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EFFECT OF THE REMOVAL OF MALFORMED PANICLES ON VEGETATIVE AND REPRODUCTIVE GROWTH OF MANGO (*Mangifera indica* L.)

Faqir Muhammad Tahir, Muhammad Azam*, Raheel Anwar and Muhammad Aslam Pervez
Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan
*Email: azam32jb@yahoo.com

Abstract

The present studies were conducted to observe the response of mango towards its vegetative and reproductive characteristics as well as the future intensity of malformation as a result of removal of affected panicles at different times and from different places. Early season flushes showed less effect of malformation and its intensity increased in the flushes of later months. Previous year's malformation was found to affect the branch in the next blooming season and 47-94% malformed inflorescence were observed on the last year malformed branches. Pruning from the base of the affected panicle and late in the season showed no positive result to improve vegetative or reproductive characteristics and to reduce bunchy top and floral malformation. When the malformed panicles were removed 4 to 6 inches away from the base and at the time of their emergence, healthy vegetative flushes sprouted early in the season, which in turn helped to give healthy panicles, more fruit setting and less fruit drop in the coming blooming season.

Key words: Mango, malformed panicles, carryover effect, vegetative and reproductive growth

INTRODUCTION

Mango (*Mangifera indica* L.) is an important fruit plant grown in all tropical and sub-tropical countries of the world. It is grown in all the continents except Europe. It is the second most important fruit crop of Pakistan and is grown over an area of 151,500 thousand hectares giving annual production of 1.72 million tonnes. Its nutritional and dietetic values are well known. Due to its excellent taste and flavour, Pakistani mangoes are best for quality and are liked much by many people in most of its importing countries.

Soil and climatic conditions of Pakistan are much suitable for producing good yield of superior quality mangoes but average yield (9 tonnes/ha) is much less than other advanced mango growing countries. This is a matter of great concern for the growers as well as for the scientist. Although mango has been grown in this region since long, yet some generations old intricate problems are still a great limitation in its successful cultivation due to which its yield cannot be improved. Malformation is the most serious problem causing heavy losses to the growers. It is one of the most serious maladies which has been described both for the vegetative and reproductive

shoots (Singh and Dhillion, 1993). Due to enigmatic blooming and growth behavior of mango, malformation is least understood (Chacko, 1991). Its intensity has been reported to vary from region to region and with cultivar (Verma et al., 1969; Singh et al., 1991).The shoots destined to bear normal inflorescences show greater initial growth, leaf area and produce 45.5% of perfect flowers in contrast to 4.52% on the shoots which bear malformed inflorescences in the following season and make less initial growth (Khan and Khan, 1962). It has been reported that trees subjected to shoot excision for the bud wood responses produces a high percentage of malformed panicles which, although hypothetically, has been attributed to ethylene release from the damaged shoots (Khader et al., 1986).

This paper describes some physiological aspects of mango malformation which are expected to help in devising strategies for solving this problem.

MATERIALS AND METHOD

These research studies were conducted in Experimental Fruit Orchard (Square 9), Institute of Horticulture Sciences, University of Agriculture, Faisalabad during 2004-2006. Ten healthy mango trees cv. Langra aging 12-15 years were selected for studies. New flushes during April to September were tagged month wise on the experimental trees. At the blooming, the tagged flushes were observed for occurrence of malformation and their carry over effect during the subsequent year. Malformed panicles were pruned from various distances staring from the base of panicle up to 6 inches away from this point. There were four treatments replicated four times in which malformed panicles were removed and in control affected panicles were allowed to remain intact to make comparison between control and treatments. The pruning was completed up to 15th April. As a result of pruning, the flushes emerged from these sites were compared with control for their various vegetative and reproductive characteristics. The experiment was comprised of following treatments.

T_0: Control
T_1: Removing of the malformed panicles at the base
T_2: Removing of the malformed panicles at 2" beyond the base
T_3: Removing of the malformed panicles at 4" beyond the base
T_4: Removing of the malformed panicles at 6" beyond the base

Maximum care was observed to reduce the infection of fungus through pruning scissor by sterilizing it after every cutting. Data were collected on the following parameters.

