International Journal of Farm Sciences **3(2)** :32-40, 2013

Rejuvenation of frost affected mango orchard through pruning treatments

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ABSTRACT

Studies were conducted to rejuvenate frost affected mango orchard of three cultivars viz Mallika, Dashehari and Amarpali by applying different pruning treatments during the year 2008. Significant results in rejuvenating the mango trees pertaining to growth and fruit yield attributes were observed. Tip pruning of frost injured mango shoots in all the three cultivars of mango gave significantly higher growth and fruit yield in comparison to unpruned plants (control).

Keywords: Rejuvenation; frost injury; tip pruning; mango; head back

INTRODUCTION

Mango (*Mangifera indica* L) known as the king of fruits has delicious taste and high nutritional value. The plant has wide adaptability due to its indigenous nature and hence is widely adapted and capable to resist weather extremes. The low productivity of quality mango fruit (7.8 tonnes per ha) in India is due to high acreage under native varieties with low yield potential, inadequately and non-scientifically managed plants and above all plants being prone to diseases and insect pests. The improved cultivars though high yielding are intolerable to weather deviations like extreme temperature regimes and frost.

The declining productivity of mango fruits due to physiological and climatic problems is a matter of serious concern for orchardists and the researchers. The Govt of India in tenth five year plan has advocated massive rejuvenation programme for increasing production potential of old, densely planted, frost and drought affected mango orchards through top working and head-backing/pruning operations. The frost played havoc in burning the foliage, tender twigs and

flowering buds of subtropical fruits in Paonta-Doon valley during 2006-07 and 2007-08 rendering many fruit trees like mango, aonla and litchi totally unproductive. In the past judicious pruning of mango shoots/stems has been advocated to obtain optimum fruit yield (Mukunda et al 2006) and growth parameters (Lal et al 2001). Mango trees have been subjected to various pruning strategies (Gross1996, Stassen et al 1999) for manipulation of required tree shape in order to increase fruit yield Therefore studies were initiated by applying different pruning treatments to rejuvenate the frost injured bearing mango orchards of three cultivars viz Mallika, Dashehari and Amarpali

MATERIAL AND METHODS

Mango cultivars viz Mallika, Dashehari and Amarpali were planted at a distance of 3 x 3 m as high density orchard in an area of about 0.4 ha at experimental farm of Regional Horticultural Research Station, Dhaulakuan, district Sirmour, HP during the year 1997-98. There were seven rows of each variety comprising 21 plants in each row. The orchard started bearing fruits during 2003-04. Severe pooled frost in four spells was experienced in the region during months of December 2007 to February 2008 resulting in complete burning of foliage and twigs. The intensity of frost was so high that the bud initiation and differentiation was ceased in the ensuing spring seasons. The entire mango orchard gave a dead look. Hence the removal of dried twigs in a scientific way became inevitable to get the frost injured mango trees rejuvenated. For the purpose the following treatments were applied during first fortnight of March 2008:

T_1 - Head back from first stem differentiation (Head backed at end point of main stem)

T_2 - Head back from second stem differentiation

T_3 - Head back from third stem differentiation

T_4 - Head back from fourth stem differentiation

T_5 - Tip pruning of frost affected shoots ie removal of twigs

T_6 - Unpruned tree (Control)

The treatments were replicated four times. Under each cultivar 24 trees were randomly selected, tagged and the said treatments were applied during the first fortnight of March 2008. Pruning treatments were applied carefully using falco pruning saw and secateurs to avoid splitting of stems/branches maintaining smoothness of cut surface by all means. Cut surfaces of stems/branches were immediately smeared with copper oxychloride paste to check microbial infection and gummosis. Each treated plant was fertilized with half dose of urea (1.25 kg), full dose of SSP (3 kg), MOP (1.5 kg) and well decomposed FYM (120 kg) which were applied during second fortnight of June. Irrigation was applied at

15 days interval till the onset of rainy season. Other cultural practices were followed as per package of practices of fruit crops.

Data on per cent survival were recorded during April 2009 wrt branch length, tree height, average tree spread (east to west and north to south) during the month of April 2009, 2010, 2011 and 2012 and number of fruits set per plant during the month of May, number of fruit drop per plant during the month of June, weight per fruit and fruit yield per plant during first fortnight of July 2010, 2011 and 2012. Observations were subjected to statistical analysis as suggested by Panse and Sukhatame (1985). Data recorded during the year 2012 for growth and fruit yield parameters have been presented in result and discussion part of the manuscript

The centre is situated at $30^0$30'20" N latitude and $77^0$20'30" E longitude at 470 m elevation in sub-tropical sub-montane low hill zone of state receiving around 1,600 mm rainfall annually. The centre has three distinct seasons. There is a dry and windy season with an average maximum temperature 37^0 C and minimum of 8^0 C from March to June and rainy season extends from July to September receiving around 85-90 per cent of total annual rainfall. There is a warm period with high humidity and severe winter with an average maximum temperature of 24^0C and the minimum temperature of -2^0C associated with pooled frost from December to February. The soils are sandy loam alluvial with pH 6.5-8.0 and organic carbon of 0.45 per cent. The soil fertility is medium for N and K and high for P.

