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MEASUREMENT OF PAR AND ITS IMPACT ON CHRYSANTHEMUM (*CHRYSANTHEMUM MORIFOLIUM* RAMAT.)

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ABSTRACT
An experiment was conducted at the Jaguli Instructional Farm, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, for two years (2009-10 and 2010-11) where three standard cultivars (Snowball, Phil Houghton and SL- Ander Reffaud) of chrysanthemum were planted on 3rd August 2009 and 2010 in 1m^2 plot laidout in the factorial randomized block design with three replication. Availability of photosynthetically active radiance (PAR) inside the polyshade, percentage of absorption, percentage of interception, albedo, percentage of interception, absorptance, transmittance and reflectance were computed. Absorption was found to be maximum when nitrogen (N_2) was applied in two split irrespective of cultivar and date of observation. Among 3 cultivars, the Snowball (Cv_1) recorded the highest absorption as well as absorptance. The lowest transmittance observed in case of N_2 dose where as nitrogen application increased the reflectance.

INTRODUCTION

Chrysanthemum also known as "Queen of the East" belongs to the family Asteraceae and is a popular flowering crop having its admirers and enthusiasts all over the world. Chrysanthemum occupies a place of pride both as commercial flower as well as pot mum and it ranks second to rose among the top ten cut flowers in the world flower trade. Japan is a rather large market for chrysanthemum, which accounts for about 35 percent of all flowers sold and the Netherland being the biggest buyer (Dadlani, 1997). In India it occupies a prestigious place both as a commercial cut flower and pot plant. Growing of crop for the production of flower is the harvesting of solar energy and its conversion into bimolecules which are deposited into sink (Russel *et al.,* 1989).The time hour of a day also determines the radiation receipt and absorption of radiation at a particular time of a day significantly affects the photosynthesis processes of crop (Pallas and Smith, 1974; Naiyyar *et al.,* 1990; Chakraborty, 1994). The impact of radiation in field crops is well known (Jena *et al.,* 2010; Dutta *et al.,* 2011). However the impact of radiation on flower development and flower productivity is not well documented. The present study intends to provide some information on the impact of PAR on the productivity of flower in chrysanthemum.

MATERIALS AND METHODS

The experiment was conducted at Instructional farm, Bidhan Chandra Krishi Viswavidyalaya, Jaguli, during winter 2009-10 and 2010-11 in standard chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv Snowball (Cv_1), Phil Houghton(Cv_2) and SL-Ander Reffaud(Cv_3). The farm is located at 22°56' N latitude 88°32' E longitudes at an altitude of 9.75m above mean sea level. Soil is sandy loam having pH 6.94, organic carbon 0.63% total nitrogen 0.06%, available phosphorus 18.47 kg ha^{-1} and potassium 127.22 kg ha^{-1}.

The experimental site belongs to tropical humid climate having the average rainfall of 1475mm, most of the amount fall in between June – September. Temperature ranges from 10°C to 38°C. The minimum temperature reaches 10.2°C in the month of January and the maximum 37.7°C in the month of May. The experimental site experiences short and mild winter season span from November to February.

The experiment was conducted under the polyshade. The colour of the polythene was white with 200μ gauze. The plants were planted on 3rd August in both the year on raised (15cm) bed. The individual plot size was 1m^2 and laid out in factorial randomized block design. Nitrogen, phosphorus and potassium were applied @ 200 kg N, 100 kg P_2O_5 and 100 kg K_2O. Phosphorus and potassium were applied in the form of single super phosphate and muruate of potash but 25% of the recommended doses of nitrogen was applied through mustard oil cake and rest 75% was applied through urea.

