International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:5, No:6, 2011

Effect of Drought Stress on Nitrogen Components in Corn

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Abstract**—**An attempt was made to study of nitrogen components response of corn (*Zea mays* L.) to drought stress. A farm research was done in RCBD as split-plot with four replications in Khorramabad, west Iran. Drought stress levels as irrigation regimes after 75 (control), 100, and 120 (stress) mm cumulative evaporation were in main plots, and four seed corn varieties include 500 (medium maturity), 647, 700, and 704 (long maturity) were as subplots. Soluble protein, nitrate and proline amino acid were measured in shoot and root at flowering stage, and grain yield was measured in harvesting stage. As the drought progressed, the amount of nitrate and proline followed an increasing trend**,** but soluble protein decreased in shoot and root. The highest amount of nitrate and proline was observed in longer maturity varieties than shorter ones, but decrease yield of long maturity varieties was higher than medium maturity varieties in drought condition, because of long duration of stress.

Keywords**—**Nitrate, Proline, Soluble protein, Yield

I. INTRODUCTION

THE corn crop requires adequate water in all stages of its physiological development to attain optimum productivity. Corn is very susceptible to drought damage due to the plants requirement for water for cell elongation and its inability to delay vegetative growth [2]. Yield is reduced when evapotranspiration demand exceeds water supply from the soil at any time during the corn life cycle [5]. Potential corn yield losses due to drought during emergence to V8 as much as 20 percent, V8 to V16 could rang from 10 to 30 percent, around flowering & pollination 3 to 8 percent for each day of stress, silking stage up to maturity 2.5 to 5.8 percent with each day of stress [2]-[5]. Thus Corn yield is most sensitive to water stress during flowering and pollination, followed by grainfilling and finally vegetative growth stages [1]-[5].

Knipp and Honermeier [4] Suggested that the modification of carbohydrates metabolism, especially the high content of soluble carbohydretes, may affect water stress-induced proline accumulation. Pinheiro *et al* [7] determined that during the water stress, most of the leaves were lost and the stem functioned as a storage repository of sugars (glucose and sucrose) and amino acids (asparagine and proline).

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Martinez *et al*. [6] reported that water stress induced an increase in glycine betain and sugar leaf contents and osmotic adjustment (OA) of *Atriplex lalimus* L., but water stress resistance could not be associated with higher OA, although the ability of plants to regulate these metabolic and physiological functions could play an important role under harmful condition. The possible roles of osmolyte accumulations are discussed in relation to the specific physiological strategy of water – stress – resistance in this species. This experiment was conducted to determine the nitrogen components and yield response of corn to drought stress.

II. MATERIAL AND METHODS

Corn (Zea mays L.) plants were grown at the lorestan Agricultural Research Center, Sarab Changaie station, Khorramabad, Iran during 2006. The texure of the research field was sandy-clay-loam.

The experiment was set up as a split plot based on a RCBD with four replications. Main plots were drought stress levels as irrigation regimes (I) after 75 (control), 100, and 120 (stress) mm cumulative evaporation, and subplots were four grain corn varieties (V) include single cross 500 (medium maturity), three way cross 647, single cross 700 and single cross 704 (long maturity). There were 5 and 1 m distance between the main- and sub-plots, respectively. Each sub-plots consisted of 5 rows with 5 m long, and 75 cm distance between rows. Plots were over planted and tinned to a population of 8 plant m-2 at the seedling stage. Complete weed control was obtained by hand weeding.

Irrigation regimes started after tinning. Soil moisture content up to the root depth obtained to the field capacity after each irrigation. Irrigation water content (IWC) measured using the formula (1).

$$IWC = (FC-PWP)\times \rho a\times ds/Ea \quad (1)$$

where FC, PWP, ρa, ds and Ea represent field capacity, permanent wilting point, volume weight, root depth and irrigation efficiency of 15%, respectively. Field capacity (in dry basis), permanent wilting point, and volume weight of the soil were 25.2%, 12.3%, and 1.2 g cm-2, respectively. Surface runoff was not occurred during the research year because of surrounded subplots.At flowering stage soluble protein, nitrate and proline amino acid were measured in shoot and root. These traits were assayed as described by Krieg [3]. Grain yield was measured in harvesting stage. In harvesting time, ears from center rows of each sub-plot were harvested manually to avoid any border influence .

