Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 4, No. 6, p. 178-184, 2014
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

The effect of auxin foliar spray on qualitative traits of forage sorghum var. speed-feed under water deficit stress

Masoud Mottaleb Nejad[1*], Tayeb Saki Nejad[1], Ali Reza Shokohfar[1]

Department of Agronomy, Ahwaz Branch, Islamic Azad University, Ahwaz, Iran

Article published on June 12, 2014

Key words: Water deficit stress, auxin hormone, qualitative traits, forage sorghum.

Abstract

In order to study the effect of water deficit stress and different levels of auxin hormone on qualitative traits of forage sorghum Var. speed-feed, a split plot experiment in the form of randomized complete block design with three replications was carried out in Shahid Salemi Field in Ahvaz in 2012. Water deficit as the main factor included three levels of irrigation after 90, 120, 150 mm evaporation from class A evaporation pan and auxin as the sub factor was applied in four levels including lack of auxin, 15, 20, 25 ppm auxin. The qualitative traits of the crop (protein percentage, ash, fiber, and the rate of prussic acid) were examined. Different levels of water deficit stress significantly affected the studied qualitative traits. In sever water deficit stress (150 mm evaporation) the percentage of protein, ash, and fiber decreased while the toxic prussic acid increased. Auxin hormone only had a significant effect on the percentage of protein and ash. The highest percentage of protein and ash was achieved through the application of 25 ppm auxin.

***Corresponding Author:** Masoud Mottaleb Nejad ✉ masoudmottalebnejad@gmail.com

Introduction

Water deficit is one of the factors limiting crops production (Sadras and Milory, 1996). Demand for animal protein is rapidly increasing worldwide and every year the need to produce more animal protein sources is increasing. Forage plants play an important role in feeding animals and are classified as one of the most important crops around the world. However, in most countries of the world, there are few studies and research on increasing production and improving qualitative and quantitative traits of this plant compared to other crops. In our country, Iran, due to the lack of rich pastures and livestock pressure on them, it is particularly important to study and investigate the cultivation of such crops (Mirlohi *et al.,* 2000).

Due to its unique morphological and physiological characteristics, sorghum is introduced as the most important crop resistant to drought and is more resistant to severe drought stress conditions and late irrigation than other crops and has less water need (Moaveni, 2003). Considering its photosynthetic system, stomatal activity and root system, this plant is able to absorb water better and also to lower water losses to atmosphere and even after a long period of drought, the stomata will be able to resume their activity without any damage (Kouchaki, 1985). One of the problems caused by water stress in sorghum is the risk of increasing cyanuric acid (hydrogen cyanide) in forage and the cattle poisoning. Cyanogenic glycoside synthesis which exists in many species is particularly important in sorghum. When plants are used by animals, some natural compounds of plant can change in animals' body into hydrogen cyanide (HCN) which when sufficient causes hydrogen cyanide poisoning or in general term prussic acid poisoning (Karimi, 1996). Decrease of protein percentage under drought stress conditions has been reported by several researchers including Misra (1994), Nakhoda *et al.,* (2001). Paigozar *et al.,* (2009) stated that the effect of drought stress treatment on the percentage of crude fiber of plant was significant, but the effect of foliar spraying and also the interactive effect of the two treatments on content of crude fiber of the forage were not significant. Their results showed that the treatments in which stress was exercised, led to the decrease of crude fiber content in millet forage. The highest percentage of crude fiber belonged to the treatment without stress and the lowest percentage of fiber belonged to the treatment with stress at stem elongation stage.

Hormones are among the factors regulating plants growth. All biological activities of plants are controlled by different chemicals. These chemicals were gradually separated as pure from plant tissues by scientists and their characteristics and formulae were determined. Hormonal regulation of growth and metabolism of plant is very complicated and results from the interactive effects of hormones (Lenoble *et al.,* 2004) Most of growth regulators generally stimulate growth and associate growth and development with each other in plant morphological evolution. Auxin is produced mainly in meristematic tissues of plant particularly in apical buds and young leaves. The role of auxin in plant is to lengthen organs and cells. Cell elongation occurs only in the presence of auxin (Kouchaki and Sarmadnia, 2008).

Materials and methods

Geographic Specifications of Experiment Location

This research was carried out in the summer of 2012 in the research field of Shahid Salemi in Ahvaz at longitude 48°40´east and latitude 31°20´ north and 22.5 m above the sea level.

