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Effect of irrigation, pruning severity & nitrogen fertilization on tree growth of plum cv. Santa Rosa

Ashima Suklabaidya and Kuldeep Mehta

Abstract
An experiment was conducted to standardize the renewal pruning intensities under different irrigation & nitrogen levels for getting better growth in *Santa Rosa* plum trees. There were three irrigation levels, four pruning severities and two nitrogen levels. Pruning was done in the month of January every year. Pruning treatments exhibited a significant effect on tree growth during both the years of study. Irrigation at 20 per cent soil moisture depletion of field capacity resulted in higher tree growth, maximum trunk girth, tree spread and volume. The maximum increase in annual shoot growth and trunk girth was recorded in T_1 (75 % of HB) pruned trees, I_1 and N_1treatments whereas minimum was recorded in I_3, T_4 and N_2 treatment. Maximum tree spread was recorded in I_1, T_3 and N_1 treatment. Among the nitrogen fertilization treatments, maximum was recorded at N_1as compared to N_2. Interaction I_1T_1 had the maximum shoot growth (93.76cm), while I_1N_1 (67.04cm) had maximum trunk girth. Interactions, IxT and Ix N exerted a significant influence on tree spread.

Keywords: Plum trees, *Prunus salicina*, pruning, nitrogen fertilization, irrigation, tree growth

Introduction
Among the stone fruits, '*Santa Rosa*' plum (*Prunus salicina*) is one of the important fruit crop of the temperate regions. Efficient orchard management practices have a key role in enhancing the growth and productivity of plums. Pruning, nitrogen fertilization, and irrigation are important cultural practices that affect growth and vigour in plums.
Work on the standardization of plum and fertilizer requirement of plum have been conducted separately by several workers under different set of agro-climatic conditions, but virtually no work has been carried out to standardize the optimum levels of pruning, irrigation & N-fertilization for regular and quality production of *Santa Rosa* plum. Keeping these facts in view, the present studies were undertaken.

Materials and methods
The present studies were undertaken in the experimental orchard of Department of pomology, Dr. Y. S. Parmar University of Horticulture and Forestry, Solan (H.P) during 2010-2012. Seventy two trees of *Santa Rosa* plum with equal age and vigour, spaced at 6 m x 6 m were selected for trial purpose. The experiments was laid out in split-split plot design with, irrigation levels as the main plot, pruning levels as the Sub-plots and nitrogen levels as the Sub-Sub-plot treatment. The experimental unit consisted of a single tree. There were three irrigation levels, four pruning severities and two nitrogen levels with three replications.
Three irrigation levels are –
I_1 – Irrigation at 20 per cent soil moisture depletion of field capacity
I_2 – Irrigation at 40 per cent soil moisture depletion of field capacity
I_3 – Irrigation at 60 per cent soil moisture depletion of field capacity

There were four pruning severities –
T_1 – Heading back of scaffolds (75 percent)
T_2 – Heading back of scaffolds (50 percent)
T_3 – Heading back of scaffolds (25 percent)
T_4 – Normal pruning

i) Heading back of scaffolds 75%:- Shortening of scaffolds branches was done by 3/4th & consisted of 45 to 50 percent thinning out.
ii) Heading back of scaffolds 50%:- In this treatment the shortening of scaffolds branches was done by 1/2 and 45 to 50 percent thinning out.

iii) Heading back of scaffolds 25%:- It consists of shortening of shoots by 1/3rd and 45 to 50 percent thinning out.
iv) Normal pruning:- In this system recommended practice of pruning is followed. Pruning was done in January every year.

Two nitrogen levels - N1, & N_2

N_1 – 75 percent additional nitrogen of recommended dose as CAN

N_2 – 50 percent additional nitrogen of recommended dose as CAN

Results and Discussion

The results obtained from the present investigation are summarized bellow (Table- 1to 3). Application of different levels of irrigation significantly affected annual shoot growth and trunk girth during both the years of study. Pooled data showed that maximum shoot growth (86.83 cm) and trunk girth (66.10 cm) was recorded in I_1 treatment while the minimum shoot growth (50.88 cm) and trunk girth (52.04cm) was recorded in I_3 treatment (Table 1a).

