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RESISTANCE/ SUSCEPTIBILITY OF DIFFERENT MANGO CULTIVARS AGAINST MANGO MEALYBUG (*Drosicha mangiferae* G.)

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The experiment was conducted on different cultivars of mango viz., Chaunsa, Black Chaunsa, Malda, Fajri, Ratul-12, Langra, Sensation, Sindhri, Dusehri, Sufaid Chaunsa, Anwar Ratul, and Tukhmi for resistance/susceptibility against mango mealy bug during 2005-2006 and 2006-2007 in Punjab, Pakistan. On an average of both the study years, based on population density count of mango mealy bug, it was recorded that population was more on Chaunsa cultivar i.e., 87.38 per 30-cm branch and minimum on Tukhmi cultivar of mango i.e., 15.86 per 30 cm branch. The following ranking positions towards susceptibility of mango cultivars were observed 'Chaunsa' > 'Black Chaunsa' > 'Malda' > 'Fajri' > 'Ratul-12' > 'Langra' > 'Sensation' > 'Sindhri' > 'Dusehri' > 'Sufaid Chaunsa' > 'Anwar Ratul' and >'Tukhmi'. Biochemical analysis of leaves and inflorescence showed that the chemical contents varies from cultivar to cultivar; however, carbohydrates were significantly higher in leaves of 'Chaunsa' cultivar i.e., 66.16 percent while Tukhmi had significantly lower contents i.e., 43.80 percent of carbohydrates. So it was concluded that special attention on Chaunsa (summer bahisht) cultivar of mango should be given when devising IPM program for the control of mango mealybug.
Keywords: Mango IPM, mealybug, biochemical analysis, population density

INTRODUCTION

Mango (*Mangifera indica* L.) a member of family Anacardiaceae, is one of the most important tropical fruits of the world. It is the most popular and best loved fruits worldwide and is known as king of fruits**.** In Pakistan, mango crop is commercially grown in the provinces of Punjab and Sindh on an area of 166.5 thousand hectare with an average production of 1730 thousand metric tons (Balal *et al.,* 2011). There are *ca* 1,000 different cultivars of mangoes throughout the world but Pakistan offers a wide choice of *ca* 3500 mango cultivars (Anonymous, 2008). The most famous and commercial cultivars of mango which are grown on large scale in Pakistan are Sindhri, Dusehri, Chaunsa (Summer bahist), Black Chaunsa, Sufaid Chaunsa, Fajri, Malda, Sensation, Anwar Ratul, Ratul-12 and Langra. All these cultivars differ in taste, flavour, colour, tinges, shape and size. The most important insect pests in Pakistan are mango hopper, *Idioscopus clypealis* (Leth), *Amritodus atkinsoni* (Leth), midges, *Erosomya indica* (Grover and Prasad), mango mealybug, *Drosicha stebbingii* (Green), scales, *Aulacaspis tubercularis* (Newstead), fruit flies, *Bactrocera zonata* (Saunders), *B. dorsalis* (Hendel), thrips, *Frankliniella occidentalis* (Pergande) and bark beetles, *Hypocryphalus mangiferae* (Stebbing), (Mohyuddin and Mahmood, 1993; Masood *et al*., 2009).

Mango mealybug is one of the most serious insect pests of mango in Pakistan. It is a polyphagous insect, which has been recorded to feed on numerous plant species. Plant resistance to insect pests is one of the best components among various tactics of IPM to reduce the insect damage. It is the result of interactions between the insects and plants that the environmental 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). The genetic properties of a cultivar to hinder the activities of insects so as to minimize percent reduction in yield as compared with other cultivars of the same species under similar condition (Dhaliwal *et al.,* 1993). Resistance is an innate characteristic that empowers 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). A wide array of chemical substances including inorganic chemicals, primary and intermediary metabolites and secondary substances are known to impart resistance to a many species of insect pests. The host plant may also be deficient in certain nutritional elements required by the insects and hence prove resistant. A number of plant characteristics are known to render the cultivar less suitable or unsuitable for feeding, oviposition and development of insect pests. The nutritionally deficient plant may cause

antibiotic and antixenotic effects on insect. Antibiosis may result from the absence of certain nutritional substances in the host plants, deficiency of some nutritional materials and /or imbalance of available nutrients.

The current project was planned to study the resistance/ susceptible cultivars of mango and their effect on various biological parameters of mango mealybug under field condition. Further biochemical analysis of leaves and inflorescence were done in the laboratory with the objective to find the role of these factors towards resistance/susceptibility.

MATERIALS AND METHODS

***Population of mango mealybug on different mango cultivars during 2005-2007*:** Three orchards were selected at three different locations in district Multan having maximum cultivars of mango during 2005-06 and 2006-07. Among these 11 most prominent, grafted, exportable and commercial cultivars viz., Chaunsa, Fajri, Langra, Black Chaunsa, Sufaid Chaunsa, Sindhri, Malda, Anwar Ratul, Dusehri, Ratul-12, Sensation and one seed born cultivar Tukhmi were selected for recording the data on population of mango mealybug. There were 12 cultivars and each cultivar had three replications. So there were 36 plants selected from one orchard. From each plant two fruit bearing branches of 30-cm in length were selected from east and south directions. These branches were tagged and write with the help of led pencil. The population of the mango mealybug were counted from these selected branches on the parts i.e. leaves, inflorescence and branches fortnightly throughout the active period of pest. The data was compiled and analyzed through Randomized Complete Block Design on an IBM-PC Computer using M. Stat (Steel and Torrie, 1980) Package. Means were separated by Duncan's New Multiple Range Test (DMRT) (Duncan, 1955).

***Population dynamics of mango mealybug on Chaunsa cultivar of mango*:** Two mango orchards with heavy mango mealybug (*Drosicha mangiferae* Green.) infestations, in district Multan were selected at two different locations during 2005-06 and 2006-07 for the study of population dynamics. Three mango plants of 'Chaunsa' cultivar were taken from each orchard. Selected trees were labelled with iron sheet fixed with 2 nails written with black permanent markers as tree No-1, 2 and 3. From each tree four fruit bearing branches of 30-cm in length were selected in four different directions i.e. east, west, south and north, were tagged. The tag was written with black permanent marker as number 1, 2, 3 and 4. The data was recorded weekly intervals. The data was compiled and analyzed through Randomized Complete Block Design on an IBM-PC Computer using M. Stat (Steel and Torrie, 1980) Package. Means were separated by Duncan's New Multiple Range Test (DMRT) (Duncan, 1955).

