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SCREENING OF LENTIL (LENS CULINARIS MEDIK.) GENOTYPES FOR DROUGHT TOLERANCE AT SEEDLING STAGE UNDER DIFFERENT LEVELS OF DROUGHT STRESS

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ABSTRACT

Water stress is one of the major issue around the world which highly influence on plant development and become the reason of loss in crop yield. Lentil is an important legume crop which suffer from insufficient soil moisture. Eight genotypes of lentil under three different concentration of drought were considered a drought tolerant genotype against drought stress. The results showed that morphological traits such as RL, FW, shoot length (SL), plant height and wilt weight act significantly different in different concentration of water. The lentil genotypes 8 and 3 are proved as tolerant against drought out of all genotypes. The investigation results reveals that lentil-8 perform well in all parameters except root length that was better in lentil- 5. The maximum plant height (7.93 cm) recorded in Lentil-1, dry weight (2.41 g), turgid weight (2.31 g), chlorophyll content (27.47 nm), canopy temperature (15.48 °C) recorded in letil-8, shoot length (7.98 cm) & fresh weight (3.68 g) recorded in lentil-3 and maximum root length (26.83 cm) recorded in lentil-5. The minimum plant height (6 cm), shoot length (6.73 cm) recorded in lentil-7, root length (21.41 cm) recorded in lentil-8, fresh weight (1.82 g) recorded in lentil-5, wilt weight (1.38 g) recorded in lentil-1.

Keywords: *Lentil, Drought, Stress, Seedling, Tolerance*

INTRODUCTION

Lentil (Lens culinaris L.), is ancient plant domesticated around the world. Origin of this Central Asia and near East, conventionally cultivated in Mediterranean basin (Zohary, D. 1972). A significant source of protein for human and entire plant material used as animal feed (Muscolo, A. et, al., 2014). The plant adjust itself to arid to semi-arid climate. Moderately it is drought tolerant crop but sharply decrease in yield of with increase in drought stress (Salehi, M. 2012). Availability of water is necessary of crop growth and for better yield (Singh, D. et, al., 2017).

Severe drought stage is alarming situation for the world food security. Plant growth and productivity limits during abiotic stresses mainly due to the drought stress in different areas of the world. Through selection and breeding development of drought tolerant cultivar for extending the crop under lying low rain fed area in the absence of proper irrigation (Singh, D. et, al., 2013). Drought stress inhibits lentil growth, especially at the blooming and seed-filling stages

(Sehgal, A. et, al., 2017). Its effect noted in the time of germination and seedling stage. They also restrict the photosynthetic activity and availability of light assimilation and energy to plant. During stress it is necessary to apply the less dose of nutrient to plant for their survival. Especially, drought is dare to agriculturist in the condition of global warming and fluctuation in the environment (Malhotra, R. et, al., 2004). During stress changing in the morphological structure of plants, enhanced in root formation, leaf thickness, leaf rolling and increase in water uptake, and reduce in leaf area, stomata number, and minimize the water losses (Morgil, H. et, al., 2019). If drought continuous plant adapt itself according to situation and produce wax to minimize the water loss (Lee, S. B., & Suh, M. C. 2013). Plant produce proline and glycine betaine to defend the different component of cell to prevent from water loss (Lamaoui, M. et, al., 2018). During drought stress some physiological changes occur such as growth stunt, decrease in the activity of photosynthesis and transpiration, also changing in the signaling pathways of lentil such as transcriptional and post-transcriptional regulation of stress responsive genes (Foti, C. et, al., 2021). The advanced studying has been developed to understand the growth of plant under drought stress. Water shortage sensed by roots that synthesize ABA in one hour of drought stress. ABA transported through capillary reaction from roots to leaves. RL is significant trait in case of water stress in plants; in broader term genotype that have longer roots growth resistance ability for drought (Kaydan, D. and M. Yagmur 2008). Some traits reported for drought tolerant genotype such as osmotic membrane stability of the leaf segment and root-to-shoot ratio and their relationship. Increase in ROS such as hydrogen peroxide, superoxide and hydroxyl radicals (H_2O_2, O_2^{-}• & OH^{-}•) by oxidative stress cause drought stress. Plants highly delicate macromolecule such as protein, lipid and nucleic acid effect by the reactive oxygen species e.g., membrane function disable by lipid peroxidation (Öktem, H. A. et, al., 2008). A virtual experiment generated for picking the elite genotype for water stress environment out of large population. These considerations led to the execution of an experiment to classify lentil genotypes in case of water stress; to choose fit genotype for tolerant and also identify the compatibility of different traits at seedling stage for tolerant and susceptible genotypes to drought stress (Bibi, A. et, al., 2012).

