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RESEARCH ARTICLE

Fluctuation of photosynthetic pigment of water-stressed cowpea *Vigna unguiculata* (L.) Walp. varieties

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ABSTRACT

Photosynthetic pigments are responsible for conversion of light energy into a form of chemical energy in the plants. The most important pigment in the light harvesting machinery of the plant is chlorophyll and Carotenoids play an important role in photo-protection of chlorophyll molecules. Cowpea responds to survive under water-deficit conditions via a series of physiological, cellular and molecular processes culminating in stress tolerance. Most cowpea is produced in arid and semi-arid zone. This experiment was conducted in the research field of Department of Biological Sciences, Sam Higginbottom Institute of Agricultural Technology and Sciences, Allahabad. To study the chlorophyll a, chlorophyll b and carotenoid content of three cowpea varieties (UU-0, VU-89 and KK-6) subjected to the different level of watering (daily watering, 2 days interval, 4 days interval and 6 days interval of watering). The experimental materials were arranged in Randomize Complete Block Design. The results indicate that the all photosynthetic pigments such as chlorophyll a, chlorophyll b and carotenoid content maximum in daily watering whereas at 6 days interval of watering observed minimum.

Key words : Cowpea, Water Stress, Chlorophyll, Carotenoid

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INTRODUCTION

The cowpea (*Vigna unguiculata* L.) is an important legume widely cultivated in tropics and subtropics for forage, green pods and grains (Ali *et al.*, 2004). Cowpea is usually better adapted to drought, high temperatures and other biotic stresses compared with other crops (Kuykendall *et al.*, 2000 and Martins *et al.*, 2003). However, growth and development of many cowpea cultivars are affected by drought and high temperatures, especially during floral development (Dadson *et al*., 2005). Under drought stress, growth and function suppression in plants involves many morphological, physiological and molecular changes including oxidative stress, metabolic disturbance (Li

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et al., 2013). Plants respond to adverse conditions by altering their morphology, physiology, and biochemistry, however, biochemical events mainly take place earlier than others.

The chlorophyll content of crop plants is positively correlated with their photosynthetic activity (Gummuluru *et al*., 1989) and Chlorophyll a and chlorophyll b contents decreased by decreasing the soil moisture content. Chl-a and chl-b changes in response to drought stress (Liu *et al.*, 2011). Reduction in chlorophyll concentration is identified as a drought response mechanism in order to minimize the light absorption by chloroplasts (Pastenes *et al*., 2005). Carotenoids are pigments with several functions in plants, besides their direct role in photosynthesis, including their involvement in the mechanisms of oxidative stress tolerance (Gill and Tuteja, 2010). Since carotenoid plays an important role in photo-protection, the increased carotenoid content under drought conditions, indicate a higher need of photo-protection by carotenoid (Elsheery and Cao, 2008). This study was conducted to study the photosynthetic pigments content in the different cowpea varieties which were irrigated at different level of watering.

MATERIAL AND METHODS

The experiment was conducted in the research field of Department of Biological Sciences, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad. Three varieties of cowpea *Vigna unguiculata* (L.) namely KK-6, VU-89 and UU-0 were treated with different level watering *viz.*, daily watering, 2 days interval, 4 days interval and 6 days interval of watering. Daily watering consider to the control.–

Chlorophyll content :

Chlorophyll was determined according to (Lichtenthaler and Wellburn, 1983). 1 g leaves sample was weighed and crushed with 80 per cent acetone made the volume to 10 ml with 80 per cent acetone, centrifuged at 800 rpm for 5 minute. The supernatant was read under 663, 645 nanometer. The readings were fed in the following formula and results were determined under spectrophotometer. The chlorophyll was calculated by following equation:

– Chlorophyll a (mg/g fresh weight) = 12.7 x (A663) - 2.69 x (A645) × V/1000 × w × a
– Chlorophyll b (mg/g fresh weight) = 20.13 (A645) – 5.03 (A663) × V/1000 × w × a
– Total chlorophyll (mg/g fresh weight) = (20.2 × A663 + 8.02 × A645) × V/1000 × w × a.

where,

A663 = Absorbance at 663nm., A645 = Absorbance at 645nm., a = Path length of cuvette (1 cm), V = Final volume of the chlorophyll extract (10 ml) and W = Fresh weight of the sample (0.10 g).

