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RESPONSE OF MANGO (*MANGIFERA INDICA* L.) TO DIFFERENT PRUNING TIME AND INTENSITY FOR VEGETATIVE, FLOWERING AND FRUITING PARAMETERS

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ABSTRACT
The minimum days taken to vegetative shoot emerges (44.89 days), highest percentage of vegetative shoot emerges at 45, 60 and 90 DAP (6.94%, 45.75% and 83.31%, respectively), highest percentage of fruit set at harvest (0.30%) and maximum yield (42.29 kg tree^{-1}) were recorded when pruning at 1st fortnight of July. The minimum days taken to vegetative shoot emerges (36.21 days), highest percentage of vegetative shoot emerges (11.35 %, 53.81 % and 81.35 %, respectively) at 45, 60 and 90 DAP, minimum days taken to flowering (181.25 days), highest percentage of flowering (77.29 %) & fruit set at harvested (0.28 %) and maximum yield (41.45 kg tree^{-1}) were observed with 25 cm of pruning intensity. The treatment combination 1st fortnight of July with 25 cm of pruning intensity (T_3P_1) recorded significantly highest percentage of vegetative shoot emergence at 45 and 60 DAP (17.50 % and 72.50 %, respectively), fruit set at harvest (0.45%) and yield (50.98 kg tree^{-1}). The control *vs* rest analysis showed significant variation in vegetative, flowering and fruiting parameters, which were recorded better with pruned treatments as compared to control. It can be concluded that pruning at 1st fortnight of July with 25 cm gave better result.

INTRODUCTION

Mango fruit has been in cultivation in Indian sub-continent for well over 4000 years and has been the favorite of the Kings and the commoners. In India, it is grown in an area of 2.5 million hectares and its production is up to 18.002 lakh metric tons with 7.2 t ha^{-1} productivity, which is much low in comparison to average world productivity (Anon., 2012-13). Kesar is the most popular mango variety in Gujarat and has good export potential. It account for ninety per cent of the mangoes exported from Gujarat (Srivastav, 2007). The area under this variety has increased not only in Gujarat but also in neighboring states like Maharashtra, Madhya Pradesh, and Rajasthan because of its higher productivity, regularity in bearing, superior fruit quality, rich flavor and pleasant aroma. It is widely appreciated by the customers for its attractive shape, size and colour (Babu *et al*., 2016). In the traditional low density cultivation, per ha plant population in mango orchard ranges from 75 -100. In such situation, mango trees become very big, which make it difficult to perform the needed cultural operations, like disease pests control harvesting etc. As a result, irregular bearing of fruits becomes the rule rather than an exception. Low yield or no yield is also common due to alternate bearing and poor light penetration. Pruning, its extent, nature and type depends on the kind of plant, the bearing habit, the age of the plant and purpose for which it is being done. Pruning is an important tree management practice to regulate vegetative growth and flowering in many fruit crops including mango (Srilatha *et al*., 2015). At present highly need to work on explore the possibility of increasing production, productivity and quality of mango under high density planting in cv. Kesar with the help of pruning in Gujarat. The time and severity of pruning is known to alter the physiological make up of the plant bringing change in the bearing behaviour and yield pattern. In Gujarat, the work on pruning for the high density planted mango orchards made recommendation from Navsari Agricultural University that the pruning at 10-20 cm annually or biannually just after the harvesting gave better results in high density planted mango cv. Kesar (Anon., 2009). But due to some reason viz., unavailability of skill labours and equipments, early onset of monsoon, gave more priority to seasonal crops etc. the farmers are not able to adopt correct recommendation practices. Therefore, to find out the solution in regards this experiment entitled, response of mango to different pruning time and intensity for vegetative, flowering and fruiting parameters was laid out and the attempts have been made to investigate the combined effect of time and intensity of pruning on vegetative, flowering and fruiting parameters through their effect on phytohormones in important mango cultivar Kesar.