Material and Method

Eight genotypes of lentil (Lens culinaris L.) were picked up on the base of their morphological and diversity to form a representative sample of the species. Plants follow CRD (completely randomize design) with factorial arrangements with three replication keep 4.5cm plant to plant distance and 6.5cm row to row distance sown in metallic tray. The three irrigation level i.e. control (T1), 75% field capacity (T2), 50% field capacity (T3) and genotypes. Temperature was maintained at 25ºC. Plants were placed in light natural and artificial to maintain 16 hrs. photoperiod. For data collection three plants from each genotypes and each replication were uprooted after twenty days of seeding. Traits which evaluated that is plant height (**PH**), SPAD chlorophyll content, root length (**RL**) fresh (**FW**) and wilt weight (**WW**), shoot length (**SL**), turgid weight (**TW**) and Canopy temperature. Length based trait measured by measuring tape, after uprooting from pots dissect into roots and shoots. Fresh root and shoot Weight trait measured by analytical balance and root and shoot covered by Kraft paper weight by drying at 70ºC in hot air for dry weight (Kaydan and Yagmur, 2008).

Relative water content (%)

Relative water contents were calculated by using the given formula

RWC (%) = FW- DW/TW-DW ×100, where RWC = Relative water contents, FW = Fresh weight, DW = Dry weight, TD = Turgid weight

Chlorophyll contents (SPAD value)

SPAD-502 plus chlorophyll meter (Konica Minolta) was used to measure chlorophyll content.

Statistical Analysis

Standard statistical procedures were used to analyze the data and means were compared by the least significance difference test.

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Results

Results showed that drought stress significantly reduce in the Plant height, Fresh weight, Wilt weight, Turgid weight, Shoot length, Chlorophyll content & Canopy temperature while increase in Root length. All genotypes behave different in drought stress. In Table. 2 Plant height of lentil-2 in normal condition & 50% water regime has higher value, in 75 % water regime lentil-2 and minimum value of Lentil-7 in normal and 50% water regime and at 75% water regime in lentil-8 obtained. In table 2. Shoot length of lentil-4 & Lentil-2 in normal condition had high value, at 75% lentil-4 & lentil-3 has high value & at 50% lentil-3 has high value but low value gives in normal & 50% condition by lentil-7 and at 75% lentil-5 had less value. Data regarding root length in table 2. in all water stress conditions lentil-1 and lentil-5 show max root length while in normal condition lentil-7 show min length, lentil-8 in 75% and 50% condition show minimum increase in root length. Data regarding Fresh weight in table. 1 lentil-3 and lentil-2 show max value while lentil-5 show less value. Data regarding Wilt weight in table. 1 in drought different level lentil-8 and lentil-2 show max value while lentil-1 show less value. Data regarding turgid weight in table. 1 in different water level lentil-8 and lentil-6 show max value while lentil-7 show less value. With respect to data chlorophyll content in table. 3 of lentil-4 and lentil-8 show max value while lentil-1 show less value. According to data Canopy temperature in table. 3 of lentil-8 and lentil-1 show max value while lentil-3 show less value.

