INTENSITY OF PANICLE MALFORMATION IN MANGO (*Mangifera indica* L.) VARIETIES

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Mango germplasm comprising of forty three varieties was evaluated for the level of the panicle malformation disease intensity. The intensity varied significantly among the genotypes. Out tested varieties four were tolerant, 27 were moderately tolerant, five were moderately susceptible while seven were recorded highly susceptible to malformation. Disease incidence frequency was highest in 'Lab-e-Mashooq' (68.70 %) followed by 'G.M. Wala' (64.28 %) and lowest in 'Sensation' (7.20%) and 'Gulab Khas' (7.8 %). The lowest affected varieties may be used for incorporating their tolerance in the other commercial varieties through breeding program. The incidence rate was higher (38.69%) in six commercial varieties under Central Punjab ecological conditions than that of (26.70%) in the Southern (Multan) region. However, the tolerance in genotypes seems specific to ecological regions and the growers of the highly susceptible varieties should be very careful and regular in carrying the control measures
Keywords: Germplasm, mango crop, *Mangifera indica*, malformation

INTRODUCTION

Mango (*Mangifera indica* L.*),* the King of fruits, has a premier status among the commercial fruits grown in Pakistan. The crop is of increasing significance because of great demand in international market and worldwide expansion of mango production up to 27.9 million (MT) of fruit during 2005 (Anon. 2006). Unfortunately, this crop suffers regularly a colossal loss due to malformation. Malformation is of two types: vegetative and floral. Normally, floral malformation is more prevalent in bearing trees than vegetative malformation. Flowers in a malformed panicle are much enlarged and crowded with hypertrophied axes of the panicle. Generally, malformed inflorescences produce no fruit, or abort at early stages (Schlosser, 1971) and is directly responsible for reduction in yield (Singh *et al.,* 1998). Various entomological (Narasimhan, 1954), pathological (Summanwar *et al.,* 1966, Charkrabarti and Ghosal, 1989), physiological (Ram and Bist, 1984; Singh *et al.,* 1998; Singh, 2006) and biochemical (Singh and Dhillon, 1993; Singh, 2006) factors have been demonstrated to be the causes of this malady. The fungus *Fusarium moniliforme var.* Subglutinans was isolated from malformed parts of the mango and its pathogenicity was also unequivocally proved (Freeman 1999; Zheng and Ploetz, 2002). Recently, these isolates were described as members of a new species, *F. mangiferae* Britz, Wingfield and Marasas sp nov. (Britz *et al.,* 2002). The fungal mycelial infection was observed through electron microscopy at the base of the malformed bud, during bud inception stages (Usha *et al.,* 1997) but its etiology and control are not still very clear. Further, it is well known that floral malformation is the most serious disease, rendering mango cultivation non-lucrative in subcontinent and other regions of the world (Ram, 1991; Ahmad *et al.,* 2002; Ploetz, 2001).

Incidence of malformation is high in many indigenous and some exotic accessions under various ecological conditions. Mango breeders have directed their research efforts to developing hybrids; rendering more yields of high quality and possessing resistant to diseases including malformation. Unfortunately, presently there is no detailed information in the country, for ranking of mango varieties for tolerance to floral malformation. The information generated from this study is useful to provide bases for designing combinations among various varieties and strategies leading to evolution of mango strains tolerant to this malady.

MATERIALS AND METHODS

The Bearing plants (12-15 years old) of 43 diverse varieties (both indigenous and exotic) namely Maya, Kensington Pride, Tomy Atkin, Neelum, Zaafran, Burma Surkha, B. M. Syed, Almas, Intikhab, Langra, Anmol, Alphanso, Gulab Khas, Bara Mashi, Dusehri, Haider Shah Wala, Swarnareka, Zil, Mome-k, Kiett, Malda, Bangan Pali, Yakta, Collector, Chaunsa

Rampuri, Sindhri, Ghafoorywala, Black Chaunsa, Malda late, Sanglakhi, Sobe Wali Ting, Pohi Lot, Totapari, Lab-e-Mashooq, G.M. Wala, Shah Pasand, Zard Aloo, Fajri, Spring Phills, Anwar Retaul, Sensation and Sammar Bahisht were selected for the study. The soil was sandy loam, lightly compact, with 0.5% organic matter and pH around 8.00. The trees spaced at 12 m between rows and plants were 5 to 8 m high depending upon the genotype. There were three general fungicide+insecticide sprays/year (first prior to blooming, second post fruit setting and third after fruit harvesting) for plant protection but no pruning of malformed panicles was practiced in the progeny orchard during, prior year and study period to allow sufficient amount of inoculum's under natural conditions. Six varieties were studied at Horticulture Research Institute, Faisalabad in central Punjab ecological zone, maintained under similar cultural operations.

