Indian J. Hort. 67(1), March 2010: 122-126

Short communication

Screening for shade tolerant genotypes of chilli for homestead cultivation

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Chilli (*Capsicum annuum* L.) is one of the most important vegetable cum spice crops of the tropics. In Kerala state vegetable crops, including chilli are often cultivated under homestead farming system where crops are grown under shade of coconut palm and other tropical perennial and semi perennial fruit crops. However, the varieties utilized are often those developed specifically for cultivating under fully open situation. In the homestead, shade act as one of the major abiotic stress factors that reduces the yield of these varieties considerably. Hence, cultivars that can perform well even under shaded situation will be the ideal ones for homestead cultivation. Such genotypes, if identified, and new varieties developed would be a boon to farmers who follow this system of farming. *C. annuum* genotypes are reported to have wide range of variability in shade tolerance and yield (Munshi and Behera, 3). In view of the above the present investigation of screening *C. annuum* genotypes was undertaken for identifying genotypes that can perform well under shaded situations

The study was conducted at the College of Agriculture, Vellayani, Thiruvananthapuram using 35 diverse genotypes of chilli (*C. annuum*) collected from different parts of the country. The experiment was laid out in randomised block design with two replications. Ten plants were maintained per plot. Four separate experiments were conducted with four levels of shade *viz.*, 0 (open), 25, 50 and 75 per cent shade. Shade was provided artificially using black high density polyethylene net.

The crop was raised adopting recommended cultivation practices with subsistence irrigation. Li-COR-LI-88 B Quantum radiometer with a photometric sensor was used to measure the light intensity inside the netted area. Five plants were selected randomly from each genotype and observations were recorded on plant height, internodal length, leaf area, petiole length, fruits per plant, fruit length, fruit girth, fruit weight and yield per plant. Five mature leaves from the top of main branches were selected at random for recording observations on leaf characters. Ten fruits were selected at random for studying fruit characters at their vegetable maturity.

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Statistical analysis was done using standard methods. Pooled analysis was done to test the significant difference between various shade levels. Significant variation for plant height, internodal length, leaf area and petiole length was observed among the genotypes under all shade levels and between different shade levels. An increasing trend in plant height, internodal length, leaf area and petiole length was observed with increasing levels of shade in all the genotypes (Tables 1 & 2). Maximum plant height (69.84 cm), internodal length (3.61 cm), leaf area (28.21 cm^2) and petiole length (5.62 cm) were recorded under 75 per cent shade. Increase in plant height under shade may be due to longer internodes (Rylski and Spigelman, 4). Increase in internodal length under shade may be due to the increased availability of auxins. Increase in leaf area under higher shade levels was also observed, which according to Yinghua and Jianzhen (6) is achieved by minimizing the use of metabolites for other growth activities. Petiole length in all the genotypes was slightly higher under shade and this is obviously due to the competition of leaves under shade for capturing maximum sunlight.

Significant variation was observed among the genotypes for number of fruits per plant and yield per plant under all levels of shade as well as between different shade levels. As the shade level increased from 25 to 75 per cent, number of fruits per plant and yield per plant was reduced significantly in all the genotypes. This may be due to poor fruit set coupled with high flower drop resulted by the reduced photosynthetic activity under shade. At the same time there was no significant difference for number of fruits per plant and yield per plant between open and 25 per cent shade indicating the tolerant nature of the genotypes towards light shade. Increased yield under light shade (10 – 30 per cent) has also been reported in tomato by Smith *et al*. (5), El–Aidy (1), El–Gizawy *et al*. (2) and sweet pepper by Rylski and Spigelman (4), and Yinghua and Jianzhen (6).

Significant difference for fruit length, fruit girth and fruit weight was observed among the genotypes

Table 1. Effect of different shade levels on the growth and yield of *C. annuum* genotypes.