Table 1 - Comparisons of lentil genotypes for turgid weight, wilt weight and fresh weight under three water regimes

	Turgid Weight (g)			Wilt Weight (g)			Fresh Weight (g)		
	Drought levels			Drought levels			Drought levels		
Genotypes	**100%**	**75%**	**50%**	**100%**	**75%**	**50%**	**100%**	**75%**	**50%**
Lentil- 1	2.36	2.12	1.63	2.48	2.29	1.38	3.93	3.73	2.76
Lentil- 2	2.26	2.11	2.1	2.32	2.19	2.16	3.99	3.63	2.86
Lentil- 3	2.15	2.07	1.48	2.26	2.10	1.65	4.14	3.95	3.68
Lentil- 4	1.82	1.91	0.97	2.49	2.36	1.62	4.40	3.13	2.20
Lentil- 5	2.39	2.20	2.13	1.96	1.86	1.81	4.29	3.48	1.82
Lentil- 6	2.58	2.42	2.35	2.08	1.99	1.92	3.6	2.69	2.29
Lentil- 7	1.75	1.52	1.56	2.46	2.33	1.72	4.82	4.69	1.9
Lentil- 8	2.87	2.92	2.41	3.80	2.54	2.31	7.13	6.56	2.59

Table 2 - Comparisons of lentil genotypes for plant height, root length and shoot length under three water regimes

	Plant Height (cm)			Root Length (cm)			Shoot Length (cm)		
	Drought levels			Drought levels			Drought levels		
Genotypes	**100%**	**75%**	**50%**	**100%**	**75%**	**50%**	**100%**	**75%**	**50%**
Lentil- 1	9.02	8.63	7.93	25.73	25.47	26.52	9.12	8.13	7.32
Lentil- 2	9.55	9.13	7.50	21.4	22.37	23.49	9.63	8.6	7.28
Lentil- 3	9.02	8.53	7.65	21.55	22.53	23.61	9.52	8.65	7.98
Lentil- 4	9.27	8.07	7.07	22.43	24.47	25.57	9.93	8.93	7.27
Lentil- 5	8.68	7.67	6.52	24.37	25.64	26.83	9.20	7.9	7.2
Lentil- 6	8.75	8.4	6.73	22.77	24.20	25.77	9.017	8.43	7.58

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Lentil- 7	8.12	7.23	6.0	20.67	22.20	22.72	8.72	8.23	6.73
Lentil- 8	8.33	7	6.37	21.03	21.17	21.41	8.87	8.13	7.4

Table 3 - Comparisons of lentil genotypes for SPAD and canopy temperature under three water regimes

	SPAD (nm) Drought levels			Canopy Temperature (°C) Drought levels		
Genotypes	**100%**	**75%**	**50%**	**100%**	**75%**	**50%**
Lentil- 1	19.27	18.83	17.63	16.38	15.8	15.37
Lentil- 2	19.4	18.93	18.24	14.52	14.06	13.8
Lentil- 3	21.43	20.13	18.93	13.9	13.57	13.33
Lentil- 4	32.77	29.7	28.2	14.5	14.17	13.99
Lentil- 5	31.88	31.13	28.77	14.23	13.9	13.47
Lentil- 6	23.38	22	19.23	14.43	14.13	13.49
Lentil- 7	29.48	28.03	27.18	15.07	14.67	14.3
Lentil- 8	30.1	28.27	27.47	16.55	15.66	15.48

Fig. 1 Turgid weight (TW) of 8 Lentils genotypes under control and water stress.

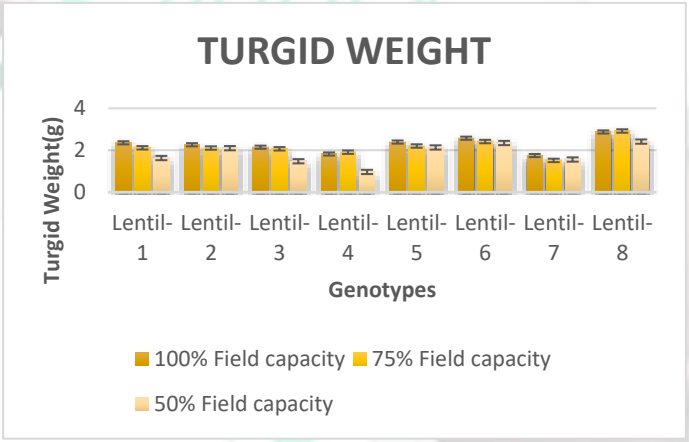

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Fig. 2 Wilt weight (WW) of 8 Lentils genotypes under control and water stress.