***Biochemical analysis of leaves and inflorescence*:** The leaves were plucked from a 30 cm branch of the trees from east, west, south and north sides of the selected cultivars from three different gardens. The distance between gardens was *ca* 3-10 km. The leaves of each cultivar were kept separately in paper envelope in three repeats and total 36 samples of leaves were collected from different cultivars. The leaves were brought to laboratory of Agriculture College Bahau-din-Zakariya University, Multan, wash and clean them and weighed. These samples were kept in the oven for the determination of moisture contents. After drying, the leaves were ground in grinder and fine powder was obtained and used for the determination of chemical analysis. When the inflorescence comes out, the samples of inflorescence were also collected and processed as described for leaves. The following chemical constituent's viz., nitrogen, potassium, crude Fiber, fat, sodium, ash, carbohydrates, phosphorus, crude protein were tested in leaves and inflorescence. The data were analyzed on an IBM-PC computer using M. Stat (Steel and Torrie, 1980) Package. Means were separated by Duncan's New Multiple Range Test (DMRT) (Duncan, 1955).

***Moisture content*:** Freshly picked leaves were cleaned with muslin's cloth and weighed. The leaves were then kept in an oven at 65^{o}C for 72 hours. After drying, leaves were weighed again and the % moisture was calculated as given below.

$$\text{Moisture (\%)} = \frac{A - B}{A} \times 100$$

A = Weight of fresh leaves; B = Weight of dried leave

***Total minerals*:** A 2g sample of dried leaf powder of each cultivar was placed in a boron-free fused silica crucible. The samples were burnt to ashes in muffle furnace at 600^{o}C for five hours. The dried matter after combustion was weighed again and placed back to same temperature until it was completely burnt to white ashes to a constant weight. The experiment was repeated four times. Total minerals were calculated using formula of Ranganna (1977).

$$\text{Total Mineral (\%)} = \frac{A}{B} \times 100$$

A = Weight of the ash; B = Weight of dried leaves

***Nitrogen*:** The 0.5 g of dried leaves tissue powder from each sample was taken to determine the nitrogen percentage by Kjeldahl Method. It was calculated by the formula (Winkleman *et. al*., 1986).

Nitrogen (%) = (N of acid x 14.007 x [ml of Titrant for sample - ml of titrant for blank])/(Weight of sample) × 100

The procedure was repeated three times.

***Crude protein*:** The crude protein was calculated by the formula followed by Winkleman *et al.* (1986) given as under:

Crude Protein (%) = Nitrogen % x 6.25

***Fat contents*:** Two grams of the bulk sample was taken in plugged thimble. Fat sample was extracted with solvent ether on Soxhlet extraction apparatus, for ten hours. The ether extract was dried and fats were calculated with the help of following formula (AOAC, 1975).

$$\text{Fats (\%)} = \frac{\text{Weight of ether extract}}{\text{Weight of sample}} \times 100$$

***Crude fiber*:** The sample left behind after fat extraction was dried and digested with 1.25 % H_2SO_4 on crude Fiber extraction apparatus. The digested material was then filtered, re-digested with N/10 NaOH and re-filtered. The materials left on the filter paper were dried and then ignited in muffle furnace for 30 minutes. After cooling for one hour in a desiccator's, the ignited material was weighed. The loss in weight after ignition was measured and the crude Fiber was calculated by using the following formula (AOAC, 1975).

$$\text{Crude fiber (\%)} = \frac{\text{Loss in weight on ignition}}{\text{Weight of the sample}} \times 100$$

***Soluble carbohydrates*:** Following formula was used to determine the soluble carbohydrates (AOAC, 1975).

Soluble Carbohydrates (%) = 100 - crude protein + % fats + crude Fiber + % ashes.

There were three replications for the determination of each component.

***Sample digestion for macro nutrients*:** One gram of the material from each sample was weighed to determine the macronutrients and digested in 10 ml concentrated nitric acid (HNO_3) and an equal quantity of 72% perchloric acid ($HCLO_4$) was added. The volume was then reduced to 3 ml and the sample became colorless, it was placed on ice to lower the temperature and then transferred to volumetric flask. The volume was increased to 100 ml by adding distilled water. The samples were then filtrated and stored in falcon tubes for further analysis.

***Phosphorus*:** Phosphorus was determined by using the digested materials from previous section of samples following method 56 and 61 (Richard, 1954), respectively on Spectro Photometer AnA-720 w Tokyo, Photoelectric Co. Ltd. Japan using 470 mm wavelength as the characteristic band.

***Potassium and Sodium*:** These were determined by using the digested materials with the help of Methods 55a, 58a and 57a (Richard, 1954), respectively on Flame Photometer, Jenway Ltd. Felsted CM6 3LB, DUNMOW ESSEX England.

RESULTS

***Population of mango mealybug on different mango cultivars during 2005-2006*:** Maximum mealybug (104.90/branch) was recorded on cultivar 'Chaunsa' (Table 1) and differed significantly from those of recorded on all other cultivars of mango. The minimum individuals of mango mealybug was observed on 'Tukhmi' (18.27/branch) and also differed significantly from those of recorded on all other cultivars. The cultivars 'Sensation' and 'Sindhri' did not show significant difference with each other having 51.68 and 51.83 mealybugs per branch, respectively. All the other cultivars of mango showed significant difference with one another. The position of cultivars in descending order was as 'Chaunsa' > 'Black Chaunsa' > 'Malda' > 'Fajri' > 'Ratul-12' > 'Langra' > 'Sindhri' > 'Sensation' > 'Dusehri' > 'Sufaid Chaunsa' > 'Anwar Ratul' > 'Tukhmi'.

Table 1. Mean population of mango mealybug on different cultivars of mango per 30-cm branch during 2005-06, 2006-07 and average of both years.

