

## EFFECT OF SHADE ON PLANT CHARACTERS AND NET ASSIMILATION RATE OF GINGER CULTIVARS

The study was undertaken at the College of Horticulture, Trichur, Kerala during 1990-91 to find out the performance of ginger cultivars under varying shade levels and to ascertain their compatibility in the coconut based cropping system.

The experiment was laid out in split plot design having four shade levels 0, 25, 50 and 75 per cent in the main plot and six ginger cultivars viz., Maran, Kuruppampadi, Himachal, Rio-de-jeneiro, Nedumangad and Amballore Local in the subplots with four replications. The main plot size was 22.50 m<sup>2</sup> and subplot size 3.75 m<sup>2</sup>. Pandals of size 27 m x 11 m were erected on wooden poles to provide artificial shade to the desired level (0, 25, 50 and 75 per cent) using unplaited coconut leaves. LI-COR integrating quantum radiometer with line quantum sensor was used for adjusting the shade intensity approximately to the desired level. Cultivation practices were adopted as per the recommendations of the Kerala Agricultural University (KAU, 1989). NAR was determined using the formula suggested by Williams (1946).

Plant height (Table 1) increased with increase in shade intensities at all the stages except 60 days after planting (DAP). The highest plant height was observed at 75 per cent shade at all the three stages, where it was significantly superior to 0, 25 and 50 per cent shade at 60 DAP and was comparable with 50 per cent shade at the other two stages. However, at both 120 and 180 DAP, the lowest plant height was recorded in the open. The cultivars also exhibited significant difference at all stages (Table 1). Both at 60 DAP and 120 DAP, Kuruppampadi, registered the highest value. At 60 DAP, Kuruppampadi was significantly superior to the other cultivars, while at 120 DAP, it was comparable with Amballore

Local. Though Nedumangad gave the highest plant height at 180 DAP, it was comparable with Kuruppampadi and Amballore Local. Cultivar x shade interaction was significant at 60 DAP and 180 DAP (Table 2). At 60 DAP, Himachal recorded the highest plant height and was comparable with Kuruppampadi in the open and at 25 per cent shade. But Kuruppampadi gave the highest value at 50 and 75 per cent shade. Plant height exhibited an increasing trend with shade levels except for Kuruppampadi at 180 DAP, where the plant height increased up to 50 per cent shade and then declined. The highest plant height was observed in Kuruppampadi in the open and at 50 per cent shade which was comparable with all cultivars except Amballore Local and Himachal respectively. Thus, the plant height increased with increase in shade intensities. This is in conformity with the result reported by Bai and Nair (1982) in coleus, sweet potato, ginger and turmeric. The increase in plant height under shade may be due to the cell elongation effect to catch up with the neighbouring plant.

Cultivars differed significantly in tiller number. Rio-de-jeneiro recorded the highest tiller number (Table 1) at all stages and was comparable with Himachal at 60 DAP. Cultivar x shade revealed significant interaction only at 180 DAP. Rio-de-jeneiro was superior to other cultivars in the open and at 50 per cent shade, while at 25 and 75 per cent shade, it was comparable with Nedumangad, Kuruppampadi gave the highest tiller number at 25 per cent shade and the lowest at 75 per cent shade.

With respect to tiller number there was no significant difference between shade levels, at any of the stages (Table 1). Though the tiller number increased up to 25 per cent shade, it

Table 1. Effect of shade on plant height, number of tillers and net assimilation rate of ginger cultivars

