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Growth characters of fodder cowpea varieties as influeced by soil moisture stress levels

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ABSTRACT

A field experiment was conducted during January 2012 to March 2014. Five fodder cowpea varieties (V_1- UPC 618, V_2-UPC - 622, V_3- Bundel Lobia-1, V_4 - COFC - 8 and V_5- CO-5) were evaluated for their drought tolerance under four soil moisture stress levels (M_1- pre sowing irrigation + lifesaving irrigation, M_2- pre sowing irrigation + irrigation at IW/CPE ratio of 0.4, M_3- pre sowing irrigation + irrigation at IW/CPE ratio of 0.6 and M_4-pre sowing irrigation + irrigation at IW/CPE ratio of 0.8). The investigation was conducted as two separate experiments, one in open and other in shade. The experiments were laid out in split plot design with four replications. Observations on growth characters such as plant height, number of branches and leaf stem ratio were recorded. The results revealed that plant height and number of branches were maximum at irrigation at IW/CPE ratio of 0.8 both in open and shade. Among the varieties, COFC - 8 recorded maximum plant height and number of branches at all irrigation levels in open and partial shade.

Key words : Irrigation, Partial shade, Soil moisture stress, Varieties.

INTRODUCTION

A serious drawback of sustainable livestock production system in Kerala is the inadequate seasonal distribution of fodder production. The quantity and quality of herbage available in the lean dry months from January to May is very low. Fodder cowpea (*Vigna unguiculata* L.Walp) is a fodder legume inherently more tolerant to drought than other fodder legumes (Fatokun *et al*., 2009) and considered as a crop capable of improving sustainability of livestock production through its contribution in improving seasonal fodder productivity and nutritive value. Singh *et al.*, (1995) reported that the tolerance to drought exhibited by fodder cowpea extends its adaptation to dries areas considered marginal for most other crops. Fodder cowpea is the most widely cultivated fodder legume in areas where rainfall is scanty and soils are sandy and relatively infertile and most households that keep livestock grew fodder cowpea as an intercrop with other crops and fodder cowpea forms an integral component of crop/livestock farming system (Singh and Tarawali, 2011). The dairy homesteads of Kerala are mostly experiencing light stress of varying intensities. Poor adaptation of many improved fodder crops/ varieties in shade environment limits fodder production in homesteads and shade affects persistence, yield and quality of under storey forages. Hence this study was proposed to findout the effect of water stress on growth characters of fodder cowpea varieties for improving the quantity and quality of fodder production under open and shaded situations during the lean dry months.

MATERIALS AND METHODS

A field experiment was conducted at the Instructional Farm, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala during January 2012 to March 2014. Five fodder cowpea varieties (V_1-UPC-618, V_2- UPC-622, V_3- Bundel lobia -1, V_4- COFC-8 and V_5- CO-5) were evaluated for their drought tolerance under four soil moisture stress levels (M_1 – pre sowing irrigation + lifesaving irrigation, M_2- pre sowing irrigation + irrigation at IW/CPE ratio of 0.4, M_3 – pre sowing irrigation + irrigation at IW/ CPE ratio of 0.6 and M_4 – pre sowing irrigation + irrigation at IW/CPE ratio of 0.8). The investigation was conducted as two separate experiments, one in open and other in shade. Both the experiments were laid out in split plot design with four replications. FYM@ 10 t ha^{-1} was applied uniformly to all the plots at the time of final preparation of land. Entire dose of phosphorus was given as basal @ 30 $kgha^{-1}$. Nitrogen @ 40kg $ha^{-1}$and potassium @ 30kg ha^{-1} was given in two equal splits, one as basal and one after one month of sowing. The fodder cowpea varieties as per treatments were sown at a spacing of 30 x 15 cm @ 2 seeds $hole^{-1}$ both in open as well as in shade (25-35 per cent). Pre sowing irrigation was given to all the plots uniformly up to 10 DAS for germination and establishment. Thereafter irrigation was given as per the treatments. Daily cumulative pan evaporation data was noted from USWB open pan evaporimeter. Based on the evaporation data and depth of irrigation, irrigation was given to the plots. The quantity of water applied to each plot in one irrigation was 60 litres.

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The daily rainfall and evaporation data along with the respective dates of irrigation are given in Table 1. The total amount of water received by each irrigation treatment is shown in Table 2. Lifesaving irrigation was given in the treatment M_1. Observations on growth characters such as plant height, number of branches plant^{-1} and leaf: stem ratio were recorded before harvest. Data relative to each character was analysed statistically by applying the analysis of variance technique (ANOVA) as suggested by Panse and Sukhatme (1967).

