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FLUSHING PATTERN OF MANGO (*Mangifera indica* L.) CULTIVARS IN RESPONSE TO PRUNING OF PANICLES AND ITS EFFECT ON CARRY OVER EFFECT OF FLORAL MALFORMATION

Muhammad Nafees[1]*, Raheel Anwar[2], Moazzam Jameel[1], Muhammad Naveed Aslam[1], Saeed Ahmad[2], Fakhar U Zaman Akhtar[1] and Noor-un-Nisa Memon[3]
[1]College of Agriculture and Environmental Sciences, The Islamia University, Bahawalpur, Pakistan
[2]Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan
[3]Sindh Agriculture University, Tandojam, Sindh, Pakistan
*Corresponding author's email: nafeescaes@gmail.com

The present study was conducted at Experimental Fruit Orchard (Square 9), Institute of Horticultural Sciences, University of Agriculture Faisalabad, Pakistan. Cultivars selected for experiment were 15 years old trees of Anwar Ratool, Samar Bahisht (S.B) Chaunsa and Alphanso. All experimental trees received similar cultural practices for fertilizers, irrigation and plant protection during the investigation period. Malformed and fruit carrying panicles (healthy panicles) and barren panicles (whose fruit dropped after betting with a pencil) were pruned on April 01, 15 and May 01, 2002. Panicles pruned in these dates were tagged and allowed to stay intact to study their vegetative and reproductive growth behavior. Significant results were recorded regarding month wise emergence of flushes, flush size and number of leaves per flush in these varieties. Emergence of cease flushes, double and triple flushes on terminals of selected varieties was significantly different and the emergence of malformed panicles on these flushes was also significantly different in selected varieties. Emergence of ceased flushes was significantly higher in cultivar Anwar Ratool, followed by Chaunsa and Alphanso respectively. Number of double flushes was higher on Chaunsa followed by Alphanso and Anwar Ratool respectively. Alphanso produced highest number of triple flushes followed by Chaunsa and Anwar Ratool respectively. More number of malformed panicles emerged on triple flush shoots than on double and ceased flush shoots respectively. Malformed panicles were highest on triple followed by double and cease flush (respectively) in Chaunsa followed by Alphanso and Anwar Ratool respectively.
Keywords: Panicle pruning, flushing pattern, mango cultivars and carryover malformation

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most important tropical fruit crops of the world (Mukherjee, 1951) with more than 28 million tonnes of annual fruit production in the world (FAO, 2006). Moreover, mango fruit is increasingly becoming well established as an item of international trade.

Mango malformation is considered to be the most fatal disorders of mango trees which not only negatively effect plant health but reduces yield. Floral malformation reducing the yield directly because malformed panicles seldom produce fruit rather presents an ugly look as they persist long on the tree (Singh and Dhillon, 1993). Floral malformation is an intricate disorder directly linked with vegetative growth behavior of mango, annually causing about 37% losses (Khan and Khan 1960) which is reduced to 15% today and seriousness of malady vary from region to region and with the cultivar (Verma *et al*., 1971). It is widely reported in all most all mango growing countries of the world i.e. India, Egypt, South Africa, Brazil, Sudan, USA, Israil, Mexico, Bangladesh and Pakistan. In Pakistan there is no region and no commercial variety which may be called free from this disorder. The intensity of infestation is however, different in various commercial cultivars of mango (Kumar and Chakrabarti 1997).

The prevalence of this disorder since long and causing heavy yield losses has attracted many agencies and governments of various mango growing countries to find out the causes to control this enigmatic malady. A lot of useful work has been done on vegetative growth and malformation of inflorescence but the phenomenon is yet least understood due to much complicated growth systems in mango (Mishra *et al*., 2000).

Understanding physiology of floral malformation and its relationship with vegetative growth of mango tree is very important as vegetative growth and floral malformation of mango trees vary greatly depending upon variety (Singh, 1978). Scholefield *et al*. (2006) reported four vegetative growth flushes during each year and most inflorescences on older shoots in Kensington mango, commercial cultivar of Australia.