III. Result And Discussion

Drought stress had significant effects on soluble protein, nitrate and proline in corn shoot and root. As the drought progressed, nitrate and proline concentration increased, but soluble protein followed a decreasing in shoot and root. I120 showed the highest nitrate and proline shoot content of 0.180 and 0.113 mg/g FW, respectively and the lowest soluble protein in shoot of 0.060 mg/g DW. The lowest nitrate and proline shoot content of 0.124 and 0.065 mg/g FW, respectively and the highest soluble protein in shoot of 0.115 mg/g DW were observed in I75. Similar trend was found for root osmolyts (Table 1). This result is supported by acheavement of Knipp and Honermeier [4], Pinheiro et al [7] and Martinez et al. [6].

The highest amount of nitrate (0.180 and 0.183 mg/g FW) and proline (0.121 and 0.115 mg/g FW) was observed in the shoot of longer maturing varieties (V700 and V704, respectively) in I120 (stress) and the lowest amount of nitrate (0.123 and 0.124 mg/g FW) and proline (0.062 and 0.067 mg/g FW) was found in the shoot of medium maturing varieties (V500 and V647, respectively) in I75 (control). Yield reduction due to drought stress was 46.9% and 49.9%, 56.2% and 55% in V500 to V704, respectively, because corn is very susceptible to drought damage [2], and yield losses due to drought during emergence to maturity depends on drought duration [2]-[5].

In average, although the higher amount of osmolyts were observed in longer maturing varieties than shorter ones, decrease yield of longer maturing varieties was higher than medium ones in drought condition. It seems that long duration of stress in longer maturing varieties increased cumulatively drought harms.

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TABLE I
MEAN COMPARISON OF AGROPHYSIOLOGICAL CHARACTERISTICS OF CORN IN DIFFERENT TREATMENTS

I	V	Root soluble protein (mg/g DW)	Shoot soluble protein (mg/g DW)	Root nitrate (mg/g FW)	Shoot nitrate (mg/g FW)	Root proline (mg/g FW)	Shoot proline (mg/g FW)	Grain yield (Kg/ha)
I75	V500	0.012	0.115	0.042	0.123	0.018	0.062	6387.3
I75	V647	0.013	0.113	0.041	0.124	0.015	0.067	6728.6
I75	V700	0.010	0.113	0.040	0.125	0.017	0.062	8103.7
I75	V704	0.016	0.119	0.041	0.123	0.014	0.068	8015.9
I100	V500	0.012	0.089	0.048	0.139	0.026	0.074	4064.5
I100	V647	0.010	0.090	0.050	0.144	0.029	0.080	4513.3
I100	V700	0.008	0.096	0.048	0.150	0.034	0.096	5175.6
I100	V704	0.009	0.095	0.049	0.140	0.036	0.109	5342.8
I120	V500	0.007	0.062	0.065	0.178	0.039	0.100	3388.6
I120	V647	0.008	0.064	0.065	0.177	0.044	0.118	3371.3
I120	V700	0.005	0.056	0.064	0.180	0.049	0.121	3550.0
I120	V704	0.006	0.058	0.066	0.183	0.048	0.115	3579.6
LSD (5%)		0.009	0.059	0.029	0.017	0.035	0.038	585.5
I75		0.013	0.115	0.041	0.124	0.016	0.065	7308.9
I100		0.010	0.093	0.049	0.143	0.031	0.090	4774.1
I120		0.006	0.060	0.065	0.180	0.045	0.113	3472.4
LSD (5%)		0.003	0.025	0.017	0.032	0.019	0.020	1139
	V500	0.010	0.089	0.052	0.147	0.028	0.079	4613.5
	V647	0.010	0.089	0.052	0.148	0.029	0.088	4871.1
	V700	0.008	0.088	0.051	0.152	0.033	0.093	5609.8
	V704	0.010	0.091	0.052	0.149	0.033	0.097	5646.1
LSD (5%)		0.004	0.005	0.004	0.006	0.009	0.015	472.8

I = Irrigation regims after 75, 100 and 120 mm cumulative evaporation.
V = varietiy (500, 647, 700 and 704 are different corn varieties).