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Absorbed photosynthetically active radiation under different moisture regimes in aonla and aonla+guava cropping system

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ABSTRACT

An experiment was conducted at Horticultural Research Farm of N.D. University of Agriculture & Technology, Faizabad during Oct,2001 to June,2002 to study the Absorbed photosynthetically active radiation under different moisture regimes in aonla and aonla+guava cropping system. Results revealed that moisture regimes produced significant variation initially on the shoot length of Aonla plant while frequency of drip irrigation had significant effect on shoot length of Aonla at 15,45,60 and 75 days of observation. Plants irrigated at 3 day interval produced significantly higher shoot length followed by 7 day interval. Shoot growth rate was significantly affected due to moisture regimes at all the stages. Lowest shoot growth rate were recorded in 7 day interval of irrigation. Higher APARp (62.25 and 82.07 μ mole S^{-1} m^{-2}) and higher APARs (246.81 and 270.28μ mole $s^{-1}m^{-2}$) were recorded at 0.8 IW/CPE of moisture regimes followed by 0.6 ratio Irrigation trickled at 3 day interval produced highest APARp and APARs value irrespective of different moisture regimes.

Key Words: APAR, moisture regimes, drip irrigation, frequency of irrigation, shoot length.

Aonla (*Emblica officinalis G*) is an important and indigenous fruit crop. It is more popular in India and commercially cultivated in Uttar Pradesh. Its fruits are a rich source of vitamin 'C' (600 mg/100g) and mineral like iron (1.2%). Aonla tree is not much affected either by hot winds or frost, however older trees are damaged with frost (Gangwar *et.al.* 1975). The mature trees can tolerate temperature as high as 46°C (Shanker, 1969). They need optimum temperature 25-30°C and clear sunny days for their vigorous growth. The drip irrigation system excels all the other methods in which every drop of water is judiciously utilized within the root zone of the plants. It has been reported as the best irrigation method for arid and semi arid situations (Goldberg and Shmueli, 1970) in conserving soil moisture and regulating the soil temperature. The water saving by drip irrigation ranges from 40 to 70 per cent over surface irrigation and water use efficiency is as high as 80 to 90 per cent and a large area can be irrigated with same amount of water. Keeping above facts in view present investigation was undertaken.

MATERIALS AND METHODS

An experiment was conducted at Horticultural Research Farm of N.D. University of Agriculture & Technology, Faizabad (U.P.) from Oct,2001 to June,2002. Experimental site is situated at a latitude 26°47', longitude 82°12' and an altitude of 113 MSL. NA.-7 variety of aonla was cropped in different treatments. The experiment was laid out in factorial randomized block design with 12 treatments comprising of four moisture regimes (0.2, 0.4, 0.6 and 0.8 IW/CPE) and three irrigation frequencies (3, 5 and 7 days interval) and a control (conventional method). Treatments were replicated three times. In drip system the irrigation was applied on the basis of IW/ CPE ratio.

Where,

IW= Irrigation water depth (mm); CPE=cumulative pan evaporation (mm).

The amount of water applied was computed as the ratio of IW over CPE for different frequencies and irrigation regimes as per the following formula;

Quantity of water (litre) = size of basin (m^2) x irrigation water depth (mm) where, size of basin = 2.5m x 2.5m (6.25m^2) irrigation water depth = IW/CPE X CPE. In conventional system irrigation were given at 40% depletion of available soil moisture.

Shoot length of Aonla plant was measured at 15 days interval from 15th Oct. onwards closely from node to growing tips with the help of measuring tape. Shoot growth rate (SGR) was calculated by formula given below;

$$SGR\ (cm\ day^{-1}) = L_2 - L_1 / D_2 - D_1$$

Where,

L_1, L_2 = Shoot length at the time D_1 and D_2; D_2-D_1 = Time interval in days. Soil moisture content from 10cm. and 20cm. depth was recorded in percentage with infrared soil moisture balance (Tanko make) during winter and summer seasons.