Genotype	Shade level (%)	Plant height (cm)	Leaf area (cm^2)	Fruits/ plant	Yield/ plant (g)	Genotype	Shade level (%)	Plant height (cm)	Leaf area (cm^2)	Fruits/ plant	Yield/ plant (g)
CA 1	0	37.00	11.05	31.68	120.38	CA 14	0	67.05	11.62	30.42	124.25
	25	56.88	13.69	30.15	119.13		25	71.75	14.06	25.13	104.50
	50	69.43	17.14	24.50	85.38		50	79.38	20.71	21.27	95.40
	75	87.63	20.82	21.18	83.88		75	89.10	29.08	16.88	91.18
	Mean	62.74	15.68	26.88	102.19		Mean	76.82	18.87	23.43	103.83
CA 2	0	48.96	8.66	34.13	116.63	CA 15	0	68.13	9.96	29.88	117.63
	25	59.13	13.70	34.05	111.25		25	72.88	13.56	25.63	106.38
	50	66.43	16.91	29.63	100.63		50	84.13	21.18	21.53	97.15
	75	84.88	20.85	28.05	89.15		75	88.25	28.87	16.63	90.05
	Mean	64.85	15.03	31.47	104.42		Mean	78.35	18.39	23.42	102.80
CA 3	0	39.38	10.21	35.30	153.00	CA 16	0	59.00	14.14	30.48	129.75
	25	55.68	14.02	37.50	160.50		25	69.30	15.59	30.35	126.75
	50	59.54	17.15	33.00	119.15		50	73.92	21.46	24.88	114.38
	75	74.67	22.45	27.13	100.90		75	85.00	26.05	20.55	102.90
	Mean	57.32	15.96	33.23	133.39		Mean	71.81	19.31	26.57	118.45
CA 5	0	39.13	6.66	34.05	145.00	CA 18	0	35.93	10.56	24.33	219.65
	25	43.75	12.02	32.43	123.00		25	45.50	13.35	24.05	233.15
	50	48.63	15.28	26.63	103.15		50	49.13	18.68	20.55	206.38
	75	54.18	17.61	24.58	89.65		75	54.21	23.75	19.48	182.80
	Mean	46.42	12.89	29.42	115.20		Mean	46.19	16.59	22.10	210.50
CA 6	0	206.38	9.77	33.77	157.63	CA 20	0	41.04	15.22	58.05	271.63
	25	59.18	11.83	36.05	177.63		25	62.84	26.65	67.63	302.68
	50	68.91	12.581	31.55	151.75		50	65.88	31.00	53.05	248.80
	75	78.18	4.41	28.55	140.80		75	78.13	33.02	33.55	150.25
	Mean	61.66	12.15	32.48	156.95		Mean	61.97	26.47	53.07	243.34
CA 8	0	36.88	15.45	49.93	273.13	CA 21	0	38.25	10.38	111.20	251.75
	25	43.88	22.12	44.18	243.00		25	57.55	21.10	111.15	263.13
	50	47.50	24.77	34.05	185.38		50	60.50	26.05	91.18	223.05
	75	59.38	26.93	33.38	180.40		75	60.38	33.21	83.68	170.40
	Mean	46.91	22.32	40.39	220.48		Mean	54.17	22.69	99.30	227.08