Pruning treatment had significant impact on shoot growth, and it was highest in T_1 treatment (75.89 cm) whereas, lowest shoot growth occurred in T_4 (normal pruning) treatment with 63.86 cm as the pooled value. The maximum trunk girth (60.28 cm) was recorded in treatment T_1 while minimum trunk girth (56.88 cm) was recorded in T_4 treatment (normal pruning). So far as the nitrogen fertilization is concerned, N_1 level of nitrogen recorded the maximum shoot growth and trunk girth, which was statistically better than the other N_2 treatment.

The interaction values between IxT, IxN and TxN are given in Table 1b. The pooled value for IxT was found to be non-significant however maximum shoot growth (93.76 cm) was recorded in I_1T_1 and minimum (45.60 cm) in I_3T_4, and all pooled interaction values differed statistically from each other and maximum shoot growth (90.62 cm) was recorded in I_1N_1 and minimum (45.95 cm) in I_3N_2 treatment. During both the years of investigations, it was observed that I x N had significant effects on trunk girth. The maximum girth (67.04 cm) was observed in I_1N_1 and minimum (51.70 cm) in I_3N_2 interaction, and all the IxN interaction values varied statistically but TxN had significant effect.

Interaction between different levels of pruning and N fertilization (T x N) in respect to annual shoot growth was also found significant during both the years of investigation. The data on the effect of interaction among irrigation, pruning and N fertilization (I x T x N) are presented in Table 1c. The second order interactions were found to be non-significant during both the years of study. The maximum girth (67.04 cm) was observed in I_1N_1 and minimum (51.70 cm) in I_3N_2 interaction, and all the IxN interaction values varied statistically but TxN had significant effect.

There were significant differences in growth and vigour of trees subjected under different soil moisture regimes. Trees irrigated at 20 per cent soil moisture depletion of field capacity attained more shoot growth, girth, spread, volume and pruning wood weight as compared to other irrigation treatments (Table 1 to 3). Although the growth and vigour was slightly lower in trees, which were irrigated at 40 per cent soil moisture depletion of field capacity than those irrigated at 20 per cent soil moisture depletion of field capacity, but was significantly higher than 60 per cent under frequent irrigation treatments i.e. 20 and 40 per cent soil moisture depletion (SMD) of field capacity. The soil moisture was with the range of readily available to the trees during the growing period and there were also more uptakes of nutrients (Tables 1 to 3). This might have accounted for higher growth of trees grown under these treatments in present study. These findings are supported by the earlier reports of Tagi (1984) [7] who recorded more vegetative growth in terms of tree height and volume due to different levels of irrigation in Santa Rosa plum. Attainment of more plant height by the plants while irrigating at 20% of SMD of field capacity could be attributed to the fact that under higher soil moisture levels the absorption and translocation of all the macro and micronutrients is significantly higher.

Under frequent irrigation treatments i.e. 20 and 40 % SMD of field capacity, the soil moisture was within the range of readily available to the trees during the growing period and there was also more uptakes of nutrients which might have accounted for higher growth of trees grown under these treatments in the present study. These findings are supported by the earlier reports of Nawar and Ezz (1993) [4], who reported more height and shoot length of apricot trees, which were irrigated at 85 per cent of field capacity.

Trees subjected to 60 per cent soil moisture depletion of field capacity irrigation treatments attained less growth and vigour in terms of height, spread volume, trunk girth, shoot growth and leaf area. Under this treatments, the soil moisture was depleted to the levels at which they were not easily available to the trees and resulted in the development of water stress conditions especially during the active growing period. The said water stress conditions interfere with cell division and may have reduced stem elongation as observed by Hsiao (1973) [1].