A Sampler Frame of size (2m×1m) was used on the four sides (North, West, South and East) on the middle height of the canopy of a tree. The total number healthy and malformed panicles in the frame were counted and averaged. For each of the cultivars, four replicates were maintained. Data for the two years were pooled and analyzed using a completely randomized design.

RESULTS AND DISCUSSION

There are about 1500 varieties of mango (*Mangifera indica* L*.)* in the world, of which about 300 are found in Pakistan. However, only a dozen varieties are grown commercially around the world. The Mango Research Station (MRS), Shujabad, maintains 73 mango accessions collected from different parts of the world. Our goal in this research was to quantify and examine the level of susceptibility of mango varieties to malformation. The intensity of mango malformation in different varieties of mango is presented in Table 1. All the genotypes clearly differed in intensities of malformation and have been ranked. It was noted that there was highest malformation frequency in Lab-e-Mashooq (68.70%), a local selection from chance seedlings, which produced medium compact type of inflorescence with reddish color. The cultivar Lab-e-Mashooq thus proved to be the most susceptible cultivar for mango malformation among all varieties. The incidence of malformation was also high in G.M. Wala (64.28%) another local selection, which also produced medium compact inflorescence.

Almas, Haider Shah Wala, Swarnareka, Collector (exotic introduction) and Mai Wala were found to be moderately susceptible cultivars, which showed medium level of malformation i.e. 42.08, 43.20, 31.53, 31.18 and 34.00%, respectively. All the cultivars produced lightly compact inflorescence.

Twenty seven varieties including Tomy Atkin, Neelum, Zaafran, Burma Surkha, Badia Mona Syed, Intikhab, Langra, Anmol, Bara Mashi, Dusehri, Kiet, Yakta, Chaunsa Rampuri, Sindhri, Ghafoorywala, Malda late, Sanlakhi, Sobe Wali Ting, Pohilot, Totapari, Shahpasand, Zardaloo and Sprigphills, Dusehri were found moderately tolerant. The average intensity of malformed inflorescences in the case of above varieties falls between 11 to 30%.

The malformation susceptibility was lowest in Sensation (7.2%) (imported from Florida) and Gulab Khas (7.80%) (a local selection from Chance seedlings) that bears compact inflorescence. Cultivars Sensation and Gulab Khas were at par to Maya and Kensington Pride cultivars, which having a lower level of malformation incidence i.e. 9.5%, and 9.8%, respectively. These cultivars were found to be the least affected by mango malformation in Southern Punjab, the famous region for high quality mango production. However, the Kensington pride and Maya never depicted good performance in terms of fruit yield under ecological conditions there. Moreover intensity of malformation in Maya at Horticulture Research Institute, Faisalabad was 50% (unpublished data) while Kensington pride possesses ability of polyembyony and can prove a good source of uniform rootstocks but its contributory response towards malformation tolerance as a rootstock, needs further investigations. Sensation variety, exhibiting consistently tolerance in southern region became medium tolerant against malformation (Ahmad *et al.,* 2002) in different ecological conditions, it is attributed to late emergence of inflorescences. In addition, to the other qualities of regular yielder, low fruit drop due to strong contact of stem end to fruit and short stature, may be kept at priority in hybridization with other important commercial cultivars. All other cultivars fall into the category of moderately tolerant cultivars for the attack of mango malformation, need to be managed for disease control. Floral malformation of mango is common in Punjab gives malformed panicles with mostly male flowers, resulting in reduced crops and this disorder has a high incidence on scarred shoots and is more prevalent in certain cultivars like Chaunsa and Lab-e-Mashooq (Majumder and Diware, 1989).

Table.1. Intensity of mango malformation in different varieties of mango grown at Mango Research Station, Shujabad (MRS), Multan Region