Cultivars	2005-06	2006-07	Average of both years
	LSD=0.78	LSD=0.75	LSD=0.54
Chaunsa	104.90 a	69.83 a	87.38 a
Fajri	80.48 d	59.48 d	69.98 d
Langra	59.52 f	46.43 f	52.97 f
Black Chaunsa	91.25 b	65.93 b	78.59 b
Sufaid Chaunsa	27.65 i	19.88 j	23.77 j
Sindhri	51.83 g	35.07 h	43.45 h
Malda	83.97 c	61.90 c	72.93 c
Dusehri	38.02 h	25.95 i	31.98 i
Anwar Ratul	20.53 j	14.20 k	17.37 k
Ratul-12	69.77 e	51.72 e	60.74 e
Tukhmi	18.27 k	13.45 k	15.86 l
Sensation	51.68 g	45.42 g	48.55 g
F-value	137.80	307.50	362.00

Means sharing similar letters are not significantly different by DMR Test at P = 0.05; LSD = Least Significant Difference Value; * = Significant at P ≤ 0.05; ** = Significant at P ≤ 0.01.

***Population of mango mealybug on different mango cultivars during 2006-2007*:** The results (Table 1) show significant variations among mango cultivars regarding population of mango mealybug per branch of 30 cm length. The cultivar 'Chaunsa' again found to be comparatively susceptible showing maximum population of mango mealybug i.e. 69.83 per branch, whereas 'Tukhmi' showed minimum population of mango mealybug i.e. 13.45 per branch which showed similar response statistically with those of 'Anwar Ratul' with 14.20 individuals per branch of the pest. The descending order of the cultivars based on population of mango mealybug towards susceptibility was as follows: 'Chaunsa' > 'Black Chaunsa' > 'Malda' > 'Fajri' > 'Ratul-12' > 'Langra' > 'Sensation' > 'Sindhri' > 'Dusehri' > 'Sufaid Chaunsa' > 'Anwar Ratul' and 'Tukhmi'.

***Average population of mango mealybug on cumulative basis both years studies*:** The data regarding mango mealybug on different cultivars of mango during both the study years are presented Table 2. The results reveal that the cultivar 'Chaunsa' was found susceptible on an average of two years data. The population of mango mealybug showing maximum population of the pest i.e. 87.38 per 30-cm branch and differed significantly from those of observed in all other cultivars. The cultivar 'Tukhmi' was found comparatively resistant to mango mealybug with minimum population of the pest i.e. 15.86 per 30-cm branch. Furthermore, all the cultivars differed significantly with one another. The descending position of these cultivars are; 'Chaunsa' > 'Black Chaunsa' > 'Malda' > 'Fajri' > 'Ratul-12' > 'Langra' > 'Sensation' > 'Sindhri' > 'Dusehri' > 'Sufaid Chaunsa' > 'Anwar Ratul' >'Tukhmi'. The south direction of the plant showed higher population as compared to East direction in all the cultivars of mango.

Table 2. Mean population of mango mealybug on chaunsa cultivar on different dates per 30-cm branch average of both studied years.

Dates	Average population of mango mealy
January 11	0.00 i
January 26	2.17 h
February13	104.60 b
February 28	86.60 c
March 14	108.79 a
March 28	82.62 d
April 12	48.37 f
April 27	48.92 e
May 10	18.46 g
May 25	2.44 h

Means sharing similar letters are not significantly different by DMR Test at P = 0.05; LSD = Least Significant Difference Value; * = Significant at P ≤ 0.05; ** = Significant at P ≤ 0.01.

***Population of mango mealybug on chaunsa cultivar of mango during2005-2006 and 2006-2007*:** The data presented in Table 2 based on both study years revealed that population of mango mealybug was appeared 2.17 per 30 cm branch during the 4th week of Jan. and reached to a peak during 2nd week of Feb. i.e. 104.60 per 30-cm branch. This population decreased down during 4th week of Feb. i.e. 86.60 and then reached to the highest peak during 2nd week of Mar. i.e. 108.79 per 30-cm branch. This population decreased down thereafter subsequently and reached to a minimum level of 2.44 per branch of 30-cm length during 4th week of May.

***Impact of various chemical factors on the population of mango mealybug*:** Various chemical factors determined from the leaves and inflorescence of different mango cultivars were correlated with the respective populations on the leaves and inflorescence. The same parameters were processed for multiple linear regression models through steps to see the impact of chemical factors and also determined the role of individual chemical factors in the fluctuation of the population of mango mealybug on the leaves and inflorescence. The results are presented under the following sub-sections.

***Simple correlation*:** The results revealed that crude fiber, fat, sodium, ashes and crude protein contents showed negative and significant correlation with the population of mango mealybug on leaves, whereas carbohydrate and potassium had significant and positive correlation with the population of the pest (Table 3). Nitrogen, phosphorus and moisture percentage did not show significant correlation with the population of mango mealybug. All the chemical plant factors resulted nonsignificant correlation with the population of mango mealybug on inflorescence except crude fiber and nitrogen. Crude fiber showed negative, whereas nitrogen showed positive and significant correlation with the pest population.

Table 3. Simple correlation between population of mealybug on mango leaves and inflorescence along with biochemical factors.

Constituents	Leaves	Inflorescence
Ash	-0.595**	0.225
Carbohydrate	0.257**	0.133
Crude Fiber	-0.884**	-0.340*
Crude protein	-0.664**	-0.034
Fat	0.400**	-0.134
Moisture	0.300	-
Nitrogen	-0.293	0.369*
Phosphorus	0.101	0.136
Potassium	0.482**	0.305
Sodium	-0.317*	-0.152

*= Significant at P ≤ 0.05; ** = Significant at P ≤ 0.01.

Multiple Linear Regression Models:

***Impact of chemical factors in population fluctuation of mango mealybug on leaves*:**

The results regarding multiple linear regression models between population fluctuation of mango mealybug on leaves and chemical factors along with coefficient of determination value are presented in Table 4. The results reveal that nitrogen content showed 8.6 percent role in the population fluctuation of mango mealybug and the impact was found to be non-significant. With the addition of potassium contents this role increased up to 25.9 percent in population fluctuation of the pest. The individual contribution of potassium was calculated to be 17.3 percent. The impact of potassium was however highly significant. Crude fiber exerted maximum contribution i.e. 55.8 percent in the population fluctuation for the pest and found to be the most important chemical. All the other factors were not so

Table 4. Multiple linear regression models between population of mealybug on mango leaves and biochemical factors along with coefficient of determination values.