Table 1a: Effect of different levels of irrigation, pruning and nitrogen on annual shoot growth (cm) and trunk girth (cm)

Treatments	Annual shoot growth (cm)			Trunk girth (cm)		
	2010-11	2011-12	pooled	2010-11	2011-12	pooled
Irrigation levels (Main Plot Treatment)						
I_1 (20% SMD of field capacity)	84.82	88.83	86.83	65.57	66.62	66.10
I_2 (40% SMD of field capacity)	67.37	72.39	69.88	56.89	57.83	57.36
I_3 (60% SMD of field capacity)	47.41	54.36	50.88	51.54	52.53	52.04
$CD_{0.05}$	4.64	5.96	5.24	0.79	0.87	0.82
Pruning (Sub plot treatment)						
T_1 (HB of scaffolds 75%)	73.33	78.46	75.89	60.70	59.85	60.28
T_2 (HB of scaffolds 50%)	67.62	73.44	70.53	58.57	59.45	59.01
T_3 (HB of scaffolds 25%)	63.96	69.06	66.51	57.44	58.39	57.91
T_4 (Normal Pruning)	61.23	66.49	63.86	56.32	57.26	56.88
$CD_{0.05}$	2.90	2.21	2.33	0.57	0.63	0.59
Nitrogen (Sub-sub plot treatment)						
N_1 (75% additional N as CAN)	71.80	76.27	74.04	58.87	59.97	59.42
N_2 (50% additional N as CAN)	61.27	67.46	64.36	57.13	58.01	57.57
$CD_{0.05}$	1.83	1.15	1.18	0.27	0.34	0.29

Table 1b: Effect of different interactions I x T, I x N and T x N on annual shoot growth (cm) and trunk girth (cm)

	Annual Shoot growth (cm)			Trunk girth (cm)		
Interactions	**2010-11**	**2011-12**	**Pooled**	**2010-11**	**2011-12**	**Pooled**
I_1T_1	92.53	95.00	93.76	67.85	66.84	68.35
I_1T_2	86.26	90.80	88.53	66.02	68.77	68.31
I_1T_3	80.86	86.09	83.48	64.58	65.77	65.18
I_1T_4	79.63	83.45	81.54	63.85	65.09	64.47
I_2T_1	72.40	77.63	75.01	57.55	58.39sss	57.97
I_2T_2	68.93	73.70	71.31	58.84	59.61	59.23
I_2T_3	66.51	71.01	68.76	56.30	57.40	56.85
I_2T_4	61.65	67.23	64.44	54.87	55.93	55.40
I_3T_1	55.06	62.74	58.90	52.16	53.10	52.63
I_3T_2	47.65	55.83	51.74	52.86	53.71	53.29
I_3T_3	44.51	50.07	47.29	50.91	51.99	51.45
I_3T_4	42.40	48.79	45.60	50.25	51.30	50.77
$CD_{0.05}$	N S	5.07	NS	0.63	NS	NS
I_1N_1	89.37	91.87	90.62	66.42	67.67	67.04
I_1N_2	80.27	85.79	83.03	64.73	65.57	65.15
I_2N_1	72.90	78.43	75.67	58.36	59.37	58.86
I_2N_2	61.84	66.36	64.10	55.42	56.30	55.86
I_3N_1	53.14	58.50	55.82	51.85	52.89	52.37
I_3N_2	41.68	50.22	45.95	51.24	52.16	51.70
$CD_{0.05}$	N S	2.00	2.04	0.47	0.58	0.51
T_1N_1	75.96	81.96	78.96	60.57	61.57	61.07
T_1N_2	70.70	74.96	72.83	57.72	58.42	58.07
T_2N_1	73.02	76.90	74.96	60.47	59.43	59.95
T_2N_2	62.21	69.98	66.10	59.13	59.83	59.48
T_3N_1	71.08	74.52	72.80	58.22	59.37	58.80
T_3N_2	56.85	63.60	60.22	56.30	57.40	56.85
T_4N_1	67.15	71.69	69.42	57.27	58.48	57.87
T_4N_2	55.30	61.29	58.29	55.38	56.40	55.89
$CD_{0.05}$	3.17	2.30	2.36	0.54	NS	0.58

