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PHYSIOLOGICAL AND BIOSTATISTICAL ANALYSIS OF REDUCING SUGAR UNDER STRESS

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Abstract

Under alkaline conditions sugars with potentially free aldehyde or ketone groups, reduces metal ions, so are known as reducing sugars. The physiological stress affects the reducing sugars in many plants. The physiological parameters shows that the crop plants respond to the saline, pre sowing and drought stress. The present study deals with the effect of physical stresses on reducing sugar in *Eleusine coracana*. The amount of reducing sugar fluctuates with the stress but crop maintains balance in reducing sugar content compared to their control, Crop shows better results under drought conditions than for other stress. There is 25-40% increase in reducing sugar is observed under 2- and 4-days drought while under presowing salt stress, in Dapoli 3, under 8mM and 30mM ,10-12 % decrease in reducing sugar is observed. The observations are conformed by analysis of variance (ANOVA), a biostatistical analysis.

Key words: - Physiological, Biostatistical, saline stress, pre sowing salt stress and drought stress, Analysis of variance (ANOVA).

Introduction

The World Bank Organizations indicates about 60% of land under cultivation. Most of the area remains uncultivated due to many reasons such as due to scarcity of water, salinity or barren conditions. Under alkaline conditions, metal ions get reduced by sugars with potentially free aldehyde or ketone groups hence the sugars are called reducing sugars.

Due to lack of proper irrigation practices, vast land remains uncultivated. Salinity is a major constraint to agriculture crop production in many parts of the world. Ackerson R.C (1981), when worked on osmoregulation in Cotton in response to water stress leaf carbohydrate status in relation to osmatic adjustment, observed increase in leaf carbohydrates to help in osmotic adjustment during water stress in cotton. According to Karadge B. A and Chavan P.D (1983), soluble sugar seems to play some role in the osmotic adjustment of *Sesbania grandiflora*, a salt tolerant legume. Nascimento WM (2003), noted down development and improvement in seed germination and seedling in Muskmelon when seed priming with PEG or KNO3 at low temperature. While Demir I, Mavi K (2004), studied the effect of priming on seedling emergence of differentially matured watermelon (*Citrullus lanatus*) seeds to observe improved germination and seedling growth of the seeds under salinity compared to non-primed seeds.

These aspects are taken into considerations and the varieties viz. Dapoli-3 and HR-374 were grown in pot culture and artificial water and salt stress conditions were created. Also the seeds are treated with presowing salt treatment to study reducing sugar content under stress.

MATERIAL AND METHOD

Estimation of reducing sugars

The reducing sugars were estimated by the method of Folin and Wu (1927). Reducing sugars were quantified by calibrating with standard graph using standard glucose.

Pot culture

Crops of Dapoli-3 and HR-374 were raised in pots giving salt stress of 8mM, 30mM, 80mM, 150mM and water stress of 2days, 4days, 6days, 8days.By giving salt presowing seed treatment, both the cultivars were grown in corresponding increasing salt concentrations and carbohydrates were analysed.

Biostatistical analysis

Three way ANOVA showing variation reducing sugar between, crops, treatment stress, concentration/ days of stress been applied. The data were statistically analysed using SPSS version 25 and the means were compared by Duncun's post hoc test ($p < 0.05$).

RESULTS AND DISCUSSIONS

Reducing Sugars at increasing drought conditions

Carbohydrates are the main assimilatory products in crop plants. Water stress reduces the photosynthetic efficiency in the crop plants. Reducing sugars were estimated from the leaves of plants growing under normal and water stress conditions. The amount of reducing sugars increased in leaves of plants, which were subjected to water stress for a short duration of two days. This increase was significant in Dapoli-3 variety; the increase was almost three folds while in HR-374 it was nearly one and a half fold. After 8 days of water stress, Dapoli-3 showed a decrease in reducing sugar level by 50 % and in HR-374, the level fell by 40 % (figure 1).

Ackerson (1981) found that increase in leaf carbohydrates that helps in osmotic adjustment during water stress in cotton. While Ford Clive W and Wilson John R (1981), observed accumulation of reducing sugars in water stressed leaves of *Panicum maximum* and considered that contribution of carbohydrate to the osmotic adjustment is relatively small to the accumulation of solutes.

Effect of Increasing Salt Stress on Reducing Sugars

The amount of reducing sugars present in the leaves of Dapoli-3 and HR-374 is depicted in figure2. When the plants were irrigated with low concentration of salts viz. 8 and 30mM there was a significant increase in the content of reducing sugars in the leaves of these plants indicating that they have capability to tolerate low concentration of salts. However, as the concentration of slats increased the levels of sugar decreased by 24 % in HR-374 but in Dapoli-3 the amount of reducing sugar were comparable to those of control plants of the same cultivar(Fig 2).