MATERIALS AND METHODS

The present investigation was undertaken at Agriculture

Experimental Station, Navsari Agriculture University, At & Po: Paria, Ta: Pardi Dist. Valsad during the year 2012-13. The experimental material *i.e.* seventeen years old trees of mango variety Kesar planted at 5 x 5 meter were used for pruning at 25 cm, 50 cm and 75 cm heading back during different time *i.e.* First fortnight of June (T_1), second fortnight of June (T_2), first fortnight of July (T_3) and second fortnight of July (T_4) and un-pruned tree treated as control. A group of two trees were selected for one treatment. There were thirteen treatments (including control) and three replications. So seventy eight trees used for present study. The experiment was laid out in a Randomized Block Design with factorial concept. 40 pruned branches in one tree were selected randomly with 10 branches in each direction and tagged it for recording different observations *viz.*, vegetative, flowering and fruiting behaviour.

The data of the morphological characters like Annual observations on vegetative parameters *viz.,* **Bio mass (kg/tree):** Weight of all forty tagged pruned branches was recorded immediate after pruning from each tree. Mean weight of pruned branches of two trees were recorded as observation and this mean express in kilogram. Shoot length (cm), shoot girth (cm), number of leaves per shoot were recorded at flower bud differentiation. The percentage of vegetative shoot emerges at 45, 60 and 90 days were estimated using the following formula.

$$\text{Percentage of vegetative shoot emerges (\%)} = \frac{\text{Number of vegetative shoot emerged}}{\text{Total number of vegetative shoot pruned}} \times 100$$

The flowering parameters *viz.,* Days taken to flowering, length of panicle (cm), staminate flowers/panicle, hermaphrodite flowers/panicle, sex ratio (Hermaphrodite: Staminate),

percentage of flowering

Out of 40 selected pruned and tagged shoots number of panicle emerged counted at full bloom stage and calculated as percentage of flowering on each tree. The formula was

$$\text{Percentage of flowering} = \frac{\text{Number of panicle emerges}}{\text{Total number of vegetative shoot pruned}} \times 100$$

The fruiting parameters *viz.,* Fruit set percentage (at harvest stages), yield (kg/tree). The data were statistically analyzed for analysis of variance. The significance of variance among the treatments was observed by applying F test and critical difference at 5% level of probability as per Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Vegetative parameters

Data presented in Table 1 indicated that the different pruning time has were unable to produced any significant impact on bio mass but numerically it was found in order of T3 > T4 > T1 > T2. The finding lend supported by Yadav *et al.* (2007). While different pruning intensity had significant effect over control. Experimental results evidently showed that the maximum bio mass (7.25 kg) was recorded under P_3 *i.e.* 75 cm of pruning intensity as compare to 25 cm (1.66 kg) and 50 cm (4.19 kg). Maximum or minimum in bio mass per unit is a directly correlated with pruning intensity. The interaction between different pruning intensity and time was found to be non-significant with bio mass. With the respect to control *vs* rest analysis, treated treatment have significantly higher bio mass over control.

A significantly minimum day taken to vegetative shoot emerges required by pruning at 1st fortnight of July (44.89 days) and maximum (53.39 days) with pruning at 2nd fortnight of June. This might be due to an ideal time *i.e.* onset of monsoon with

Table 1: Effect of different pruning time and intensity on vegetative parameters of mango cv. Kesar under high density planting

