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Effect of Drought Stress on Vegetative and Reproductive Growth Behaviour of Mango (*Mangifera indica* L.)

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Abstract: Present research studies were carried out to find the effect of artificial drought stress on the emergence of vegetative flushes in the same season and production of normal or malformed panicles in the next blooming season. It has been found that drought stress caused a great reduction in the emergence of vegetative flushes during the stress period. Number of leaves per flush, flush length and weight, leaf water contents and root growth was also reduced due to drought stress. Number of malformed panicles and percentage of malformation was minimized in the plants on which drought stress was imposed. Complete drought stress proved better to reduce the intensity of malformation than partial drought stress.

Key words: Mango, drought stress, vegetative growth, malformation

Introduction

Mango (*Mangifera indica* L.) is one of the oldest and most popular fruit of the tropical world. It has been grown in Indo-Pak subcontinent from centuries. Because of its excellent flavour, delicious taste and nutritive values, mangoes of Pakistan have attained a good reputation and appreciation in many countries. It is a fact now that Pakistani mangoes are considered far superior in quality throughout the world.

Mango is the second important fruit crop of this country and there is a great scope to earn foreign exchange by exporting mangoes to Middle East and Europe. Pakistan's soil and climatic conditions are highly suitable for mango cultivation. It is helpful to produce good yield of high quality. The average however, is not appreciable which is due to the negligence on the part of growers and some history old problems out of which mango malformation is much serious which causes a great loss at the time of blooming due to which yield reduces too much.

Flowering was found dependent on drought stress, which took place earlier than unstressed trees. In tropical conditions flowering occurs after a period of drought (Scholefield *et al*., 1986). Water stress advanced floral bud break by nearly two weeks in about 40% buds of mango. It stimulated growth of floral buds and delayed the development of vegetative buds. Low temperature after a period of drought has been shown to be beneficial for floral induction. (Whiley, 1986; Nunez-Elisea and Davenport, 1994; Schaffer *et al*., 1994; Chaikiattiyos *et al*., 1994). Evidence indicated that the primary impact of water stress on mango was to prevent vegetative flushing during stress period. The accumulating age of stems was great in water stressed trees than in trees maintained under well watered conditions which could vegetatively flushes more frequently (Schaffer *et al*., 1994) and such delay in flushing may provide more time for accumulation of a proposed floral stimulus (Schaffer, 1994).

Problem of malformation has been found more serious on the late season flushes i.e. July to onward and if by some means, these flashes can be reduced, the intensity of mango malformation will automatically minimized. Keeping in view this hypothesis, present project was initiated with an idea that drought stress may discourage the emergence of late season vegetative flushes. This practice may of great helpful in two ways i.e. firstly due to decreased number of flushes, problem of malformation will be minimized and secondly the tree may not become exhausted due to use of these stored food for initiation of useless flushes. Because such flushes produced only malformed panicles and their production potential is very low. At the same time, the reserve food materials will be economically used for initiation of normal panicles on early season flushes and a reasonable yield can be obtained.

Materials and Methods

These studies were carried out in fruit Experimental garden, sq. No. 9, Department of Horticulture, Univ. Agric. Faisalabad during 1999-2000. The experiment was conducted during July-September. The idea was to reduce flushes from July and onward. Three trees of mango cv. Langra at the age of 15 years growing under similar agro-climatic conditions were selected for these studies. The tree, which served as control, was irrigated fortnightly. Irrigation was stopped for the second tree, although rainwater was allowed to leach down to the root zone, thus partial drought stress was observed (the amount of rain during stress period was 339.6 mm). In case of third tree, five feet deep trench was dug around the periphery of the tree. Thick polythene sheet was spread from the main trunk to the base of trench all around to stop leaching of water to root zone from any source. Drought conditions were maintained up to the end of September. Then polythene paper was removed and normal irrigation was restored. Following data were recorded:

* Number of flushes emerged during the experimental period.
* Vegetative growth behaviour of flushes
* Pattern of root growth in upper five feet
* Number of malformation panicles and percentage of malformation.

Vegetative growth characters were noted during the same year whereas floral behaviour was observed in the next blooming season.

Results and Discussion

The data were recorded at the end of drought stress period. Leaf water potential, leaf chlorophyll contents and leaf area was found statistically unaffected as a result of water stress. However leaf water contents, flushing intensity, root growth and emergence of healthy and malformed panicles were affected due to water stress. Maximum leaf water content (70.35%) was found in the leaves of control tree followed by partially and completely stressed plants in which 63.25 and 51.22% water contents were determined (Table 2).