1st year (Vegetative growth)

1. Initiation of flushes (days)
2. Number of flushes
3. Length of flushes (cm)
4. Number of leaves
5. Size of leaves (cm^2)
6. Bunchy top (%) (on the basis of total number of flushes/month)

2nd year (Reproductive Growth)

1. Time of panicle emergence (days)
2. Number of panicles
3. Healthy and malformed panicles (%)
4. Sex ratio
5. Fruit set (%)
6. Fruit drop (%)

RESULTS AND DISCUSSION

Effect on Vegetative Growth Characteristics

After statistical analysis of the data significant results were obtained for various vegetative characteristics as in clear from the Table 1. The initiation of the new flushes took maximum time (83.02 days) from control. The minimum time for the initiation of the vegetative growth was noted when pruning was done at the base or 2 inches behind the base taking 67.14 and 65.67 days, respectively. Although with increase in the distance from the base of the malformed panicle for pruning, the number of days taken to initiate vegetative growth was increased (72.02 and 73.68 days), however, the number and length of flushes (13 and 23.4, respectively) and number and size od leaves was found significantly higher in these treatments (T_3 and T_4). Further, the percentage of bunchy top was also significantly reduced (45-47%) on treatments (T_3 and T_4) compared to control (84%) (Table 1).

And no statistical difference could be located among these two treatments. When the pruning length was increased to 4 and 6 inches, vegetative growth initiated a bit later i.e., after 72.02 and 73.68 days, respectively and both of treatments showed similar results statistically.

Variable number of flushes from various sites was observed as a result of different pruning lengths. Minimum number of flushes (4.75) was observed in control where no pruning was done and malformed panicles were allowed to remain intact, although it was found similar to T_1 where affected panicles were pruned at the base by producing 7.25 flushes and no statistical difference could be located among them. Maximum number of flushes (13) were observed in T_4 where pruning was done at a distance of 6 inches from the base of the panicle although this treatment was found similar to T_2 and T_3 in which affected panicles were removed at a distance of 2 and 4 inches from the base of the panicles with the production of 12.75 and 12.25 panicles, respectively having no statistical difference among them.

As a result of pruning from variable distances, the emerging flushes from these sites showed variable lengths. Maximum flush length (23.24 cm) was observed in T_4 where pruning was done at a distance of 6 inches from the base of panicle.

Table 1: Effect of the removal of malformed panicles on vegetative growth characteristics in mango (*Mangifera indica* L.)

Treatments	Initiation of flushes (days)	Number of flushes	Length of flushes (cm)	Number of leaves	Size of leaves (cm^2)	Bunchy top (%)
T_0	83.02a	4.75b	6.03b	5.55c	47.60d	83.99a
T_1	67.14c	7.25b	6.28b	6.88b	51.29c	81.15a
T_2	65.67c	12.75a	9.08b	7.09b	63.31c	68.35b
T_3	72.02b	12.25a	15.06ab	10.33a	72.01a	47.64c
T_4	73.68b	13a	23.24a	9.84a	75.42a	45.82c

Effect on Reproductive Characteristics

Statistical analysis of data showed significant results for various reproductive characteristics as in clear from the Table 2. Control showed similar results 6.03 cm flush length as those of T_1 and T_2 where pruning was done at the base or 2 inches behind the base by producing 6.28 and 9.08 cm flush length, respectively. When the malformed panicles were removed at distance of 4 inches from the base (T_3), it joined hands with T_4 on one side and with other treatments on the other side and flush length was observed as 15.06 cm.

When the malformed panicles were pruned, the size of the leaf on the new flushes was found variable for various pruning distances. In case of control much stunted leaves (47.60 cm^2) were observed. When the malformed panicles were pruned from the base poor sized leaves i.e., 51.29 cm2 were produced. By increasing the pruning distance up to 2 inches, leaf size was 63.31

cm^2. When the malformed panicles were pruned at a distance of 4 and 6 inches behind the base of the panicle an increased leaf size was observed i.e., 72.01 and 75.42 cm^2, respectively. Although both of these treatments were found similar and no statistical difference could be located among them.