Thakur M. and Sharma AD (2005), worked on sorghum seeds and observed that the stress causes a decrease in starch content and an increase in sugar content. Besma Ben Dkhil and Mounir Denden (2010) reported their studies about *Abelmoschus esculentus* L under salt stress conditions as "The amount of total soluble sugar/embryonic axes free weight increase rapidly answering to the increasing concentrations of NaCl ". Fariba Amini and Ali Akbar Ehsanpour (2005) revealed that reduced sugars of stem & leaf in *Lycopersicon esculentum* cultivars decreased when plants exposed to salt stress. While Nigwekar A. S (1988), reported higher accumulation of reducing sugars in root while decrease in the level of starch content at the higher salinity in *Dolichos biflorus.*

Effect of Presowing Salt Stress on Reducing Sugars

Results obtained are depicted in **figure 3**. There was increase in the reducing sugar content of Dapoli-3 cultivar but HR- 374

showed 38 % decrease in the reducing sugar content at 8 mM concentration of NaCl. At 150mM i.e. high salt concentration, the reducing sugars decreased in both the cultivars but the decrease in HR 374 cultivar was by 74 %(Fig 3).

Rozbeh Farhoudi, *et.al*.,(2011), reported that Seed priming increased antioxidant enzyme activity, soluble carbohydrate and proline content. Zhang, Y.Y.*et.al.,* (2006), Exogenous application of NO as pre-sowing treatment to maize seeds resulted in enhanced salt tolerance ability of maize seedlings. "Wheat straw, pretreated with ozone and stated that the concentration of reducing sugars was increased by 3, 59 – 5, 22 mg g–1 dry compared with that of reducing sugars in not pretreated straw" Kristína Gerulova, Lenka Blinova, (2011).

In the present investigation, decrease in the level of carbohydrate contents under higher salt stress condition is a common feature for both the cultivars, grown under higher salt stress condition. However, total carbohydrate content in Dapoli-3 variety was lower than HR-374 indicating slightly higher salt tolerance ability. The studies in plant physiology are also been confirmed by biostatical application of Analysis of Variance (ANOVA).

Table Effect of different stress on Reducing Sugar levels of two types of crops

Crops	**Concentration**	**Salt stress**	**Pre sowing salt treated salt stress**	**Water stress**	
Dapoli-3	**Control**	4.2107±0.06	4.1917±0.140	Control	1.7493±0.119
	8 mM	3.8067 ±0.057	3.4677 ±0.118	2 Days	5.4090 ±0.173
	30 mM	3.6797±0.115	3.2533±0.230	4 Days	5.7763±0.117
	80 mM	1.4103±0.230	1.5993±0.230	6 Days	4.3260±0.173
	150 mM	1.8453±0.116	1.8323±0.117	8 Days	2.8187±0.115
HR 374	**Control**	2.8227±0.057	1.8607±0.118	Control	2.7893±0.125
	8 mM	2.2157 ±0.115	3.4187 ±0.119	2 Days	4.3733 ±0.230
	30 mM	3.8590±0.173	3.1927±0.288	4 Days	2.1427±0.115
	80 mM	2.2217±0.288	1.5593±0.230	6 Days	5.2007±0.288
	150 mM	1.7833±0.113	1.7713±0.112	8 Days	1.8310±0.100

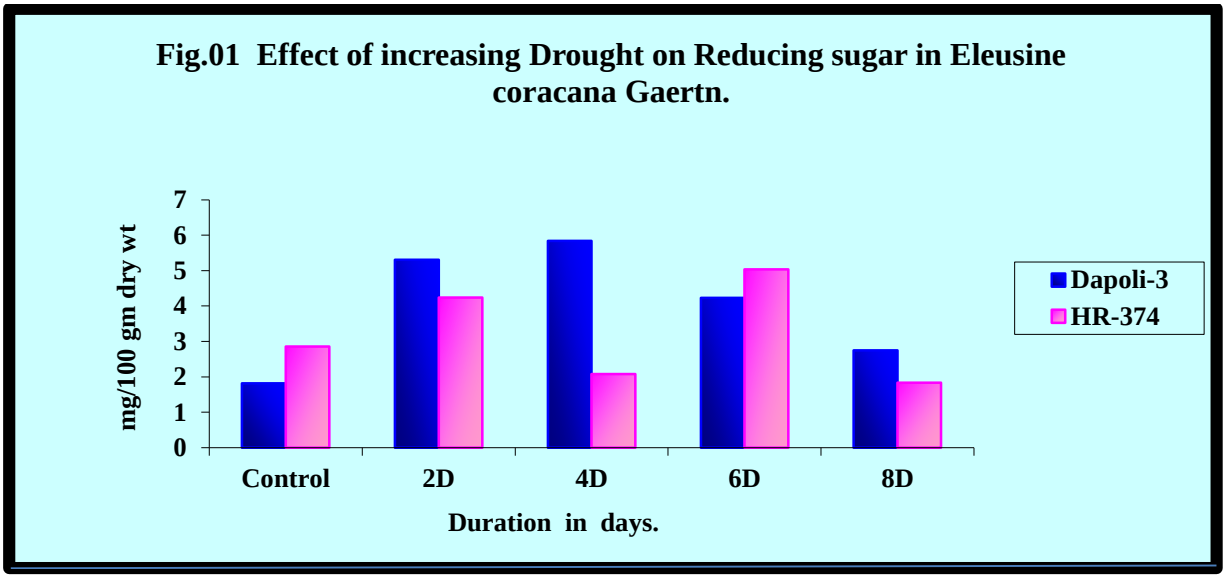
Each value is the mean and SD of three replicate measurements.