Physical and Chemical Characteristics of the Soil of Experiment Locatio

Table 1. Physical and chemical characteristics of the soil of experiment location

Type of soil	Percentage of soil components (%)			Lime (%)	Organic materials (%)	Saturation Percentage (SP)	pH	Ec*10^	Soil depth (cm)
	Sand	Silt	Clay					mmoh/cm	
Clay silt loam	21	39	41	38	0.624	54.97	7.74	4.64	0-30
	18	40	42	39	0.702	57.94	7.76	6.56	30-60

Experiment methods

This research was carried out in June 2012 as a split plot experiment in the form of randomized complete block design with three replications in Shahid Salemi Research Field in Ahvaz. Water deficit as the main factor included three levels of irrigation after 90, 120 and 150 mm evaporation from class A evaporation pan and auxin as the sub factor was applied in four levels including lack of auxin, 15, 20 and 25 ppm auxin. Auxin foliar was sprayed at 8-leaf stage. After omitting the margins 18 plants were harvested from two middle lines in order to study the desired traits.

The measured traits and their measurement procedure

Protein Percentage

In order to measure protein percentage, at first the samples were dried in the oven and then they were ground by and electric grinder with 1 mm mesh and then 1 g of each sample was separated and the percentage of protein was obtained by means of Kajaltak machine and based on micro-Kjeldahl modified model of Nelson and Sommer (1973).

fiber percentage

To measure the fiber percentage the suggested method of Joring and Van Soest (1970) was used.

rate of ash

The rate of ash was obtained through the following formula (Jones *et al.,* 1999):

$$\text{Ash percentage} = \frac{\text{ash weight}}{\text{sample weigh}} \times 100$$

amount of prussic acid

The amount of prussic acid was obtained in ppm based on laboratory method of titration (Samuel, 2003).

Statistical analysis

Data variance analysis was done by SAS statistical software and the means were compared by Duncan's tests at 1% level.

Results and discussion

The ANOVA results showed that the irrigation treatment had a significant effect on all measured traits while auxin had a significant effect just on percentage of protein and ash (Table 1).

Protein Percentage

The effect of water deficit stress, auxin, and the interactive effect of stress and auxin on this trait were significant at 1% (Table 1). The highest percentage of protein belonged to the treatment with irrigation after 90 mm evaporation which was equal to 11.4% and the lowest percentage of protein belonged to the treatment with irrigation after 150 mm evaporation equal to 7.4% (Table 2, Fig. 1). The reason could be due to thebreakdown of some proteins in drought stress conditions and lack of their re-synthesis in such circumstances (Kramer, 1983; Levitt, 1980).

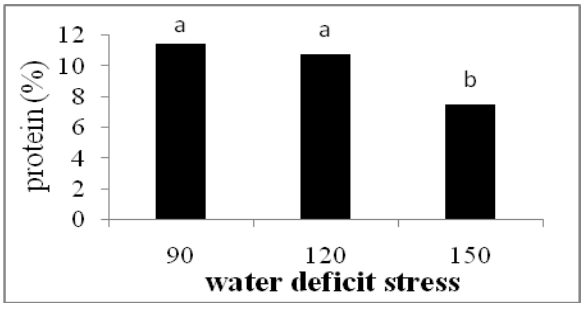

Fig. 1. The effect of different levels of water deficit stress on protein percentage

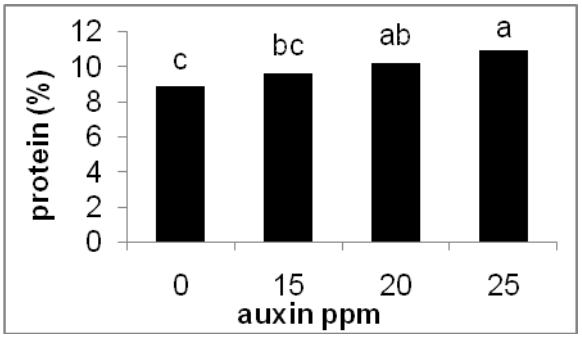

Fig. 2. The effect of different levels of auxin on protein percentage

Among auxin treatments, the highest percentage of protein by 10.9% belonged to the treatment with application of 25ppm auxin and the lowest percentage by 8.8% belonged to the treatment without auxin application (Table 2, Fig. 2). Auxin increases the production rate of proteins by increasing the production of RNA and activity of RNA polymerase (Tayebi *et al.,* 2011).