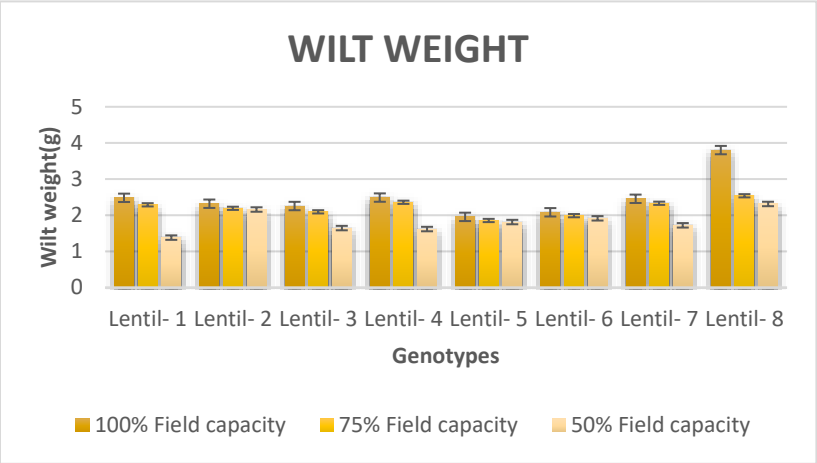

Fig. 3 Fresh weight (FW) of 8 Lentils genotypes under control and water stress.

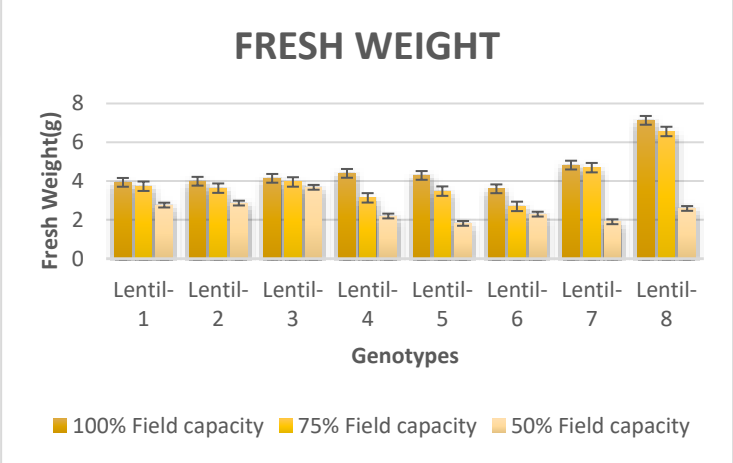

Fig. 4 Plant height (PH) of 8 Lentils genotypes under control and water stress.

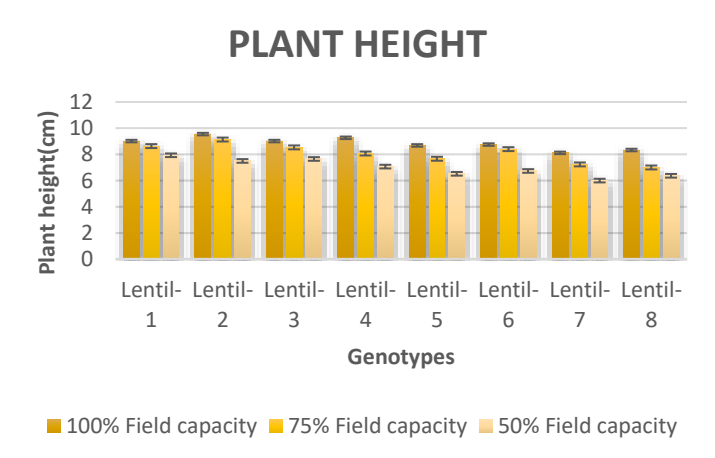

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Fig. 5 Root Length (RL) of 8 Lentils genotypes under control and water stress.

