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Original Article

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# STUDIES ON BIOLOGY AND ANTIBIOSIS RESISTANCE IN MANGO (*MANGIFERAE INDICA*) VARIETIES AGAINST MANGO MEALY BUG, *DROSICHA MANGIFERAE* GREEN (HEMIPTERA: MARGARODIDAE)

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**ABSTRACT.** Mango is known as king of fruits. Among mango pests, mango mealy bug, *Drosicha mangiferae* (MMB), is considered one of the most destructive pests of mango orchards and other plantations. Whenever it enters in any orchards it is difficult to eradicate it from those orchards. The experiment was conducted at Entomological Research Sub Station, Multan-Punjab, Pakistan, during 2009 and 2010, to evaluate fitness of mango mealy bug on different varieties of mango and biology on 'Chaunsa' variety. Mango mealy bug, *Drosicha mangiferae* Green (Hemiptera: Coccoidea: Margarodidae), is matter of concern, as it is widespread pest of woody plants even in urban areas. A study was conducted on cultivar resistance and fecundity of mango mealy bug. The 'Chaunsa' cultivar of mango proved highly susceptible to mango mealy bug with maximum number of eggs laid, *i.e.* 335.90, and maximum weight, *i.e.* 0.239 g of the female, was recorded on the cultivar 'Chaunsa'. The maximum length, *i.e.* 1.63 cm, and width, *i.e.* 0.80 cm of female, was observed on 'Chaunsa', which showed a susceptible response and did not differ significantly with the width of female on 'Black Chaunsa'. Regarding biology, the 1st instar male and female duration on an average is 56.3 days, whereas the 2nd instar has 26 days. In case of the 3rd instar, female has duration 19.5 days and male has three days. Male has pupal stage, while it is absent in female. On an average two study years, the ranking of susceptibility of mango cultivars was as under: 'Chaunsa' > 'Black Chaunsa' > 'Malda' > 'Fajri' > 'Retaul-12' > 'Langra' > 'Sensation' > 'Sindhri' > 'Dusehri' > 'Sufaid Chaunsa' > 'Anwar Reutul' and > 'Tukhmi'.

**Keywords:** giant coccids; culivars; 'S.B. Chaunsa' mango; lifecycle; biological interaction; Punjab, Pakistan.

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## INTRODUCTION

Pakistan offers a wide choice of *circa* 3500 among 1000 mango cultivars (Anonymous, 2008). The most famous and commercial cultivars of mango were studied in this work, detail is discussed in next section. These are also different in shape and size. Mango is one of the most extensively exploited fruits used for food, juice, fragrance and color. Antixenosis, antibiosis, and tolerance are three modalities of host plant resistance (Painter, 1951; Kogan and Ortman, 1978; Panda and Khush, 1995). Antibiosis (causes adverse effects on insect life history) is one form of host plant resistance, the other forms are antixenosis resistance (where the pest is unable to locate or colonize a host) and tolerance (where the plant does not suffer from the presence of pest). Plant resistance to insect pests is one of the best components among various tactics of integrated pest management (IPM). It is the result of interactions between the insects and plants that the environment conditions under which a plant grown is not favorable for the development and growth of the insects that are associated with the plants.

As this approach is environment friendly, so it is regarded as the key to integrated pest management. It also provides cumulative protection against insect pests and is often compatible with other pest management tactics. During the last two decades, spectacular progress has been achieved in development of insect resistant cultivars to major insect pests of agricultural crops (Dhaliwal and Singh, 2004). Resistance is a heritable characteristic that enables a plant to inhibit the growth of insect population or to recover from the damage caused by populations that were not inhibited to survive (Kogan, 1982).

The present studies were planned to study the antibiosis resistance against mango mealy bug on different cultivars of mango and to study the biology of mango mealy bug on susceptible cultivar of mango, with the objective to find out the weakest link for control measures.