Ash Percentage

The effect of water deficit stress and auxin hormone on this trait was significant at 1% level, and their interactive effect on ash percentage was significant at 5% level (Table 1). As the water deficit stress increased, the ash percentage of shoots decreased. Among the water stress treatments, the highest percentage of ash belonged to the treatment with irrigation after 90mm evaporation by 10.51% and the lowest percentage belonged to irrigation after 150 mm evaporation by 8.34% (Fig. 3). The decrease of ash percentage of foliar under drought stress condition was also reported by Wilson (1983), Nakhoda *et al.,* (2000). Since the ash percentage represents the amount of minerals in plant tissues (Modir Shanechi, 2000), and absorption of these materials by the root in increased in drought conditions, the decrease of ash percentage of foliar in such conditions is very probable (Kramer, 1983).

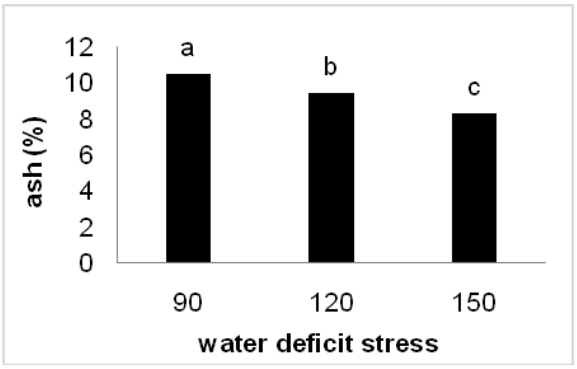

Fig. 3. The effect of different levels of water deficit stress on ash percentage

Among all treatments of auxin hormone the highest percentage of ash by 10.31% belongs to the treatment with 25 ppm auxin and the lowest percentage by 8.76% belongs to the treatment without

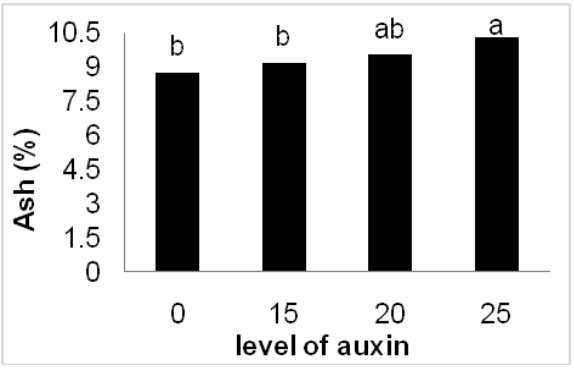

Fig. 4. The effect of different levels of auxin on ash percentage

auxin application which was statistically placed in group (b) along with the treatment of 15 ppm auxin (Fig. 4). Studying the effect of foliar spray on content of ash of forage showed that as the absorption of minerals increased by sorghum plant and they accumulated in the forage, the percentage of ash of forage sorghum increased through auxin foliar spray. One of the effects of drought stress is disturbing the nutritional balance in plants (Lewis and Farlane, 1986; Mobser *et al.,* 2005). Foliar spray improved plant growth status in stress conditions. By developing the root system, plant will have access to more soil moisture reserves and will be able to absorb optimal materials which have faced mobility reduction under lack of moisture and thus will

increase the percentage of ash which represents the amount of minerals in plant tissues.

Fiber Percentage

The effect of water deficit stress on this trait was significant at 1% level while the effect of auxin and the interactive effect of water stress and auxin on fiber percentage were not significant (Table 1). As the rate of water deficit stress increased the fiber percentage of the shoots decreased (Table 2). The highest percentage of fiber belonged to the irrigation after 90 mm evaporation by 32.1% which was statistically placed in the same group with the treatment of 120 mm evaporation (Group a) and the lowest percentage of fiber belonged to the irrigation after 150 mm evaporation by 26.8% (Fig. 5).