Treatment	Bio mass (kg)	Shoot length (cm)	Shoot girth (cm)	Number of leaves	Days taken to vegetative shoot emerges (DAP)	Percentage of vegetative shoot emergence (DAP)		
						45 Days	60 Days	90 Days
Pruning time (T)								
T_1- 1st fortnight of June	4.28	27.43	0.78	12.54	52.89	3.17	36.50	67.69
T_2- 2nd fortnight of June	4.25	28.44	0.78	12.96	53.39	4.38	37.17	69.94
T_3- 1st fortnight of July	4.50	29.66	0.84	13.99	44.89	6.94	45.75	83.31
T_4- 2nd fortnight of July	4.44	29.00	0.82	13.77	46.67	4.39	37.83	78.64
S.Em.±	0.142	1.315	0.028	0.635	2.102	0.200	1.609	2.733
C.D. at 5%	NS	NS	NS	NS	6.17	0.59	4.72	8.02
Pruning intensity (P)								
P_1- 25 cm	1.66	29.38	0.84	13.11	36.21	11.35	53.81	81.35
P_2- 50 cm	4.19	28.23	0.81	13.75	50.88	2.44	37.63	74.54
P_3- 75 cm	7.25	28.29	0.77	13.08	61.29	0.29	26.50	68.79
S.Em.±	0.123	1.139	0.024	0.550	1.821	0.173	1.393	2.367
C.D. at 5%	0.36	NS	NS	NS	5.34	0.51	4.09	6.94
Treated mean	4.37	28.63	0.80	13.31	49.46	4.69	39.31	74.90
Control	0.00	26.43	0.76	13.00	70.00	0.00	18.08	50.00
C v/s R								
S.Em.±	0.174	1.654	0.035	0.784	2.807	0.245	2.027	3.440
C.D. at 5%	0.51	NS	NS	NS	8.19	0.71	5.92	10.04
Interaction effect (P×T)								
S.Em.±	0.246	2.278	0.049	1.065	3.641	0.346	2.787	4.733
C.D. at 5%	NS	NS	NS	NS	NS	1.02	8.17	NS
CV%	10.17	13.78	10.41	14.30	12.75	12.78	12.28	10.95

Table 2: The interaction effect of time and intensity of pruning on percentage of vegetative shoot emergence at 45 and 60 DAP of mango cv. Kesar under high density planting

Treatments	Pruning intensity							
	45 Days after pruning				60 Days after pruning			
Time of Pruning	P_1: 25 cm	P_2: 50 cm	P_3: 75 cm	T mean	P_1: 25 cm	P_2: 50 cm	P_3: 75 cm	T mean
T_1: 1st fortnight of June	6.25	2.92	0.33	3.17	38.75	41.00	29.75	36.50
T_2: 2nd fortnight of June	10.42	2.25	0.17	4.28	50.25	37.75	23.50	37.17
T_3: 1st fortnight of July	17.50	2.92	0.42	6.94	72.50	38.25	26.50	45.75
T_4: 2nd fortnight of July	11.25	1.67	0.25	4.39	53.75	33.50	26.25	37.83
P mean	11.35	2.44	0.29		53.81	37.63	26.50	
Treated mean	4.69							
Control	0.00							
SOV	P	T	P x T	C v/s R	P	T	P x T	C v/s R
S. Em ±	0.173	0.200	0.346	0.245	1.393	1.609	2.787	2.027
C. D. at 5%	0.51	0.59	1.02	0.71	4.09	4.72	8.17	5.92
C. V. %	12.78				12.28			

moist and warm condition is there which initiate shoots frequently resulting in vegetative shoot induction due to the short period of stem rest between flush. Similar result was discovered by Swaroop *et al*. (2001). Among different pruning intensity, pruning at 25 cm required significantly minimum days (36.21 days) for the vegetative shoot emerges compare to 50 cm (50.88 days) and 75 cm (61.29 days) of pruning intensity. From the data clearly indicating that, with the increasing pruning intensity days taken to vegetative shoots were delay. This might be due to increasing the pruning intensity causes more removal of apical branch resulting to reducing the auxin content in branch which delays the vegetative shoot emergence. These findings are in close association with that of Mohammed *et al*. (2006) in guava crop. The interaction effect between pruning intensity and pruning time was observed non significant with day taken to vegetative shoot emerges. The treated treatment takes significantly less day (49.46 days) to vegetative shoot emerges compared to control (70.00 days). It might be because of the removal of apical dominance, release of buds from correlative inhibitors and well functioning of communicated system within the tree. This result is supported by Bisla *et al*. (1990) in ber and Mohammed *et al*. (2006) in guava.

