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Influence of shade regimes on the physiological parameters of ginger

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Abstract

A study was carried out at College of Agriculture, Vellayani to determine the relation of various physiological parameters on the yield of ginger under different shade levels. The experimental design was a completely randomized design with five treatments (0, 20, 40, 60 and 80 per cent shade levels) and four replications. Higher dry matter production (DMP), leaf area index (LAI), net assimilation rate (NAR) and crop growth rate (CGR) were observed in low shade level (20 per cent). The higher yield at this shade level may be due to the higher values of these physiological parameters. The results suggest a positive response of shade on the physiological parameters and yield of ginger, provided the intensity of shade is low. Regression equation fitted showed the influence of shade on DMP, NAR, CGR and yield, while no significant relation was observed with regard to LAI.

Key words: Crop Growth Rate, Dry Matter Production, ginger, Leaf Area Index, Net Assimilation Rate, shade.

Introduction

Ginger is one of the major spice crops grown in Kerala with a production of 49,946 tonnes from an area of 14,568 ha (FIB 2001). Percentage share of Kerala on total ginger cultivated area of India is progressively decreasing mainly due to the expansion of ginger cultivation in non-traditional regions of other states. However, the major share of export is met from ginger produced in Kerala due to superior quality. Since there is practical difficulty in increasing the area under ginger as pure crop in Kerala, utilization of the partially shaded coconut gardens for intercropping ginger is an alternate way to increase the production. Though the shade loving/tolerant nature of ginger has been reported from India and abroad (Aclan & Quisumbing 1976; Jayachandran *et al.* 1991; KAU 1992) detailed study on physiological parameters under different shade levels was not undertaken. Hence, the present study was carried out to find the influence of different shade levels on physiological parameters and yield of ginger.

Materials and methods

A pot culture experiment was carried out which involved the sowing of 15 g each of treated rhizomes in uniformly filled pots (30 x 30 cm) containing potting mixture of fertile soil, coarse sand and dried powdered cowdung at 1:1:1 ratio. There were five treatments which consist of S_0 - 0; S_1 - 20; S_2 - 40; S_3 - 60 and S_4 - 80 per cent shade levels in four replications. Different

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shade levels were provided by pre calibrated high density polyethylene nets. Quantum photosensors were used for confirming the intensity of light under different shade levels. The mean photosynthetically active radiation observed on leaf surface under open condition at 14.00 h was 1279.50 µmol $m^{-2}s^{-1}$. Fertilizer application, mulching and weeding were carried out following the recommended package of practices (KAU 1996). Observations on physiological parameters viz. dry matter production (DMP), leaf area index (LAI), net assimilation rate (NAR) and crop growth rate (CGR) under various shade levels were recorded from 60 days after planting (DAP) while the dry ginger yield was recorded from 90 DAP. Leaves, petioles, pseudostem, rhizomes and roots of the uprooted plants were separated and dried to constant weight at 70 - 80° C in a hot air oven at monthly intervals. The sum of these individual components gave the dry matter production. Dry ginger yield was recorded after drying the sample in hot air oven at a temperature of 70 - 80° C till constant weight was obtained. Leaf area index was calculated after estimating leaf area by length and breadth method (Ancy & Jayachandran 1994).

The formula given by Buttery (1970) was followed for calculating the NAR. Crop growth rate was worked out using the formula of Watson (1958). The experimental data were analysed statistically by applying the techniques of analysis of variance for completely randomized design (Gomez & Gomez 1984). Regression equation has been fitted for different levels of shade for each chosen parameter.

Results and discussion

The effect of shade on dry matter production was found to be significant except at 90 DAP (Table 1). Maximum dry matter production was reported from 20 per cent shade level at all growth stages. With further increase in shade, dry matter production was found to decrease. Ancy (1992) and Babu (1993) observed increased dry matter production in ginger under 25 per cent shade level. Regression equation fitted for DMP at different levels of shade showed no linearity during the initial periods (60 and 90 DAP) (Table 4). But as days progressed, at 120, 150 and 180 DAP, higher R^2 values were obtained. The results thus imply the influence of shade on DMP at later stages.

LAI at different shade levels exhibited significant variation from 90 to 180 DAP (Table 1). Ginger plants grown under 20 and 40 per cent shade levels recorded more LAI and in plants grown under open condition it was least. Ravisankar & Muthuswamy (1988) and Ancy (1992) observed maximum LAI under low shade levels. Ginger plants kept under 20 and 40 per cent shade levels exhibited significantly higher LAI (Ajithkumar 1999). The tendency to increase the LAI was more under low to medium shade levels. According to Attridge (1990) this may perhaps be an adaptation to expose larger photosynthetic surface under limited illumination. For LAI, none of the regression coefficents got significant R^2 values when first degree equations were fitted. The effect of different shade levels on LAI is thus insignificant.