Several researchers attributed this disorder due to certain biotic and/or abiotic factor like viruses, mango hopper as vector, (Narasimhan, 1954), fungi *(Fusarium subglutanens*, *F. moniliform*) (Ram *et al.*, 1997), deficiency of certain micro elements (Tahir, 2000) and imbalanced synthesis of certain hormones (Singh & Dhillon, 1993). Infestation is more dominant and significant in the ignored and neglected orchards and a tree once infested maintains its level of infestation. Moreover, prolonged hanging of malformed panicles would delay the emergence of lateral shoots which increased malformation percentage (Muhammad *et al*., 1999) and pruning of young malformed panicles or shoots reduced infection of fungal mycelium (Tripathi and Ram, 1998).

This disorder is highly intricate in its manifestation. On different shoots of a single terminal, few buds produce healthy panicles, while others were malformed. Likewise, on the same panicle, one rachis contains healthy florets and others are malformed (personal observation). Such observation point toward complex physiology of malformation and indicates that there is some disorder in the internal system which either stops proper functioning or promotes abnormal functions at a certain site, as a result normal growth of the panicle is disrupted. Thus, it may be expected that the responsible factor might be localized in the infected site and immediate removal of malformed part would help to check further spread of malformation. So, keeping the plant in healthy condition and removal of malformed panicles may help to reduce disorder. Therefore, the present studies were designed to minimize the incident through pruning of malformed panicles for prompt emergence of healthy flushes which would yield healthy panicles during subsequent year.

MATERIAL AND METHODS

Reported research work was conducted in Experimental Fruit Orchard, (Square 9), Institute of Horticultural Sciences, University of Agriculture, Faisalabad during 2002-2004. Experimental material consisted of 15 years old, nine bearing mango trees of three cultivars named Anwar Ratool (T_1), S. B. Chaunsa (T_2) and Alphanso (T_3). All these trees exhibited natural occurrence of malformation and alternate bearing. During investigation, all experimental trees received similar cultural practices for nutrition, irrigation and plant protection.

As earlier reported by Muhammad *et al*. (1999) that prolonged hanging of panicles on shoots delayed the emergence of lateral flushes which further increased percentage of malformed panicles in forthcoming blooming season, so different type of panicles i.e. "malformed and healthy (fruit carrying) were pruned and tagged on April 01, 15 and May 01 to study their vegetative and reproductive growth behavior. To select another type of panicles at each date of pruning, panicles were lightly beaten with lead pencil, the penciles whose fruit dropped, were pruned and tagged as "barren panicles". Thirty panicles (ten of each type of panicles from each tree) were randomly selected, all around the tree from shoulder height in each term of pruning practice. Panicle selection and pruning method of Ibrahim and Ziaf (2003) was followed.

Emerging flushes (as a result of panicle pruning) on tagged shoots were classified on the basis of their growth habit i.e. April, May, June, July, August or September flushes. Tagged shoots which did not produced any further growth after its first flush, were categorized as "ceased flushes" and if there were two flushes second on the terminal of first and three flushes produced as third on the terminal of second and second on the terminal of first, tagged shoots, were named as "double and triple flushes", respectively. Each treatment was replicated three times.

Varietal response towards malformation of inflorescence was observed by recording shoot growth of pruned terminals, number of emerging flushes, flush size and number of leaves per flush at fortnightly intervals.

The experiment was arranged according to randomized complete block design (RCBD) with factorial arrangements. The experimental data was subjected to analysis of variance (ANOVA) using Genstat Release 8.2 (Lawes Agricultural trust, Rothmsted Experimental Station, UK). Within the analysis of variance, the effects of different treatments and their interaction were assessed. Least significant differences (Fisher's protected LSD) was calculated following significant F test (P=0.05). All assumptions of analysis were checked to ensure validity.