Table 1c: Effect of irrigation, pruning and nitrogen fertilization (I x T x N) on annual shoot growth (cm) and trunk girth (cm)

	Annual Shoot growth (cm)			Trunk girth (cm)		
Interactions	**2010-11**	**2011-12**	**Pooled**	**2010-11**	**2011-12**	**Pooled**
$T_1N_1I_1$	95.91	98.25	97.08	66.81	68.06	67.46
$T_2N_1I_1$	91.66	93.97	92.81	68.47	69.47	68.97
$T_3N_1I_1$	87.18	89.96	88.57	65.55	66.92	66.23
$T_4N_1I_1$	82.73	85.31	84.02	64.85	66.20	65.53
$T_1N_2I_1$	89.15	91.75	90.45	65.22	65.62	65.42
$T_2N_2I_1$	80.87	87.63	84.25	67.23	68.07	67.65
$T_3N_2I_1$	74.55	82.22	78.39	63.62	64.62	64.12
$T_4N_2I_1$	76.53	81.58	79.05	62.85	63.98	63.41
$T_1N_1I_2$	76.31	82.39	79.35	59.13	59.98	59.56
$T_2N_1I_2$	73.59	78.42	76.00	60.10	61.14	60.62
$T_3N_1I_2$	72.88	77.77	75.32	57.84	58.83	58.34
$T_4N_1I_2$	68.82	75.15	71.99	56.35	57.51	56.93
$T_1N_2I_2$	68.48	72.87	70.67	55.96	56.80	56.38
$T_2N_2I_2$	64.27	68.98	66.62	57.59	58.09	57.84
$T_3N_2I_2$	60.14	64.26	62.20	54.76	55.97	55.36
T_4N_2I2	54.47	59.31	56.89	53.39	54.34	53.86
$T_1N_1I_3$	55.66	65.24	60.45	52.35	53.37	52.86
$T_2N_1I_3$	53.80	58.32	56.06	53.16	54.11	53.63
$T_3N_1I_3$	53.18	55.84	54.51	51.28	52.36	51.82
$T_4N_1I_3$	49.90	54.62	52.26	50.60	51.72	51.16
$T_1N_2I_3$	54.47	60.25	57.36	51.96	52.84	52.40
$T_2N_2I_3$	41.51	53.34	47.42	52.57	53.31	52.94
$T_3N_2I_3$	35.85	44.31	40.08	50.53	51.62	51.07
$T_4N_2I_3$	34.90	42.97	38.94	49.90	50.85	50.39
$CD_{0.05}$	N S	N S	N S	NS	NS	NS

These findings are in conformity with those of Vavra (1969) [10], who reported that the soil moisture content below 60 per cent of field capacity over a prolonged period reduced the height and shoot growth of peach trees. Torrecillas *et al*. (1989) [8] also observed that the water stress conditions reduced the trunk cross sectional and canopy area of almond tree**.** Maximum tree spread and volume was recorded in trees irrigated at 20 per cent soil moisture depletion of field capacity. In pruning treatments, maximum tree spread and volume was in T_3 treatment. Interactions, IxT and IxN exerted a significant influence on tree spread. Maximum tree spread was observed in I_1T_3 (55.10 cm) and highest tree volume in I_1N_1 (17.05 cm) interaction.