Regression Equation	D.F.	F-value	P- value	R^2	Individual Role (%)
Y = 16.03 – 4.54 X1	34	2.78	0.08	0.086	8.6 X1
Y= 4.37 – 2.63 X1 + 6.66 X2	33	2.70	0.004	0.259	17.3 X2
**Y= 27.07 - 2.56 X1* + 1.08 X2- 3.57 X3	32	3.17	0.001	0.187	55.8 X3
Y= 27.37-2.64 X1* + 1.63 X2 -3.33 X3-1.13 X4	31	2.50	0.001	0.823	0.6 X4
Y= 21.75 - 2.61 X1* +1.65X2 -3.57 X3-0.68 X4+6.63X5	30	2.16	0.001	0.854	3.3 X5
Y= 25.52 - 2.50 X1 + 2.16 X2*-3.11X3**-0.02 X4 + 8.09 X5 - 2.52 X6**	29	2.21	0.002	0.906	5.2 X6
Y= 26.22-2.25 X1+1.94 X2-3.16 X3**-0.01 X4 + 8.18 X5-2.58 X6**-0.05 X7	28	2.37	0.003	0.906	0.0 X7
Y= 34.47-2.44 X1+1.61 X2-2.03 X3**-1.50 X4-3.70 X5-2.25 X6**-0.07 X7+2.48 X8**	27	2.38	0.005	0.938	3.2 X8
Y= 26.05-2.67 X1+2.07 X2-2.77 X3**-1.39 X4-1.03 X5-2.31 X6-0.07 X7** +2.57 X8** +0.70X9	26	2.43	0.004	0.938	0.0 X9
Y= 45.40+1.58 X1+1.02 X2-2.36 X3-2.71 X4**-8.84 X5-1.48 X6**-0.11 X7+1.02 X8-0.70 X9-2.15 X10**	25	3.59	0.003	0.965	3.5 X10

Where X1 =Nitrogen, X2 =Potassium, X3 =Crude fiber, X4=Fat, X5 =Sodium, X6 =Ash, X7 =Carbohydrates, X8=Phosphorus, X9 =Moisture, X10=Crude Protein. *= Significant at $P \leq 0.05$; **= Significant at $P \leq 0.01$.

important which contributed 0.00 to 8.3 percent role in the population fluctuation of the pest. From these results it was observed that the effect of all the factors when computed together resulted in 96.5 percent contribution in population fluctuation of the pest.

***Impact of chemical factors in population fluctuation of mango mealybug on inflorescence*:** Linear multiple regression models between population fluctuation of mango mealybug on inflorescence and different chemical factors (Table 5) indicated that nitrogen content had a significant impact on the population fluctuation of the pest and 13.6 percent of the variation in the insect fluctuation. Ash content 26.4 percent of the variation in the population fluctuation of the pest and was found to be the most important factor. The coefficient of determination value was calculated to be 0.539 when the effects of all the chemical factors were computed together.

Chemical Factors in Leaves of Different Cultivars of Mango:

***Nitrogen*:** The results regarding nitrogen contents in the leaves of various cultivars of mango reveal significant differences among various mango cultivars (Table 6, Column A). The maximum nitrogen content (3.0 percent) was observed in 'Sufaid Chaunsa' leaves which were significantly higher than 'Dusehri', 'Ratul-12', 'Langra' and 'Anwar Ratul', i.e. 2.1, 1.8, 1.6 and 1.6 percent nitrogen

Table 5. Linear multiple regression models between population of mealybug on mango inflorescence and biochemical factors along with coefficient of determination values.

Regression Equation	D.F.	F-value	P- value	R^2	Individual Role (%)
Y = -4.96+3.59 X1	34	1.46	0.03	0.136	13.6 X1
Y = -5.80+3.23 X1+1.37 X2	33	0.31	0.73	0.137	0.1 X2
Y = -1.12+1.54 X1+3.73 X2-1.59 X3	32	2.47	0.07	0.179	4.2 X3
Y = -9.18+3.66 X1+2.96 X2-2.25 X3+1.36 X4	31	2.28	0.08	0.237	5.8 X4
Y = -9.49+3.68 X1+2.99 X2-2.25 X3+1.35 X4+0.02 X5	30	1.77	0.14	0.237	0.0 X5
Y = -36.24+4.89 X1+0.61 X2-3.47 X3+ 0.33 X4 +0.39 X5+18.12 X6**	29	1.15	0.01	0.483	26.4 X6
Y = -36.00+5.05 X1-0.04 X2-3.48 X3+ 0.46 X4+0.35 X5+18.15 X6**+0.17 X7	28	1.67	0.00	0.497	1.4 X7
Y = -35.52 +5.07 X1-0.62 X2-3.51 X3 +0.46 X4+0.35 X5+18.26**X6+0.17 X7+0.12 X8	27	2.45	0.00	0.498	0.1 X8
Y = -36.64+6.81 X1-1.63 X2-2.99 X3+ 0.22 X4+0.32 5+19.75**X6+0.09X7-0.24 X8-1.45 X9	26	2.86	0.00	0.539	4.1 X9

Where X1 =Nitrogen, X2 =Potassium, X3 =Crude fiber, X4=Fat, X5 =Sodium, X6 =Ash, X7=Carbohydrates, X8=Phosphorus, X9 =Moisture, X10=Crude Protein. *= Significant at $P \leq 0.05$; **= Significant at $P \leq 0.01$.

Table 6. Mean percent of chemical constituents of leaves in different cultivars of mango.