Significantly higher percentage of vegetative shoot emerges (6.94 %, 45.75 % and 83.31 %, respectively) was discovered with 1st fortnight of July (T_3) at 45, 60 and 90 days after pruning. The data perusal that vegetative shoot emerges at 45, 60 and 90 days after pruning were increase since 1st fortnight of July and then after decrease. During this time humidity is increase and warmness of temperature is decrease due to onset of monsoon, creates warm and humid atmospheres suitable for vegetative shoot emergence. Significantly higher percentage of vegetative shoot emerges (11.35 %, 53.81 % and 81.35 %, respectively) was revealed with 25 cm of pruning intensity at 45, 60 and 90 days. This finding probably be due to pruning intensity increase lead to decease in auxin content of branches this direct to decreasing vegetative shoot emerges with increasing pruning intensity. The maximum percentage of vegetative shoot emerges at 45 and 60 DAP (17.50 % and 72.50 %, respectively) was noted in the treatment containing 1st fortnight of July with 25 cm of pruning (T_3P_1) while minimum (0.17 % and 23.50 %, respectively) recorded at 2nd fortnight of June with 75 cm of pruning (T_2P_3). This might be due to combine effect of individual pruning time and intensity. Percentage of vegetative shoot emerges at 45, 60 and 90 DAP (days after pruning) highly significant as the maximum percentage of vegetative shoot emerges noted with pruned treatments compare to unpruned treatments (control).

However, the shoot length, shoot girth and number of leaves remain unaffected due to different pruning time, intensity and their interaction.

Flowering and fruiting parameters

Among the different pruning time, significantly minimum days taken to flowering (178.78 days) was obtained with pruning at 2nd fortnight of July, while maximum days taken to flowering (224.44 days) were noted with 1st fortnight of June. While, among different pruning intensity, 25 cm of pruning intensity *i.e.* P_1 required minimum days to flowering (181.25days) as compare to other pruning intensity. The might be due to the shoot sprouts appear little early after pruning which may be due to immediate loss of apical dominance and due to early shoot production, these shoots attained the desired maturity it give rise to early panicles emergence. Similar pattern of positive growth response to different pruning intensity was observed by Singh *et al*. (2010), Oosthuyse and Jacobs (1997) and Chen *et al*. (1996). The interactions effect between P x T, Y x P, Y x T, Y x P x T and Y x C vs R were found non significant with days taken to flowering. The treated treatment takes significantly less day (202.38 days) to flowering compared to control (241.17 days). It might be owing to the redistribution of endogenous hormonal substances to favour flowering. Similar finding was reported by Yadav *et al*. (2007) in mango, Oosthuyse and Jacobs (1997) in mango and Bisla *et al*. (1990) in ber.

Among different pruning time, pruning at 2nd fortnight of June (T_2) discovered significantly maximum percentage of flowering (82.17 %), while significantly minimum percentage of flowering (63.97 %) noted with 2nd fortnight of July (T_4). It might me due to environmental condition and cutting of branches and twigs induces simultaneous accumulation of ethylene, ascorbic acid, abscisic acid, cytokinin and sudden lowering of gibberellins, all these lead to profuse flowering. Similarly the higher percentage of flowering was observed by Yadav *et al*.

Table 3: Effect of different pruning time and intensity on flowering and fruiting parameters of mango cv. Kesar under high density planting

