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Influence of Plant Extracts on the Life History and Population Development of House Fly, *Musca domestica* L. (Diptera: Muscidae)

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Abstract.- The present studies examined the use of plant extracts *viz*., Niaz boo (*Ocimum basilicum* L.), Gardenia (*Gardenia jasminoides* (J Ellis), Sanatha (*Dodonaea viscosa* Jacq.) and Lantana (*Lantana camara* (Linn.) as oviposition attractant and larval growth promoter/inhibitor on the house fly (*Musca domestica* L.). The plant chemicals in different final concentrations (25 and 50%) were mixed in a larval media prepared by mixing wheat bran, dried milk and brewer's yeast. *D. viscosa* acted as strong attractant for house fly with minimum larval duration (5.25^{c} and 3.5^{e} days), maximum larval (83.11^{b} and 77.78^{b} %) and pupal (73.22^{c} and 71.11^{e} %) survival, female sex ratio, intrinsic rate of increase (0.31 and 0.26), maximum biotic potential (0.67 and 0.77) and fecundity (259 and 242.4 eggs female^{-1}) in 25 and 50% concentrations, respectively. *L. camara* was a strong repellent for oviposition and showed a significant larvicidal activity, too. Gardenia showed maximum development time (11.20 days), less intrinsic rate of increase (0.213) and male sex ratio. *O. basilicum* was repellent for oviposition (92.56 eggs female^{-1}) with minimum biotic potential (0.46), intrinsic rate of increase (0.19), less larval and pupal survival (55.56^{f} and 54.00^{e} %) at 50% concentration. The reasons for these differences and their role in the development of the house fly are discussed.

Keywords: Plant extracts, house fly, *Ocimum basilicum, Gardenia jasminoides, Dodonaea viscosa, Lantana camara.*

INTRODUCTION

House Fly, *Musca domestica* L. is an important insect pest of household and dairy farming (Greening, 1995). The control of this injurious pest has been dependent upon the insecticides but development of the insecticides resistance in house flies restricts this control strategy. The house fly not only resisted insecticides which were used as spray, but also the insecticides mixed in the baits (Chapman and Morgan, 1992; Kim *et al*., 1997). In order to search out alternate measures against this insect, biocontrol agents like parasitic wasps *Pteromalids* gave satisfactory results in the control of house fly in the poultry shed (Crespo *et al*., 1998), however, these have not proved successful in other situations.

Plants chemicals have also been used in place of insecticide as killing agent for *M. domestica* (Naqvi and Tabassum, 1992; Naqvi *et al*., 1993). Hydrated colocynithin from alcoholic extracts of *Citrullus colocynthis* was toxic to the adult house fly (El-Naggar *et al*., 1989). Lectin from *Ricinus communis* and pellitorine, a petroleum ether extract, from *Piper guineense* male roots had insecticidal activity (Gbewonyo and Candy, 1992; Alvarez Montes de Oca *et al*., 1996). Latex (5%) of *Calotropis procera* @ 3 µl topically applied to 3rd stage larvae of *M. domestica* killed and partially digested the larvae in 3 hr (Morsy *et al*., 2001). The concentrations of 25 to 100% of *Trigonella foenum-graecum* completely killed 3rd stage of larvae of *M. domestica*. 5%, 2% and 1% caused mortality of 44.4, 33.3 and 22.2%, respectively. Fecundity of emerged adults was 20%, 0% and 28.6% (Abdel-Halim and Morsy, 2006). Application of sublethal doses of thyme oil to *M. domestica* decreased significantly longevity of both sexes. Larval vitality and pupal survival was also affected by treating females with thyme oil (Pavela, 2007). All these studies revealed toxicity based on treating adults or larvae directly with plant extract, however, these chemicals have not been tested in the bait formulation or in growth medium of *M. domestica.*

The proposed plants in the present studies for use against *M. domestica* include *O. basilicum*, *G. jasminoides*, *D. viscosa* and *L. camara* and these plants were chosen because of their therapeutic value (Li, 2006). The aqueous extracts of the plants were mixed in the larval media to determine egg laying, larval and pupal duration, larval and pupal

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survival, development time, biotic potential, sex ratio and intrinsic rate of increase, in order to determine stimulation or inhibition of life traits of the house fly.