Table 2a: Effect of different levels of irrigation, pruning and nitrogen on increase in tree spread (cm) and tree volume (m^3)

Treatments	Increase in tree spread (cm)			Tree volume (m^3)		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Irrigation levels (Main Plot Treatment)						
I_1 (20% SMD of field capacity)	50.44	52.34	51.39	16.14	17.00	16.57
I_2 (40% SMD of field capacity)	45.39	46.71	46.05	15.28	15.76	15.52
I_3 (60% SMD of field capacity)	33.44	37.70	35.57	14.61	15.19	14.90
$CD_{0.05}$	0.73	1.24	0.65	0.51	0.48	0.47
Pruning (Sub plot treatment)						
T_1 (Heading back of scaffolds 75%)	40.41	42.06	41.68	14.85	15.64	15.24
T_2 (Heading back of scaffolds 50%)	42.26	44.66	43.46	15.23	15.89	15.56
T_3 (Heading back of scaffolds 25%)	45.90	48.27	47.09	15.70	16.29	16.00
T_4 (Normal Pruning)	43.80	46.45	45.12	15.59	16.11	15.85
$CD_{0.05}$	0.71	0.68	0.56	0.18	0.02	0.17
Nitrogen (Sub-sub plot treatment)						
N_1 (75% additional N as CAN)	45.19	47.37	46.28	15.60	16.32	15.96
N_2 (50% additional N as CAN)	40.99	43.80	42.40	15.09	15.64	15.36
$CD_{0.05}$	0.49	0.62	0.47	0.12	0.14	0.10

Table 2b: Effect of different interactions I x T, I x N and T x N on increase in tree spread (cm) and tree volume (m^3)

	Increase in tree spread (cm)			Tree volume (m^3)		
Interactions	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
I_1T_1	49.42	51.12	50.27	15.67	16.65	16.16
I_1T_2	51.00	53.62	52.31	16.04	19.98	16.51
I_1T_3	54.25	55.94	55.10	16.46	17.28	16.87
I_1T_4	47.09	48.67	47.88	16.37	17.07	16.72
I_2T_1	47.30	48.88	48.09	14.89	15.33	15.11
I_2T_2	45.91	47.13	46.52	15.23	15.68	15.45
I_2T_3	44.98	46.10	45.54	15.58	16.08	15.83
I_2T_4	43.37	44.73	44.05	15.44	15.96	15.70
I_3T_1	30.76	35.47	33.11	13.99	14.94	14.46
I_3T_2	34.48	38.59	36.53	14.43	15.01	14.72
I_3T_3	32.38	36.75	34.56	15.05	15.51	15.28
I_3T_4	36.16	39.99	38.07	14.97	15.29	15.13
$CD_{0.05}$	1.63	1.56	1.29	NS	NS	NS
I_1N_1	51.52	52.87	52.20	16.48	17.62	17.05
I_1N_2	49.36	51.81	50.58	15.79	16.38	16.08
I_2N_1	47.86	49.00	48.43	15.53	15.96	15.75
I_2N_2	42.92	44.42	43.67	15.04	15.56	15.30
I_3N_1	36.19	40.23	38.21	14.80	15.39	15.09
I_3N_2	30.70	35.16	32.93	14.42	14.99	14.71
$CD_{0.05}$	0.85	1.08	0.81	NS	0.23	0.17
T_1N_1	38.45	41.14	39.80	15.22	16.03	15.63
T_1N_2	40.12	42.55	41.33	14.48	15.25	14.86
T_2N_1	41.66	45.18	43.42	15.57	16.24	15.90
T_2N_2	42.37	44.77	43.57	14.90	15.54	15.22
T_3N_1	48.07	50.22	49.14	15.86	16.63	16.24
T_3N_2	45.94	47.72	46.83	15.54	15.96	15.75
T_4N_1	44.39	46.77	45.58	15.76	16.39	16.08
T_4N_2	43.74	46.32	45.03	15.43	15.82	15.63
$CD_{0.05}$	NS	NS	NS	0.23	NS	NS

Table 2c: Effect of irrigation, pruning and nitrogen fertilization (I x T x N) on increase in tree spread (cm) and tree volume (m^3)