Cultivars	Nitrogen	Potassium	Crude Fiber	Fat	Sodium	Ash	Carbo-hydrates	Phosphorus	Moisture	Crude protein
	A**	B**	C**	D**	E**	F**	G**	H**	I**	J**
Anwar Ratul	1.64 d	1.078 fg	28 a	3.5 a	0.334 b	14 a	44.29 j	1.39 b	50.49 k	10.20 e
BlackChaunsa	1.52 e	1.466 b	14 e	1.5 e	0.224 e	9 d	66.02 b	0.47 j	57.89 b	9.48 g
Chaunsa	1.58 de	1.201 d	11 f	2.0 d	0.185 f	11 bc	66.16 a	0.42 k	60.60 a	9.84 f
Dusehri	2.10 b	1.008 h	20 cd	2.5 c	0.259 d	14 a	50.37 h	1.17 d	54.58 e	13.13 c
Fajri	1.23 g	1.192 d	19 cd	2.5 c	0.297 c	9 d	61.84 d	2.08 a	49.94 l	7.66 i
Langra	1.64 d	1.034 .c	15 e	3.0 b	0.259 d	12 b	59.79 f	1.24 c	56.06 c	10.21 e
Malda	1.40 f	2.748 a	14 e	3.0 b	0.222 e	12 b	62.25 c	0.97 e	50.70 j	8.75 h
Ratul-12	1.75 c	1.080 fg	16 e	1.5 e	0.408 a	11 bc	60.59 e	0.62 g	51.56 i	10.94 d
Sensation	1.40 f	1.158 de	18 d	3.5 a	0.222 e	10 cd	59.75 f	0.52 i	53.95 f	8.75 h
Sindhri	1.58 de	1.123 ef	20 cd	2.5 c	0.258 d	10 cd	57.66 g	0.74 f	53.77 g	9.84 f
SufaidChaunsa	3.04 a	1.060 gh	21 c	2.5 c	0.259 d	10 cd	47.54 i	0.57 h	55.68 d	18.96 a
Tukhmi	1.23 g	1.096 fg	24 b	2.5 c	0.259 d	14 a	43.80 k	0.22 l	52.78 h	15.63 b
LSD @ 5%	0.09	0.05	1.97	0.18	0.01	1.73	0.05	0.02	0.17	0.05
F-value	256.7	566.1	49.6	118.2	3638.4	10.2	357907.2	220.6	3145.4	51535.0

Means sharing similar letters in columns A to J for means did not differ significantly by DMR Test at P = 0.05
LSD = Least Significant Difference Value. * = Significant at P ≤ 0.05; ** = Significant at P ≤ 0.01.

contents, respectively. The minimum nitrogen content was recorded to be 1.2 percent in the leaves of both 'Tukhmi' and 'Fajri' cultivars. Non-significant differences were found in the leaves of 'Chaunsa', 'Black Chaunsa' and 'Sindhri' with 1.6, 1.5 and 1.6 percent nitrogen, respectively. Similarly nitrogen content i.e. 1.4 percent each in the leaves of 'Malda' and 'Tukhmi' did not show significant difference with one another.

***Potassium*:** The results relating to potassium contents in the leaves of various cultivars of mango show significant variations among cultivars (Table 6, Column B). The maximum potassium content (2.75 percent) was found in the leaves of 'Malda' and differed significantly from those of observed in the leaves of all other cultivars followed by 1.47, 1.03, 1.20, 1.19 and 1.15 percent potassium contents in the leaves of 'Black Chaunsa', 'Langra', 'Chaunsa', 'Fajri' and 'Sensation', respectively. The later mentioned figure in cultivar 'Sensation' also did not show significant variation with those of observed in the leaves of 'Sindhri' i.e. 1.12 percent potassium. Non-significant difference were found to exist among 'Tukhmi', 'Ratul-12', 'Anwar Ratul' and 'Sufaid Chaunsa' having 1.09, 1.08, 1.07 and 1.06 percent potassium contents in their leaves, respectively. The minimum potassium content was determined in the leaves of 'Dusehri' i.e. 1.01 percent and did not show significant difference with those of observed in the leaves of 'Sufaid Chaunsa' (1.06 percent).

***Crude fiber*:** The results pertaining to crude fiber in the leaves of various cultivars of mango reveal significant difference among cultivars (Table 6, Column C). The maximum crude fiber contents (28.0 percent) was observed in the leaves of 'Anwar Ratul' and differed significantly from those of observed in the leaves of all other cultivars followed by 24.0, 21.0, 20.0, 20.0, 19.0 and 18.0 percent crude fiber contents in the leaves of 'Tukhmi', 'Sufaid Chaunsa', 'Sindhri', 'Dusehri', 'Fajri' and 'Sensation', respectively. The minimum crude fiber contents was found to be 11.00 percent in the leaves of 'Chaunsa' and differed significantly from those of observed in all other cultivars. Non-significant differences were found to exist among leaves of 'Black Chaunsa' (14.0 percent), Langra (15.0 percent), Malda (14.0 percent) and Ratul-12 (16.0 percent) in crude fiber contents.

***Fat contents*:** Significant variations were found to exist among cultivars regarding fat contents in their leaves (Table 6, Column D). The maximum fat contents was found in the leaves of Anwar Ratul and Sensation with 3.5 percent each and differed significantly from those of observed in all other cultivars followed by 3.0 percent fat contents each in the leaves of 'Malda' and 'Langra'. No significant differences were found to exist among 'Fajri', 'Sufaid Chaunsa', 'Sindhri', 'Dusehri' and 'Tukhmi' each showing 2.5 percent fat contents in their leaves. The minimum fat content was found in the leaves of 'Ratul-12' and 'Black Chaunsa' each showing 1.5 percent fat contents. The cultivar 'Chaunsa' showed 2.0 percent fat contents in the leaves and differed significantly from those of observed in the leaves of all other cultivars.

***Sodium contents*:** Differences were found to be significant among cultivars regarding sodium contents in their leaves (Table 6, Column E). The maximum sodium contents was observed in the leaves of 'Ratul-12' at 0.41 percent followed by 0.33 and 0.30 percent in the leaves of 'Anwar Ratul' and 'Fajri', respectively and showed significant difference with

each other as well as from those of observed in all other cultivars. Non-significant differences was found to exist among 'Langra', 'Sufaid Chaunsa', 'Sindhri', 'Dusehri' and 'Malda' showed 0.26, 0.26, 0.26, 0.26 and 0.26 percent sodium contents in their leaves, respectively. The cultivar 'Chaunsa' possessed the lowest sodium percentage in the leaves i.e. 0.19 and differed significantly from those of observed in leaves all other cultivars as well as in the leaves of Sensation with 0.22 percent sodium contents.