RESULTS AND DISCUSSION

Growth parameters

Different pruning treatments had a significant effect on growth attributes of three mango cultivars (Tables 1-3). Maximum survival (84%) was recorded in cultivar Dashehari followed by Amarpali (83.1%) and Mallika (82.1%) at T_5 pruning treatment indicating statistically non-significant differences from each other whereas the lowest percentage of survival was recorded in cultivar Mallika (39.2%) at T_6 pruning treatment. Retention of more number of actively growing buds in tip pruning treatment (T_5) might be the only reason for maximum rejuvenation while in unpruned (Control) plant (T_6) competition for nutrients exerted by numerous shoots causing slow growth rate could be the reason for minimum extent of survival. Tip pruning is the pruning of terminal tip anywhere from the apex to a point down the shoot that is not larger than 1cm in diameter. Tip pruning in mango trees helps in removing the growth inhibiting panicle structure left from previous season's flowering as suggested by Davenport (2006) that also supports these findings. Maximum branch length of 222 cm was recorded in cultivar Mallika followed by Dashehari and Amarpali at T_5 pruning

treatment indicating significant differences in comparison to control. Similarly maximum tree spread was recorded in cultivar Amarpali followed by Dashehari and Mallika yielding significant variation in comparison to unpruned trees. Tip pruning of mango stimulates branching flushes of lateral shoots in order to formation of spreading canopy to facilitate early flowering. Average tree spread was maximum in cultivar Amarpali followed by Dashehari and Mallika and minimum tree spread was in unpruned plants (control). The fact is attributed to efficient utilization of nutrients in shoot development and subsequent vegetative growth pertaining to tree spread. The findings draw support from Lal et al (2001). Pruning is an unavoidable necessity of virtually all arboreal fruit crops in order to maintain tree size and orchard productivity. Light to severe pruning is used in a variety of circumstances to produce predictable and useful results for various reasons.

Reproductive parameters

Significant effect of different pruning treatments on fruit attributes and yield of three mango cultivars was observed (Table 2). Maximum Fruit set (180 per plant), fruit weight (486 g) and fruit yield (79.2 kg per tree) were observed in T_5 when shoots were tip pruned indicating significant variation in comparison to all other treatments and the minimum fruit set (101 per tree), fruit weight (310 g) and fruit yield (28.2 kg per tree) were recorded in control (unpruned plants). Fruit drop was maximum in unpruned trees (control) as the plants might have exerted to their maximum extent for vegetative growth. Besides the favorable effect of pruning intensities might have allowed maximum sunlight and chlorophyll content of leaves required for optimum photosynthesis in comparison to unpruned trees. The findings draw support from Schaffer and Gauge (1989). Results reported by Rao and Shanmugavelu (1976) on different pruning treatments in mango orchard rejuvenation also support the present investigations.

The per cent fruit drop was doubled in unpruned trees in comparison to T_5 as tip pruning provided reliable synchronized flowering. Different pruning treatments inhibit vegetative growth and encourage reproductive growth viz flowering, fruit setting, fruit drop and yield potential in subtropical fruit crops. Davenport (2006) suggested tip pruning to encourage frequent flushing and branching in mango trees to bring back the orchard into commercial production in comparison to unpruned ones. It also stimulates timely flushes of lateral shoots to receive maximum amount of sunlight for higher fruit yield. These findings support our results. Flowering and fruit production in mango occurs on stem terminals due to increase in canopy size and production of fruits moves to the top because competition for available light continues as lower branches supporting previous year's productive stems die back

Table 1. Per cent survival and branch length attributes under different pruning treatments

Treatment	% survival			Branch length (cm)											
	C1	C2	C3	C1				C2				C3			
				2009	2010	2011	2012	2009	2010	2011	2012	2009	2010	2011	2012
T_1	62.4	64.6	65.3	92	110	135	162	72	91	118	150	84	106	133	165
T_2	64.3	66.1	65.2	102	124	154	181	0.94	116	139	171	0.98	117	145	174
T_3	71.3	72.3	73.1	115	138	166	198	110	128	152	184	114	136	163	196
T_4	76.4	78.4	77.6	124	150	183	215	125	148	165	193	128	146	174	205
T_5	82.1	84.4	83.1	135	158	184	222	138	160	187	218	142	160	187	217
T_6	39.2	41.2	40.4	84	102	128	155	66	81	107	135	74	93	119	147
$CD_{0.05}$	7.6	8.0	8.3	8.34	8.37	10.32	12.36	10.6	12.7	11.32	12.34	9.8	11.4	12.6	12.4

