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Full Length Research Article

Effect of Water Stress Conditions on the Growth, Sugar Content, Chlorophyll Content and Biocrude Productivity of *Pedilanthus tithymaloides* (L) Poit.

Anshu Rani*[1]

[1] Department of Botany, S.M.C.C. Government College, Aburoad - 307 026, Rajasthan, India

Abstract

Pedilanthus tithymaloides is a promising petro plant which can be grown in arid and semi-arid climate of Rajasthan. Water stress has a definite impact on biomass production, though the extent depends on the magnitude of stress, its duration and the plant involved. Different levels of irrigation variously influenced the plant growth. A gradual decline in above ground plant part's weight was observed at 75, 50, 25 and 10 percent field capacities. However, lowest level of irrigation (10 percent) favoured maximum percent dry weight in above ground part of the plants while percent dry weight of underground part was maximum at 100 percent field capacity. Higher level of stress (10 and 25%) favoured more hydrocarbon yield in comparison to well irrigated (50 and 75 percent field capacities). Plants irrigated at 10 percent field capacity exhibited minimum level of hexane extractables. Increasing levels of irrigation exhibited greater fall in sugar accumulation. Maximum sugars were obtained in the 10 percent field capacity provided plants.

Key words: *Pedilanthus tithymaloides*, Bio-crude, Biomass, Chlorophyll, Sugars

Pedilanthus tithymaloides var. green is a promising petro plant which can be grown in arid and semi-arid climate of Rajasthan. An assumption that appears to underlie this emphasis on dry matter productivity is that yield improvements can be accomplished without significantly affecting feed stock cost or bio crude content and consequently that higher yield will be associated with greater economic returns.

Water stress has a definite impact on biomass production, though the extent depends on the magnitude of stress, its duration and the plant involved. The interaction between hydraulic conductivity of tissue and influence of water stress may produce changes in growth and metabolic activity that characterize many features of plant development [1-2]. Plants when subjected to water stress, hardening process takes place which makes the plant less sensitive to renewed water stress by osmotic adjustment of leaves [3-4] influencing leaf morphology [5] and by changing elastic modulus of leaf cells [6]. Osmotic adjustment may occur by inorganic solute uptake [7-8] and increase in organic solutes [9].

Restricted water supply affects various parameters of plant growth and metabolism in different plants like spinach [10], *Quercus* Linn. Sp. [11], cotton 12-13], sugarcane [14-17], pearl millet [1] tobacco [18] and *Euphorbia lathyris* L. [19] Water stress has been reported to enhance hydrocarbons of wax of cocoa trees [20]. However, a large number of laticiferous plants are able to grow under conditions of mild water stress. Hydrocarbons were reported to increase at moderate levels of water stress in *E. tirucalli* and *E. lathyris* [21]. Present investigations were undertaken to study the influence of water stress on plant growth, hydrocarbon yield, sugar and chlorophyll contents of *P. tithymaloides* var. *green.*

MATERIALS AND METHODS

25 cm earthen pots were filled with 4 kg soil mixed with 250g of manure. Plants raised in beds were transferred to these polythene lined pots. Plants were irrigated with different water levels so as to maintain 10, 25, 50, 75 and 100 percent field capacities. Experiments were conducted for a period of six months. Plants were uprooted after six months of growth washed and blot dried. Plant length and weight is measured followed by oven drying at 60-degree Celsius temperature till the weight becomes constant.10 g finely ground dried powdered plant material was packed in thimbles of Whatman filter paper No. 1. The extraction was done in Soxhlet apparatus using hexane for about 18 hrs. at 40 to 50 degree Celsius temperature. Excess of hexane is than distilled out and bio crude is collected and weighed till the weight becomes constant.

Determination of chlorophyll

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Correspondence to: Anshu Rani, Department of Botany, S.M.C.C. Government College, Aburoad - 307 026, Rajasthan, India; E-mail: dranshursaxena@gmail.com

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One gram of leaves from plants were crushed and homogenized in 80 percent acetone. A pinch of calcium carbonate is also added to check breakdown of chlorophyll and pheophytin formation. Filtrate is collected and volume is made up to 100 ml with 80 percent acetone. Absorbance was measured at 645, 652 and 663nm for determination of chlorophyll a,b and total chlorophyll following Arnon's method [22]. Optical density of test samples was recorded.