***Ash contents*:** The results regarding ash contents in the leaves of different cultivars of mango reveal significant variations among cultivars (Table 6, Column F). The leaves of 'Tukhmi', 'Anwar Ratul' and 'Dusehri' showed maximum ash contents i.e. 14.00 percent each followed by 12.00 percent in the leaves of each 'Langra' and 'Malda'. The cultivar 'Ratul-12' and 'Chaunsa' each contained 11.00 percent ash contents in the leaves and showed non-significant difference with those of observed in the leaves of 'Sensation', 'Sindhri' and 'Sufaid Chaunsa' each contained 10.00 percent ash contents as well as with those of observed in the leaves of 'Langra' and 'Malda'. Non-significant difference was also observed in the leaves of 'Fajri' and 'Black Chaunsa' each showed 9.00 percent ash contents and was statistically at par with the contents in the leaves of 'Sufaid Chaunsa', 'Sindhri' and 'Sensation'.

***Carbohydrate*:** All the cultivars of mango differed significantly with one another regarding carbohydrate contents in their leaves (Table 6, Column G). The cultivar 'Chaunsa' had the highest carbohydrates in the leaves i.e. 66.2 percent followed by 66.0, 62.3 and 61.8 percent in the leaves of 'Black Chaunsa', 'Malda' and 'Fajri', respectively. The lowest carbohydrate was observed in the leaves of 'Tukhmi' i.e. 43.8 percent and also differed significantly from those of observed in the leaves of all other cultivars. Non-significant variation was found to exist between 'Langra' and 'Sensation' showing 59.8 and 59.8 percent carbohydrates in their leaves, respectively. The cultivar 'Ratul-12', 'Sindhri', 'Dusehri' and 'Anwar Ratul' contained 60.6, 50.4, 47.5 and 44.3 percent carbohydrates in their leaves, respectively and were differed significantly from each other.

***Phosphorus*:** The results regarding phosphorus contents in the leaves of various mango cultivars reveal significant variation among cultivars (Table 6, Column H). The maximum phosphorus contents was observed to be 2.1 percent in the leaves of 'Fajri' and differed significantly from those of observed in the leaves of all other cultivars of mango. The minimum phosphorus content was found to be 0.2 percent in the leaves of 'Tukhmi' and also differed significantly from those of observed in the leaves of all other cultivars. The phosphorus contents in descending order were 1.4, 1.2, 1.2, 1.0, 0.7, 0.6, 0.6, 0.5, 0.5 and 0.4 percent in the leaves of 'Anwar Ratul', 'Langra', 'Dusehri', 'Malda', 'Sindhri', 'Ratul-12', 'Sufaid Chaunsa', 'Sensation', 'Black Chaunsa' and 'Chaunsa', respectively.

***Moisture*:** The results relating to moisture percentage in the leaves of various mango cultivars showed significant variation among cultivars (Table 6, Column I). Maximum moisture percentage was recorded to be 60.6 in the leaves of 'Chaunsa' followed by 57.9 56.1, 55.7, 54.6, 54.0, 54.0, 53.0, 51.6, 50.7 and 50.5 percent in the leaves of 'Black Chaunsa', 'Langra', 'Sufaid Chaunsa', 'Dusehri', 'Sensation', 'Sindhri', 'Tukhmi', 'Ratul-12', 'Malda' and 'Anwar Ratul', respectively and all these showed significant difference from each other. The minimum moisture percentage was observed to be 49.9 in the leaves of 'Fajri' and also showed significant variation from those of observed in the leaves of all other cultivars of mango.

***Crude protein*:** The results relating to crude protein in the leaves of various cultivars of mango reveal significant difference among cultivars (Table 6, Column J). The maximum crude protein was observed in the leaves of 'Sufaid Chaunsa' i.e. 19.0 percent followed by 15.6, 13.1 and 14.9 percent in the leaves of 'Tukhmi', 'Dusehri' and 'Ratul-12', respectively. No significant differences were found to exist between 'Chaunsa' and 'Sindhri' each showing 9.8 percent crude protein in their leaves. Similarly 'Langra' and 'Anwar Ratul' did not show significant difference regarding crude protein in their leaves showing 10.2 and 10.2 percent, respectively. The protein contents were 8.8 percent in the leaves of each 'Malda' and 'Sensation' and also showed non-significant difference from one another. The minimum crude protein was found to be 7.7 percent in the leaves of 'Fajri' and showed significant difference with those of observed in the leaves of 'Black Chaunsa' i.e. 9.5 percent and as well as from those of observed in all other cultivars.

Chemical Factors in Inflorescence in Different Cultivars of Mango:

***Nitrogen*:** The data regarding nitrogen percentage in the inflorescence of different cultivars of mango are given in Table 7, Column A. The results reveal significant differences among cultivars. The cultivar 'Tukhmi' showed maximum nitrogen percentage in inflorescences i.e. 2.0 and showed significant difference with those of observed in all other cultivars followed by 1.9 percent nitrogen contents in inflorescences of each 'Dusehri', 'Malda', 'Langra' and 'Chaunsa' which were statistically similar with one another. The minimum nitrogen content was found to be 1.6 percent in the inflorescence of each 'Black Chaunsa' and 'Ratul-12' which also showed non-significant difference with each other. The cultivars 'Sufaid Chaunsa', 'Anwar Ratul' and 'Sensation' did not show significant difference with one another regarding nitrogen contents with 1.6, 1.6 and 1.6 percent, respectively. The later mentioned figure also showed non-significant variation with those of observed in 'Ratul-12' and 'Black Chaunsa'. The cultivars 'Fajri' and

Table 7. Mean comparison of the data regarding chemical constituents (percent) of inflorescence in different cultivars of mango.