C1: Mallika, C2: Dashehari, C3: Amarpalli

T_1- Head back from first stem differentiation, T_2- Head back from second stem differentiation, T_3- Head back from third stem differentiation, T_4- Head back from fourth stem differentiation, T_5- Tip pruning, T_6-Unpruned tree (Control)

Table 2. Tree height under different pruning treatments

Treatment	Tree height (m)											
	C1				C2				C3			
	2009	2010	2011	2012	2009	2010	2011	2012	2009	2010	2011	2012
T_1	2.2	2.6	3.0	3.4	2.7	3.1	3.5	4.0	2.3	2.8	3.5	3.9
T_2	2.3	2.8	3.2	3.7	3.2	3.7	4.1	4.5	2.5	2.9	3.4	3.8
T_3	3.2	3.8	4.3	4.8	3.8	4.3	4.8	5.2	2.6	3.1	3.6	4.1
T_4	3.6	4.1	4.5	4.9	4.0	4.4	4.9	5.4	2.8	2.2	3.6	4.0
T_5	3.8	4.4	4.8	5.3	4.6	5.1	5.4	5.9	3.4	3.9	4.3	4.6
T_6	1.7	2.1	2.5	2.9	1.5	1.9	2.3	2.7	1.6	2.1	2.6	3.0
$CD_{0.05}$	0.6	0.7	0.7	0.6	0.8	0.7	0.7	0.8	0.6	0.7	0.6	0.7

C1: Mallika, C2: Dashehari, C3: Amarpalli

T_1- Head back from first stem differentiation, T_2- Head back from second stem differentiation, T_3- Head back from third stem differentiation, T_4- Head back from fourth stem differentiation, T_5- Tip pruning, T_6-Unpruned tree (Control)

Table 3. Average tree spread under different pruning treatments

Treatment	Average tree spread (m)											
	C1				C2				C3			
	2009	2010	2011	2012	2009	2010	2011	2012	2009	2010	2011	2012
T_1	1.6	2.0	2.4	3.0	1.7	2.1	2.6	3.2	1.8	2.2	2.5	3.2
T_2	1.8	2.5	3.0	3.5	1.9	2.3	2.7	3.3	2.0	2.3	2.6	3.2
T_3	2.1	2.4	2.9	3.4	2.2	2.6	3.0	3.5	2.3	2.8	3.1	3.7
T_4	2.4	2.8	3.2	3.6	2.5	2.8	3.2	3.8	2.5	2.9	3.3	3.9
T_5	2.6	2.9	3.4	4.0	2.9	3.3	3.6	4.2	3.0	3.3	3.7	4.3
T_6	1.6	1.9	2.3	2.8	1.5	1.8	2.2	2.6	1.6	1.9	2.3	2.9
$CD_{0.05}$	0.6	0.6	0.5	0.6	0.7	0.6	0.5	0.6	0.5	0.6	0.5	0.5

C1: Mallika, C2: Dashehari, C3: Amarpalli

T_1- Head back from first stem differentiation, T_2- Head back from second stem differentiation, T_3- Head back from third stem differentiation, T_4- Head back from fourth stem differentiation, T_5- Tip pruning, T_6-Unpruned tree (Control)

Table 4. Fruit set per plant under different pruning treatments

Treatment	Fruit set per plant								
	C1			C2			C3		
	2010	2011	2012	2010	2011	2012	2010	2011	2012
T_1	138	156	188	145	152	190	153	169	201
T_2	145	162	197	149	155	205	159	175	208
T_3	150	169	205	157	174	218	164	183	214
T_4	158	175	209	164	176	225	176	194	227
T_5	172	188	222	169	185	236	188	206	234
T_6	101	118	152	117	135	182	122	130	155
$CD_{0.05}$	13.1	16.5	18.4	11.4	14.6	18.7	14.4	16.7	18.2

C1: Mallika, C2: Dashehari, C3: Amarpalli

T_1- Head back from first stem differentiation, T_2- Head back from second stem differentiation, T_3- Head back from third stem differentiation, T_4- Head back from fourth stem differentiation, T_5- Tip pruning, T_6-Unpruned tree (Control)