Carotenoid content :

Carotenoid was determined according to (Lichtenthaler and Wellburn, 1983). 0.5 g and homogenized in 10 ml of acetone (80% acetone). Next to the centrifuged at 3000 rpm at 10 min. The absorbance was recorded at 470 nm. It is calculated by the formula :

Total carotenoids =1000 A470-(3027 Chl-a+104 Chl-b)/229

RESULTS AND DISCUSSION

Application of different levels of watering on physiological parameters like content of chlorophyll ‘a’, chlorophyll ‘b’ and caratotenoid was significant and non-

Table 1: Effect of different water levels on chlorophyll a, chlorophyll b and total chlorophyll in cowpea varieties

	Chlorophyll a(mg/g fresh weight)				Chlorophyll b(mg/g fresh weight)				Total chlorophyll content (mg/g fresh weight)			
	Daily	2 day interval	4 day interval	6 day interval	Daily	2 day interval	4 day interval	6 day interval	Daily	2 day interval	4 day interval	6 day interval
UU-0	1.475	1.275	1.173	0.992	1.108	0.948	0.855	0.767	2.583	2.262	2.027	1.760
VU- 89	1.603	1.390	1.138	0.938	1.185	1.043	0.938	0.868	2.787	2.433	2.075	1.805
KK-6	1.632	1.375	1.070	0.865	1.285	1.132	0.922	0.877	2.892	2.508	1.992	1.742
C.V.	4.746	7.359	2.462	2.800	5.693	5.134	5.000	5.143	4.535	6.703	2.848	2.758
F Prob.	0.052	0.279	0.005	0.001	0.028	0.008	0.087	0.020	0.033	0.168	0.210	0.252
S.E.±	0.037	0.050	0.014	0.013	0.034	0.027	0.023	0.022	0.062	0.080	0.029	0.024
C.D. (P=0.05)	NS	NS	0.048	0.045	0.117	0.092	NS	0.075	0.216	NS	NS	NS

NS= Non-significant

significantly reduced with increase water stress conditions. Similar results were reported in tomato by (Al Hasan *et. al.,* 2015).

The result showed that, the different water levels non-significantly changed chlorophyll 'a' values at daily watering and 2 day interval watering whereas in 4 day and 6 day interval watering there was significant variation in chlorophyll a value. Among all the varieties KK-6 showed the maximum chlorophyll a content (1.632 mg/g fresh weight) in daily watering condition whereas it also showed the minimum chlorophyll a content (0.865 mg/g fresh weight) at 6 day interval watering condition (Table 1 and Fig.1a). The different water levels non-significantly changed chlorophyll 'b' values only at 4 days interval watering whereas in daily watering, 2 day interval and 6 days interval watering there was significant variation in chlorophyll b value. Among all the varieties KK-6 showed the maximum chlorophyll content (1.285 mg/g fresh weight) in daily watering condition whereas UU-0 showed the minimum chlorophyll b content (0.767 mg/g fresh weight) at 6 days interval watering condition (Table 1 and Fig. 1b). The different water levels non-significantly changed total chlorophyll values only at 2 day interval, 4 days interval, 6 day interval watering whereas in daily watering there was significant variation in total chlorophyll value. Among all the varieties KK-6 showed the maximum chlorophyll content (2.892 mg/g fresh weight) in daily watering condition whereas KK-6 showed the minimum total chlorophyll content (1.742 mg/g fresh weight) at 6 days interval watering condition (Table 1 and Fig. 1b).

The different water levels non-significantly changed chl a/chl b values at daily watering, 2 day interval watering whereas in 4 day interval, 6 day interval watering there was significant variation in chl a/chl b value. Among all the varieties UU-0 showed the maximum chl a/chl b (1.372) in 4 ay interval watering condition whereas KK-6 showed the minimum chl a/chl b (0.986) at 6 days interval watering condition (Table 2 and Fig. 2a). The different water levels non-significantly changed carotenoid values at 2 day interval, 6 days interval watering whereas in daily watering there was significant