Cultivars	Nitrogen	Potassium	Crude fiber	Fat	Sodium	Ash	Carbohydrates	Phosphorus	Crude protein
	A**	B**	C**	D**	E**	F**	G**	H**	I**
Anwar Ratul	1.64 e	1.73 e	12 a	3.50 a	0.185 b	3 b	73.43 g	4.12 e	10.57 e
Black Chaunsa	1.58 f	1.84 cd	8 b	1.50 d	0.148 c	3 b	77.66 b	7.51 b	9.78 h
Chaunsa	1.92 b	1.60 f	8 b	1.50 d	0.185 b	6 a	72.47 h	3.52 i	12.03 b
Dusehri	1.92 b	1.49 g	11 a	1.00 e	0.148 c	2 b	73.97 f	4.02 g	12.03 b
Fajri	1.86 c	1.93 b	12 a	1.50 d	0.148 c	4 b	70.83 j	3.35 j	11.67 c
Langra	1.92 b	1.63 f	8 b	1.50 d	0.185 b	4 b	71.47 i	2.28 l	12.03 b
Malda	1.92 b	2.13 a	12 a	3.00 b	0.148 c	4 b	70.47 k	7.42 c	12.03 b
Ratul-12	1.58 f	1.78d e	11 a	1.50 d	0.148 c	2 b	75.66 d	5.46 d	9.84 g
Sensation	1.60e f	1.90 bc	7 b	3.50 a	0.148 c	3 b	79.25 a	9.89 a	8.75 i
Sindhri	1.75 d	1.89 bc	10 a	1.50 d	0.185 b	3 b	74.56 e	3.67 h	10.94 d
Sufaid Chaunsa	1.64 e	1.87 bc	10 a	2.50 c	0.185 b	3 b	75.79 c	4.09 f	10.21 f
Tukhmi	2.04 a	1.52 g	11 a	1.50 d	0.223 a	7 a	58.78 l	2.78 k	12.76 a
LSD @5%	0.05	0.08	1.77	0.05	0.02	1.77	0.02	0.02	0.05
F-value	256.7	566.1	49.6	118.2	3638.4	10.2	357907.2	220.6	51535.0

Means sharing similar letters in columns A to I for means did not differ significantly by DMR Test at P = 0.05
LSD = Least Significant Difference Value. * = Significant at P ≤ 0.05; ** = Significant at P ≤ 0.01.

'Sindhri' possessed 1.9 and 1.8 percent nitrogen percentage in their inflorescence and differed significantly with each other.

***Potassium*:** The results (Table 7, Column B) reveal significant variation among cultivars regarding potassium contents in their inflorescence. The cultivar 'Malda' had significantly the highest potassium contents followed by 1.9, 1.9, 1.9, 1.9 and 1.8 percent in the inflorescence of 'Fajri', 'Sensation', 'Sindhri', 'Sufaid Chaunsa' and 'Black Chaunsa', respectively and did not differ significantly with one another. Minimum content of potassium was observed to be 1.6 percent in the inflorescence of 'Chaunsa' and did not show significant difference with 1.6 percent in 'Langra'. Similarly 'Anwar Ratul' and 'Ratul-12' showed no significant difference from each other having 1.7 and 1.8 percent potassium, respectively. Also no significant difference was also observed in the inflorescence of 'Tukhmi' and 'Dusehri' with 1.5 and 1.5 percent potassium content, respectively.

***Crude fiber*:** The results presented in (Table 7, Column C) reveal significant differences among mango cultivars regarding crude fiber contents. The maximum contents of crude fiber was observed to be 12.0 percent in the inflorescence of each 'Fajri', 'Malda' and 'Anwar Ratul' and showed non-significant difference with 11.0, 11.0, 11.0, 10.0 and 10.0 crude fiber contents in the inflorescence of 'Tukhmi', 'Ratul-12', 'Dusehri', 'Sindhri' and 'Sufaid Chaunsa', respectively. The cultivars 'Chaunsa', 'Black Chaunsa' and 'Langra' each had 8.0 percent crude fiber in their inflorescence and did not differed significantly from 'Sensation' 7.0 percent crude fiber in the inflorescence.

***Fat contents*:** The results pertaining to fat contents in the inflorescence of various cultivars reveal significant difference among cultivars (Table 7, Column D). 'Anwar Ratul' and 'Sensation' had the highest fat contents with 3.5 percent each. These cultivars were followed by 'Malda' and 'Sufaid Chaunsa' with 3.0 and 2.5 percent fat contents respectively. 'Malda' and 'Sufaid Chaunsa' and differed significantly with one another as well as with 'Anwar Ratul' and 'Sensation'. Fat contents of 1.5 percent was found in the inflorescence of each 'Chaunsa', 'Fajri', 'Langra', 'Black Chaunsa', 'Sindhri', 'Ratul-12' and 'Tukhmi' had the same fat content (1.5 percent). The lowest fat content was found in the inflorescence of 'Dusehri' at 1.0 percent and differed significantly from those of observed in all other cultivars.

***Sodium*:** Significant variations were found to exist among cultivars regarding sodium contents in their inflorescence (Table 7, Column E). The lowest sodium content was found to be 0.223 percent in the inflorescence of 'Tukhmi' and this differed significantly from those of observed in all other cultivars. No significant difference was found to exist between 'Chaunsa', 'Langra', 'Sufaid Chaunsa', 'Sindhri' and 'Anwar Ratul' each possessed 0.19 percent sodium contents in their inflorescence. Similarly non-significant variation was found to exist among 'Ratul-12', 'Dusehri', 'Malda', 'Black Chaunsa' and 'Fajri' all contained 0.15 percent sodium content in their inflorescence and categorized as intermediate.

***Ash contents*:** The data regarding ash content in the inflorescence of various cultivars of mango are given in (Table 7, Column F). The results reveal that highest ash contents were observed in the inflorescence of 'Tukhmi' (7

percent) and 'Chaunsa' (6 percent). All the other cultivars had significantly lower ash content. These other varieties did not differ significantly regarding ash content present in their inflorescence and ranged from 2 to 4 percent.

***Carbohydrate*:** Significant differences were found to exist among cultivars of mango regarding carbohydrates present in their inflorescence (Table 7, Column G) The highest carbohydrate level was observed in the inflorescence of 'Sensation' (79.3 percent) and followed by the inflorescences of 'Black Chaunsa', 'Sufaid Chaunsa' and 'Ratul-12' with 77.7, 75.8 and 75.7 percent carbohydrate, respectively. The later mentioned figures also differed significantly from one another. The lowest carbohydrate was observed in the inflorescence of 'Tukhmi' (58.8 percent) and this differed significantly from other cultivars of mango tested viz., 'Chaunsa', 'Fajri', 'Langra', 'Sindhri', 'Malda', 'Dusehri' and 'Anwar Ratul' with 72.5, 70.8, 71.5, 74.6, 70.5, 74.0 and 73.4 percent carbohydrates in their inflorescence, respectively and ranked as intermediate.