The entire amount of P_2O_5, K_2O and 25 % of the N (in the form of mustard oil cake) ware applied as basal. The rest 75%t of nitrogen *i.e.* urea was applied in two (N_2) and three (N_3) split doses in equal proportion. In case of two split (N_2) doses urea was applied at 15 DAP (days after planting) and 30 DAP but in case of three split (N_3) doses, urea was applied at 15 DAP, 30 DAP and 45 DAP. The experiment comprises of nine treatments *viz.*Cv_1N_0, Cv_1N_2, Cv_1N_3, Cv_2N_0, Cv_2N_2, Cv_2N_3, Cv_3N_0, Cv_3N_2 and Cv_3N_3. All the treatment combinations were replicated thrice.

The incident PAR under open condition was measured at 11:30 h on three dates (20th December, 5th January and 20th January in both the year) with the subsequent measurement of incident of PAR under polyshade. Availability of PAR inside the polyshade, percentage of absorption, percentage of interception, albedo, percentage of interception, absorptance, transmittance and reflectance were computed.

RESULTS AND DISCUSSION

Availability of PAR inside the polyshade

Result showed the reduction of PAR inside the polyshade ranged from 53-64% (Table 1) out of this total incident PAR, absorption was found to be maximum when nitrogen (N_2) was applied in two split irrespective of cultivar and date of observation (Table 2). Among 3 cultivars, the Cv_1 recorded the highest absorption. This might be attributed to maximum individual leaf area and the maximum number of leaves of this cultivar. When nitrogen was applied in two (N_2) splits, both the individual leaf area and number of leaves were found to be maximum. Increased area of the leaves as well as increased number of leaves increased the total leaf volume which helped plant to absorb more PAR on all dates of observation. This was also evident from the percentage of transmission of PAR (Table 3). The transmission was found to be the lowest in case of N_2 irrespective of cultivars. The interception of PAR within the chrysanthemum canopy recorded the similar trend to that of absorption (Table 5). Albedo from chrysanthemum canopy (Table 4) did not show any definite trend because the use of polyshade which might have created multiple scattering with in the shade.

Spectral Properties

Among the spectral properties, absorbtance was maximum when nitrogen was applied in two (N_2) split, irrespective of cultivar. Among the three cultivars, Cv_1, recorded highest absorbtance (Table 6a). This showed the potentiality of the cultivar Cv_1 to absorb more radiation in comparison to other two cultivars. The lowest transmittance observed in case of N_2 dose showed that splitting of nitrogen in two split (N_2) enhanced the leaf production as well as individual leaf area. The increase in leaf area helped the plant to absorb more and transmit less PAR to the ground levels. The reflectance did not show any pattern, however with the advancement of age the reflectance increased which was more pronounced when nitrogen (N) was applied to the crop. Nitrogen application increased the reflectance (Table-6c) due to the higher deposition of carbohydrate in the leaf tissue. As application of nitrogen (N) increased chlorophyll content of leaves, it reflects more radiation in the wave length of 550-580nm (Monteith and Unsworth, 2001). Therefore increased application nitrogen (N), irrespective of split, reflectivity of chrysanthemum increased. This might be helpful to dump the heat load to the environment, reducing the temperature of leaves and producing better size flower.

Table 1: Availability of PAR inside the polyshade

Incident (open) in w/m²	Incident (shade) in w/m²	% Reduction
187.38	86.62	53.77
194.94	83.81	57
188.78	66.42	64.82

Table 2: Percentage of absorption of PAR by the Chrysanthemum cultivars under different nitrogen management

Treatment	(w/m²)			(w/m²)			(w/m²)		
	Yr1	Yr2	Pooled	Yr1	Yr2	Pooled	Yr1	Yr2	Pooled
Cv_1N_0	25.05	22.20	23.63	27.71	23.39	25.55	32.36	25.88	29.12
Cv_1N_2	78.80	70.20	74.50	54.12	71.26	62.69	39.67	68.78	54.23
Cv_1N_3	62.10	58.61	60.35	79.00	65.21	72.10	67.48	52.85	60.16
Cv_2N_0	27.86	25.49	26.67	21.35	31.24	26.29	21.36	33.36	27.36
Cv_2N_2	64.34	63.72	64.03	70.62	68.82	69.72	59.84	50.73	55.28
Cv_2N_3	59.85	49.38	54.61	37.63	49.36	43.49	41.95	31.87	36.91
Cv_3N_0	21.63	26.74	24.19	17.66	27.63	22.65	18.91	25.14	22.03
Cv_3N_2	52.12	43.52	47.82	36.73	54.25	45.49	36.42	47.48	41.95
Cv_3N_3	31.68	42.28	36.98	54.51	44.72	49.61	25.69	31.38	28.54