TABLE 1: Quantity of water received by each irrigation treatment during the crop period

Treatment	Irrigation (mm)	Effective rainfall (mm)	Total amount of water received (mm)
Lifesaving irrigation	60	Nil	60
Irrigation at IW/CPE ratio of 0.4	60	Nil	60
Irrigation at IW/CPE ratio of 0.6	90	Nil	90
Irrigation at IW/CPE ratio of 0.8	12	Nil	120

RESULTS AND DISCUSSION

The results on the effect of treatments (soil moisture stress levels and varieties) with respect to the plant height of fodder cowpea under open and shaded condition are presented in Table 1. In open, plant height showed significant difference for various soil moisture stress and varietal treatments. The plant height was significantly higher (100.83 cm) when irrigated at IW/CPE ratio of 0.8 (M_4) followed by irrigating at IW/CPE ratio of 0.6 (M_3).

Minimum plant height was recorded by lifesaving irrigation. This may be due to the fact that plants grown under dehydrated conditions causes as reduction in plant height by reduction of photosynthesis and consequently reduction of internode length. A similar result was also reported by Hajibabaee *et al*. (2009) in forage corn hybrids and by Purbajanti *et al*. (2012) in guinea and napier grasses. Compared to open condition, under 25-35 per cent shade, the plant height of all the varieties increased in all the soil moisture stress levels. Significantly higher plant height (102.89 cm) was recorded by irrigation at IW/CPE ratio of 0.8 (M_4). It is a well-known fact that plants grown in shade are always taller than those grown in full sunlight. In open, the phytochrome pigment will be in Pr form which prevents elongation and results in increase in internode length. Production of auxins are more under shaded conditions which results in strong apical growth, preventing side shoot sprouting and further development. Similar results were also reported in three *Brachiaria sp.* by Guenni (2007) and in guinea grass varieties by Anita (2002). Among the varieties, COFC-8 ($V_{4)}$ recorded higher plant height (101.36 cm), which was on par with that of UPC-618 (V_1) in open condition. In shade, COFC -8 (V_4) recorded a plant height of 102.31 c.m. Considerable variations in plant height was also reporte4d by Shekara *et al*. (2012) in fodder cowpea genotypes viz., MFC 08-14, IL-117, UPC-5286, Bundel lobia-1 and UPC - 622.

The perusal of the data on number of branches presented in Table 3. showed that soil moisture stress levels and varieties had significant effect on number of branches in open condition. Significantly higher number of branches (4.57) was recorded by irrigation at IW/CPE ratio of 0.8 (M_4), followed by IW/CPE ratio of 0.6 (M_3) (4.22). Least number of branches was recorded at lifesaving irrigation (M_1). Lima *et al*. (2011) reported that reduction in plant tillering under water deficit mainly occurs due to low immediate availability of nutrients for the growth conditions because the nutrients for the growth conditions because the nutrients are absorbed by the system through the soil solution.

TABLE 2: Effect of soil moisture stress levels and varieties on plant height (cm), number of branches plant^{-1} and leaf: stem ratio of fodder cowpea.

Treatments	Plant height		Number of branches Plant^{-1}		Leaf: stem ratio	
	Open	Shade	Open	Shade	Open	Shade
Soil moisture stress levels (M)						
M_1- Life saving	97.98	98.48	3.70	2.98	0.90	0.94
M_2- IW/CPE = 0.4	98.34	98.44	3.80	3.08	0.94	0.94
M_3- IW/CPE = 0.6	100.14	102.49	4.22	3.23	1.09	0.94
M_4- IW/CPE = 0.8	100.83	102.89	4.57	3.23	1.09	1.01
SEm (±)	0.397	0.340	0.075	0.086	0.001	0.002
CD (0.05)	0.636	0.544	0.121	NS	NS	NS
Varieties (V)						
V_1 - UPC 618	99.30	100.54	3.85	3.40	0.90	0.93
V_2 - UPC 622	100.06	101.09	4.33	3.20	1.08	0.95
V_3- Bundel lobia-1	98.71	100.48	4.03	2.99	1.00	0.94
V_4 - COFC -8	101.36	102.31	4.79	3.52	1.18	1.05
V_5 - CO-5	97.16	98.42	3.37	2.54	0.86	0.90
SEm (±)	0.449	0.475	0.086	0.082	0.092	0.002
CD (0.05)	0.639	0.675	0.123	0.117	0.131	NS

TABLE 3: Interaction effect of soil moisture stress levels and varieties on plant height (cm), number of branches plant^{-1} and leaf: stem ratio of fodder cowpea.