Table 5. Fruit drop per plant under different pruning treatments

Treatment	Fruit drop per plant								
	C1			C2			C3		
	2010	2011	2012	2010	2011	2012	2010	2011	2012
T_1	18	30	47	22	35	48	15	26	42
T_2	16	25	43	19	31	45	13	22	39
T_3	15	26	40	16	28	41	11	21	37
T_4	13	23	37	14	26	38	11	20	35
T_5	11	20	34	12	24	36	10	19	33
T_6	23	35	52	26	42	58	28	29	46
$CD_{0.05}$	3.4	4.8	5.6	4.1	5.7	6.3	2.8	3.7	4.3

C1: Mallika, C2: Dashehari, C3: Amarpalli

T_1- Head back from first stem differentiation, T_2- Head back from second stem differentiation, T_3- Head back from third stem differentiation, T_4- Head back from fourth stem differentiation, T_5- Tip pruning, T_6-Unpruned tree (Control)

Table 6. Fruit drop per cent under different pruning treatments

Treatment	Fruit drop (%)								
	C1			C2			C3		
	2010	2011	2012	2010	2011	2012	2010	2011	2012
T_1	13.1	19.2	25	15.17	23	25.3	9.8	15.4	21
T_2	11	15.4	21.8	12.7	18.7	22	8.2	12.6	18.7
T_3	10	15.5	19.5	10.7	16.1	18.8	6.7	11.5	17.3
T_4	8.2	13.1	17.7	8.8	14.8	17.4	6.2	10.3	15.4
T_5	6.3	10.6	15.3	7.2	13	15.2	5.3	9.2	14.1
T_6	22.7	30	34.2	22.2	31.1	32	22.9	22.3	30
$CD_{0.05}$	4.8	5.3	6.8	4.9	5.4	6.3	4.2	5.2	6.0

C1: Mallika, C2: Dashehari, C3: Amarpalli

T_1- Head back from first stem differentiation, T_2- Head back from second stem differentiation, T_3- Head back from third stem differentiation, T_4- Head back from fourth stem differentiation, T_5- Tip pruning, T_6-Unpruned tree (Control)

Table 7. Fruit weight (gm per fruit) under different pruning treatments

Treatment	Fruit weight (gm per fruit)								
	C1			C2			C3		
	2010	2011	2012	2010	2011	2012	2010	2011	2012
T_1	450	448	452	328	330	324	412	410	414
T_2	455	455	458	335	334	330	418	420	422
T_3	462	460	456	340	338	335	426	429	421
T_4	471	471	468	348	450	352	435	438	430
T_5	486	490	490	356	358	360	445	442	440
T_6	435	438	435	310	312	315	395	402	404
$CD_{0.05}$	16.3	16.9	16.4	15.4	15.8	15.5	14.5	14.7	14.6

C1: Mallika, C2: Dashehari, C3: Amarpalli

T_1- Head back from first stem differentiation, T_2- Head back from second stem differentiation, T_3- Head back from third stem differentiation, T_4- Head back from fourth stem differentiation, T_5- Tip pruning, T_6-Unpruned tree (Control)

Table 8. Fruit yield (kg per plant) under different pruning treatment

Treatment	Fruit yield								
	C1			C2			C3		
	2010	2011	2012	2010	2011	2012	2010	2011	2012
T_1	50	74	104	40.3	72	89	57	74.5	102.1
T_2	58.7	83.4	109.1	43.5	66.4	91.1	61	80.1	105.6
T_3	62.5	88.8	114.8	48	73.2	99.7	65.2	84.6	110.2
T_4	68.3	95.6	119.4	52.2	77.8	104.2	72	92.4	117.1
T_5	79.2	107.1	128.8	56	81.9	109.1	78.2	98.7	123.2
T_6	34	51.2	70.4	28.2	53.6	70.8	37.1	55.2	80.1
$T_{0.05}$	9.3	11.4	12.3	6.5	7.9	8.8	8.8	9.7	10.7

C1: Mallika, C2: Dashehari, C3: Amarpalli

T_1- Head back from first stem differentiation, T_2- Head back from second stem differentiation, T_3- Head back from third stem differentiation, T_4- Head back from fourth stem differentiation, T_5- Tip pruning, T_6-Unpruned tree (Control)

due to shading by higher branches. Summerville (1996) suggested pruning and training of temperate fruit trees in order to provide the specific shape and canopy for stimulating the development of lateral branching that form reproductive spurs. This study also supports our results. From the present investigations it is concluded that different pruning treatments affected growth and fruit yield parameters variably in all the three cultivars of mango. However tip pruning (T_5), head back from the fourth (T_4), third (T_3) and second (T_2) stem differentiation in all the three cultivars produced significantly higher growth and fruit yield in comparison to unpruned (control) and head back from first stem differentiation (T_1) pruning treatments.

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Received: 6.3.2013 *Accepted: 15.5.2013*