Leaf discs were dipped into each extract for 20 second and then allowed paper towel to suck extra water for 1 hour. The treated leaf discs were shifted into petri dish and 30 adult mites were selected randomly from mass culture and transferred directly onto leaf discs with the help of fine camel hair brush. The data were collected after 48 hours of post treatment. Twenty gravid female of red spider mites were released on leaves for oviposition to a night. Next day, leaves containing 60 eggs were selected sprayed with botanical extract to assess the ovicidal properties of the plant extracts. There were three replications and each replication consists of 60 eggs. Water used as control. The percentage of hatchability was checked for both treated and untreated batches of eggs for a period of 12 days after oviposition. Data were statistically analyzed. LC_{50} and LC_{95} values were calculated using method of probit analysis while mortalities were corrected using Abbott's formula (Abbott, 1925).

RESULTS AND DISCUSSION

Plant based products have recorded ecofriendly and safer for biological agents such as predators, parasitoids and pollinators. The insect resistance is far less likely to develop with the applications of botanicals. Data showed that minimum egg hatchability was recorded on concentration of neem (*A. indica*) (1.39 ± 0.001) followed by tobacco (*N. tabacum*) (1.94 ± 0.006) and datura (*D. alba*) (2.67 ± 0.009) as shown in table 1. The lowest mortality (3.089 ± 0.0006) of adults was recorded by the application of *D. alba* while highest on *A. indica* (2.800 ± 0.0009) (Table 2).

Table 3 shows the slopes of regression lines as well as the lethal concentration values at 50% kill (LC_{50}). Mortality data and the slope values showed that the most toxic plant extract against eggs was *A. indica* (LC_{50} = 2.523%) followed by *N. tabacum* (LC_{50} = 3.789%) and *D. alba* (LC_{50} = 3.854%). Handique *et al.* (2017) had reported that *Sapindus mukorossi* was most toxic plant extract followed by *Nyctanthes arbor-tristis* and *Phlogacanthus thyrsiformis*. Another study was conducted by Handique et al. (2015) in India 2015 using many botanicals such as *N. arbor-tristis*, *P. thyrsiformis* and *S. mukorossi* to check the toxicity on mites. It has been reported that all these tested plant parts are easily available nearby areas of India (Puri et al. 1994; Kalita and Deb, 2004; Phurailatpam et al. 2014) and have also medicinal values (Barua et al. 2013).

Table 1: Toxicity of plant extracts on eggs hatchability of *T. urticae.*

Treatments	N	*df*	X2	Slope ± SE	95% FL^2 of LC_{50}	LC_{95} (%)
Azadirachta indica	150	4	1.70	1.39 ± 0.001	1.65–0.71	1.01
Nicotiana tabacum	150	4	2.84	1.94 ± 0.006	5.98–3.85	3.87
Datura alba	150	4	4.97	2.67 ± 0.009	5.73–3.77	4.91

Notes: N= Number of mites tested; FL= Fiducial limits; *df* = degrees of freedom; LC_{50}= (Lethal concentration, 50%); LC_{95}= (Lethal concentration, 95%).

Table 2: Toxicity of plant extracts on adults of *T. urticae*.

Treatments	N	*Df*	X2	Slope ± SE	95% FL^2 of LC_{50}	LC_{50} (%)	LC_{95} (%)
A. indica	200	4	2.546	2.800 ± 0.0009	2.32–3.87	2.523	14.895
N. tabacum	200	4	6.267	2.934 ± 0.0008	2.64–3.14	3.789	16.543
D. alba	200	4	3.987	3.089 ± 0.0006	3.69–1.78	3.854	17.123

Note: N= Number of mites tested; FL= Fiducial limits; *df* = degrees of freedom; LC_{50}= (Lethal concentration, 50%); LC_{95}= (Lethal concentration, 95%).

The significant ovicidal results had reported by Rai et al. (1993) on the applications of neem-based products. The similar results about eggs hatchability of mite have been reported by Ramraju and Sundara Babu (1989). Some botanicals such as Derrimax have tested against *Oligonychus coffeae* adults on tea in India (Babu et al. 2008; 2008). They had reported 100% adult mortality while Dodia et al. (2000) reported the toxicity of pongam aqueous extract *T. macrogerlanei* and *O. indicus.* It has been reported that mortality percentage varied with respect to time. Recorded no mortality at 12 hours of post treatment while after 12 hours of post treatment mortality of adult was started (Sridhar et al. 2011; Ram et al. 2017). Our current study findings are in line with the findings of previous as well as early researchers (Bhardwaj et al. 2007; Kumar et al. 2010).

CONCLUSION

Finally, all of the botanical extracts examined had varied degrees of ovicidal and adulticidal activity. To accomplish an integrated management of mites on okra, more research is required.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

All authors have equal contribution in performing this research.

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