## MATERIALS AND METHODS

Three orchards were selected at three different locations in district Multan, having the most common or popular cultivars of mango, during 2009 and 2010. For the study of antibiosis resistance, 11 most prominent, grafted, exportable and commercial cultivars, *viz.* 'Chaunsa', 'Fajri', 'Langra', 'Black Chaunsa', 'Sufaid Chaunsa', 'Sindhri', 'Malda', 'Anwar Retaul', 'Dusehri', 'Retaul-12', 'Sensation' and one seed born cultivar 'Tukhmi' were selected for recording the data on population of mango mealy bug. In the month of May, 10 egg carrying females were collected from these selected cultivars coming downward the tree *via* trunk having dominant similar size. The females of each cultivar were kept separately in a petri dish of 5 × 5 cm size. These were brought to the laboratory and were weighed with electronic balance; their length and width were measured with the

help of steel scale. These females were returned to the orchards and were kept singly in a pit of 4 × 5 cm for laying eggs, which was made in semi wet soil with the help of wooden rod and steel spoon. The pits were covered with plastic Petri dish of 5 cm and were written with black permanent marker having cultivar name and female number. At the end of June, the pits were opened and the females were taken out with steel spoon and were kept in plastic petri dishes of 5 × 5 cm size. Ovisac length and width were measured and the numbers of eggs laid were counted. The data regarding biological parameters, which were conducted in laboratory were compiled and analyzed through Completely Randomized Design.

**Methodology to study the biology of mango mealy bug under field conditions**

Five plants of mango cultivar 'Chaunsa' having age of 3-4 years and height 5-6 feet were selected. These plants were marked as 1, 2, 3, 4 and 5. After selection, the plants were cleaned before the releasing of nymph. Dried branches, leaves and small branches were removed, so that the settled nymphs can easily be observed on the plants. A funnel of 15 cm polyethylene sheet in width and length according to trunk was made on the trunk of trees by using needle, thread, solution tape and rope. The needle and thread was used on one sides of the polyethylene sheet to reduce the length and can easily be wrapped on the trunk with solution tap in the form of cup. A thread of sun hemp was used below the funnel on the solution tap to make it tight. The funnel was made for the releasing of the1$^{st}$ instar nymph, to stop the downward and upward movement of nymph on the ground, as well as for the pupation of males and collection of egg carrying females. In this funnel small amount of mud and sand mixture with ratio 1:1 were added. After every rainfall, the wet mixture were replaced with dry one.

**Collection of eggs**

The eggs of the mango mealy bug are oval in shape, yellowish in colour like turnips seed. Eggs of mango mealy bugs were collected on the 15$^{th}$ of Dec., 2009, from the infested mango orchard. These eggs were kept in the five polyethylene bags of 2 kg each, along with soil and were placed in the selected orchards for hatching.

**Hatching of eggs**

Hatching of eggs were checked after every 48 hrs at 10 A.M. and the newly emerged nymphs were collected with handmade aspirator and were destroyed after counting and recording the data, until maximum number of nymphs were obtained. The 416 nymphs were collected on the 1$^{st}$ Jan., 2010, with handmade aspirator. These were kept in eight plastic Petri dishes of 5 × 5 cm size for a period of 48 hrs. After two days, these nymphs were released in the funnel of two experimental plants. There were 208 nymphs/ plant. The nymphs started their movement upward and were settled on the plants within 48 to 72 hrs after releasing. The nymphs were observed daily. When 188 nymphs (more than half population) were observed half in *exuviae* and half out of the 2$^{nd}$ instar were collected for two days with camel hair brush in plastic Petri dish. These were kept in plastic Petri dish for 24 hrs. After that, the nymphs of the 2$^{nd}$ instar were released on the 3$^{rd}$ plant. The maximum 96 nymphs of the 3$^{rd}$ instar were collected when observed half in *exuviae* and half out with camel hair brush in plastic Petri dish and were kept for 24 hrs. These were released on the 4$^{th}$

plant. When the maximum number of females (n=41), which were half in the *exuviae* and half out, were collected and kept them in Petri dishes for 24 hrs and then released on the 5th plants. The speed of the 1st, 2nd and 3rd and adult females were measured after releasing in the plant funnel. The duration of survival without food of all instar was also noted. As soon as the males came down the plants for pupation, they were counted and 15 males were picked from the plastic funnel and put in a pit of 5 × 5 cm (width and depth). When the fuzz was secreted, the fuzz (cottony material like secretions) was removed once, twice and thrice time and adult males were observed for any effects caused by removing the fuzz. The pupation period, adult life and male copulation time was also noted. The number of eggs laid, out of five females each, by the females, were counted daily, separately.

## RESULTS

The biological parameters detailed below were studied under field conditions. The results are shown in *Table 1*, column A to F, and described under the following subsections.