Determination of sugars

Total soluble sugars in the plant were estimated by phenol sulphuric acid method [23]. The method is sensitive to soluble carbohydrates including sugar derivatives, oligo and polysaccharides. 10 mg of powdered plant material was taken in separate test tubes, mixed with 50 percent alcohol and kept for two hours. The aliquot was boiled on water bath to evaporate alcohol. 10 ml of distilled water was added to the alcohol-free extract and mixed properly. 1ml of the aliquot of the aqueous solution was taken in a separate test tube. One ml of 5% phenol solution was mixed with it. Blank was maintained with water instead of the extract. 5ml of 96% sulphuric acid was rapidly mixed. After standing for 10 minutes at room temperature the contents were mixed. Tubes were placed in a water bath at 25-30 degree Celsius for 20 minutes. The yellow orange colour indicated the presence of sugars. Absorbance was measured at 490nm for hexoses and methylated hexoses. Glucose was used as the standard for estimation.

Statistical methodology

The observation of each parameter of the experiment was analyzed statistically for mean, analysis of variance, standard error mean and critical difference by applying '*F –Test'*.

RESULTS AND DISCUSSION

As per methods given. Different levels of irrigation variously influenced the plant growth (Table 1). Maximum increase in fresh weight and dry weight of above ground parts was observed in plants irrigated at 100% field capacity while that of underground parts was observed in plants irrigated at 75%field capacity. A gradual decline in above ground part's weight was observed at 75, 50, 25 and 10 percent field capacities (Fig 1).