Treatments	Plant height		Number of branches plant^{-1}		Leaf: stem ratio	
	Open	Shade	Open	Shade	Open	Shade
M x V						
m_1v_1	99.10	99.40	3.32	3.23	0.85	0.92
m_1v_2	97.60	97.63	4.15	2.97	0.96	0.95
m_1v_3	97.23	97.80	3.57	2.82	0.82	0.92
m_1v_4	100.10	100.93	4.5	3.43	1.12	1.02
m_1v_5	95.88	96.63	2.80	2.46	0.77	0.88
m_2v_1	98.60	98.88	3.40	3.36	0.80	0.93
m_2v_2	98.78	98.10	4.18	3.05	1.01	0.93
m_2v_3	98.08	98.23	3.95	2.89	0.99	0.90
m_2v_4	100.33	99.55	4.68	3.48	1.10	1.00
m_2v_5	95.90	97.43	2.97	2.65	0.78	0.92
m_3v_1	100.98	102.08	4.05	3.46	0.99	0.95
m_3v_2	100.03	104.98	4.26	3.45	1.18	0.92
m_3v_3	99.28	102.20	4.11	3.19	1.09	0.91
m_3v_4	101.78	104.43	4.95	3.53	1.25	1.00
m_3v_5	98.63	98.75	3.71	2.53	0.94	0.93
m_4v_1	101.58	101.83	4.60	3.56	0.99	0.93
m_4v_2	100.80	103.68	4.75	3.36	1.18	1.00
m_4v_3	100.25	103.70	4.48	3.10	1.09	1.05
m_4v_4	103.25	104.35	5.03	3.63	1.25	1.20
m_4v_5	98.25	100.88	4.01	2.51	0.94	0.89
SE m (+)	0.449	0.475	0.086	0.082	0.092	0.002
CD(0.05)	NS	1.35	0.783	NS	NS	NS

The cell expansion is other process that depends on the cell water conditions, also decreasing with the water deficit. The water condition is essential for the vegetative growth, mainly for tiller emerging in forage plants. Similar results were also reported by Purbajanti *et al.* (2012) in guinea grass and rapier grass. Among the varieties, COFC-8 (V_4) produced significantly more number of branches (4.79), followed by UPC-622 (V_2) (4.33) in open condition. Under partial shade, COFC-8 (V_4) and UPC-618 (V_2) recorded significantly higher number of branches of 3.52 and 3.40. Similar results were also reported by Rajasree and Pillai (2001) in some forage legumes. The results on the effect of soil moisture stress levels on leaf : stem ratio was not significant in open and shade. However, varieties had significant effect in open condition only. COFC-8 (V_4) recorded significantly higher leaf : stem ratio (1.18) which was on par with UPC- 622 (V_2) (1.08). Considerable variations in leaf : stem ratio was reported in different cowpea genotypes by Shekara *et al.* (2012).

Interaction effect was non significant in open condition with respect to plant height. In partial shade, interaction effect was significant and the plant height of 104.98 cm recorded for m_3v_2 (UPC-622 irrigated at IW/CPE ratio of 0.6) was significantly higher which was on par with m_3v_4 (104.43 cm), m_4v_4 (104.35 cm), m_4v_3 (103.70 cm) and m_4v_2 (103.68 cm) (Table 3). Regarding the number of branches, the interaction effect was significant only in open condition and m_4v_4 (COFC-8 irrigated at IW/CPE ratio of 0.8) recorded significantly higher number of branches (5.03) and it was on par with m_3v_4 (4.95), m_4v_4 (4.75), m_2v_4 (4.68), m_4v_1 (4.60), m_4v_3 (4.48) and m_3v_2 (4.26). The study also revealed that shade has dominating influence on inhibition of number of branches. Number of branches of all the varieties decreased under partial shade. The increase in number of tillers in open condition may be due to the higher leaf area index which might have resulted in more carbohydrate assimilation. A similar decrease in the number of tiller production with increase in shade intensity was reported by Anita (2002) in guinea grass cv.. Hamil and Haritha.

CONCLUSION

Based on the results, it can be concluded that water stress caused a significant reduction in growth characters such as plant height, number of branches and leaf stem ratio in all the varieties in open and shaded experiments. For all the soil moisture stress levels, COFC-8 has presented a more important morphological growth than other varieties, which in turn leads to relative tolerance of this cultivar under moisture stress situations. All these criteria should be considered while selecting cultivars to be grown in water deficit situations and in the agronomic management of fodder production under moisture stress situation.

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