MATERIALS AND METHODS

Rearing of house fly

A large number of adults of *M. domestica* were collected from fields around University of Agriculture, Faisalabad campus and were brought in the laboratory. These flies were never exposed to the application of insecticides. The flies were bred for bioassay at room temperature in Toxicology Laboratory, Department of Agri. Entomology, University of Agriculture, Faisalabad, during months of April-September, 2007. The flies were maintained in a mesh cage containing granulated sugar and water soaked-cotton ball in Petri dishes, as adult food. Larval medium consisted of brewer's yeast, dry milk powder, wheat bran and water. A beaker of 500 ml was filled with this larval medium and was put in the cages with flies. After 2-3 days, these beakers were removed from the cages, and beakers were covered at the open end with a nylon mesh held in a position by a rubber band. The larval medium was changed continually depending upon the number of larvae. When the pupae were formed, these beakers were kept in another cage for adult emergence.

Preparation of plant extracts

Fresh leaves of Niaz boo (*O. basilicum* L.), Gardenia (*G. jasminoides* J. Ellis), Sanatha (*D. viscosa* Jacq.) and Lantana (*L. camara* Linn.) were dried under shade and then ground into a powder. This powder was added into the water in a ratio of 1:2 (powder:water). The mixture was filtered through Whatman Filter No. 48. This filtrate formed 100% plant extract, which was used in subsequent experiments with dilution in water. The water extracts were supposed to contain polar compounds, which has capacity to penetrate insect cuticle easily.

Exposure of house flies to larval media with plant extracts

The larval medium containing different concentrations of a plant extract was kept in the rearing cages along with a control treatment having only the solvent / water for preparation of the plant extracts in larval medium.

Life history parameter and intrinsic rate of increase

Larval and pupal duration, fecundity, development time, sex ratio, generation time, emergence percentage and number of females produced per female were studied. These parameters allowed the intrinsic rate of increase, the biotic potential and the net replacement rate to be calculated. Net replacement rate is the number of females produced female^{-1}. To study the net replacement rate, the eggs from known number of females were placed and sexed to count the number of females. The intrinsic rate of increase (r) measures the rate at which a population is increasing per generation. It is calculated by the following equation (Lewontin, 1965):

$$r = \log_e Ro/T$$

where Ro is net replacement rate, and T is mean generation time.

The formula for biotic potential is: Biotic potential = $\log_e$ fecundity/development time.

Five mated pairs were collected from rearing cages, and released in a separate cage containing larval medium in plastic jars (300 ml) with different concentrations of each plant extract. The number of eggs laid by females of these pairs was counted daily in these media. Total number of eggs was divided by five to get fecundity per female. This was replicated thrice. For studying larval/pupal durations, larval/pupal survival, development time and generation time, 100 eggs were removed form stock culture and placed in larval media with different concentrations of plant extracts. The time between formation of 1st pupa to last one was averaged to get larval duration. The adult emergence was pupal duration and in this way, development time was calculated and subsequent egg laying by a female was the generation time.

All the experiments were carried out in three replications in Completely Randomized Design. Data were subjected to ANOVA to find out the

difference among the concentrations of the plant extracts using DMR test at 5% level of probability.

RESULTS

Shortest larval duration was recorded in *D. viscosa* 25% (3.25 days) which was non-significantly different with *O. basilicum* 25% (3.30 days). A significant longest duration (8.25 days) was recorded in *G. jasminoides* 50% followed by 7.20 and 7.21 days in *G. jasminoides* 25% and *O. basilicum* 50%, respectively. Pupal duration in two different concentrations of each plant extract showed non significant difference (p = 0.05) between each other and also among all the extracts. A significant longest development time (11.20 days) was recorded in *G. jasminoides* 50%, followed by 9.70 days and 9.20 days in *O. basilicum* 50% and *G. jasminoides* 25%, respectively (Table I).