Treatment levels of shade, %	Plant height, cm			No. of tillers			Net assimilation rate g m <sup>2</sup> days	
	60 DAP	120 DAP	180 DAP	60 DAP	120 DAP	180 DAP	60 DAP	120 DAP
T <sub>1</sub> (0)	41.9	48.1	51.1	2.51	10.89	14.29	41.12	1.88
T <sub>2</sub> (25)	39.7	55.8	69.6	2.07	10.58	15.59	2.76	2.05
T <sub>3</sub> (50)	36.2	57.3	81.5	2.51	12.17	14.02	2.52	2.58
T <sub>4</sub> (75)	47.5	60.1	82.6	1.82	9.16	12.28	3.06	2.26
SEm±	2.4	1.45	3.95	0.43	0.90	0.75	0.44	0.19
CD(0.05)	5.5	3.29	8.93	NS	NS	NS	0.99	0.43
<b>Cultivar</b>								
V <sub>1</sub> (Maran)	42.9	51.5	69.0	2.22	10.33	12.62	2.29	2.59
V <sub>2</sub> (Kuruppampadi)	47.0	61.0	72.9	1.48	8.96	12.25	3.22	3.33
V <sub>3</sub> (Himachal)	43.3	53.4	68.9	3.05	11.80	11.75	3.65	2.46
V <sub>4</sub> (Rio-de-jeneiro)	37.1	55.0	70.5	3.34	15.02	20.42	2.98	1.70
V <sub>5</sub> (Nedumangad)	37.2	54.4	74.7	1.50	9.12	12.40	3.35	2.21
V <sub>6</sub> (Amballore Local)	40.4	56.6	71.3	1.78	8.98	13.32	3.20	0.85
SEm±	1.45	2.63	2.06	0.21	0.99	1.19	0.38	0.31
CD(0.05)	2.90	5.27	4.13	0.43	1.97	2.38	0.76	0.62

Table 2. Interaction effect of shade levels and ginger cultivars on plant height at 60 DAP and 180 DAP

Cultivar	Shade level, %					Shade level, %				
	0	25	50	75	Mean	0	25	50	75	Mean
V <sub>1</sub> (Maran)	46.9	37.3	35.1	52.3	42.9	52.1	61.9	80.8	81.2	69.0
V <sub>2</sub> (Kuruppampadi)	45.3	42.6	44.5	55.6	47.0	56.9	70.7	85.7	78.3	72.9
V <sub>3</sub> (Himachal)	49.3	43.6	34.6	45.6	43.3	51.6	72.6	74.5	77.0	68.9
V <sub>4</sub> (Rio-de-jeneiro)	35.8	39.4	27.1	46.1	37.1	51.1	61.9	83.0	86.0	70.5
V <sub>5</sub> (Nedumangad)	39.9	36.1	32.1	40.9	37.2	50.0	78.3	81.5	89.1	74.7
V <sub>6</sub> (Amballore Local)	34.2	39.0	44.1	44.4	40.4	45.2	72.3	83.5	84.2	71.3
Mean	41.9	39.7	36.2	47.5	-	51.1	69.6	81.5	82.6	-
						60 DAP		180 DAP		
SE for difference between 2 subplot means at the same level of main plot						2.90		4.13		
CD (0.05) for the above						5.81		8.25		
SE of difference between 2 main plot means at the same level of subplot						3.63		5.46		
CD (0.05) for the above						7.69		11.66		

exhibited a progressive decrease with increase in shade intensities. Taller plants observed at higher shade intensities indicate the possible diversion of energy for increasing the plant

height rather than to increase the tiller number. In the case of net assimilation rate (NAR), open condition was significantly superior to the other shade levels at 60 DAP. But at 120

Table 3. Interaction effect of shade levels and ginger cultivars on net assimilation rate at 60 DAP and 120 DAP

Cultivar	Shade level, % at 60 DAP					Shade level, % at 120 DAP				
	0	25	50	75	Mean	0	25	50	75	Mean
V <sub>1</sub> (Maran)	3.69	2.26	1.92	1.29	2.29	4.76	2.62	0.81	2.15	2.59
V <sub>2</sub> (Kuruppampadi)	6.36	2.06	2.91	1.55	3.22	1.99	2.46	4.94	3.91	3.33
V <sub>3</sub> (Himachal)	5.23	2.85	3.02	3.52	3.65	2.69	2.71	1.51	2.91	2.46
V <sub>4</sub> (Rio-de-jeneiro)	2.36	2.01	1.89	5.65	2.98	1.09	2.35	2.46	0.91	1.70
V <sub>5</sub> (Nedumangad)	4.30	3.28	3.19	2.61	3.35	1.68	1.36	3.95	1.86	2.21
V <sub>6</sub> (Amballore Local)	2.78	4.08	2.19	3.74	3.20	0.97	0.81	1.77	1.81	0.85
Mean	4.12	2.76	2.52	3.06	-	1.88	2.05	2.58	2.26	-
							60 DAP		180 DAP	
SE for difference between 2 subplot means at the same level of main plot							0.76		0.62	
CD (0.05) for the above							1.52		1.24	
SE of difference between 2 main plot means at the same level of subplot							0.82		0.60	
CD (0.05) for the above							1.70		1.21	