Treatment	Days taken to flowering (DAP)	Percentage of flowering	Staminate flowers per panicle	Hermaphrodite flowers per panicle	Sex ratio (H:S)	Percentage of fruit set at harvest stage	Yield (Kg per tree)
Pruning time (T)							
T_1- 1st fortnight of June	224.44	65.42	1446.53	300.23	0.21	0.18	32.73
T_2- 2nd fortnight of June	211.89	82.17	1453.13	328.49	0.23	0.20	34.24
T_3- 1st fortnight of July	194.39	79.64	1517.97	361.68	0.24	0.30	42.29
T_4- 2nd fortnight of July	178.78	63.97	1512.10	351.44	0.24	0.22	39.54
S.Em.±	9.524	2.639	62.487	13.952	0.012	0.011	1.270
C.D. at 5%	27.93	7.74	NS	40.72	NS	0.031	3.73
Pruning intensity (P)							
P_1- 25 cm	181.25	77.29	1505.00	345.93	0.23	0.28	41.45
P_2- 50 cm	207.08	72.73	1481.60	329.13	0.22	0.23	36.40
P_3- 75 cm	218.79	68.38	1460.70	331.33	0.23	0.17	33.76
S.Em.±	8.248	2.285	54.116	12.083	0.010	0.009	1.100
C.D. at 5%	24.19	6.70	NS	NS	NS	0.027	3.23
Treated mean	202.38	72.80	1482.43	335.46	0.23	0.23	37.20
Control	241.17	60.42	1411.90	258.57	0.18	0.12	25.87
C v/s R							
S.Em.±	11.711	3.518	79.656	17.78	0.015	0.013	1.554
C.D. at 5%	34.18	10.27	NS	51.91	0.043	0.039	4.54
Interaction effect (P×T)							
S.Em.±	16.496	4.571	108.231	24.165	0.020	0.018	2.200
C.D. at 5%	NS	NS	NS	NS	NS	0.054	6.45
CV%	14.12	10.88	12.69	12.70	15.29	14.46	10.07

(2007) in mango *cv*. Alphonso during November. While, percentage of flowering significantly found maximum (77.29 %) with 25 cm of pruning intensity and minimum (68.38 %) with 75 cm of pruning intensity. This might be due to pruning intensity increases lead to increase removal of bio mass as a result of this early new growth and better availability of photosynthetic solar radiation to leaves with low pruning intensity which leads to causing alteration in IAA activities, which enhance flowering. Similar result was obtained by Singh (2010) and Srihari and Rao (1998).

Flowering parameters *viz.,* staminate flowers per panicle and sex ratio were found non significant due to different pruning time. The results are in accordance with the finding of Waghmare and Joshi (2008). While hermaphrodite flowers per panicle was noted significant with different pruning time. Among different pruning time, pruning during 1st fortnight of July (T_3) conformed maximum number of hermaphrodite flower per panicle (361.68) but it was found statistically at par with T_4 *i.e.* 2nd fortnight of July (351.44) and T_2 *i.e.* 2nd fortnight of June (328.49), While significantly the lowest hermaphrodite flowers per panicle was observed with pruning time T_1 *i.e.* 1st fortnight of June (300.23). Similarly the maximum number of hermaphrodite flower was observed by Yadav *et al*. (2007) in mango *cv*. Alphonso during November and Swroop *et al*. (2001) in mango *cv*. Dashehari during November-December and also during July. While, among the different flowering parameters staminate flowers per panicle, hermaphrodite flowers per panicle and sex ratio were found to be non significant under different pruning intensity. This might be due to all treatments comes in flowering during end of January to first week of February in the presence of the same environmental condition with the same variety. This result is in agreement with those reported by Singh (1995) and, Waghmare and Joshi (2008). All interaction between different pruning intensity and time was found non-significant with the all flowering parameters *viz.*, days taken to flowering, percentage of flowering, staminate flowers, hermaphrodite flowers and sex ratio**.** All the flowering parameter likewise days taken to flowering, percentage of flowering, length of panicle, hermaphrodite flowers and sex ratio except staminate flowers discover significantly perform better in all pruned treatment than the control (unpruned treatment). Similar finding was reported by Yadav *et al*. (2007) in mango, Oosthuyse and Jacobs (1997) in mango and Bisla *et al*. (1990) in ber.