***Phosphorus*:** Significant variations were found to exist among cultivars regarding phosphorus content in their inflorescence (Table 7, Column H). The cultivar 'Sensation' showed the highest phosphorus content and differed significantly from those of observed in all other cultivars. The lowest phosphorus contents was found to be 2.3 percent in the inflorescence of 'Langra' cultivar and also showed significant variations from those of observed in all other cultivars. The descending position of other cultivars were 'Black Chaunsa', 'Malda', 'Ratul-12', 'Anwar Ratul', 'Sufaid Chaunsa', 'Dusehri', 'Sindhri', 'Chaunsa', 'Fajri' and 'Tukhmi' with 7.5, 7.4, 5.5, 4.1, 4.1, 4.0, 3.7, 3.5, 3.4 and 2.8 percent phosphorus contents, respectively and all these cultivars differed significantly with one another.

***Crude protein*:** The highest crude protein observed was 12.8 percent in the inflorescence of 'Tukhmi' and this differed significantly from those of found in all other cultivars and followed by 12.0 percent crude protein for 'Dusehri', 'Malda', 'Langra', and 'Chaunsa' (Table 7, Column I). The lowest crude protein was found to be 9.8 percent in the inflorescence of 'Black Chaunsa' which was significantly greater than observed in the inflorescence of all other cultivars of mango. The descending position of other cultivars was 'Fajri', 'Sindhri', 'Anwar Ratul', 'Sufaid Chaunsa' and 'Ratul-12' with 11.7, 10.9, 10.6, 10.2 and 9.5 percent crude protein in their inflorescence, respectively, and all differed significantly from one another statistically.

DISCUSSION

Usage of insect-resistant varieties of agricultural crops is considered naturally, economically and environmentally advantageous. By the application of these practices the crop yield can be protected from loss to insect pests and money is saved without or minimum use of insecticides. The Integrated Pest Management model forces the necessity to use multiple strategies to maintain insect pest richness and damage below levels of economic significance. In view of the importance of IPM, the following cultivars of mango viz., 'Chaunsa', 'Fajri', 'Langra', 'Black Chaunsa', 'Sufaid Chaunsa', 'Sindhri', 'Malda', 'Anwar Ratul', 'Dusehri', 'Ratul-12', 'Tukhmi' and 'Sensation' were undertaken to screen the resistance/susceptibility cultivars against mango mealybug. Our results suggests that 'Chaunsa' cultivar is the most susceptible cultivar among various cultivars of mango having maximum population of mango mealybug i.e. 87.38 individuals per 30 cm branch whereas minimum population was observed on Tukhmi i.e. 15.86 per 30 cm branch. Furthermore it was concluded that the southern side of the tree had significantly higher population of mango mealybug as compared with other sides of the tree. The results are comparable with that of Karar *et al.,* 2013 who reported that that southern side of the plant had maximum population of mango mealybug as compared with western and eastern sides. Whereas northern side of the tree showed the lowest population of Mango mealy bug. Moreover it was also observed that the peak activity period of this pest is the 2nd week of February, to 2nd week of March and the population decreased thereafter. The results of present studies are in contrast to Matokot *et al.,* 1992 who reported that the fluctuations in populations of mango mealybug are linked to the physiological and phenological characteristics of the host plant than to climatic factors. Further our results suggested that the gravid females laid more number of eggs which feed on Chaunsa cultivar as compared with the females which feed on Anwar Ratul cultivar. Similarly, the females have more weight, length and width and ovisac size which feed on Chaunsa cultivar and vice versa. The results are similar to that of Karar *et al*., 2007 who reported that female mealybug feeds on 'Chaunsa' cultivar is broader than the females feed on other cultivars of mango. The most probable reason for such variations is that the 'Chaunsa' cultivar is the most susceptible and preferred host for mealybug therefore the insects had enough food to survive and gain weight. The results are similar to Karar, 2010 who reported that higher the weight of female, the more fecund it will be (Karar, 2010). From the results it was concluded that some varieties are susceptible while others are resistant, so there is significant difference among different varieties of mango. The current findings add significantly to those of Nachiappan and Bhaskaran (1984), Bagle and Prasad (1984), Pathak and Dhaliwal (1986), Khaire *et al.* (1987), Hansen *et al.* (1989), Angeles (1991), Dhaliwal *et al.,* (1993), Carvalho *et al.* (1996), Dhaliwal and Dilawari (1996) and Salem *et al.* (2006) who studied host plant resistance against different insect pests on different hosts. Further the role of various chemicals like nitrogen, potassium, crude fiber, fat, sodium, ash, carbohydrates, phosphorus, moisture and crude protein

in tolerance to mango mealybug suggested that the chemical contents varies from cultivar to cultivar however, carbohydrates were significantly higher in leaves of 'Chaunsa' cultivar, which was susceptible to mango mealybug, while Tukhmi, comparatively resistant to mango mealybug had significantly lower contents of carbohydrates. Furthermore, it was observed that crude fiber, fat, sodium, ash and crude protein showed negative significant correlation with the pest population on leaves, while carbohydrate and potassium had positive correlation with the pest population. Linear Multiple Regression Models showed that crude fiber was the most important content in leaves which played a maximum role in population fluctuation of mango mealybug. The pest population recorded on inflorescence, ash contents showed maximum percent contribution in population fluctuation of the pest followed by nitrogen, fat, crude fiber, protein, phosphorus and potassium. In contrast to the current findings, Tobih *et al.* (2002) have shown that mealybug infestation caused significant reduction in the ash content, crude fiber and reducing sugar level of both ripe and unripe fruits. To the best of my knowledge there is no documented case where it has been shown that carbohydrates play an important role in infestation of mango mealybug. Though we do not have direct evidence to prove that carbohydrates increased mango mealybug infestations on the tree but we found the highest number of mango mealybug on 'Chaunsa' cultivar, which had significantly high level of carbohydrates content. This suggests that carbohydrate content might play a role in mealybug abundance. However, further studies where application of carbohydrates from 'Chaunsa' cultivar onto a resistant cultivar could prove that susceptibility in 'Chaunsa' cultivar is due to carbohydrates.

***Conclusion*:** The cultivars 'Chaunsa', 'Black 'Chaunsa' and 'Malda' are found to be susceptible for mango mealy bug whereas 'Tukhmi' and 'Anwar Ratul' are resistant having minimum population of this pest. The females of mango mealybug which feed on 'Chaunsa' cultivar gain more weight, size and number of eggs. It was concluded that special attention should be given on susceptible cultivars of mango when devising IPM program for the control of this pest.

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