	Increase in tree spread (cm)			Tree volume (m^3)		
Interactions	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
$T_1N_1I_1$	16.19	17.31	16.75	16.19	17.31	16.75
$T_2N_1I_1$	16.46	17.58	17.02	16.46	17.58	17.02
$T_3N_1I_1$	16.68	17.94	17.31	16.68	17.94	17.31
$T_4N_1I_1$	16.59	17.64	17.11	16.59	17.64	17.11
$T_1N_2I_1$	15.15	15.98	15.56	15.15	15.98	15.56
$T_2N_2I_1$	15.61	16.38	16.00	15.61	16.38	16.00
$T_3N_2I_1$	16.25	16.63	16.44	16.25	16.63	16.44
$T_4N_2I_1$	16.15	16.51	16.33	16.15	16.51	16.33
$T_1N_1I_2$	15.13	15.49	15.31	15.13	15.49	15.31
$T_2N_1I_2$	15.47	15.84	15.65	15.47	15.84	15.65
$T_3N_1I_2$	15.82	16.33	16.08	15.82	16.33	16.08

$T_4N_1I_2$	15.69	16.20	15.94	15.69	16.20	15.94
$T_1N_2I_2$	14.65	15.17	14.91	14.65	15.17	14.91
$T_2N_2I_2$	14.99	15.52	15.25	14.99	15.52	15.25
$T_3N_2I_2$	15.34	15.84	15.59	15.34	15.84	15.59
T_4N_2I2	15.18	15.72	15.45	15.18	15.72	15.45
$T_1N_1I_3$	14.35	15.29	14.82	14.35	15.29	14.82
$T_2N_1I_3$	14.77	15.30	15.04	14.77	15.30	15.04
$T_3N_1I_3$	15.07	15.63	15.35	15.07	15.63	15.35
$T_4N_1I_3$	14.99	15.34	15.17	14.99	15.34	15.17
$T_1N_2I_3$	13.63	14.59	14.11	13.63	14.59	14.11
$T_2N_2I_3$	14.10	14.73	14.41	14.10	14.73	14.41
$T_3N_2I_3$	15.02	15.40	15.35	15.02	15.40	15.35
$T_4N_2I_3$	14.95	15.24	15.09	14.95	15.24	15.09
$CD_{0.05}$	NS	NS	NS	NS	NS	NS

The maximum increase in spread (51.39 cm) and tree volume (16.57 m^3) at 20 per cent soil moisture depletion of field capacity and the minimum was observed in trees that received 60 per cent depleted soil moisture.
The maximum increase in spread (47.09 cm) and tree volume (16.00 m^3) was found in T_3 treatment while minimum increase in spread (41.68 cm) and tree volume (15.24 m^3) was observed in T_1 treatment. The nitrogen fertilization treatment N_1 registered an increase of 46.28 cm in tree spread as compared to 42.40 cm in N_2 treatment. The irrigation and pruning (I x T) interaction were found to be significant during both the years. The interaction between irrigation and nitrogen fertilization (I x N) had marked influence on tree spread. The first order (T x N) and the second order interaction (I x T x N) was non- significant during both the years for tree spread. Different levels of irrigation and pruning (I x T) had non-significant effect on the tree volume (Table 2b). The pooled data showed that the other first order interaction (I x N) had significant effect on tree volume. The maximum tree volume (17.05 m^3) was observed in I_1N_1 and the minimum (14.71 m^3) was observed in I_3N_2 interaction.
Interaction between pruning and nitrogen fertilization (T x N), was significant during the first year and non-significant during the subsequent year. For tree volume second order interaction (I x T x N) was found to be non-significant during both the years.