RESULTS AND DISCUSSION

Varietal response against month-wise emergence of vegetative growth (flushes)

There were significant differences between varieties regarding month wise emergence of flushes (Table 1). Emergence of flushes in different months and interaction of varieties and month of emergence was also significant. From Table 1 it was clear that highest number of flushes (3.87) sprouted on tagged shoots of cv. Alphanso which was statistically at par with cv. S.B. Chaunsa followed by Anwar Ratool (1.86 flushes). In month wise emergence of flushes, highest number of flushes (6.17) was recorded in June followed by May which was statistically similar to the emergence of flushes in April and July. Regardless to the variety, there was least number of flushes emerged in September, August and July, respectively. In interaction, maximum flushes (8.61) emerged on terminals of S.B.Chaunsa during June which was at par with Alphanso during the same month. There were zero emergences of flushes in Chaunsa during September followed by Anwar Ratool with 0.67 flushes during September as shown in Table 1.

Table 1. Varietal response against month-wise emergence of vegetative growth (flushes)

Month	Anwar Ratool	S.B. Chaunsa	Alphanso	Means
April	3.61 bcd	4.17 bc	1.22 ef	3.00 bc
May	2.39 cde	4.05 bc	3.67 bcd	3.37 b
June	2.28 cde	8.61 a	7.61 a	6.17 a
July	0.83 ef	1.83 def	5.17 b	2.60 bc
August	1.39 ef	0.33 ef	4.22 bc	1.98 c
September	0.67 ef	0.00 f	1.33 ef	0.67 d
Means	1.86 b	3.17 a	3.87 a	

Any two means not sharing a letter in common differ significantly at 5% level of significance

Diversity in flushing pattern of selected cultivars under same agro climatic conditions are in agreement with the findings of Majumdar *et al*. (1989), Singh & Chadha (1981), Chacko (1984, 1986) and (Singh, 1978) who reported that vegetative growth patterns of mango trees vary greatly depending upon variety. Different in intensity of flushing in selected cultivars might be due inbuilt potential which is proved to be different in different cultivars under same agro climatic conditions. Different in month wise emergence of flushes in mango cultivars might be due to difference in genetic make up in them.

Effect of pruning of different panicles on month wise emergence of flushes

Emergence of flushes in different months on malformed, healthy and barren panicle pruned terminals was statistically significant while means of flushes emergence these terminals did not significantly vary (Table 2). Highest number of flushes (6.17 flushes) were counted in June followed by May (3.37). There was no statistical difference in the emergence of lateral flushes on panicles pruned terminals during April, May and July as shown in Table 2. In interaction of type of panicle pruned and month wise emergence of flushes, significant number of flushes (7.27) emerged in June on terminals whose fruit barren panicles were pruned. This was at par with healthy panicle pruned terminals during the same month followed by malformed panicle pruned terminals with emergence of lateral flushes of 4.17 during June. Minimum number of flushes sprouted on barren panicle pruned terminals in April. Our results are in accordance with the findings of Willis and Marler (1993).

Ratio of flush length to leaf number

Significant difference in flush length to leaf ratio was recorded in selected mango cultivars as shown in Figure 1. The highest length of flush (6.87 cm) and number of leaves (7.76) was recorded on cultivar S.B. Chaunsa followed by Alphanso and Anwar Ratool with mean values of 5.86 cm and 5.18cm, respectively. Results further showed a positive correlation between flush lengths to leaf number. Trees of cultivar S.B. Chaunsa were proved more vigorous than rest of the varieties. Results are inline with the statement of (Chanana, 2005; Shrivastava *et al*., 1987) that flushes vigor and number of leaves is known to vary in different cultivars of mango.

