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THE TIME OF FLORAL BUD DIFFERENTIATION, FLOWER SEX RATIO AND EMERGENCE OF NORMAL AND MALFORMED INFLORESCENCES IN MANGO

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Duration of floral bud differentiation of healthy and malformed inflorescences was 65 days (first week of August to first week of October) and 49 days (first week of August to third week of September) respectively. Ratio of malformed to healthy inflorescences was found 1 : 1 but malformed panicles were more in number during earlier and less in later part of the emergence period. This rythm was reverse in case of emergence of healthy inflorescences.

Perfect flowers were 35.80 percent and staminate 64.20 percent in healthy while 6.24 percent perfect and 93.76 percent staminate flowers were found in malformed inflorescences. No pistillate flowers were found in any case. Inflorescence emerged in the later part of the season had more perfect flowers, proving the phenomenon of "End Season Fertility".

It is recommended that the growth regulators should only be applied at the time when higher proportion of floral buds are being differentiated into malformed buds which was found to be the third week of August to first week of September and deblossoming may be done of those panicles immediately which emerge during the month of January to minimise the intensity of malformation of mango inflorescence.

INTRODUCTION

The mango industry of Pakistn and also of other mango growing areas of the world has the challenge of malformation of mango inflorescence. This malady was reported first of all in Indo-Pak sub-continent by Burns in 1910. Since then the symptoms of the disease and various forms of malformed inflorescences have been studied to explore its causes both from biological and physiological aspects. Unfortunately, uptil now, no clear cut evidence has been obtained regarding the causing factor and so the control of this malady. Although it is speculated that there seems to be some physiological disturbances (imbalance of some growth regulating substances) produced by the casual

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organism in the metabolism of flowering shoots at the time of floral bud differentiation. To take care of this deficiency many workers, applied growth regulators like planofix/NAA (100 ppm and 200 ppm) at the time of floral bud differentiation and reportd a considerable reduction in the incidence of malformation of mango inflorescence in the following season particularly at the higher rate of NAA (Majumder *et al.*, 1970; Pandey *et al.*, 1974 and Shant, 1975). Observations made by Beniwal *et al.* (1979) also indicated that the amount of plant growth regulators was significantly less in malformed as compared to healthy tissues. These findings, therefore, put more emphasis to know the exact time of fruit bud differentiation in mango at a particular place, so that the application of growth regulators could be made at proper time. Khan (1943) and Gunjate *et al.* (1977) found that time of flower bud differentiation in mango ranged from the middle of August to the end of October at Faisalabad (Pakistan) and Kankan (India). Ravishankar (1978) observed in Alphanso and Totapuri cvs. of mango that fruit bud differentiation was initiated in October and attained the peak in mid November, and by the middle of December the buds were developed in Mysore (India).

It was also tentatively suggested by many workers in the line that floral malflormation in mango can be controlled by deblossoming of newly emerged panicles (Chadha *et al.*, 1979 and Ali and Malik, 1980). So the knowledge of the time of emergence of panicles is also essential for proper and effective deblossoming which is different at different places. Ibrahim (1952) observed at Faisalabad (Pakistan), Singh (1954) at Saharanpur (India) and Ravishankar (1978), India, observed that mango flower buds emerged in the months of January and February. Ali and Mazhar (1960) found that this time was extended upto March in different mango cultivars of Pakistan. No differences in the time of emergence of malformed and healthy inflorescences was observed by Raza (1979) but on the other hand Kulkarni (1979) found that malformed inflorescences emerged later than the normal ones.

Studies were also made by many workers to observe the flower sex ratio of healthy and malformed inflorescences of mango. Ahmad and Sattar (1950) figured out that the ratio of staminate to perfect flowers in malformed inflorescence was as high as 49 : 1. Kausar (1959) also proclaimed that the malformed

panicles had a very high percentage of unisexual staminate flowers. Khan and Khan (1962) pointed out that normal inflorescence produced 45.5 percent while malformed inflorescence produced only 4.53 percent perfect flowers.