Two concentrations of *L. camara* (50 and 25%) were not suitable for the larvae to complete development. The larval survival in this case was 2.66 and 15.89%, respectively. Among plant chemicals where larvae were able to complete their development, survival was least (55.56%) in *O. basilicum* followed by 62.11% in *G. jasminoides* each at 50% concentration; however, *O. basilicum* at 25% having 63.67% larval survival was statistically similar with *G. jasminoides*. Two concentrations of *O. basilicum* (50 and 25%) had non-significant difference of pupal survival between each other. Highest survival (77.78%) was recorded in *D. viscosa* 25%, which was significantly different from other treatments. Highest number of eggs (259.0) was deposited in *D. viscosa* 50% and least (92.06) in *O. basilicum* 50%. The control treatment had less number of eggs deposited (179.3) as compared to *D. viscosa* and *G. jasminoides* at tested concentrations (Table II).

M. domestica had maximum ratio of females in (1.14) *D. viscosa* 50% followed by 1.13 in control and 1.1 in 25% concentration of former extract. In all other concentrations of plant extracts, ratio of the males was high as compared to the females. A significant high biotic potential (0.77) was recorded in *D. viscosa* 25% and least (0.47) was observed in *G. jasminoides* at 50% concentration. Intrinsic rate of increase in *D. viscosa* 25% was non-significantly different from *G. jasminoides* 25%. Two concentrations of *O. basilicum* 50 and 25% had non-significant difference of biotic potential between each other. The non-significant high intrinsic rate of increase *D. viscosa* and *G. jasminoides* was followed by the control treatment (Table III).

Table I.- Larval and pupal duration and development time of *M. domestica* in different treatments.

Treatment	Duration (days)		Development time (Days)
	Larval	Pupal	
D. viscosa 50%	5.25c	3.30 N.S.	8.25d
D. viscosa 25%	3.25e	3.25	7.10e
G. jasminoides 50%	8.25a	3.25	11.20a
G. jasminoides 25%	7.20b	3.25	9.20c
O. basilicum 50%	7.15b	3.20	9.70b
O. basilicum 25%	3.30e	3.15	6.55f
Control	4.80d	3.35	8.90c

Means sharing same letter are significantly different at p=0.05. N.S., non significant

Table II.- Comparison of larval and pupal survival and fecundity of *M. domestica* in different treatments.

Treatment	Survival %		Fecundity %
	Larval	Pupal	
D. viscosa 50%	73.22c	71.11c	259.0a
D. viscosa 25%	83.11b	77.78b	242.4b
G. jasminoides 50%	62.11e	60.45d	209.4c
G. jasminoides 25%	70.22d	60.00c	237.4b
L. camara 50%	2.66h	ND	ND
L. camara 25%	15.98g	ND	ND
O. basilicum 50%	55.56f	54.00e	92.56f
O. basilicum 25%	63.67e	57.78e	103.7e
Control	92.11a	91.11a	179.3d

ND= not detected. Means sharing same letter are significantly different at p=0.05.

Table III.- Comparison of Sex ratio, biotic potential and intrinsic rate of increase in different treatments of plant extracts.

Treatments	Sex ratio	Biotic potential	Intrinsic rate of increase
D. viscosa 50%	1:1014	0.67c	0.263c
D. viscosa 25%	1:1.1	0.77a	0.310b
G. jasminoides 50%	1:3.1	0.47e	0.213d
G. jasminoides 25%	1.15:1	0.60d	0.306b
O. basilicum 50%	1.02:1	0.46b	0.199e
O. basilicum 25%	1.3:1	0.72b	0.181e
Control	1:1.13	0.48e	0.382a

Means sharing same letter are significantly different at p=0.05.