### Number of eggs laid per female

It is evident from the results (*Table 1*, *column A*) that maximum number of eggs were laid by the female, which have fed on the cultivar 'Chaunsa' (335.9/female) and did not differ significantly from those of collected from 'Black Chaunsa' (328.9/female) and followed by 'Malda', 'Fajri', 'Langra', 'Retaul-12' and 'Sensation', with number of eggs, *i.e.* 305.6, 302.5, 301.9, 293.5 and 286.7 by single female, respectively. The minimum number of eggs laid by a single female of mango mealy bug was 156.0 on 'Anwar Retaul', and did not show significant difference with 159.8 eggs per female, on 'Tukhmi'.

### Weight of female

The results (*Table 1*, *column B*) show significant difference among mango cultivars regarding weight of female. The specimens of mealy bug, collected from 'Chaunsa' cultivar, had maximum weight, *i.e.* 0.24 g/female, and did not show significant difference with 0.23 g/female for those specimens which were collected from the cultivar 'Black Chaunsa', followed by 0.22 and 0.22 g/female on 'Malda' and 'Fajri', respectively. The female collected from 'Sindhri' showed 0.17 g/weight per female. The minimum weight of female was observed on those specimens that were collected from 'Tukhmi' cultivar, *i.e.* 0.11 g/female, and did not show significant difference with those of recorded on 'Anwar Retaul', *i.e.* 0.12 g/female.

### Body length of female

The results regarding body length (*Table 1*, *column C*) reveal significant variations among cultivars. The maximum length of female was observed on 'Chaunsa', *i.e.* 1.6 cm/female, followed by 1.5 cm each/female on 'Malda', 'Black Chaunsa', 'Retaul-12', 'Sensation', 'Langra' and 'Fajri', respectively. The minimum length of female was

observed on cultivar 'Tukhmi' and 'Sindhri', each showing 1.2 cm/female.

**Table 1 - Mean comparison of the data regarding biological parameters of mango mealy bug feeding on different cultivars of mango under field condition during 2009 and 2010**

| Name of cultivars | Average number of eggs per female (A)** | Average female weight (g) (B)** | Average female length (cm) (C)** | Average female width (cm) (D)** | Average ovisac length (mm) (E)** | Average ovisac width (mm) (F)** |
|---|---|---|---|---|---|---|
| Anwar Retaul | 156.00 e | 0.116 fg | 1.22 d | 0.51 f | 5.90 b | 4.90 b |
| Black Chaunsa | 328.90 a | 0.231 a | 1.53 b | 0.74 ab | 10.20 a | 6.20 a |
| Chaunsa | 335.90 a | 0.239 a | 1.63 a | 0.80 a | 10.10 a | 6.10 a |
| Dusehri | 186.60 d | 0.121 ef | 1.28 b | 0.50 f | 5.90 b | 4.70 b |
| Fajri | 302.50 b | 0.219 b | 1.50 b | 0.68 bcd | 9.90 a | 5.80 a |
| Langra | 301.90 b | 0.183 c | 1.51 b | 0.69 bc | 10.10 a | 6.00 a |
| Malda | 305.60 b | 0.222 b | 1.54 d | 0.70 b | 10.00 a | 6.30 a |
| Retaul-12 | 293.50 b | 0.186 c | 1.52 b | 0.61 e | 9.80 a | 6.10 a |
| Sensation | 286.70 b | 0.186 c | 1.52 b | 0.63 cde | 9.60 a | 5.80 a |
| Sindhri | 217.00 c | 0.167 d | 1.21 cd | 0.62 de | 5.80 b | 5.00 b |
| Sufaid Chaunsa | 187.20 d | 0.126 e | 1.34 c | 0.51 f | 5.80 b | 4.90 b |
| Tukhmi | 159.80 e | 0.113 g | 1.21 d | 0.45 f | 6.00 b | 4.70 b |
| LSD at 5% | 18.26 | 0.01 | 0.07 | 0.06 | 0.75 | 0.72 |
| F-value | 109.5 | 292.0 | 35.3 | 22.4 | 62.0 | 6.3 |

Means sharing similar letters in column A to F are not significantly different by DMR Test at $P = 0.05$; LSD = least significant difference value; * = significant at $P \leq 0.05$; ** = significant at $P \leq 0.01$.

**Width of female**

The data relating to the width of female reveal significant difference among cultivars. The maximum width (0.80 cm) of female was observed on cultivar 'Chaunsa', which showed a susceptible response and did not differ significantly from 0.74 cm width of female on 'Black Chaunsa'. The minimum width of female was recorded to be 0.45 cm, in 'Tukhmi', and did not show significant variation with those of observed on 'Anwar Retaul', 'Sufaid Chaunsa' and 'Dusehri', with 0.51, 0.51 and 0.50 cm width of female, respectively, as shown in *Table 1*, *column D*.