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Genotype	Shade level (%)	Plant height (cm)	Leaf area (cm^2)	Fruits/ plant	Yield/ plant (g)	Genotype	Shade level (%)	Plant height (cm)	Leaf area (cm^2)	Fruits/ plant	Yield/ plant (g)
CA 9	0	39.93	12.82	46.15	282.55	CA 22	0	41.38	6.30	47.50	175.13
	25	55.63	20.46	35.80	215.38		25	56.38	7.88	47.50	173.88
	50	54.30	22.55	31.13	187.75		50	62.54	13.85	35.23	142.08
	75	58.68	25.02	27.10	172.98		75	74.18	18.00	31.55	133.20
	Mean	52.14	20.21	35.05	214.67		Mean	58.62	11.51	40.45	156.07
CA 11	0	41.68	14.75	58.33	316.25/	CA 23	0	45.92	8.88	121.05	359.98
	25	61.55	28.01	53.05	319.13		25	54.68	15.76	123.00	341.85
	50	65.38	30.47	41.05	207.05		50	60.13	19.43	77.63	211.55
	75	70.30	31.89	34.49	168.70		75	69.18	37.42	60.25	147.80
	Mean	59.73	26.28	46.73	252.78		Mean	57.48	20.37	95.48	265.30
CA 12	0	38.98	6.31	44.30	172.75	CA 24	0	33.96	9.79	34.00	171.38
	25	43.93	12.22	41.37	176.00		25	52.89	15.91	37.38	176.13
	50	49.05	13.73	33.60	145.38		50	55.18	19.09	27.55	147.05
	75	54.20	15.04	27.05	107.99		75	58.88	23.95	23.48	116.90
	Mean	46.54	11.83	36.58	150.50		Mean	50.23	17.19	30.60	152.87
CA 13	0	39.93	7.24	125.00	319.38	CA 25	0	47.55	12.64	108.00	339.75
	25	59.43	16.63	139.00	340.60		25	59.50	20.32	116.68	354.13
	50	59.80	19.24	74.18	187.85		50	60.68	22.05	97.30	296.40
	75	61.00	24.02	69.05	150.25		75	62.04	24.47	82.68	198.85
	Mean	55.04	16.78	101.81	249.52		Mean	57.44	19.87	101.17	297.28
CA 28	0	35.00	15.60	115.05	333.88	CA 55	0	46.88	16.78	49.53	202.50
	25	49.71	18.01	123.18	321.75		25	62.88	20.88	45.00	178.38
	50	52.00	19.63	100.13	269.75		50	76.80	28.21	39.00	152.93
	75	59.43	21.90	75.05	180.25		75	88.18	34.29	36.11	147.85
	Mean	49.04	18.79	103.35	276.41		Mean	68.69	25.04	42.41	170.42
CA 29	0	40.43	15.58	75.18	244.05	CA 59	0	35.18	12.45	38.05	182.63
	25	63.04	23.21	76.25	230.30		25	53.93	18.96	39.18	180.13
	50	70.54	24.93	65.18	180.10		50	60.18	24.20	27.25	152.55
	75	89.18	27.99	49.13	136.35		75	64.30	32.05	26.05	147.80
	Mean	65.80	22.93	66.44	197.70		Mean	53.40	21.92	32.63	165.78

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Genotype	Shade level (%)	Plant height (cm)	Leaf area (cm^2)	Fruits/ plant	Yield/ plant (g)	Genotype	Shade level (%)	Plant height (cm)	Leaf area (cm^2)	Fruits/ plant	Yield/ plant (g)
CA 32	0	27.43	11.35	16.10	73.75	CA 60	0	41.38	12.22	31.13	202.25
	25	29.71	16.08	17.13	102.63		25	46.04	23.76	33.25	214.25
	50	39.47	19.29	13.63	84.45		50	58.63	25.01	27.38	184.50
	75	54.75	23.54	13.18	83.05		75	63.00	27.23	23.55	165.35
	Mean	37.84	17.57	15.01	85.97		Mean	52.26	22.06	28.83	191.59
CA 34	0	30.68	11.83	19.93	102.13	CA 64	0	40.93	18.22	26.82	206.50
	25	38.84	15.42	21.43	109.68		25	51.29	31.03	23.00	207.75
	50	61.79	17.09	15.13	108.90		50	54.43	33.18	16.63	172.83
	75	78.39	19.21	18.00	144.13		75	57.38	36.96	17.38	167.85
	Mean	52.43	15.89	18.62	116.21		Mean	51.01	29.85	20.96	188.73
CA 36	0	42.50	15.93	35.92	320.38	CA 81	0	39.21	16.84	19.93	199.13
	25	48.23	29.85	43.10	367.88		25	43.39	30.69	20.88	202.95
	50	45.37	34.87	27.25	248.13		50	53.88	34.45	16.93	165.23
	75	55.30	41.49	23.55	241.05		75	58.18	37.53	16.11	170.15
	Mean	47.85	30.54	32.46	296.36		Mean	48.67	29.88	18.46	184.37
CA 37	0	54.18	18.03	31.20	297.30	CA 82	0	42.47	15.20	45.30	201.25
	25	63.88	28.89	29.75	304.13		25	46.88	21.75	47.13	215.25
	50	69.43	35.17	19.13	153.00		50	63.63	26.58	31.39	140.33
	75	82.55	38.94	13.38	127.68		75	72.82	31.42	25.18	145.50
	Mean	67.51	30.26	23.37	220.53		Mean	56.45	23.74	37.25	175.58
CA 38	0	39.00	18.86	26.87	382.88	CA 83	0	42.93	16.08	37.18	170.13
	25	41.00	31.47	28.13	397.38		25	57.00	22.37	38.83	145.30
	50	49.13	35.77	23.43	310.13		50	66.88	24.19	37.18	145.30
	75	58.05	42.44	19.88	250.65		75	71.30	26.33	34.05	147.65
	Mean	46.80	32.14	24.58	335.26		Mean	59.53	22.24	36.81	152.10
CA 39	0	69.18	19.38	26.20	126.63	CD (5%) Shade					
	25	73.88	38.31	24.30	87.60		CD (0)	3.89	3.02	8.09	16.71
	50	77.188	42.09	16.50	72.80		CD (25)	3.58	2.19	6.23	16.72
	75	9.18	49.22	14.75	71.05		CD (50)	3.73	1.84	6.36	16.70
	Mean	77.36	37.25	20.44	89.52		CD (75)	4.76	2.25	6.15	14.56