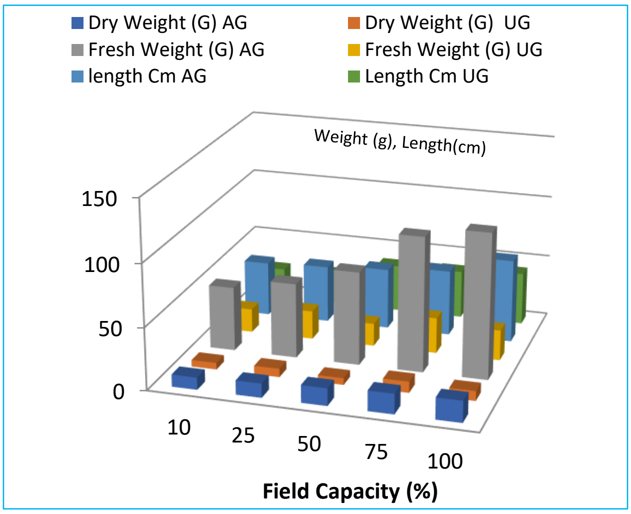

Fig 1

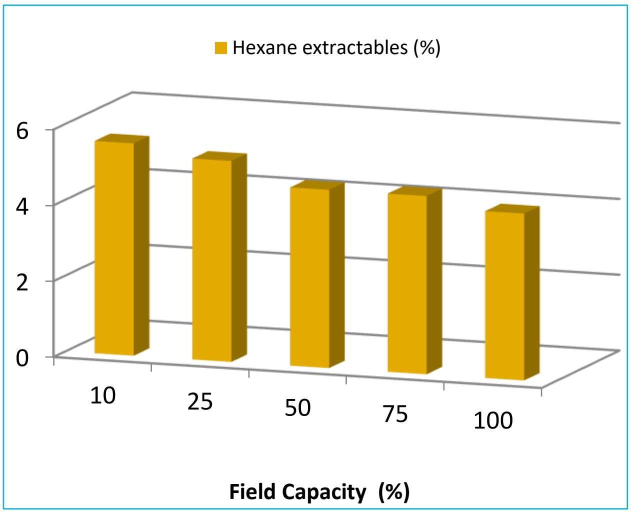

Fig 2

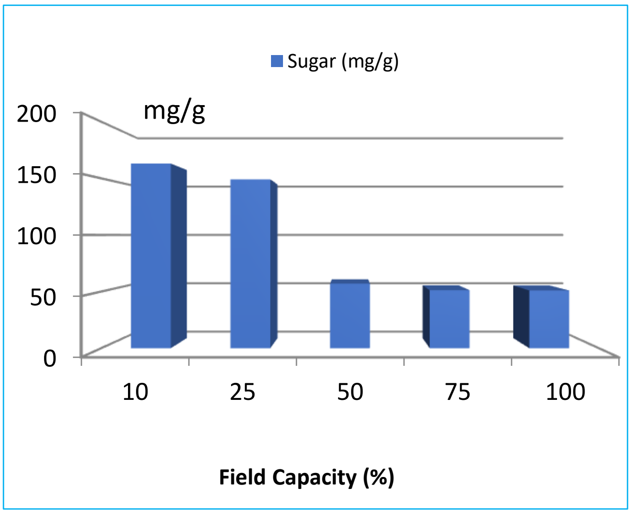

Fig 3

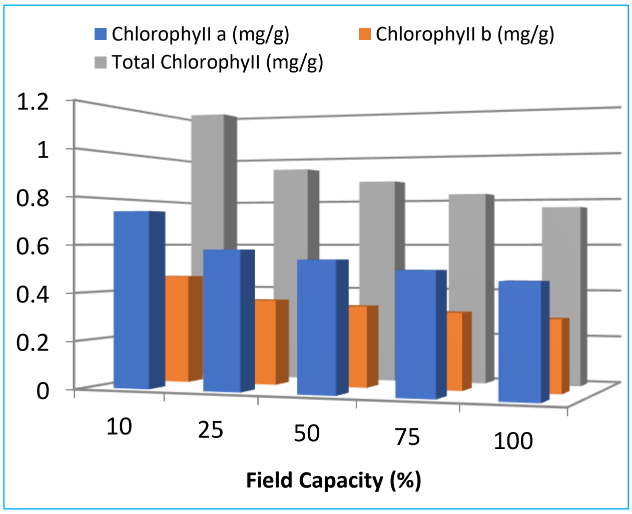

Fig 4

However, lowest level of irrigation (10 percent) favoured maximum percent dry weight in above ground part of the plants while percent dry weight of underground part was maximum at 100 percent field capacity. Higher level of stress (10 and 25 percent) favoured more hydrocarbon yield in comparison to well irrigated (50 and 75 percent field capacities). Plants irrigated at 10 percent field capacity exhibited minimum level of hexane extractables (Fig 2).

Increasing levels of irrigation exhibited greater fall in sugar accumulation. Maximum sugars were obtained in the 10 percent field capacity provided plants followed by a gradual decline in subsequently increased field capacities i.e., 25, 50, 75 and 100 percent (Fig 3).

Chlorophyll contents which were maximum at 10 percent, declined at increasing levels of irrigation, up to 100 percent field capacity (Fig 4).

Table 1 Effect of water stress on plant growth, hexane extractables, sugar and chlorophyll contents of *Pedilanthus tihymaloides* var. Green

Field capacity (%)	Length (cm)		Fresh wt. (g)		Dry wt. (g)		Dry wt. (%)		HE	Sagar	Chlorophyll (mg/g)		
	AG	UG	AG	UG	AG	UG	AG	UG	(%)	(mg/g)	Chl ‘a’	Chl ‘b’	Total
10	44	24.8	51.6	19	9.81	5.35	19.01	28.16	5.6	163	0.74	0.46	1.2
25	46	25.5	60.1	23	11.38	6.76	18.94	29.39	5.3	149	0.58	0.36	0.94
50	49	38	75	18.4	14.07	5.39	18.76	29.29	4.7	57	0.54	0.34	0.88
75	52.98	38.7	108.35	28.7	16.25	8.96	15	31.22	4.7	51.2	0.5	0.32	0.82
100	67	42.25	116.55	24.5	17.31	7.85	14.85	32.04	4.4	51	0.46	0.3	0.76
'F" test	Sig.	Sig.	Sig.	NS	Sig.	Sig.							
Sem	1.03	1.43	3.39		1.13	0.42							
CD at 5%	2.18	3.03	7.18		2.39	0.89							
CD at 1%	3.01	4.18	9.92		3.3	1.23							

Sig. = Significant; NS = Non-significant

Water stress in plants is reported to cause the generalized sensitivity of some processes to water stress, cytokinin levels, the cell growth, wall synthesis, protein synthesis, nitrate reductase level and stomatal opening. Carbon di oxide assimilation decreased while abscisic acid, proline and sugar accumulation increased, as a result of water stress [24]. As soil water influences the leaf water potential, the leaf enlargement also depends on water availability [25]. Water stress increases the production of abscisic acid production leading to senescence acceleration [26]. The plants have variable water requirements as 50% soil moisture was best for the growth of sugarcane [17]. In *Pedilanthus tithymaloides* var. *green i*ncreasing level of irrigation up to 100 percent field capacity almost doubled the fresh weight yield. The growth was adversely affected by underwater stress. A decrease in yield has been reported at low soil moistures for several plants [14-16, [27-28]. However, 10 percent of field capacity resulted in maximum chlorophyll, sugars and hexane extractable which decreased with increasing water level in the soil. Lack of irrigation is appropriate condition for optimum hydrocarbon yield [29]. Greater accumulation of percent dry weight at increased stressed condition was also reported for cotton [13] and *Grindelia integrifolia* DC [30].

Increased sugar levels under water stress conditions in the present investigations can be justified by the observation that under dry soil conditions, the sugar: starch ratio is modified, resulting into greater accumulation of sugars [31]. In bean also the starch reserves of leaves were depleted as soil dried out [32].

CONCLUSION

Taking percent hexane extractable as an important factor for yield, the lower levels of irrigation are favourable for bio crude but the biomass production requires higher levels of irrigation which in turn reduced the bio crude yield. A proper balance has to be achieved by improving the plant yield at lower levels of irrigation by experimental manipulations.

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