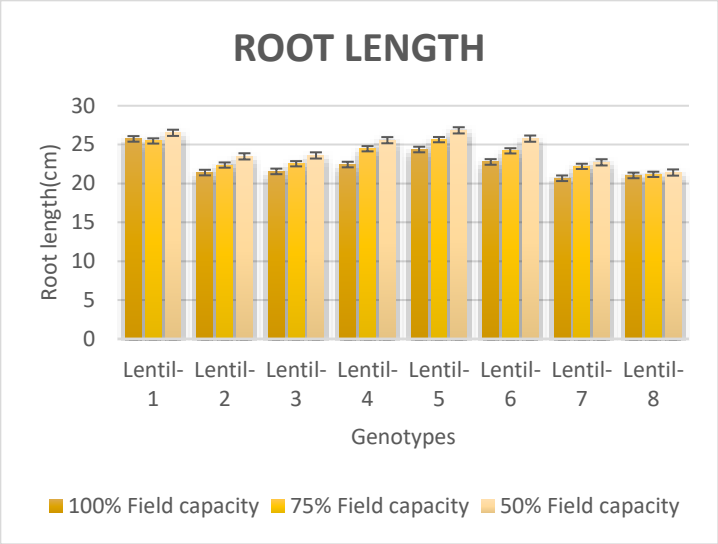

Fig. 6 Shoot Length (SL) of 8 Lentils genotypes under control and water stress.

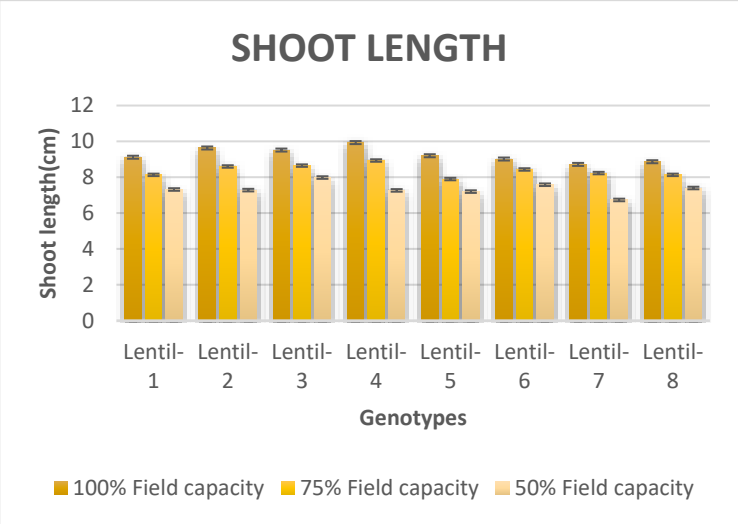

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Fig. 7 chlorophyll content (SPAD) of 8 Lentils genotypes under control and water stress.