Table 3: Percentage of transmission of PAR by the Chrysanthemum cultivars under different nitrogen management

Treatment	Yr1	Yr2	Pooled	Yr1	Yr2	Pooled	Yr1	Yr2	Pooled
Cv_1N_0	73.69	68.73	71.21	71.01	71.78	71.39	65.85	72.45	69.15
Cv_1N_2	14.71	22.31	18.51	38.27	22.16	30.22	44.72	15.61	30.16
Cv_1N_3	28.18	33.04	30.61	17.01	28.99	23.00	22.76	31.71	27.24
Cv_2N_0	62.48	69.40	65.94	76.51	61.52	69.01	78.12	62.12	70.12
Cv_2N_2	30.55	31.92	31.23	24.48	27.06	25.77	29.27	43.74	36.50
Cv_2N_3	36.78	47.12	41.95	58.25	44.46	51.35	52.85	61.14	56.99
Cv_3N_0	64.94	67.14	66.04	77.75	68.19	72.97	77.02	73.97	75.50
Cv_3N_2	43.38	51.48	47.43	60.95	40.72	50.84	58.37	49.11	53.74
Cv_3N_3	64.58	53.48	59.03	41.75	53.22	47.48	73.50	64.23	68.86

Table 4: Albedo of Chrysanthemum cultivars under different nitrogen management

Treatment	Yr1	Yr2	Pooled	Yr1	Yr2	Pooled	Yr1	Yr2	Pooled
Cv_1N_0	6.98	8.22	7.60	5.54	5.00	5.27	6.84	4.67	5.75
Cv_1N_2	7.48	8.98	8.23	10.18	8.11	9.15	19.18	17.55	18.37
Cv_1N_3	11.00	10.00	10.50	6.44	7.86	7.15	13.82	18.86	16.34
Cv_2N_0	10.56	7.11	8.84	4.61	7.35	5.98	3.63	4.53	4.08
Cv_2N_2	7.35	6.37	6.86	7.09	6.57	6.83	13.17	9.11	11.14
Cv_2N_3	5.98	6.98	6.48	7.86	9.28	8.57	9.27	10.09	9.68
Cv_3N_0	13.88	7.13	10.51	6.74	5.58	6.16	4.35	2.98	3.67
Cv_3N_2	6.49	7.35	6.92	6.71	7.60	7.15	9.11	7.32	8.21
Cv_3N_3	6.98	7.23	7.11	6.57	5.29	5.93	6.67	8.46	7.57

Table 5: Percentage of interception of PAR by the Chrysanthemum cultivars under different nitrogen management

Treatment	Yr1	Yr2	Pooled	Yr1	Yr2	Pooled	Yr1	Yr2	Pooled
Cv_1N_0	19.33	22.32	20.82	23.46	23.22	23.34	27.32	22.88	25.10
Cv_1N_2	77.81	68.70	73.26	51.55	69.72	60.63	36.10	66.83	51.46
Cv_1N_3	60.48	56.49	58.48	76.55	63.15	69.85	63.41	49.43	56.42
Cv_2N_0	26.96	23.48	25.22	18.89	31.13	25.01	18.25	33.35	25.80
Cv_2N_2	62.10	61.35	61.73	68.43	66.37	67.40	57.56	47.15	52.36
Cv_2N_3	57.23	45.89	51.56	33.89	46.26	40.08	37.89	28.78	33.33
Cv_3N_0	21.18	32.86	27.02	15.51	26.23	20.87	18.62	21.54	20.08
Cv_3N_2	50.13	41.15	45.64	32.35	51.68	42.01	32.52	43.58	38.05
Cv_3N_3	28.43	39.28	33.86	51.68	41.50	46.59	19.84	27.32	23.58