Light was recorded with the help of Lux meter one meter above the canopy and at 90 per cent of height of Aonla tree. Reflection of light from canopy and soil was recorded at 30 cm height before and 24 hours after the irrigation during both winter and summer seasons. The values of light (Kilo Lux) were converted into solar radiation in μ mole s^{-1} m^{-2} and by multiplying with 19.5 (Rosenthal *et.al.* 1991). Photosynthetically Active Radiation (PAR) was calculated by following formula;

$$PAR = 0.48 \times \text{solar radiation}\ (\mu\ \text{mole}\ s^{-1}\ m^{-2})$$

$$APARp = PARo - (PARr + PAR_T) + PARrs$$

Where,

APARp = Absorbed photosynthetically active radiation by plants; PARo=Incident photosynthetically active radiation on the canopy; PARr = Reflected radiation from plant (above canopy); PAR_T= Radiation within the canopy; PARrs = Radiation reflected by the soil

Absorbed photosynthetically active

Table 1: Effect of moisture regimes and frequency of drip irrigation on the shoot length at successive stages of Aonla plant

Treatments	Shoot length (cm)					
	0 days	15 days	30 days	45 days	60 days	75 days
Moisture regimes						
0.2 IW/CPE	67.36	71.49	73.87	74.58	74.85	74.90
0.4 "	63.28	67.62	70.25	71.26	71.68	71.72
0.6 "	57.87	62.03	67.86	69.56	70.45	70.48
0.8 "	70.11	74.78	77.41	78.85	79.38	79.51
CD 5%	14.43	NS	NS	NS	NS	NS
Irrigation frequencies						
3rd day	72.48	76.88	79.35	80.88	81.69	81.82
5th day	55.73	59.94	63.26	64.67	65.00	65.10
7th day	66.5	70.13	72.27	72.68	72.78	72.79
CD 5%	NS	12.98	NS	12.47	12.48	12.48
Surface irrigation	68.17	71.92	73.92	75.42	75.58	75.60

* 0 day – indicates starting of observation i.e. 15th Oct.

Table 2: Shoot growth rate (cm day^{-1}) of Aonla plant.

Treatments	0-15 days	15-30 days	30-45 days	45-60 days	60-75 days
Moisture regimes					
0.2 IW/CPE	0.27	0.15	0.04	0.01	0.006
0.4 "	0.28	0.17	0.06	0.02	0.002
0.6 "	0.27	0.38	0.11	0.05	0.002
0.8 "	0.31	0.17	0.09	0.03	0.008
Irrigation frequencies					
3rd day	0.29	0.16	0.10	0.04	0.008
5th day	0.28	0.20	0.09	0.02	0.006
7th day	0.24	0.17	0.02	0.01	0.001
Surface irrigation	0.25	0.13	0.10	0.01	0.001

radiation by soil (APARs) = PAR_T –PARrs

RESULTS AND DISCUSSION

The moisture regimes produced significant variation on the shoot length of Aonla plant initially while it was significantly affected due to frequency of drip irrigation at 15,45,60 and 75 days stage (Table 1). Plants irrigated at 3 day interval produced significantly higher shoot length followed by 7 day treatment. While lowest shoot length were recorded at 5 day interval of irrigation frequency shoot growth rate was significantly affected due to moisture

Table 3: Photosynthetically active radiation (PAR) at different canopy levels of Aonla plant under moisture regimes and frequency of drip irrigation