Table 4. Interaction effect of shade levels and ginger cultivars on rhizome yield on fresh and dry weight basis (t ha<sup>-1</sup>)

Cultivar	Rhizome yield (fresh weight) at shade level, %					Rhizome yield (dry weight) at shade level, %				
	0	25	50	75	Mean	0	25	50	75	Mean
V <sub>1</sub> (Maran)	6.72	18.62	19.01	14.26	14.65	1.19	3.33	3.42	2.61	2.64
V <sub>2</sub> (Kuruppampadi)	15.53	14.88	19.18	19.01	17.16	2.66	2.58	3.38	3.43	3.01
V <sub>3</sub> (Himachal)	14.57	22.91	22.13	26.62	21.56	2.62	4.19	4.11	5.06	4.00
V <sub>4</sub> (Rio-de-jeneiro)	4.98	13.40	13.50	13.50	11.35	0.59	1.63	1.66	1.69	1.39
V <sub>5</sub> (Nedumangad)	4.09	25.06	18.08	14.06	15.32	0.62	3.84	2.80	2.21	2.37
V <sub>6</sub> (Amballore Local)	7.14	12.34	14.56	12.07	11.53	1.37	2.41	2.87	1.92	2.14
Mean	8.84	17.87	17.74	16.60	-	1.51	2.99	3.04	2.82	-
							Fresh weight		Dry weight	
SE for difference between 2 subplot means at the same level of main plot							2.08		0.35	
CD (0.05) for the above							4.16		0.71	
SE of difference between 2 main plot means at the same level of subplot							2.59		0.45	
CD (0.05) for the above							5.50		0.96	

DAP (Table 1), 50 per cent shade recorded the highest NAR which was comparable with 75 per cent shade. Ravisankar and Muthuswamy (1988) reported that NAR was higher in ginger grown in low light intensities. The cultivars exhibited significant difference at both 60 and 120 DAP (Table 1). Himachal recorded the highest NAR at 60 DAP, which was comparable with all other cultivars except Maran. But at 120 DAP, though Kuruppam-

padi was found to be significantly superior to the other cultivars, Himachal also performed well. Significant interaction between shade levels and cultivars was observed at both 60 and 120 DAP (Table 3). At 60 DAP, Kuruppampadi recorded the highest NAR in the open, which was comparable with that of Himachal. At 25 per cent shade, it was comparable with Amballore Local which gave the highest NAR. At 50 per cent, no significant

difference was observed among the cultivars. Rio-de-jeneiro was found to be superior to all the other cultivars at 75 per cent shade. At 25 per cent shade, highest NAR was observed in Himachal which was comparable with all cultivars except Nedumangad and Amballore Local. At 50 and 75 per cent shade, Kurupampadi gave the highest value which was comparable with Nedumangad and Himachal, respectively. NAR (120 DAP) went on increasing with shade up to 50 per cent and then showed a slight decline. However, the NAR at 50 and 75 per cent shade levels were comparable. High NAR at higher shade levels could be attributed to the increased rate of photosynthesis under shade. The light compensation point for photosynthesis was found to be higher for plants in the open than that under shade (Okali and Owusu, 1975). High value of NAR at initial stages may be due to the transfer of assimilates from relatively large sized rhizome to the developing plant and also the vertical leaf ori-

entation during this period (Mithorpe, 1963). Low NAR values at later stage is attributed to the dense canopy of ginger stand, which has many horizontal leaves resulting in excessive mutual shading and increased rate of respiration. Shade levels had significant effect on rhizome yield of ginger both on fresh weight dry weight basis (Table 4). Plants in the open were significantly inferior to those under shade in terms of rhizome yield. Among the cultivars Himachal gave the highest rhizome yield while Rio-de-jeneiro recorded the lowest value. Hardy (1958) attributed the better performance of the crops under shade to the presence of a threshold illumination intensity beyond which the stomata of shade living plants tend to close. Another favourable effect of shade on plants is believed to be the auxin enhancement probably acting synergistically with gibberellic acid (Leopald, 1964). This paper forms a part of M. Sc.(Ag.) thesis of the first author submitted to the Kerala Agricultural University.

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