Three way ANOVA showing variation reducing sugar between, crops, treatment stress, concentration/ days of stress

Source	df	F	P value
Crops	1	**129.487**	.000
Treatment Stress	2	**408.422**	.000
Concentration	4	**381.990**	.000
Crops * Treatment Stress	2	**47.144**	.000

Crops * Concentration	4	**74.464**	.000
Treatment stress * Concentration	8	**144.247**	.000
Crops * Treatment stress * Concentration	8	**116.507**	.000

Inference: Reducing sugar level is significantly affected by different stress levels, on two types of crops. There was a significant interaction effect noticed among the crops and different levels of Treatment stress (F = 116.507, P<0.05)



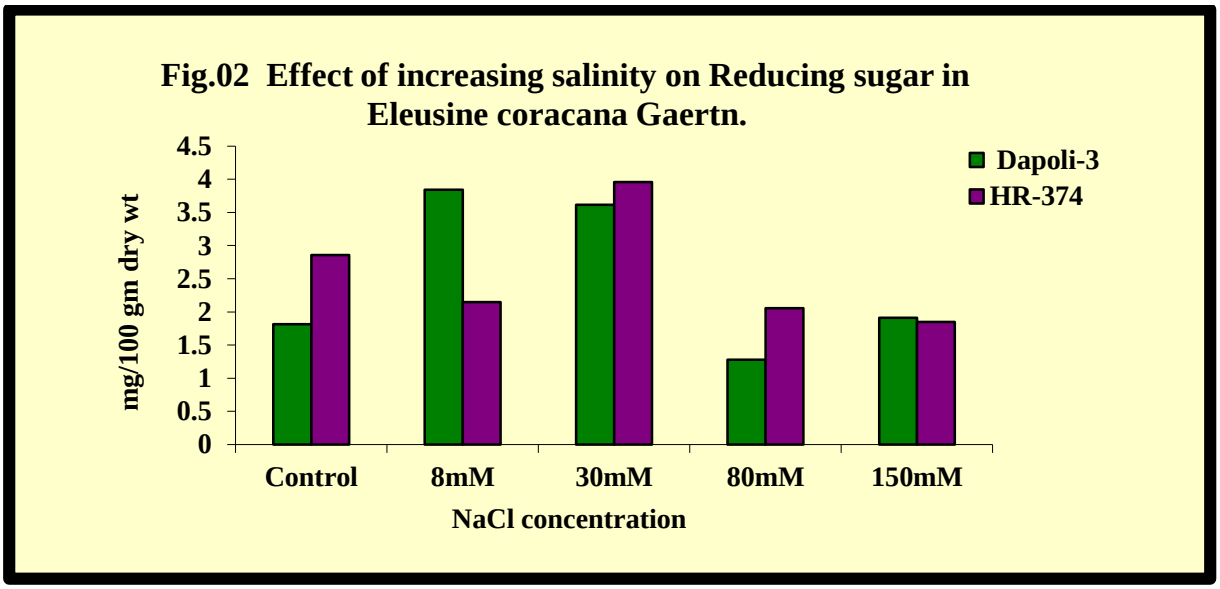
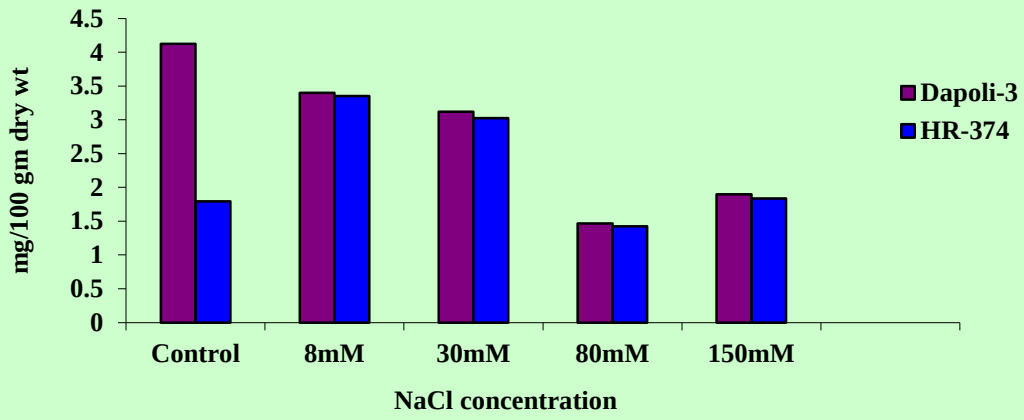


Fig.03 Effect of increasing salinity on Reducing sugar in Presowing salt treated Eleusine coracana Gaertn.



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