Table 1. Effect of shade level on DMP and LAI of ginger

Shade level	Period (DAP)									
	DMP (g plant^{-1})					LAI				
	60	90	120	150	180	60	90	120	150	180
S_0	6.01	11.82	21.36	31.95	47.25	0.538	0.661	1.62	2.46	6.94
S_1	7.43	13.64	23.95	33.24	50.90	0.635	0.762	2.07	3.92	8.18
S_2	7.27	12.95	21.56	30.15	43.12	0.594	0.782	2.03	3.69	7.57
S_3	6.18	12.02	18.78	24.92	38.35	0.548	0.677	1.78	3.34	7.13
S_4	5.91	12.16	17.93	24.41	37.15	0.529	0.668	1.75	2.80	7.13
F test	S	NS	S	S	S	NS	S	S	S	S
CD(0.05)	0.3427	-	2.032	1.9512	3.605	-	0.0796	0.1436	0.3695	0.504

Table 2. Effect of shade level on NAR and CGR of ginger

Shade level	Period (DAP)							
	NAR (g m^{-2} day^{-1})				CGR (g $m^{-2}day^{-1}$)			
	60 - 90	90 - 120	120 - 150	150 - 180	60 - 90	90 - 120	120 - 150	150 - 180
S_0	0.323	0.256	0.156	0.099	0.194	0.292	0.318	0.464
S_1	0.298	0.219	0.117	0.106	0.207	0.312	0.344	0.625
S_2	0.274	0.204	0.101	0.077	0.188	0.284	0.283	0.430
S_3	0.251	0.157	0.080	0.086	0.152	0.214	0.204	0.451
S_4	0.257	0.161	0.092	0.080	0.154	0.194	0.209	0.398
F test	S	S	S	S	S	S	S	S
CD(0.05)	0.0398	0.0398	0.0181	0.012	0.02	0.0398	0.0398	0.0563

NAR was found to differ significantly under different shade levels (Table 2). During all growth phases, high NAR was recorded from open condition except between 150 - 180 DAP. Maximum NAR between 150 - 180 DAP was reported from low shade level. Shade beyond 20 per cent showed less NAR. This finding is in agreement with the result of Ancy (1992). Blackman & Wilson (1951), Newton (1963) and Coombe (1966) reported a positive correlation between NAR and irradiance. The high rate of NAR may be due to higher rate of photosynthesis. The low NAR at later stage of growth in open compared to 20 per cent shade level may be due to the increased rate of respiration in open. With increase in shade level (40, 60 and 80 per cent) the photosynthetically active radiation falling on leaf surface may be less compared to open and 20 per cent shade and this might have reflected in low net assimilation rate under these situations. Linear trend of net assimilation rate was observed between 60 - 90, 90 - 120 and 120 - 150 DAP and significant R^2 values were obtained during these periods (Table 4).

The variation observed in crop growth rate under different shade levels revealed significant difference at all growth phases (Table 2). Highest value of CGR was obtained from 20 per cent shade level followed by open. Ancy (1992) and Babu (1993) reported maximum CGR in plants grown under 25 per cent shade level. Low shaded condition (20 per cent shade level) seems to be very favourable for enhanced CGR. The higher leaf area index and enhanced NAR might have reflected in the higher CGR. This showed that 20 per cent shade was more favourable for the crop growth. However higher shade levels (60 and 80 per cent) were found to be unfavourable for the growth of the crop. Higher R^2 values were obtained for CGR at 60 – 90, 90 – 120 and 120 – 150 DAP (Table 4). The results indicate the influence of shade on CGR during these periods.

Significant variation in dry ginger yield was noticed among shade levels at all the growth stages (Table 3). Highest dry ginger yield was recorded from 20 per cent shade right from the initial period to the last stage. The dry ginger yield at 0 and 40 per cent and at 60 and 80 per cent shade were statistically on par at all growth

Table 3. Effect of shade level on dry ginger yield

Shade level	Yield (dry g $plant^{-1}$)					
	90 DAP	120 DAP	150 DAP	180 DAP	210 DAP	240 DAP
S_0	0.574	4.33	10.97	19.91	28.30	44.25
S_1	0.594	5.01	13.85	25.32	40.45	57.57
S_2	0.538	3.60	8.80	18.05	26.30	39.10
S_3	0.438	3.18	6.00	13.05	17.98	26.05
S_4	0.367	3.07	5.62	12.45	14.90	21.37
F test	S	S	S	S	S	S
CD (0.05)	0.132	0.7949	2.419	4.680	4.680	7.875

Coefficients of the regression equation y = ax + b
a - constant
b - regression coeffcient
x - shade levels
y - corresponding parameter

Table 4. Coefficients of the regression equation y = ax + b for DMP and yield

	DMP			Yield					
	120*	150	180	90	120	150	180	210	240
a	23.12	33.61	49.90	0.6162	4.70	12.75	23.19	35.44	53.12
b	-0.0601	-0.1170	-0.1637	-0.0028	-0.0217	-0.0927	—0.1359	-0.2463	-0.3864
R^2(%)	63	83	79	87	70	72	66	61	71

* Days after planting

Table 5. Coefficients of the regression equation y = ax + b for NAR and CGR

	NAR				CGR			
	60-90*	90-120	120-150	150-180	60-90	90-120	120-150	150-180
a	0.3164	0.2498	0.1422	0.1012	0.206	0.3180	0.3431	0.5348
b	-0.0008	-0.0012	-0.0008	-0.0002	-0.006	-0.0014	-0.0017	-0.0015
R^2 (%)	90	92	79	54	75	80	80	30

* Days after planting

stages. In general the R^2 values for dry ginger yield with different shade levels are high for different DAP (Table 4). The result is thus an indication of superior relation between shade and yield.

It has been observed from the above experiment that plants showing high DMP, LAI, NAR as well as CGR at final stage showed higher yield at all growth stages under 20 per cent shade level. DMP, CGR as well as yield of plants grown at open and 40 per cent shade levels were on par at 120 and 150 DAP. For plants grown under heavy shade levels (60 and 80 per cent), DMP, NAR, CGR as well as yield were low at all growth stages.

Higher DMP, LAI, NAR and CGR were observed from low shade level (20 per cent). The higher yield at this shade level may be due to the higher values of these physiological parameters. The results suggest the positive response of shade on the physiological parameters and yield of ginger, provided the intensity of shade is low.

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