As a result of removal of malformed panicles, new emerging flushes produced variable number of leaves. Maximum numbers of leaves (10.33) were observed when pruning was done at a distance of 4 inches behind the base of panicle. Next best treatment was T_4 where pruning distance was 6 inches behind the affected panicles where (10.33) leaves were observed, although both of treatments could not be differentiated statistically. In case of control minimum numbers of leaves (5.55) were produced. T_1 and T_2 where malformed panicles were pruned at base or 2 inches behind the base, similar result were obtained by producing 6.88 and 7.9 leaves, respectively and no statistical difference could be located among them.

Percentage of bunchy top was also found affected due to removal of malformed panicles and variable results were observed. When the malformed panicles were allowed to remain intact or removed from the base, maximum percentage of bunchy top was noted with 83.99 and 81.15% bunchy top, respectively and no statistical difference could be located among them.

The least percentage of bunchy top was found when pruning length was increased up to 4 or 6 inches behind the base of the affected panicle in which 47.64 and 48.82% bunchy top was noted with no statistical difference. Intermediate results were observed when the pruning was done behind 2 inches from the base of the panicle having 68.35% bunchy top.

During first year of study, malformed panicles were removed. New flushes emerged from these sites during the same year and bloomed in the next blooming season. At the start of blooming, data were collected on various reproductive characteristics. Table 2 depicts significant results for various reproductive characteristic in response to removal of malformed panicles from different lengths.

In case of the control where affected panicles were allowed to remain intact, the new panicles emerged too late and took maximum time (218.12 days) for their initiation. Similarly when pruning was done from the base of the panicle (T_1) 218.68 days were taken for the initiation of new panicles and no statistical difference could be located between control and T_1. When the pruning length was increased to level of 2, 4 or 6 inches behind the panicle, an earlier initiation of panicles was observed by taking 212.45, 211.57 and 209.69 days respectively. All of these three treatments behaved similarly and no statistical difference could be located among them.

As a result of removal of malformed panicles, the number of new panicles was also found in a variable range. Maximum number of panicles (34.25) was observed when the pruning was done at 6 inches (T_4) behind the base of the panicle. This was followed by T_3 where the malformed panicles were removed 4 inches behind the base by producing 33.25 panicles, although both of these treatments showed no difference statistically. Next position was occupied by T_2 having 2 inches pruning distances behind the base and pruning at the base (T_1) with the production of 26.75 and 17.25 panicles, respectively. Control, where affected panicles were allowed to remain intact produced minimum number (13.25) of panicles.

Due to variable pruning distances behind the base, the percentage of healthy and malformed panicles was also found variable. Maximum malformation (70.77%) was noted in control where no pruning was done and affected panicles were allowed to remain intact. Similar results were obtained when pruning was done at the base of panicles with 68.23% malformed panicles having no statistical difference with control. In T_2 where pruning was done at the distance of 2 inches behind the base, showed 63.8% malformed panicles. Next two treatments (T_3, T_4) in which the pruning distance was 4 and 6 inches behind the base of the affected panicle showed decreased percentage of malformed panicles having 49.89% and 52.46%. Both of these treatments showed similar results statistically.

Table 2: Effect of the removal of malformed panicles on reproductive characteristics in mango (*Mangifera indici*a L.)

Treatments	Panicle emergence (days)	Total number of panicles	Healthy and malformed panicles (%)		Sex ratio (ratio of male and hermaphrodite flowers)	Fruit set (%)	Fruit drop (%)
T_0	218.12a	13.25d	29.22c	70.77a	36.31d	9.95d	98.25a
T_1	218.68a	17.25c	31.77c	68.23a	48.12c	17.75c	95.31b
T_2	209.69c	26.75b	36.7bc	63.8b	45.68b	19.68c	90.62c
T_3	212.45b	33.25a	43.35ab	49.89c	66.39a	27.56b	85d
T_4	211.57c	34.25a	47.54a	44.22c	66.12a	31.45a	87.06d

The production of the healthy panicles showed a reverse pattern as against malformed panicles due to variable lengths of removal of malformed panicles. T_4 where malformed panicles were removed 6 inches behind the base, maximum healthy panicles (47.57%) were observed. This was followed by the treatment where pruning distance was 4 inches in which 43.35% healthy panicles were noted. Remaining two treatments and control showed similar results statistically showing a slight difference in the percentage of healthy panicles by decreasing pruning distance having 36.7, 31.77 and 29.22% healthy panicles for T_2, T_1 and control, respectively.