DISCUSSION

Plant leaves aqueous extracts used in larval media showed different values of larval duration at 25% and 50% concentrations. Minimum larval duration (3.25 and 3.30 days) was observed in *D. viscosa* and *O. basilicum* extracts at 25% concentration, respectively. Ascending order of the larval duration at 25% concentration was *D. viscosa* < *O. basilicum* < *G. jasminoides*. At 50% concentration minimum larval duration (5.25 days) was recorded in *D. viscose*. Ascending order of the larval duration at 50% concentration was *D. viscosa* < *O. basilicum* < *G. jasminoides*. As far as the larval survival at two concentrations of plant leaf extracts is concerned, *L. camara* leaf extract at 50% and 25% concentrations were not suitable for larvae to complete their development. The larval survival in these cases was 2.66 and 15.89%, respectively. Larval survival at 50% and 25% concentrations in ascending order was *L. camara* 25% < *L. camara* 50% < *O. basilicum* 50% < *G. jasminoides* 50% < *O. basilicum* 25% < *D. viscosa* 50% < *D. viscosa* 25% < control. These results suggest that *L. camara* leaf extract acts as a strong repellent for the house fly, first they avoid oviposition and then due to strong toxic effect, larvae were killed after few hours. These results did not match with Ba-Angood and Al-Sunaidy (2003) who found that *Lantana camara* was least effective for oviposition by *Callosobruchus chinensis* on stored cowpea. There may be chances that *Lantana* leaf extract was more toxic than in the powder form. Pupal duration had non-significant difference among the plant extracts at their respective concentrations; however, significant difference among plants was found for pupal survival. These results did not match with Abdel-Aziz and Omer (1995) who found that hexane extract of *D. viscosa* was the most effective and gave the highest larval mortality and reduction in pupation, fecundity and hatchability. The results of the development time showed significantly maximum development time of 11.20 days at 50% concentration of *G. jasminoides* leaf extract, and least (6.55 days) was in *O. basilicum* 25%. It has been noticed that small changes in development time could have much more greater effect on reproductive potential than small changes in fecundity (Lewontin, 1965). As far as biotic potential is concerned, *D. viscosa* 25% showed maximum biotic potential (0.77) followed by *O. basilicum* 25%. Minimum biotic potential was observed in *O. basilicum* 50% that was not significantly different from *O. basilicum* 25%. These results did not match with Subashini *et al*. (2004) who investigated the significantly reduced the adult longevity (3 days) and adversely affected the reproductive potential in *Helicoverpa armigera* (Hubner) by *Dodonaea angustifolia* L. Aqueous plant leaf extracts used in larval media showed maximum number of eggs laid by a single female in *D. viscosa* 50% followed by *G. jasminoides* 25%. As far as sex ratio is concerned, *D. viscosa* 50% showed maximum ratio of females 1.14 followed by 1.13 in control and 1.1 in *D. viscosa* 25%. In all other concentrations of plant chemicals, the ratio of males was high as compared to females. These results matched with situations where well fed mothers live longer and produce more females (Rotary and Gerling, 1973).

Aqueous plant leaf extracts used in larval media showed maximum intrinsic rate of increase in (0.31 and 0.30) *D. viscosa* 25% and *G. jasminoides* 25%, respectively, and least was observed in *O. basilicum* 25%. Results obtained during the project revealed that plant leaves extract of *D. viscosa* acts as a strong attractant for house fly with minimum larval duration, maximum larval, pupal survival, female sex ratio, intrinsic rate of increase, shorter development time, maximum biotic potential and fecundity. *L. camara* acted as a strong repellent for oviposition and showed a significant larvicidal activity. *G. jasminoides* proved attractant for oviposition with a maximum development time, intrinsic rate of increase, and male sex ratio. *O. basilicum* acts as a repellent for oviposition with minimum biotic potential, intrinsic rate of increase, larval duration and pupal survival. The effect of *O. basilicum* oil as topical application on *M. domestica* was different from situation shown in the present study (Pavela, 2008).

The effect of *L. camara* in a antibiosis mechanism from the present results cannot be proved by a study where this plant powder effected larval duration, pupation percent, pupal weight, pupal duration, adult emergence percent, sex ratio,

adult longevity, and fecundity were determined and induced deformities in all stages of *M. domestica* (Elkattan *et al*., 2011), however, *L. camara* did not allow the larvae to grow in the present study.

Based on these results it can be stated that decoction of leaves of *D. viscosa*, *L. camara* and *O. basilicum* proved effective for the management of flies, either as spray or in bait systems.

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