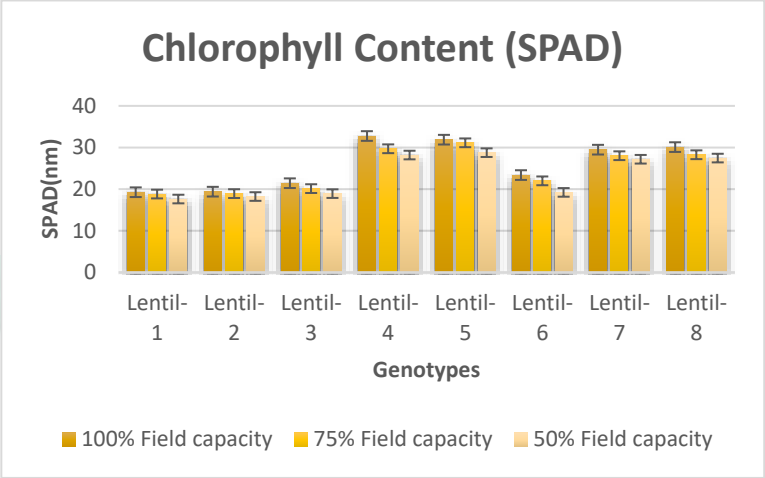
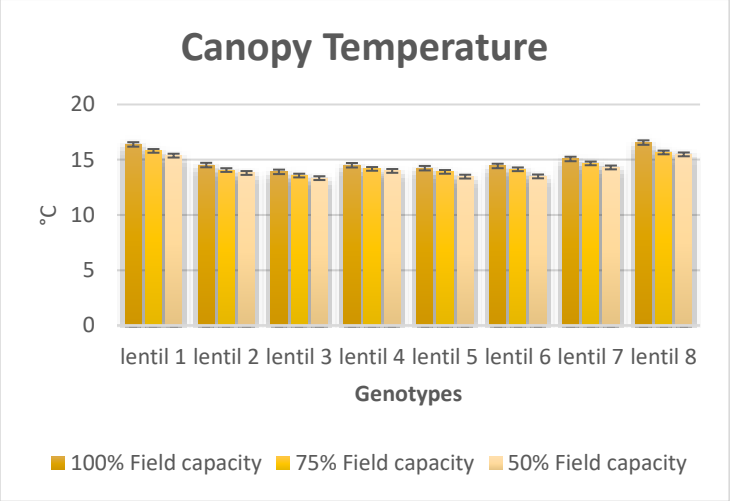


Fig. 8 canopy temperature of 8 Lentils genotypes under control and water stress.



Discussion

Water stress cause the decrease in expression of characters' shoot length, fresh weight, wilt weight, turgid weight, plant height, SPAD, root weight and shoot weight. Growth and productivity mainly affects by drought stress, the progress of drought tolerant varieties of lentil is feasible and reasonable in case of yield in semi moisture condition. For estimating drought tolerance main trait are root and shoot development (Idrissi, O., et, al., 2015). In recorded data shoot length of lentil decrease due to drought stress. The recorded length reduction insignificant at low stress and significant at high level (Foti, C., et, al., 2018). The roots which are exposed firstly to the water stress, root length increase and root weight decreases due to thin roots. Water stress cause restriction in cell division for the development of roots (Qadir, M. 2016). During stress leaf expansion decreases which results in enhancing the root growth. (Younis, M. E. et, al., 2000) reported that crude protein increases due to drought which increase in root length which exhibit that shoot length is more effected than root length in drought stress. The shoot weight decreases in recorded data due to reduction in water absobtion and external osmotic potential drought stress our findings similar to the results of (Imtiaz, A. A. et, al., 2020 & Kaydan and Yagmur, 2008). Fresh and dry weight of lentil

decreases significantly over the drought stressed condition. Drought result in drop of plant weight, that act to harm the photosystem II's oxygen-evolving complex and its reaction centers (Subrahmanyam et al. 2006). Restriction in photosynthetic activity not only due to alternate in energy flow via PS II it also due to decline in pigment content (Guo, Y. Y., et, al., 2016). The recorded data show that the performance of photosynthesis decreases due to the decrease in chlorophyll content like chl (a, b and a+b) which were measured by SPAD. The recorded data show that plant height decreases due to the drought stress. Drought stress serious impact on cell expansion and cell growth which is linked with loss of turgidity of cell that results in reduction in plant height and turgid weight (Gurumurthy, S. et, al., 2019).

Conclusions

Results show that among the different genotypes Lentil-8 and Lentil-5 perform well under normal and water stress conditions. Due to their drought-tolerant properties, these genotypes will be used in the future breeding program to develop drought-tolerant genotypes.

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