For the sex ratio male and hermaphrodite flowers were counted separately and it was calculated on the basis of hermaphrodite flowers. Maximum number of perfect flowers was observed in last two treatments (T_3 and T_4) where malformed panicles were removed 4 and 6 inches behind the base of the panicle having 66.39% and 66.12% perfect flowers, respectively. Both of these treatments behaved similarly and could not be differentiated statistically. Next best treatment was T_2 in which length of the pruning wood was 2 inches behind the base by producing 54.68% perfect flowers. When the pruning was done at the base of the affected panicles, it produced only 48.12% flowers. Lowest percentage of the perfect flowers (36.31%) was observed in the panicles where no pruning was done and affected panicles were allowed to remain intact.

Fruit set was also found affected as a result of removal of malformed panicles. Maximum fruit set (31.45%) was observed in T_4 where pruning was done 6 inches behind the base of the panicles. This was followed by T_3 having length of the pruning wood 4 inches with 27.56% fruit set. Next two treatments where affected panicles were removed at a distance of 2 inches behind the base or from the base (T_2 and T_1) showed the similar results and no statistical difference could be located among them having 19.68 and 17.75% fruit set, respectively control showed lowest fruit set (9.95%).

In case of the data regarding fruit drop, a reverse pattern was observed as against fruit set (%) due to the removal of the malformed panicles. Maximum fruit drop (98.25%) was recorded in the control where no pruning was done and affected panicles were allowed to remain intact. This was followed by T_1 where pruning was done at the base having 95.31% fruit drop. When the length of the pruning was increased up to 2 inches behind the affected panicles, fruit drop was found decreased up to 90.62%. Last two treatments (T_3 and T_4) where pruning was done at 4 and 6 inches behind the panicle least fruit drop was observed with 85 and 87.06% fruit drop. Both of these treatments showed similar results statistically.

CONCLUSION

It has been observed that if malformed panicles were not removed, the incidence of bunchy top or floral malformation was much enhanced due to carry over effect of the malformation as proved by our results. Future incidence of malformation was reduced by increasing the distance of site of pruning from the malformed panicles and early pruning. It shows that the spores of the fungus causing malformation may be present in the branches adjacent to the affected panicles and this problem can be controlled properly if at the time of pruning some part of the branch should be removed along with the malformed panicles rather than pruning of these panicles from base as it has been practiced by most of the farmers. The reoccurrence of malformation increases rapidly and linearly during the following year with the direct proportion to the distance and time of pruning from the panicles. The removal of malformed panicles, besides affecting the floral malformation in the following year also affected the induction of vegetative growth during the same year. Removal of the malformed panicles at a larger distance and early in the season was also found helpful to initiate more vegetative growth early in the season thus maximum normal panicles were observed on such terminals during next blooming.

Our results are confirmed by the previous findings (Singh et al., 1974; Dhillon, 1988) who are of similar opinion, like wise, cutting of the terminal buds during or just before flowering resulted in an increase in the auxiliary flower bud induction and decrease in the incidence of malformation (Sesa, 1989). Similarly, Tripathi (1954) found that the malformation of inflorescence and vegetative shoot of mango (bunchy top) were highly correlated with each other.