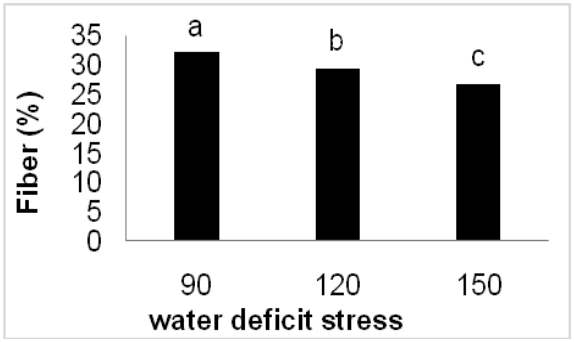

Fig. 5. The effect of different levels of water deficit stress on fiber percentage

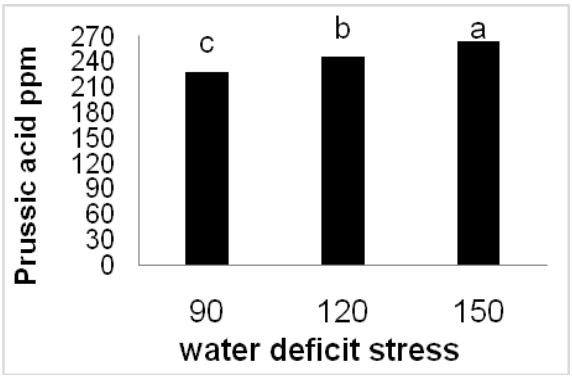

Fig. 6. The effect of different levels of water deficit stress on the rate of prussic acid

The decrease of percentage of crude fiber of forage under drought stress conditions has been reported by different researchers such as Wilson (1993) and Nakhoda *et al.* (2000). Kramer (1983) believes that the decrease of percentage of crude fiber of forage in plants under drought stress is due to the decrease of construction of cell wall components in such conditions.

Prussic Acid

The effect of different levels of water deficit stress on this trait was significant at 1% level while the effect of auxin and the interactive effect of irrigation and auxin on prussic acid was not significant (Table 1). The highest rate of prussic acid was observed in irrigation after 150 mm evaporation by 263.81 ppm (Table 2, Fig. 6). The increase of prussic acid in the forage under drought stress conditions has been reported by Moaveni *et al.,* (2004). One of the reasons that leads to the increase of this poison in sorghum is the shock of environmental stresses particularly drought stress. Therefore, in order to minimize prussic acid irrigation intervals in hot areas should be shorter so that the plant wouldn't be under water deficit stress (Moaveni and Heidari, 2004).

Conclusion

The results of this study showed that irrigation procedure after 90 mm evaporation was ranked higher than the treatments under stress in terms of all qualitative traits of the forage and the forage produced by this treatment had a better quality. The reason could be due to the negative effect of drought stress on all physiological responses of the plant on one hand, and the high potential production ability of the plant in appropriate growth conditions on the other hand. Moreover, the results showed that auxin foliar spray impressed the quality of foliar sorghum and increased the percentage of protein and ash.

Table 2. Variance analysis of the effect of water deficit stress and auxin hormone on qualitative traits of foliar sorghum Mean of squares

Mean of squares					
Protein percentage	**Prussic acid**	**Ash percentage**	**Fiber percentage**	**Degree of freedom**	**Sources of variation S.O.V**
0.62 ns	230.09 ns	0.559 ns	6.91 ns	2	replication
53.6 **	3947.59 **	14.09 **	84.54**	2	Water deficit stress (A)
0.45 ns	392.47 ns	0.27 ns	5.73 ns	4	Error of a
7.05 **	39.65 ns	3.82 **	5.26 ns	3	Auxin hormone (B)
1.78 **	90.77 ns	1.25 *	2.43 ns	6	Water deficit stress x Auxin hormone
7.7	167.06	8.89	2.51	18	Error of b
6.61	5.3	7.5	6.1	***	C.V

ns , *, ** respectively mean non-significant difference, and significant difference at 5% and 1% probability levels.

Table 3. Mean comparison of the effects of water deficit stress and auxin hormone on qualitative traits of foliar sorghum

treatment traits mean				
Protein percentage	**Prussic acid (ppm)**	**Ash percentage (%)**	**Fiber percentage (%)**	
				Irrigation levels
11.44 a	227.51 c	10.51 a	31.90 a	I_0 = 90 mm
10.75 a	245.01 b	9.48 b	29.20 b	I_1=120 mm
7.48 b	263.81 a	8.34 c	26.60 c	I_2=150 mm
				Auxin concentration
8.83 c	245.91 a	8.76 b	28.68 a	A_0 = 0 ppm
9.62 bc	245.28 a	9.19 b	28.71 a	A_1=15 ppm
10.2 ab	242.71 a	9.52 ab	29.22 a	A_2=20 ppm
10.92 a	247.86 a	10.31 a	30.32 a	A_3=25 ppm

Means with similar letters in each column do not have significant difference at 1% level according to Duncan's tests.