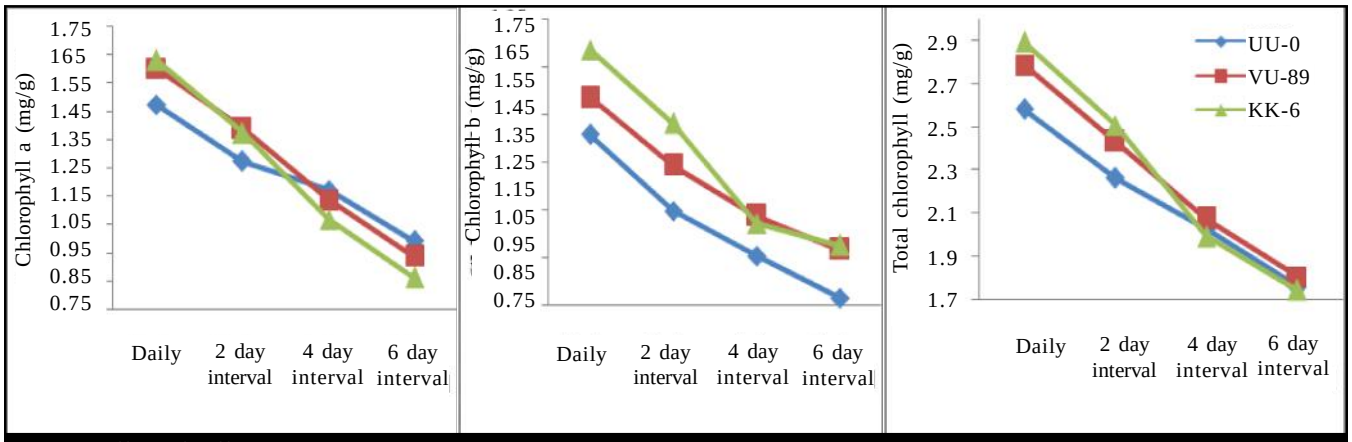

Fig. 1 : Effect of different water levels on chlorophyll a, chlorophyll b and total chlorophyll in cowpea varieties

Table 2 : Effects of different water levels on the chl a/chl b and carotenoid content in cowpea varieties

	Chl a/Chl b				Carotenoid content (mg/g fresh weight)			
	Daily	2 day interval	4 day interval	6 day interval	Daily	2 day interval	4 day interval	6 day interval
UU-0	1.333	1.345	1.372	1.296	2.282	1.963	1.991	1.727
VU- 89	1.353	1.334	1.215	1.082	2.49	2.133	2.12	1.738
KK-6	1.271	1.215	1.164	0.986	2.592	2.19	2.164	1.71
C.V.	3.544	5.317	4.980	6.355	5.1	7.279	3.312	4.861
F Prob.	0.104	0.067	0.008	0.002	0.033	0.171	0.029	0.897
S.E.±	0.023	0.035	0.031	0.036	0.063	0.076	0.035	0.042
C.D. (P=0.05)	NS	NS	0.108	0.123	0.217	NS	0.12	NS

NS=Non-significant

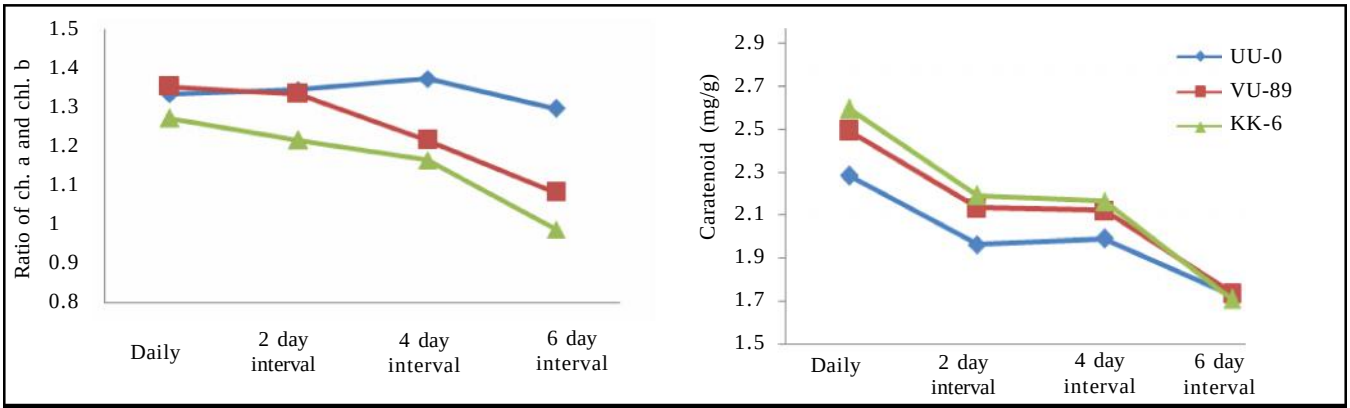

Fig. 2 : Effect of different water levels on the chl a/ chl b and total carotenoid content in cowpea varieties

variation in caratenoid content value. Among all the varieties KK-6 showed the maximum carotenoid content (2.592 mg/g fresh weight) in daily watering condition whereas KK-6 showed the minimum total chlorophyll content (1.71 mg/g fresh weight) at 6 days interval watering condition (Table 2 and Fig. 2b).

Conclusion :

From the present investigation it is concluded that the photosynthetic pigments were decrease with the increase water stress. Thus, it shows that daily watering in cowpea [*Vigna unguiculata* (L.) Walp.] Varieties UU-0, VU-89 and KK-6 have highest content of photosynthetic pigments .

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