Table 3a: Effect of different levels of irrigation, pruning and nitrogen on pruned wood weigh (kg tree^{-1})

Treatments	**Pruned wood weight (kg tree^{-1})**		
	2010-11	**2011-12**	**Pooled**
Irrigation levels (Main Plot Treatment)			
I_1 (20% SMD of field capacity)	12.59	6.31	9.45
I_2 (40% SMD of field capacity)	10.10	5.51	7.80
I_3 (60% SMD of field capacity)	8.59	5.09	6.84
$CD_{0.05}$	0.53	0.12	0.28
Pruning (Sub plot treatment)			
T_1 (Heading back of scaffolds 75%)	16.77	6.35	11.57
T_2 (Heading back of scaffolds 50%)	10.55	5.82	8.19
T_3 (Heading back of scaffolds 25%)	7.83	5.35	6.59
T_4 (Normal Pruning)	6.55	5.02	5.78
$CD_{0.05}$	0.48	0.14	0.25
Nitrogen (Sub-sub plot treatment)			
N_1 (75% additional N as CAN)	10.89	5.94	8.41
N_2 (50% additional N as CAN)	9.96	5.33	7.65
$CD_{0.05}$	0.40	0.09	0.19

Table 3b: Effect of different interactions I x T, I x N and T x N on pruned wood weight (kg/ tree)

Interactions	**2010-11**	**2011-12**	**Pooled**
I_1T_1	20.58	7.49	14.04
I_1T_2	12.36	6.72	9.54
I_1T_3	9.61	5.84	7.72
I_1T_4	7.80	5.21	6.50
I_2T_1	16.27	6.09	11.18
I_2T_2	10.37	5.60	7.98
I_2T_3	7.63	5.29	6.46
I_2T_4	6.11	5.07	5.59
I_3T_1	13.47	5.48	9.47
I_3T_2	8.92	5.15	7.03
I_3T_3	6.26	4.93	5.60
I_3T_4	5.73	4.78	5.26
$CD_{0.05}$	0.28	0.22	0.38
I_1N_1	13.30	6.94	10.12
I_1N_2	11.88	5.69	8.78
I_2N_1	10.45	5.53	7.99
I_2N_2	9.74	5.50	7.62

I_3N_1	8.91	5.35	7.13
I_3N_2	8.82	4.82	6.55
$CD_{0.05}$	NS	0.10	0.22
T_1N_1	17.55	6.79	12.17
T_1N_2	16.00	5.92	10.96
T_2N_1	10.90	6.20	8.55
T_2N_2	10.20	5.45	7.82
T_3N_1	8.32	5.62	6.97
T_3N_2	7.35	5.08	6.21
T_4N_1	6.77	5.14	5.96
T_4N_2	6.32	4.89	5.61
$CD_{0.05}$	NS	0.12	0.26

Table 3c: Effect of irrigation, pruning and nitrogen fertilization (I x T x N) on pruned wood weight (kg/ tree)

Interactions	2010-11	2011-12	Pooled
$T_1N_1I_1$	21.70	8.34	15.02
$T_2N_1I_1$	12.74	7.61	10.17
$T_3N_1I_1$	10.63	6.41	8.52
$T_4N_1I_1$	8.14	5.40	6.77
$T_1N_2I_1$	19.46	6.64	13.05
$T_2N_2I_1$	11.99	5.84	8.91
$T_3N_2I_1$	8.59	5.26	6.93
$T_4N_2I_1$	7.46	5.01	6.24
$T_1N_1I_2$	16.88	6.37	11.62
$T_2N_1I_2$	10.59	5.69	8.13
$T_3N_1I_2$	7.93	5.18	6.55
$T_4N_1I_2$	6.39	4.89	5.64
$T_1N_2I_2$	15.66	5.82	10.74
$T_2N_2I_2$	10.15	5.52	7.83
$T_3N_2I_2$	7.33	5.40	6.36
T_4N_2I2	5.82	5.25	5.54
$T_1N_1I_3$	14.06	5.68	9.87
$T_2N_1I_3$	9.38	5.32	7.35
$T_3N_1I_3$	6.40	5.27	5.84
$T_4N_1I_3$	5.79	5.14	5.46
$T_1N_2I_3$	12.87	5.29	9.08
$T_2N_2I_3$	8.46	4.98	6.72
$T_3N_2I_3$	6.12	4.59	5.36
$T_4N_2I_3$	5.68	4.42	5.05
$CD_{0.05}$	NS	0.22	NS