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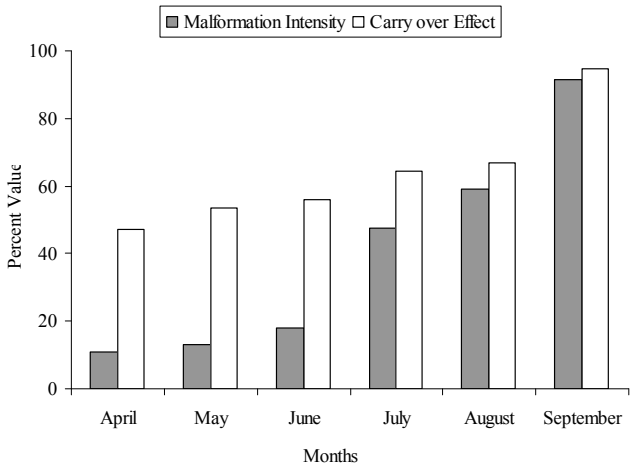

Figure 1: Intensity of malformation and its carry over effect in various flushes

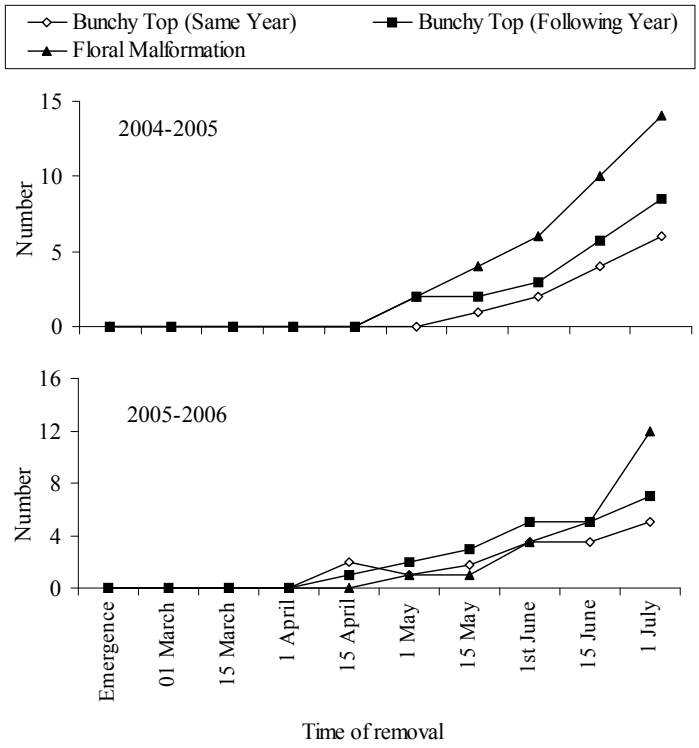

Figure 2: Malformation as affected by the time of removal of panicles

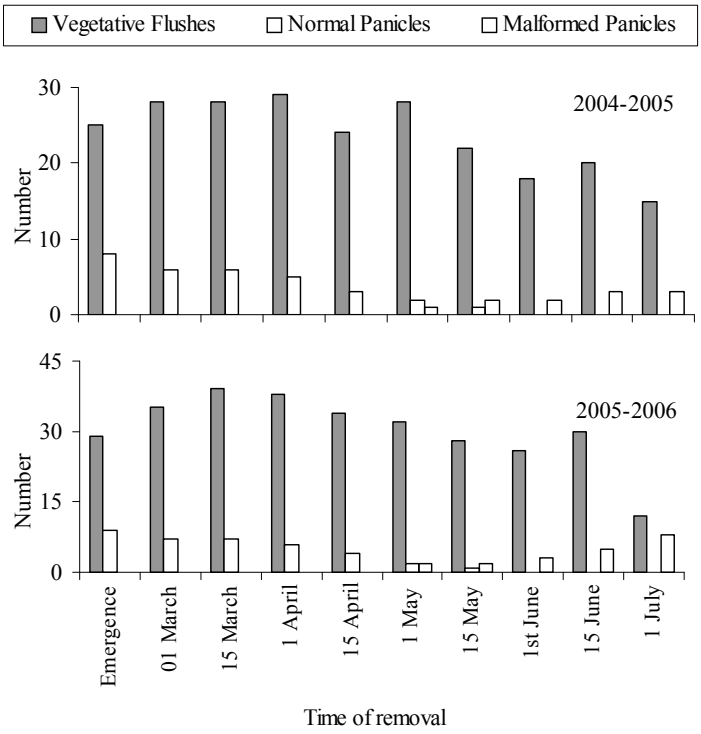

Figure 3: Effect of time of removal of malformed panicles on vegetative and reproductive growth