Name of variety	Ist Year %	IInd Year %	Average %	Type of Inflorescence	Ranking[a]
Maya	9.35	9.65	9.5 k	Compact	T
Kensingtan Pride	10.00	9.60	9.8k	Slightly loose	T
Tomy Atkin	11.08	11.24	11.16k	Heavy compact, red in colour	MT
Neelum	24.53	25.13	24.83h	Semi loose	MT
Zaafran	20.52	20.72	20.62i	Medium compact	MT
Burma Surkha	25.36	25.96	25.66h	Medium compact	MT
Badia Mona Syed	25.30	24.90	25.05h	Medium compact	MT
Almas	42.58	41.58	42.08e	Medium compact	MS
Intikhab	26.34	25.74	26.04h	Medium compact	MT
Anmol	28.00	28.52	28.26h	Semi compact	MT
Alphanso	53.06	54.46	53.76c	Medium compact	S
Gulab Khas	8.10	7.50	7.80 *l*	Compact	T
Bara Mashi	20.00	20.62	20.31i	Medium compact	MT
Haider Shah wala	43.60	42.80	43.20e	Medium compact	MS
Swarnareka	31.83	31.23	31.53g	Mix and light compact	MS
Zil	54.13	52.33	53.33c	Medium compact	S
Mome-k	54.86	54.10	54.48c	Medium compact	S
Kiett	28.20	26.42	26.31h	Medium compact	MT
Bangan Pali	19.03	19.73	19.38i	compact	MT
Yakta	30.19	28.99	29.59g	Compact, reddish	MT
Collector	31.48	30.88	31.18g	Medium compact	MS
Chaunsa Rampri	15.93	16.43	16.18j	Medium compact	MT
Sindhri	21.53	20.93	21.23i	Medium compact	MT
Ghafoory Wala	19.35	19.95	19.65i	Medium compact	MT
Black Chaunsa	49.48	51.08	50.28d	Medium compact	S
Malda late	28.40	27.40	27.90h	Medium compact	MT
Sanglakhi	25.07	24.27	24.67ih	Compact	MT
Sabe Wali Ting	13.07	13.57	13.32jk	Compact	MT
Pohi Lot	17.05	16.45	16.75j	Medium compact	MT
Totapari	19.50	20.30	19.90i	Compact, reddish	MT
Lab-e-Mashooq	69.6	67.8	68.70a	Compact, reddish	S
G.M. Wala	63.48	65.08	64.28b	Medium compact	S
Mai Wala	34.50	33.50	34.00f	Medium compact	MS
Shah Pasand	16.00	16.60	16.30*	Large size, compact	MT
Zard Aloo	24.14	23.54	23.84hi	Medium compact	MT
Fajri	34.40	35.60	35.00f	Light compact, mixed	MS
Spring Phills	25.58	25.08	25.33*	Medium compact	MT
Anwar Retaul	20.03	19.33	19.68i	Medium compact	MS
Sensation	7.35	7.05	7.20*l*	Compact and large size	T
Chaunsa (Sammar Bahisht)	28.05	29.05	28.55h	Medium compact	MT
Langra	19.06	19.66	19.36 i	Loose and open	MT
Malda	56.01	54.79	55.21c	Semi compact	S
Dusehri	30.83	29.73	30.23g	Medium compact	MT
Average of the means of intensities in six varieties:			26.70%		

Intensity of mango malformation in six different varieties of mango grown at Horticulture Research Institute (HRI), Faisalabad (Central Punjab Region)

Anwar Retaul	55.73	56.63	56.18c	Medium compact	S
Sensation	15.20	16.51	15.85j	Compact and large size	MT
Chaunsa (Sammar Bahisht)	44.50	44.05	44.27e	Medium compact	MS
Langra	35.25	34.48	34.86fg	Loose and open	MS
Malda	44.55	43.05	43.80e	Medium compact	MS
Dusehri	37.83	36.73	37.28f	Medium compact	MS
Average of the means: 26.70%38.69%					

Different letters with the means denote significant difference at P=0.05; separated according to Duncan's Multiple Range Test**.**
[a]**Criteria for ranking: Intensity:** (i) 0-10% (T), (ii) 11-30% (MT), (iii) 31-50% (MS), (iv) > 50% (S)

This variation in the disease intensity among varieties having the lowest, medium and the highest levels might be attributable to the interaction of the host genotype to the pathogen. The malformation incidence is influenced by several factors like tree growth habit (time of flushing), physiology, rate of transpiration and cellular structure. A large body of literature provides circumstantial evidences on physiological aspects of the mango crop cultivars in relation to incidence of malformation. It was reported that early-emerging flower buds were severely infected; where as later buds escaped the disease; this difference was empirically attributed to the relatively high temperature during panicle development (Kumar *et al.* 1993). In India, the disease is present in all mango-producing areas (Verma et al., 1971), with a lower incidence in the southern and eastern than in the northern region. Temperatures in those regions are warmer than in the north cold conditions precede flowering. Similarly, incidence of mango malformation in central Punjab-Pakistan was comparatively higher (38.69%) in six commercial cultivars (Ahmad *et al.,* 2002) (Table I) than that of in the southern parts (26.70%) as detected in the present study. The varieties like Anwar Retaul, Chaunsa, Langra and Dusehri which were moderatetly tolerant with less intensity than 30 % at MRS (Multan); showed moderately susceptible with more than 30% level of disease incidence under ecological conditions of Central Punjab (Faisalabad) see (Table 1). Khan and Khan (1960) revealed to the trend found in the present investigations. Singh *et al.* (1998) also stated that the occurrence of floral malformation can be minimized by elevating the temperature of the orchard during flower genesis