Emergence of vegetative flushes decreased during the stress period as compare to non-stressed trees. On control tree 544 flushes were emerged during July. The average number of leaves per flush, length of flush, fresh and dry weight were observed as 16.52, 12.81, 14.58 and 11.04 g, respectively. In partially stressed plant, the number of flushes were reduced to 297 having 13.43 leaves, 8.76 cm flush, 6.00 and 4.26 g fresh and dry weight, respectively. The number of malformed panicles observed in these two cases were 71 and 23 (Table 1).

Under complete stressed conditions the number of flushes emerged dropped to 217 during July with concurrent reduction of other growth characters like 9.36 leaves, 6.31 cm flush length, 5.09 and 3.50 g fresh and dry weight, respectively by producing 9 malformed panicles. Observation recorded for August indicated the number of flushes like 387, 113 and 71 in control, partially and completely stressed plants, respectively. Other growth characters were 15.27 leaves, 13.29 cm flush length 13.96 and 10.21 g fresh and dry weight in control, 12.19, 7.61 cm,

Table 1: Comparison of flushes and malformed panicles as affected by drought stress

Trees	No. of flushes	Leaves per flush	Flush length (cm)	Fresh wt. (g)	Dry wt. (g.)	No. of malformed panicles
July						
1	544	16.52	12.81	14.58	11.04	71
2	297	13.43	8.76	6.00	4.26	23
3	217	9.36	6.31	5.09	3.50	9
August						
1	387	15.27	13.29	13.96	10.21	24
2	113	12.19	7.61	9.43	7.35	7
3	71	10.47	5.39	6.73	4.21	4

Table 2: Effect of water stress on vegetative growth, malformation and leaf water contents

Trees	No. of flushes	No. of malformed panicles	Malformation (%)	Leaf water content (%)
1	931	95	10.20	70.35
2	410	30	7.32	63.25
3	288	13	4.51	51.22

Table 3: Studies of root system in response to water stress

Soil depth (ft)	T_1		T_2		T_3	
	Fresh wt.(g)	Moisture (%)	Fresh wt. (g)	Moisture (%)	Fresh wt. (g)	Moisture (%)
0-3	4.79	81.23	3.40	72.63	2.13	57.16
3-5	2.37	74.39	1.69	61.29	0.93	42.31

9.43 and 7.35 g for partially stressed and 10.47, 5.39 cm, 6.73 and 4.21 g for completely stressed plant, respectively. The number of malformed panicles were 24, 7 and 4 in these plants. During September, no flush appeared on completely stressed tree hence data of July and August could not be compared.

Drought stress discouraged vegetative growth during July and later months and as such the intensity of malformation on these trees was found significantly reduced. Maximum malformed panicles i.e. 95 (10.20%) were observed on non-stressed plant out of 931 flushes, followed by partially stressed with 30 (7.32%) and completely stressed tree in which only 13 (4.51%) malformed panicles appeared out of 410 and 288 flushes, respectively (Table 2).

Root growth which was estimated from the weight of root pieces collected from under the experimental trees with 4 inches dia soil sampler, indicated that fresh weight of roots within upper three feet was 4.79, 3.40 and 2.13 g with their moisture contents of 81.23, 72.63 and 57.16% in control, partially and completely stressed plants, respectively. Similarly observations from within lower 3-5 feet indicated fresh root weight as 2.37, 1.69 and 0.93 g with their 74.39, 61.29 and 42.31% moisture contents, respectively (Table 3).

The observations thus indicated that the roots which develop more frequently in the upper three feet of the root system, their growth was significantly affected from the availability of water. There was great difference between the control and even between the partially stressed trees as regard the fresh weight of their roots, available within the sampled area. The stressed trees lost major part of their root system and it was clear even from the top growth, which was quite stunted and the trees looked shorter as compared the trees under control conditions. The root system thus seems to need water and oxygen both in sufficient quantity for growth and development in mangoes. Similar observations were reported by Davenport *et al.* (1980) who found that several days were required for correction of growth after rewatering.

Furthermore, the number of vegetative flushes was decreased by imposing water stress from July onwards which was found favourable to reduce the problem of mango malformation because the flushes of this period were found more susceptible to the incidence of malformation. Development of vegetative buds was delayed and growth of floral buds was stimulated in response to water stress as reported by Schaffer *et al.* (1994); Nunez-Elisea and Davenport (1994); Chaikiattiyos *et al.* (1994); Scholefield *et al.* (1986); Whiley (1986) and Schaffer 1994).

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