Table 6: Spectral properties of Chrysanthemum cultivars under different nitrogen management

Table 6a: Absorptance (á)

Treatment	Yr1	Yr2	Pooled	Yr1	Yr2	Pooled	Yr1	Yr2	Pooled
Cv_1N_0	0.24	0.22	0.23	0.28	0.23	0.26	0.32	0.26	0.29
Cv_1N_2	0.79	0.70	0.75	0.54	0.71	0.63	0.40	0.69	0.54
Cv_1N_3	0.62	0.59	0.60	0.79	0.65	0.72	0.67	0.53	0.60
Cv_2N_0	0.28	0.25	0.27	0.21	0.31	0.26	0.21	0.33	0.27
Cv_2N_2	0.64	0.64	0.64	0.71	0.69	0.70	0.60	0.51	0.55
Cv_2N_3	0.60	0.49	0.55	0.38	0.49	0.43	0.42	0.32	0.37
Cv_3N_0	0.22	0.27	0.24	0.18	0.28	0.23	0.19	0.25	0.22
Cv_3N_2	0.52	0.44	0.48	0.37	0.54	0.45	0.36	0.47	0.42
Cv_3N_3	0.32	0.42	0.37	0.55	0.45	0.50	0.26	0.31	0.29

Table 6b: Transmittance (ô)

Cv_1N_0	Yr1	Yr2	Pooled	Yr1	Yr2	Pooled	Yr1	Yr2	Pooled
Cv_1N_2	0.74	0.69	0.71	0.71	0.72	0.71	0.66	0.72	0.69
Cv_1N_3	0.15	0.22	0.19	0.38	0.22	0.30	0.45	0.16	0.30
Cv_2N_0	0.28	0.33	0.31	0.17	0.29	0.23	0.23	0.32	0.27
Cv_2N_2	0.62	0.69	0.66	0.77	0.62	0.69	0.78	0.62	0.70
Cv_2N_3	0.31	0.32	0.32	0.24	0.27	0.26	0.29	0.44	0.37
Cv_3N_0	0.31	0.47	0.39	0.58	0.44	0.51	0.53	0.61	0.57
Cv_3N_2	0.65	0.67	0.66	0.78	0.68	0.73	0.77	0.74	0.75
Cv_3N_3	0.43	0.51	0.47	0.61	0.41	0.51	0.58	0.49	0.54
Cv_1N_0	0.65	0.53	0.59	0.42	0.53	0.47	0.74	0.64	0.69

Table 6c: Reflectance (ñ)

Treatment	Yr1	Yr2	Pooled	Yr1	Yr2	Pooled	Yr1	Yr2	Pooled
Cv_1N_0	0.07	0.08	0.08	0.06	0.05	0.05	0.07	0.05	0.06
Cv_1N_2	0.07	0.09	0.08	0.10	0.08	0.09	0.19	0.18	0.18
Cv_1N_3	0.11	0.10	0.11	0.06	0.08	0.07	0.14	0.19	0.16
Cv_2N_0	0.11	0.07	0.09	0.05	0.07	0.06	0.04	0.05	0.04
Cv_2N_2	0.07	0.07	0.07	0.07	0.07	0.07	0.13	0.09	0.11
Cv_2N_3	0.06	0.07	0.07	0.08	0.09	0.09	0.09	0.10	0.10
Cv_3N_0	0.14	0.07	0.11	0.07	0.06	0.06	0.04	0.03	0.04
Cv_3N_2	0.06	0.07	0.07	0.07	0.08	0.07	0.09	0.07	0.08
Cv_3N_3	0.07	0.07	0.07	0.07	0.05	0.06	0.07	0.08	0.08

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