Present study was taken in hand to determine the time of floral bud differentiation, time of emergence of panicles and sex ratio in case of normal and malformed inflorescences in mango. This knowledge is necessarily required for the fruit growers to regulate the cultural practices such as application of growth regulators and to perform deblossoming at proper time to minimise the malformation of mango inflorescence to save the mango industry of Pakistan from disaster.

MATERIALS AND METHODS

This study was conducted in the Department of Horticulture, University of Agriculture, Faisalabad, during the year 1979-80. Four plants of bearing Dusehri mango cultivar were selected for these studies which had been bearing both healthy and malformed inflorescences for the last many years. Having in view their previous record, branches bearing healthy and malformed panicles were tagged separately. Bud samples were collected from these branches after 15-days intervals from first August to mid November to determine the time of floral bud differentiation by microtomic studies, and thus were preserved separately as follows:

i) Killing and fixing of the buds were done according to the method and formula of FAA solution given by Sass (1958).

ii) Dehydration of bud samples was performed by passing these through different grades of alcohol as suggested by Jensen (1962).

iii) Infiltration was done by adding wax to the tube according to the schedule mentioned by Jensen (1962).

iv) The tissue sections were cut properly following the methods of Sass (1958).

v) Cleaning, staining, dehydration and mounting of these sections in Canada Balsam were done according to the techniques given by Jensen (1962). Hematoxylene was used for staining the sections.

vi) The slides showing time of floral bud differentiation were selected and photomicrographed.

The following observations were also made .

1. *Time of emergence of inflorescence.* Each tree was divided into two sectors (north and south). Time of emergence of each inflorescence was noticed on tagged branches in each sector separately.
2. *Study of flower sex ratio :* Percentage of male, female and perfect flowers on healthy and malformed inflorescences were calculated by counting all the flowers of a sample of 10 inflorescences which were collected at random from each of the two sectors of the individual trees.

RESULTS AND DISCUTION

Floral bud differentiation started in the first week of August (33.33%) which became maximum (66.66%) during last week of September to first week of October (Table 1). Photomicrograph of longitudinal sections of healthy bud (Plate II) shows floral bud differentiation and the Plate I is given to show the differentiation of vegetative bud to distinct it from floral bud. Comparative study on the the mode of differentiation of vegetative and floral buds indicated that vegetative buds remaind conical and the cells of its growing points underwent a rapid division while initiation of leaves took place on either sides. On the other hand the apical meristem of a floral bud became flattened and gave rise to floral parts without showing any alongation of meristem in a conical form. Calyx was formed first of all and other floral parts followed it. Broadening of apical meristem and appearance of calyx were taken as criteria for floral bud differentiation.

Table 1. *Amount of floral bud differentiation of healthy and malformed inflorescences in mango*

Date	Amount of fruit bud differentiation	
	Healthy (%)	Malformed (%)
1.8.79	33.33	50.00
16.8.79	50.00	66.66
2.9.79	50.00	83.33
18.9.79	66.66	33.33
4.10.79	66.66	—
20.10.79	66.66	—
4.11.79	—	—
20.11.79	—	—

Plate I.

Longitudinal section of differentiating vegetative bud. ←

Plate II.

Longitudinal section of a differentiating floral bud of healthy inflorescence. →

Plate III.

Longitudinal section of a differentiating floral bud of malformed inflorescence. ←

It was observed that the duratin of differentintion of healthy floral buds was 65 days starting from early August and accomplished by the beginning of October. The duration time coincides with the findings of Khan (1942) and Gunjate *et al.* (1977), but differs with the observations of Ravishankar (1978), which might be due to some climatic variations from year to year and from place to place.

The duration of bud differentiation in malformed inflorescence was found to be 49 days also starting from first week of August but completed in the third week of September (Table 1). A higher proportion of buds was differentiated during the month of August and in the first week of September (66.66-83.33%). Photomicrograph (Plate III) of longitudinal sections of buds shows differentiation of floral bud of malformed inflorescence. Comparative studies of differentiation of healthy and malformed floral buds indicated that there was clear cut anatomical difference between the mode of differentiation of these two types of buds. Different initiating floral parts of malformed buds were more broadening as compared with the healthy ones during differentistion.