References

Pai Gozar Y, Ghanbari A, Heidary M, Tavasoli A. 2009. The effect of foliar spray of micronutrients on quantitative and qualitative characteristics of pearl millet Var. nitrified under drought stress. Journal of Agriculture, Islamic Azad University, Tabriz **3,** 67-81.

Karimi H. 1996. Agriculture and reforming forage crops. Tehran University Publications. P.256-272

Kouchaki A. 1985. Agriculture in arid areas (translation). Jihad Daneshgahi Publications, Mashhad, 202p.

Kouchaki A, Sarmadnia GhH. 2008. Crops physiology. Translation. Jihad Daneshgahi Publications, Mashhad, 400 p.

Mobser H, Heidari Sharif AbadH, Mousavi Nik M, Noor Mohammadiov Darvish Gh. 2005. The effect of application of potassium, zinc, and copper on the yield and enrichment of wheat seeds under water deficit conditions. Journal of agriculture **11,** 133-143.

Modir Shanechi M. 2000. Crops production and management. Astan-e Ghods-e Razavi Publication, 430 p.

Moaveni P. 2003. The effect of planting interval on quantitative and qualitative yield of forage sorghum, Islamic Azad University, Iranshahr.

Moaveni P, Heidari Y. 2004. The effect of planting density and irrigation on yield and some physiological traits of forage sorghum, Iranian Journal of Agriculture **6,** 374-382.

Mirlohi A, Bozorgvar N, Basiri M. 2000. The effect of different levels of nitrogen fertilizer on growth, yield, and silage quality of three hybrids of forage sorghum. Journal of Agriculture and Natural Resources **4,** 105-116.

Nakhoda B, Dezfuli A. 2000. The effect of deficit irrigation on yield and yield components of nitrified millet. Iranian Journal of Agriculture **3,** 701-712.

Devlin R M, Withan FH. 1983. Plant physiology. 4th Ed. Wadsworth Publishing Company. A division of wadsworth. Inc. Belmont, California.

Georing HK, Van Soest PJ. 1970. Forage fiber analyses; apparatus, reagents, procedures, and some application. USDA Agriculture Handbooks. 379. U.S. Government Printing Office, Washington, DC.

Jones JB, Wolf B, Mills HA. 1999. Plant analysis Handbook, Micro-Macro publishing, Inc, Athens, GA., Pp: 110.

Kramer PJ. 1983. Water relation of plants. Academic Press, New York. 540 Pp.

Lenoble ME, Spollen WG, Sharp RE. 2004. Maintenance of shoot growth by endogenous ABA:genetic assessment of the involvement of ethylene suppression. Journal of Experimental Botany. **55,** 237-254.

Levitt J. 1980. Responses of plants to environmental stresses. Academic Press, New York. 215 Pp.

Lewis DC, Farlane JDMc. 1986. Effect of foliar applied manganese on the growth of safflower and the diagnosis of manganese deficiency by plant issue and seed analysis. Australian Journal Agriculture Research. **72,** 57-59.

Misra AN. 1994. Pearl millet, Seedling estabilishment under variable soil moisture stress. Acta Physiologia Plantarum. **16,** 101-103.

Sadras VO, Milory SP. 1996. Soil-water thresholds of leaf expansion and gas exchange: A review. Field Crop Research. **47,** 253-266.

Samuel R. 2003. The Samuel Roberts Nobe foundation, Agricultural Division, P.O. Box 2180, Ardmore, ok 73402.

Tayebi A, Saki Nejad T, Shoukofar AR. 2011. The use of Hormone Auxin in the Different Period Growth on Yield Components of Plant Vetch.World Academy of Science, Engineering and Technology 60 2011.

Wilson JR. 1983. Effect of water stress on invitro dry matter digestibility and chemical composition of herbage of tropical pasture species. Australian Journal Agriculture Research. **34**, 377-390.