Pooled data of both the years showed that trees irrigated at 20 per cent soil moisture depletion of field capacity registered the maximum weight of pruned wood (9.45 kg/tree). Pooled data on pruning intensities revealed that heavily pruned trees produced significantly more pruning wood weight than medium, light and normal pruned trees (Table 5a).Nitrogen fertilization treatment had a significant effect on pruning wood weight. N_1 treatment had (8.41 kg/tree) weight of pruning wood whereas N_2 treatment had (7.65 kg/tree).

First order interactions between IxT, IxN and TxN were significant. Maximum weight of pruning wood (14.04 kg/tree) was obtained from I_1T_1 whereas the minimum (5.26 kg/tree) was obtained from I_3T_4 interaction which was statistically at par with I_3T_3 and I_2T_4.

The effect of irrigation and nitrogen fertilization (IxN) interaction was non-significant during the first year of study, but was significant during the subsequent year (Table 3b). Maximum pruned wood weight (10.12 kg/tree) was recorded with I_1N_1 interaction and the minimum pruning wood weight (6.55 kg/tree) was in I_3N_2. In TxN interaction highest pruning wood weight (12.17 kg/tree) was recorded in T_1N_1 and minimum (5.61 kg/tree) was recorded in T_4N_2 interaction.

The data depicted in Table 3c revealed that ((I x T x N) interaction did not exhibit any significant influence on pruning wood weight of plum trees during the first year of study. Such effects however, were statistically significant during the year 2011-12 and highest pruned wood weight (8.34 kg/tree) was observed in $T_1N_1I_1$ followed by $T_2N_1I_1$ interaction and was lowest (4.42 kg/tree) in $T_4N_2I_3$.

Tree growth vigour was also influenced significantly by pruning treatments during both the years of study. Increased shoot growth with the increase in pruning severity as observed in the present study has also been reported by different workers (Kanwar, 1979 and Singh, 1992) [3, 5]. When the shoots were shortened to different lengths, the new terminals become longer with the increased shoot shortening (Jonkers, 1982) [2]. Growth responses of pruning can be attributed to certain physiological changes particularly altered hormonal and nutritional translocation pattern in the tree (Sharma 1995) [6]. Increase uptake on N, P and K was observed in the present study which might be one of the contributory factors towards increased shoot growth in heavily pruned trees. The higher trunk girth was recorded in heavily pruned trees, which was significantly higher than heading back of scaffolds 50 %, 25 % and normal pruning treatment. The heavily pruned trees had significantly longer shoots than other pruning treatments. The increase in growth is primarily a function of greater availability of photosynthates and nutrients in the heavily pruned trees as with the increase in severity of pruning there was proportionate reduction in the number of vegetative buds likely to develop into new shoot, thereby reducing competition for carbohydrates and other metabolites. Kanwar (1979) [3] and Singh (1992) [5] also observed a significant increase in trunk girth and pruned wood weight in Flordasun and July Elberta peaches that were heavily pruned. The increase in tree spread and volume was highest in lightly pruned trees, which decreased with increase in pruning severity. Increase in volume and spread due to light pruning in Elberta cultivar of peach has been reported by Sharma (1995) [6]. Similar results have also been reported by Thakur (1993) [9] in July Elberta peach.

Conclusions

Annual shoot growth, trunk girth tree spread, tree volume and pruned wood were significantly affected by different levels of irrigation, pruning and nitrogen fertilization. Maximum tree growth was obtained from $I_{1,}$ T_1 and N_1 treatments whereas minimum was found in $I_{3,}$ T_4 and N_2 treatments. Different interactions also exerted significant impact on all the growth characteristics during both the years of study.

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