The percentage of fruit set at harvest stage of fruit set showed significantly maximum percentage of fruit set (0.30 %) observed with 1st fortnight of July (T_3) pruning time, while lowest percentage of fruit set (0.18 %) conformed with 1st fortnight of June (T_1) as compare to other pruning time. Nearer to same finding was also discovered by Yadav *et al*. (2007) in mango *cv*. Alphonso during December. In case of pruning intensity significantly maximum percentage of fruit set was noted with 25 cm of pruning intensity (0.28 %) as compare to 50 cm (0.23 %) and 75 cm (0.17 %). Nearer to same finding also discovered by Pratap *et al*. (2003) and Gill *et al*. (1998) with mango. The maximum fruit set percentage at harvest stage (0.45 %) was noted in the treatment containing 1st fortnight of July with 25 cm of pruning (T_3P_1) which was recorded maximum over the treatment combination 1st fortnight of June with 75 cm of pruning (T_1P_3) *i.e.* 0.12 %. It might be due to combination effect of pruning intensity and time. The fruit set percentage at harvest stage shows significantly maximum fruit set with pruned treatment (0.23 %) while lowest fruit set percentage at harvest stage was obtained with control (0.12 %) (unpruned treatment).

Among different pruning time, significantly maximum yield

Table 4: The interaction effect of time and intensity of pruning on percentage of fruit set at harvest stage and yield of mango cv. Kesar under high density planting

Treatments	Pruning intensity							
	Percentage of fruit set at harvest stage				Yield (kg per tree)			
Time of Pruning	P_1: 25 cm	P_2: 50 cm	P_3: 75 cm	T mean	P_1: 25 cm	P_2: 50 cm	P_3: 75 cm	T mean
T_1: 1st fortnight of June	0.22	0.22	0.12	0.18	32.65	33.35	32.19	32.73
T_2: 2nd fortnight of June	0.19	0.23	0.18	0.20	35.22	34.07	33.45	34.24
T_3: 1st fortnight of July	0.45	0.24	0.21	0.30	50.98	40.68	35.20	42.29
T_4: 2nd fortnight of July	0.25	0.22	0.19	0.22	46.97	37.49	34.18	39.54
P mean	0.28	0.23	0.17		41.45	36.40	33.76	
Treated mean	0.23	37.20						
Control	0.12	25.87						
SOV	P	T	P x T	C v/s R	P	T	P x T	C v/s R
S. Em ±	0.009	0.011	0.018	0.013	1.100	1.270	2.200	1.554
C. D. at 5%	0.027	0.031	0.054	0.039	3.23	3.73	6.45	4.54
C. V. %	14.46				10.07			

(42.29 kg tree^{-1}) was produced when the pruning done at 1st fortnight of July (T_3), while significantly minimum yield (32.79 kg tree^{-1}) noted with pruning at 1st fortnight of June (T_1). This might be due to early vegetative shoot emergence, early flowering, higher sex ratio and fruit set percent during 1st fortnight of July which leads to increase yield. Similar higher yield was reported by Fivaz and Stassen (1997) in mango cv. Sensation when pruned at October, Yadav *et al*. (2007) in mango cv. Alphonso when pruned at November and Ravishankar *et al*. (1992) in mango *cv*. Alphonso when pruned at early to mid November. The pruning intensity significantly influences the yield (kg tree^{-1}). Significantly the maximum yield was noted with 25 cm of pruning (41.45 kg tree^{-1}) intensity which was 5.05 and 7.69 kg tree^{-1} more than 50 and 75 cm pruning intensity, respectively. This might be due to removal of less vegetative branches, early vegetative shoot emergence and more days to maturity in low intensity pruning which leads to increase photosynthesis and utilization of solar light causes more yield. Pratap *et al*. (2003) reported nearer to same finding in mango. The interaction effects of different pruning time with different pruning intensity for yield (kg tree^{-1}) was found significantly maximum (50.98 kg tree^{-1}) in the treatment containing 1st fortnight of July with 25 cm of pruning (T_3P_1) which was higher over the treatment combination 1st fortnight of June with 75 cm of pruning (T_1P_3) *i.e.* 32.19 kg tree^{-1} . It might be due to combination effect of pruning time and intensity. The near to similar result is supported by Ravishankar *et al*. (1992). The unpruned *vs* rest analysis showed that, pruned treatment significantly gave maximum yield (37.20 kg tree^{-1}) per tree over that control (25.87 kg tree^{-1}). It might be due to facilitate light penetration in the canopy, the photosynthetic activity during fruit growth period might be augmented to increase yield.

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