It is obvious that malformed floral buds need less time (49 days) to get well developed than the healthy ones (65 days). Ravishankar (1978) observed the same duration to get well developed healthy floral buds in case of Alphanso mango.

Emergence of inflorescence in mango : It was observed that first healthy inflorescence emerged on 7th of January when maximum and minimum temperatures were 19 °C and 5 °C respectively, and relative humidity was 78 per cent. This confirms the observations of Ravishankar (1978) who found emergence of floral panicles in Alphanso and Totapuri cvs. during early January. Singh (1954) observed the emergence of healthy inflorescence in mango from mid to later half of January. But Ibrahim (1952) and Ali and Mazhar (1960) claimed that emergence of inflorescences in mango started in February under the Punjab conditions. This difference might be due to difference in cultivars at different localities or year to year climatic and temperature variations.

The emergence of malformed inflorescence was also observed on 7th of January which made it clear that there was no difference in the temperature and humidity requirements for the emergence of both malformed and healthy

inflorescences. The important thing observed was that the number of healthy panicles emerged was more than double the amount of malformed inflorescences in the later part of the flowering season and vice versa (Table 2). This study confirms the findings of Ali and Malik (1980) that panicles emerged in the later part of the flowering seasons have less number of malformed inflorescences with more number of perfect flowers which proved the phenomenon of "End Season Fertility". These findings differ with the results of Razn (1979) who stated that there was no differnce in the emergence time of healthy and malformed mango panicles and of Kalkarai (1979) who reported that malformed inflorescences emerged later than the normal ones. The ratio of total numberof healthy to malformed inflorescences was observed 1:1 (about 50%) in this study of Dusehri mango.

Table 2. *Time of emergence of healthy and malformed inflorescences in mango*

Period (dates)		Emergence of Inflorescence	
From	to	Healthy (%)	(Malformep%)
7.1.80	16.1.80	40	60
17.1.80	26.1.80	50	50
27.1.80	7.2.80	70	30

Flower sex ratio : Perfect flowers were observed 35.80 per cent and staminate 64.20 per cent on healthy inflorescences while no pistillate flower was found in case of Dusehri mango. This confirms the observations of Ali and Mazhar (1960) and Khan and Khan (1962) that higher percentage of staminate flowers as compared to perfect flowers was found on malformed inflorescences. On an average the perfect flowers were only 6.25 per cent and staminate 93.76 per cent in malformed inflorescence (Table 3). The per cent results supported the findings of Ahmad andSattar (1950), Kausar(1959) and Khan and Khan(1962) who proclaimed that the proportion of staminate flowers in malformed inflorescence was much higher than perfect flowers.

Table 3. *Flower sex ratio of healthy and malformed inflorescences in mango*

Plants	Healthy inflorescence			Malformed inflorescence		
	Perfect flowers (%)	Staminate flowers (%	Pistillate flowers (%)	Perfect flowers (%)	Staminate flowers (%)	Pistillate flowers (%)
I	44.22	55.78	—	7.82	92.18	—
II	32.15	67.85	—	55.0	94.50	—
III	28.85	74.15	—	5.47	94.53	—
IV	41.00	59.00	—	6.18	93.82	—
Total	146.22	256.78	—	24.97	375.03	—
Average	36.80	64.20	—	6.24	93.76	—

It had been revealed that the differentiation of malformed buds required less time to get well developed as compared with healthy ones. It also affected the time of emergence of inflorescence as most of the malformed inflorescences emerged earlier than the healthy ones. So it is clear that the time of floral bud differentiation affects the emergence time of healthy and malformed inflorescences. This information may prove very useful to know the exact time of application of planofix/NAA or any other plant growth regulator which are being recommended nowadays by many workers of the line to minimise the malformation of mango inflorescence (Majumder *et al.*, 1974; Shant, 1975 and Chadha *et al*; 1979). On the basis of these observations it is recommended that the sprays of plant growth regulators and other cultural practices to minimise the malformation incidence should be done when a higher proportion of malformed buds are being differentiated, that was found to be from third week of August to first week of September in this study. It is also recommended that the deblossoming of those panicles should be done immediately which emerge earliest during the month of January to minimise the intensity of the malformation of mango inflorescence.

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