Besides this, a natural defensive metabolite against mango malformation i.e. Mangiferin is also reported in some cultivars, which reduces the incidence of malformation (Chakrabarti *et al*., 1997). Higher rate of transpiration in susceptible cultivars with a concomitant increase in relative humidity and increased moisture holding capacity by malformed tissues were demonstrated (Pal *et al.,* 1983). Higher rate of transpiration that was recorded in susceptible cultivar (Singh 2006, Dashhan, 1987) may be due to presence of higher number of stomata as has been reported in other crop (Zeiger, 1983). Lower leaf temperature and higher relative humidity in susceptible cultivars were also obtained by Varma *et al.*, 1971) where it was monitored that the fungus *F. mangiferae (pv. moniliforme var. subglutinans)*, the casual organism of mango malformation, grows well at lower temperature and higher relative humidity. It seems the varieties investigated in present work with variable genetic make up differ in physiological aspects and it will be highly valuable to investigate the germplasm available according to aforesaid factors.

Furthermore, it is interesting to be mentioned here, in some instances, the trees of the same variety growing at the same location differed significantly among themselves for the incidence of mango malformation (data not shown). This might be due to the fact that the disease causes systemic infection and appear in sporadic form. The availability of more sugar contents in Alphonso, Malda and Black Chaunsa (more sweet varieties) might be favorable for proliferation of pathogen (*Fusarium mangiferae pv subglutinans*) and thus make it more susceptible for the attack of mango malformation. The results of this study are in line with the findings of Ram *et al*. (1990) and Sharma and Badiyala (1990) that Chaunsa, Dusehri and Langra revealed a high percentage of malformed panicles. Furthermore, Om *et al.* (1987) recorded that the majority of mango cultivars were susceptible and were not tolerant to mango malformation. A strong positive correlation was found between the incidence of floral malformation and both, enzyme activity and phenolic contents and thus polyphenole oxidase (PPO) activity can be used as a biochemical index for screening mango germplasm against malformation (Sharma *et. al.,* 2001). A mango variety Elaichi in India, possessing high activity of PPO and higher level of mangiferin was found field tolerant to mango malformation (Misra *et al.,* 2000; Singh, 2006) such genotypes can prove a

good promise for acquiring tolerance against the malady. The shape and structure of the panicles differed markedly among the varieties depending upon the cellular structure and physiology under environmental factors (Chakrabarti *et al.,* 1990). Similarly malformed inflorescences of different varieties were variable in respect of their shapes, sizes, growth and compactness. In case of Langra variety malformed inflorescences (Figure 1) continue their growth and attained specific shape that can be recognized from a distant place. In the same way, Tomy Atkin possessed typically compact panicles. In case of Sensation malformed inflorescence has branch-lets (Figure 2).

Fig.1. Malformed panicle of mango cv. Langra

These results indicate mango accessions for tolerant to panicle malformation under Southern and Central Punjab ecological conditions. Further studies are needed for the inheritance of malformation tolerance to facilitate its use as a character in selecting parental stock or these may be marked through DNA analysis techniques. Based on the results of evaluation of mango varieties for panicle malformation, the 43 mango cultivars tested can be classified into four groups, viz. tolerant to panicle malformation: Sensation, Gulab Khas, Maya and Kensington Pride (rank T), moderately tolerant: 25 varieties (rank MT), moderately susceptible: Almas, Haider Shah Wala, Swaranreka, Collector Mai Wala, Fajri and Anwar Rataul (rank MS) and the susceptible varieties: Alphanso, Zil, Mome-K, Black Chaunsa, Lab-e-Mashooq, G.M. Wala and Malda (rank S).

Fig. 2. Malformed panicle of sensation

Keeping in view the results of present study, it can be derived that if some tolerant cultivars like Sensation and Gulab Khas are used in breeding program and crossed with the main commercial cultivars having low/medium tolerance like Dusehri, Langra and Chaunsa and/or other commercial cultivars, it may result in production of moderately tolerant or tolerant cultivars. The growers of the highly susceptible varieties should be very careful and regular in carrying out the control measures. Lastly, epidemiological studies on the malformation are required in the ecological regions. The changes in the host susceptibility to infection between production cycles due to environmental and physiologic conditions of the host may be important and its incorporation into an epidemic model may be needed in future investigations. However, none of the genotypes in 43 accessions was found completely resistant to the disease or free from the pathogen attack, source of resistance may be sought in other species of *Mangifera* for introgression to the existing germplasm through biotechnological tools.

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