**Length of ovisac**

The results (*Table 1*, *column E*) show significant difference among mango cultivars regarding ovisac length of mango mealy bug. The maximum length of ovisac, *i.e.* 10.20 mm/female, was found on cultivar 'Black Chaunsa' and did not show significant difference with those of observed on 'Chaunsa', 'Langra',

'Malda', 'Fajri', 'Retaul-12' and 'Sensation''. The minimum length of ovisac, *i.e.* 5.80 mm each on 'Sufaid Chaunsa' and 'Sindhri', was recorded and did not show significant difference with 5.90, 5.90 and 6.00 on 'Dusehri', 'Anwar Retaul' and 'Tukhmi', respectively.

**Width of ovisac**

The maximum width of ovisac was observed to be 6.3 mm on 'Malda' and did not differ significantly with that on 'Black Chaunsa', 'Chaunsa', 'Retaul-12', 'Langra', 'Fajri' and 'Sensation', respectively. The minimum width of ovisac was found on those specimens that were collected from the cultivars 'Tukhmi' and 'Dusehri' each showing 4.7 mm/female, followed by 4.9, 4.9 and 5.0 mm width of ovisac on 'Anwar Retaul', 'Sufaid Chaunsa' and 'Sindhri', respectively (*Table 1, column F*).

**Biology of mango mealy bug on susceptible cultivar 'Chaunsa'**

***First stadium***

Maximum nymphs hatched on last days of December, 2009; 416 crawlers were caught from the polyethylene bags with handmade aspirator. These were kept in plastic Petri dishes at ambient temperature in the orchard for 48 hrs. After four days, the nymphs were released at 10 A.M. in the plastic funnel of two plants. They started their movement upward the plants. All the nymphs settled themselves on the leaves of plants within 48-72 hrs. They were checked daily. After 39 days, four nymphs out of 405 (11 were found absent) stopped feeding, became sluggish and attached to the leaves with no excretion. These were encircled with black permanent maker with date on the leaves. The nymphs were covered with whitish powder. After 4-5 days, a streak appeared longitudinally on the head side of the nymphs and the second instar nymph came out, but remained half in the *exuviae*. After 24 hrs, the nymphs shed the exuviae and again started feeding. All the nymphs shed their *exuviae* within 56.5 days, as shown in *Table 2*. The maximum number of nymphs (188) was observed, out of which half in the *exuviae* (49 to 50 days passing in same instar) were separated from the leaves with camel hair brush in petri dish. These were kept in room present in the orchard for a period of 24 hrs.

***Second stadium***

The collected 188 nymphs were released on the 28$^{th}$ Feb., 2009, in the funnel of the 3$^{rd}$ plant in the morning, at 10 A.M. These went upward and settled on the leaves and tip of branches within 48 hrs. After 13 days, more than half nymphs out of 188 stop their feeding with no excretion present on the leaves, covered with whitish powder and were encircled with date. After four days, a streak appeared on the head side longitudinally and nymphs crawled out, but remained half in *exuviae*. After 24 hrs, on the 14$^{th}$ Mar., the

nymphs shed *exuviae* and again started their feeding. All the nymphs shed their *exuviae* within 26 days (*Table 2*). The maximum number of 96 nymphs were observed, which were half in the *exuviae* on 15 to 16 Mar. and were separated from the leaves with camel hair brush in Petri dish. These were kept in room present in the orchard for a period of 24 hrs.

**Table 2 - Life cycle of mango mealy bug on chaunsa mango on an average during the year 2008-2009 and 2009 - 2010**

| Stage | Duration | |
|---|---|---|
| | Females | Males |
| First stadium | 56.5 days | 56.5 days |
| Second stadium | 26 days | 26 days |
| Third stadium | 19.5 days | 3 days |
| Pupa | Absent | 12 days |
| Adult life | 29 days | 6 days |
| Number of eggs laid | 282/female | - |
| Number of days in which eggs completed by females | 12.5 days | - |
| Total life from hatching to death of adult | 143 days | 103 days |

***Third stadium***

The collected 96 nymphs were released in the funnel of the 4th plant on the 7th Mar., 2009. Among these, one nymph out of 96 stopped feeding on the 18th day and was seen under the main branch of the plant covered with whitish powder. After five days, a streak appeared on the head side longitudinally and nymphs crawled out from the *exuviae*, but remained half in and half out. After 24 hours, the nymphs left the *exuviae* and again started their feeding. All the nymphs shed their *exuviae* within 19.5 days (*Table 2*). As soon as the females shed the *exuviae*, mating started. A maximum numbers of 41 nymphs were observed on the 36th day and stopped feeding, which were collected after six days, when they were half in the *exuviae* and separated from the leaves with camel hair brush in Petri dish. These were kept at room temperature in the orchard for 24 hrs.