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under all shade levels. However there was no significant difference in the individual fruit characters, among the different levels of shade. This indicates that fruit morphology is governed by the genetic architecture, and is not altered by the environmental factors.

Results of the study indicate that number of fruits and fruit yield per plant are on par in open and 25 per cent shade level. The above yield parameters decreased in all the genotypes with increase in the level of shade (Table 2). The overall mean yield under 25 (212.39 g), 50 (165.60 g) and 75 (142.72 g) per cent shade levels, expressed as percentage of yield in the open (213.23 g), were 99, 78 and 67 respectively. Though the extent of decline in yield was significant at the maximum shade level of 75 per cent, the crop still gave a high yield of 67 per cent. However, the response of different genotypes to shade intensity was variable. Under shaded conditions increase in plant height, internodal length, leaf area and petiole length was recorded. If the percentage of increase due to shade in a genotype is not conspicuous, it can be assumed that such genotype can tolerate shaded situation to a greater extent. It was found that among the genotypes, the percentage increase in plant height, internodal length, leaf area and petiole length was minimum in the genotype CA 38 under 25 per cent shade. The genotype CA 38 recorded highest yield per plant both under open and 25 per cent shade. Also there was no significant difference in number of fruits per plant and yield per plant between open and 25 per cent shade. Considering all these characters into account, CA 38 could be proposed as a shade tolerant genotype in *C. annuum* suitable for cultivation under shaded situation like that of the homestead cultivation system prevalent in Kerala.

Table 2. Mean overall performance of *C. annuum* genotypes under different shade levels.

Shade level (%)	Plant height (cm)	Inter-nodal length (cm)	Leaf area (cm^2)	Petiole length (cm)	Fruits/ plant	Yield/ plant (g)	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)
0	43.08	2.52	12.76	3.46	48.05	213.23	6.68	5.25	6.02
CD (5%)	2.75	0.14	2.14	0.16	5.72	11.81	NS	NS	NS
25	54.63	2.95	19.99	4.67	48.65	212.39	6.74	5.22	6.14
CD (5%)	2.54	0.12	1.55	0.18	4.42	17.45	NS	NS	NS
50	61.14	3.25	23.66	5.07	37.30	165.60	6.72	5.14	6.00
CD (5%)	2.64	0.10	1.30	0.16	4.39	11.83	NS	NS	NS
75	69.84	3.61	28.21	5.62	31.85	142.72	6.69	5.06	6.02
CD (5%)	3.36	0.14	1.59	0.22	4.34	10.30	NS	NS	NS

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Received: May, 2006; Revised: November, 2009; Accepted : December, 2009