Type of flush and its relation with carryover effect of malformation

There was significant difference between varieties regarding the emergence of “cease flushes”, “double flushes” and “triple flushes”. A large number of cease flushes (43%) was recorded in Anwar Ratool, followed by S.B. Chaunsa and Alphanso with 17.54% and 11.21% respectively (Figure 2). The highest percentage of double flushes (30.40%) was observed on S.B. Chaunsa followed by Alphanso and Anwar Ratool with 17.66% and 14.70% double flushes, respectively. Number of triple flushes was more (13.84%) in Alphanso followed by S.B. Chaunsa and Anwar Ratool with 2.63% and 2.45% respectively (Figure 2).

Table 2. Effect of pruning of different panicles on month wise emergence of flushes

Panicles pruned	Barren panicles	Malformed panicles	Healthy panicles	Means
April flushes	1.61 de	3.67 bc	3.72 bc	3.00 bc
May flushes	3.06 bcd	3.22 bcd	3.83 bc	3.37 b
June flushes	7.27 a	4.17 b	7.06 a	6.17 a
July flushes	2.94 bcd	1.33 de	3.56 bc	2.60 bc
August flushes	2.50 bcde	1.28 de	2.17 cde	1.98 c
September flushes	0.61 e	0.61 e	0.78 e	0.67 d
Means	3.0	2.38	3.52	

Any two means not sharing a letter in common differ significantly at 5% level of significance.

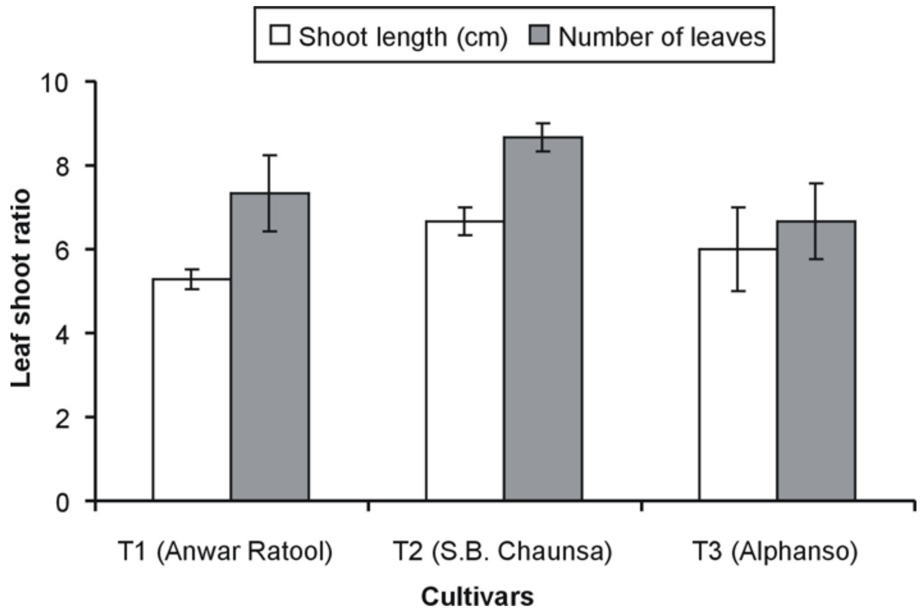

Fig. 1. Varietal response different mango cultivars to leaf flush ratio. Vertical bars represent mean (±S.E.) of three replications (P<0.05)