**Females**

A number of 41 females were released on the 5th plant, the males gathered there and started the mating. After mating, the females started feeding on the plants. All the females came down the tree within 29 days. The females took 12.5 days to lay its full quota of eggs, after which the female died, but its ovisac remained attached to the body. Total lifecycle of female from hatching to die was 143 days (*Table 2*).

**Males**

The 59 male's nymphs were recorded from all the five plants started to come down on the 2nd Apr.,

2009, stopped feeding, gathered in the funnel and hibernated in the material present in the funnel. After 1-5 days, the males started pupation. But, some pupated soon after emerging from the *exuviae*. A number of 10 males were picked from the funnel before pupation and put in to a pit of 1.5 × 2 inch, covered with Petri dish for further study. The males were checked daily, in the beginning they stopped their movement and started covering with whitish cocoon on their bodies. Pupation was completed within 2-3 days after keeping in the pit and remained in this condition for 12 days. After this period, winged males of crimson colour came out from the pupae. Adult male life was six days and male completed life cycle within 103 days (*Table 2*). The insect has only one generation in a year.

## DISCUSSION

Antibiosis resistance affects the biology of the insect, so pest abundance and subsequent damage is reduced, compared to that which would have occurred if the insect was on a susceptible crop variety. Antibiosis resistance often results in increased mortality or reduced longevity and reproduction of the insect (Teetes, 1996). To determine the impact of host plants on fitness of mango mealy bug, the descending females of mango mealy bug from the tree were collected, weighed and the length and width were measured. The data on number of eggs lay per female, length and width of ovisac were also recorded for each cultivar. The data suggested that the female collected from 'Chaunsa' cultivar laid maximum number of eggs (336), while 'Anwar Retaul' cultivar had minimum (156). Similarly, maximum weight gain, length and width of female and ovisac were observed on 'Chaunsa' cultivar, than others varieties.

The most probable reason for such discrimination is that the 'Chaunsa' cultivar is the most susceptible and preferred host for mealy bug; therefore, the insects had enough food to survive and gain weight. It is well established that higher the weight of female, the more fecundity it retains. We also have found in the present studies that the 'Chaunsa' cultivar has higher percentage of carbohydrates than the other cultivars (Karar *et al.,* 2015). This finding suggests that carbohydrates might be playing a role to trigger increased uptake of sap from the vegetative parts, resulting more gained weight on 'Chaunsa' cultivar than others. The current findings add significantly to those of Khaire *et al.* (1987), who studied resistance of mango varieties against mango hoppers. Similarly, Carvalho *et al.* (1996) reported resistance against fruit fly, whereas Salem *et al.* (2006) deliberate resistance in mango cultivars against *Icerya seychellarum*. Karar *et al*. (2012; 2013; 2015; 2016) studied resistance on pecan cultivars against aphid, in onion varieties against thrips, in mango against

mango mealy bug, on cotton against insect pest complex.

### Biology and behaviour of mango mealy bug on 'Chaunsa' cultivar

The development times for various instars were 57 days, 26 and 20 days for the 1st, 2nd and 3rd instars, respectively. Nymphs were negatively geotropic and the first instar moved upward with an average speed of 12 cm per min, the 2nd instar - 17 cm per min and, the 3rd instar - 37 cm per min. The female laid eggs on an average of 282 in 29 days. In contrast, other researcher reported that mango mealy bug female was found to lay 336, 372 and 300 eggs in the field (Rahman and Latif, 1944; Haq and Akmal, 1960; Chandra *et al.,* 1987), and these variations could be due to weather conditions, locations and methodology.

## CONCLUSION

It has been concluded that 'Chaunsa' and 'Black Chaunsa' both are susceptible to mango mealy bug, and cultivars, like 'Tukhmi', a seed born variety, present better properties related to plant resistance and breeders can utilize these traits to evolve a good orchard management tool.

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