Treatments	Before irrigation				After irrigation			
	PARo	PAR_T	PARrs	PARr	PARo	PAR_T	PARrs	PARr
Summer season								
Moisture regimes								
0.2 IW/CPE	374.98	278.51	34.28	56.52	377.82	281.46	30.85	52.01
0.4 IW/CPE	376.03	280.34	32.61	54.09	381.34	286.78	28.48	46.67
0.6 IW/CPE	379.25	284.78	30.53	51.65	387.00	290.06	26.12	41.77
0.8 IW/CPE	382.05	285.83	27.79	49.84	391.66	294.72	24.44	38.65
SEm±	0.48	0.75	0.34	0.47	0.35	0.19	0.78	0.69
CD at 5%	NS	NS	0.94	1.37	1.05	0.56	2.28	2.02
Irrigation frequencies								
3rd day	383.81	284.81	28.36	48.26	392.78	392.40	25.34	39.33
5th day	380.59	282.51	29.72	52.40	388.02	287.81	27.46	48.70
7th day	377.73	278.90	31.45	56.60	381.36	281.72	29.58	52.57
SEm±	0.86	0.65	0.29	0.40	0.41	0.68	0.74	0.60
CD at 5%	NS	NS	0.84	NS	NS	1.97	2.24	1.75
Surface irrigation	375.40	280.00	33.33	54.28	393.10	293.55	23.60	38.14
SEm±	2.11	1.59	0.72	0.99	0.99	1.47	0.75	0.40
CD ar 5%	NS	NS	2.06	2.91	2.91	4.30	2.18	1.19
Winter season								
Moisture regimes								
0.2 IW/CPE	330.40	252.41	28.66	49.86	336.68	256.73	25.57	46.81
0.4 IW/CPE	331.82	254.30	26.08	47.54	339.56	259.52	23.87	43.26
0.6 IW/CPE	334.70	256.08	23.30	44.35	343.05	262.92	21.36	39.96
0.8 IW/CPE	338.02	258.40	21.91	43.79	346.34	266.41	19.60	37.28
SEm±	1.30	1.08	0.47	0.43	0.51	0.63	0.71	0.59
CD at 5%	NS	NS	1.39	1.27	NS	1.87	2.11	1.78
Irrigation frequencies								
3rd day	339.09	258.04	20.98	42.15	346.87	265.80	18.91	37.06
5th day	334.23	253.94	22.57	44.13	34270	263.17	20.45	40.30
7th day	330.43	248.60	25.15	46.32	339.26	261.87	23.35	44.06
SEm±	1.99	0.41	0.12	0.37	0.44	0.55	0.93	0.62
CD at 5%	NS	NS	0.37	1.09	1.29	1.62	2.75	1.87
Surface irrigation	335.43	258.85	24.89	45.89	346.92	266.12	17.61	36.32
SEm±	1.55	1.80	0.84	0.74	0.85	0.72	0.93	1.08
CD at 5%	NS	NS	2.39	2.16	NS	2.17	2.73	3.17

PARo = Incident photosynthetically active radiation on the canopy, PARr = reflected radiation from the canopy, PAR_T = radiation within the canopy, PARrs = radiation reflected from the soil.

Table 4: Effect of moisture regimes and frequency of drip irrigation on the optical characteristics (APARp and APARs) of Aonla plants.

Treatment	Optical characteristics (μmole s^{-1} m^{-2})							
	Summer season				Winter season			
	B.I.		A.I.		B.I.		A.I.	
	APARp	APARs	APARp	APARs	APARp	APARs	APARp	APARs
Moisture regimes								
0.2 IW/CPE	74.23	244.23	75.20	250.61	56.79	223.75	58.71	231.16
0.4 IW/CPE	74.21	247.73	76.37	258.30	56.06	228.22	60.63	235.65
0.6 IW/CPE	73.35	254.25	81.29	263.94	57.57	232.78	61.53	241.56
0.8 IW/CPE	74.17	258.04	82.07	270.28	57.74	236.49	62.25	246.81
Irrigation frequencies								
3rd day	79.91	255.64	86.39	267.06	59.88	237.06	62.92	246.89
5th day	75.40	252.75	81.97	260.35	58.73	231.37	59.68	242.72
7th day	73.68	247.45	76.63	252.14	60.66	223.45	56.68	238.52
Surface irrigation	75.54	546.67	85.01	269.95	55.58	233.96	64.09	248.51

APARp = Absorbed Photosynthetically Active Radiation by Plant,
APARs = Absorbed Photosynthetically Active Radiation by soil, BI = Before irrigation,
AI = After irrigation

regimes at all the stages (Table 2) lowest shoot growth rate were recorded in 7 day irrigation interval. PAR, APARp and APARs during summer and winter season increased successively with increase in the moisture regimes from 0.2 to 0.8 IW/ CPE. Higher APARp (62.25 and 82.07 i mole $s^{-1}m^{-2}$ and higher APARs (246.81 and 270.28i mole $s^{-1}m^{-2}$) were recorded at 0.8 IW/CPE of moisture regimes followed by 0.6 ratio treatment after irrigation during winter and summer seasons respectively, mainly due to low albedo value of wet soil. Higher APARp and APARs were recorded under the trickle irrigation at 3 day interval in both the seasons irrespective of different moisture regimes mainly due to higher absorbivity. Irrigation given at 7 day interval in general produced lowest APARp (56.68 & 76.63 i mole $s^{-1}m^{-2}$) and lowest APARs (238.52 & 252.14 i mole $s^{-1}m^{-2}$) after irrigation during winter and summer season respectively. Higher APARp and APARs with 0.8 IW/ CPE ratio at 3rd day interval of irrigation was also supported by report of Kondratieve (1969).

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