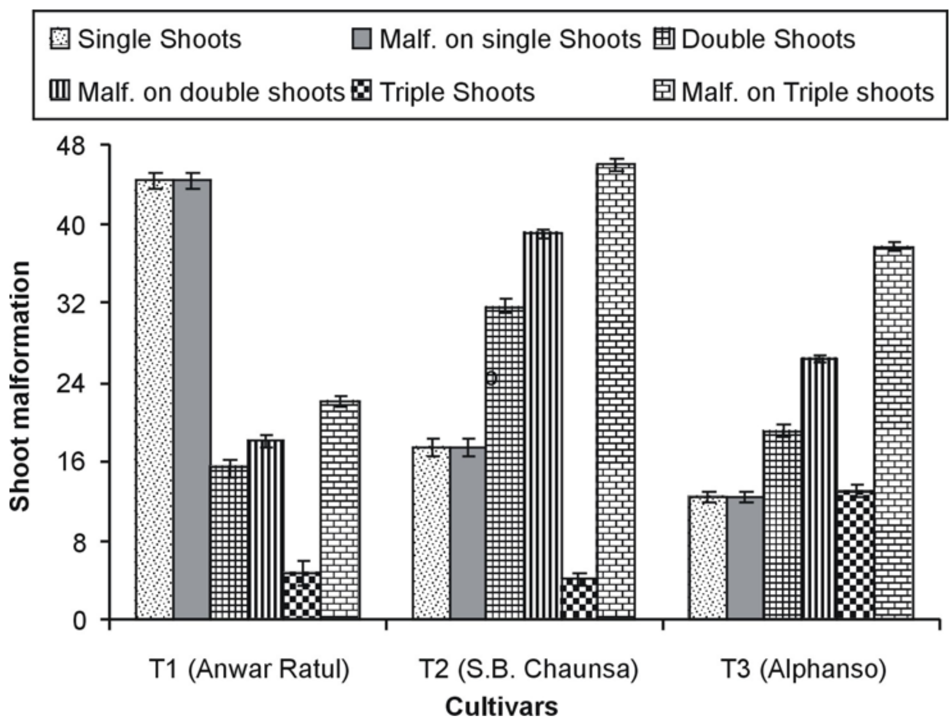

Figure 2. Varietal response of different mango cultivar to flushing and malformation of inflorescence. Vertical bars represent mean (±S.E.) of three replications (*P*<0.05)

From above results it is revealed that different cultivars of mango receiving same cultural practices vary significantly in their vegetative growth behavior. It might be due to reason that each mango cultivar have different genetic make than others that is way they differ in flushing pattern and hence vary in intensity of malformation and production. Our results are inline with the finding of Muhammad (2000) who proved that within the same cultivar, individual trees may exhibit variation in behavior pertaining to time and the number of different type of flushes.

More number of malformed panicles emerged on triple flush shoots than on double and ceased respectively (Figure 2). Maximum numbers of malformed panicles (46%) were recorded on triple flush shoots in S.B. Chaunsa followed by Alphanso and Anwar Ratool with 39% and 21%, respectively. Maximum numbers of malformed panicles (39%) were emerged on double flush shoots in cv. S.B. Chaunsa followed by Alphanso and Anwar Ratool with 27% and 17% respectively. On cease flush shoots, highest intensity of carryover malformation (31%) was observed in cv. S.B. Chaunsa plants followed by Alphanso and Anwar Ratool with 21% and 12%, respectively.

A perusal of results shows that the incidence of carryover effect of malformation was highest in cultivar S.B. Chaunsa, followed by Alphanso and Anwar Ratool, This shows that floral malformation is highly linked with flushing pattern in all cultivars of mango. Our results proved that more number of malformed panicles emerged on triple flushes followed by double and ceased flushes, regardless to the variety. This shows an agreement with the finding of (Maiti & Sen, 1978) who noted that early cessation of vegetative growth favors increased fruit production and leads to reduction of malformation of inflorescence. It is again speculated that the emergence of more malformed panicles on double and triple flushes could be due to prolonged growth of these shoots, leading to depletion of their carbohydrate reserves, and thus to a reduced number of sufficiently matured terminals for normal development of panicles (Ping Lu, 2005; Sing, 1978; Reddy, 1983). Generally, single flush shoots are more fruitful than double and triple flush shoots. These results supports to the findings of (Muhammad *et.al.1999,*) who proved that older flushes (ceased flushes) got maximum maturity and thus got maximum blooming with low intensity of malformation of inflorescence.

CONCLUSION

Pruning practices resulted in early vigorous vegetative growth with positive correlation between flush lengths to leaf number. Carryover effect of malformation is more on triple flushes followed by double and cease. Controlled vegetative growth might be helpful to reduce the incident of malformation of inflorescence in mango.

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