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An investigation on determining the effects of different nitrogen and zinc fertilizer doses on plant nutrient composition of Sorghum-Sudangrass Hybrid (*Sorghum bicolor* X *Sorghum sudanense*) grown as main crop under Çukurova/Turkey conditions

Serap KIZIL *1, Veyis TANSI [2], Selahattin CINAR [1]

[1] Çukurova Research Enstitü, Forage Crops Department, Adana, Turkey
[2] Çukurova University, Agriculture Faculty Field Crops Department, Adana, Turkey

Abstract

This study was carried out in order to determine the most suitable nitrogen (N) and zinc (Zn) fertilizer doses for sorghum-sudangrass hybrid grown as main crop under Çukurova Conditions during 2001-2002 at Çukurova Agricultural Research Institution. In the study, effects of different doses of nitrogen (0, 7, 14, 18 and 24 kg/da) and of zinc (0, 0.5, and 1 kg/da) on the nutrient composition of cultivar Grazer of Sorghum-Sudangrass were studied.

As a result of this research, while the highest N content (2.41 %) in the leaf was obtained from N-7+ Zn-0 application, the lowest N content (2.23 %) in the leaf was obtained from N-7+ Zn-0.5 application. While the highest P content (0.29%) in the leaf was obtained from N-0+ Zn-0, N-0+ Zn-0.5 and N-14+ Zn-0.5 applications, the lowest P content (0.27 %) in the leaf was obtained N-18+Zn-0, N-18+ Zn-0.5 and N-24+ Zn-0 applications. While the highest K content (1.05 %) in the leaf occurred in the application of N-7+ Zn-1, the lowest K content (0.86 %) in the leaf occurred in the application of N-7+ Zn-0. While the greatest Mg Content in the leaf occurred with 0.25% value from application of N-18 and Zn-1, the littlest Mg Content in the leaf occurred with 0.21% value from application of N-24 and Zn-0. While the greatest Zn Content in the leaf occurred with 37.08 mg/kg value from application of N-18 and Zn-1, the littlest Zn Content in the leaf occurred with 24.69 mg/kg value from application of N-0 and Zn-0. While the greatest Cu Content in the Leaf occurred with 5.99 mg/kg value from application of N-0 and Zn-1, the littlest Cu Content in the Leaf occurred with 4.00 mg/kg value from application of N-7 and Zn-0.5.

Generally, Nitrogen fertilizer treatment increased N and Zn content in the leaf. Zn fertilizer treatment increased K, Mg, and Cu in the leaf and especially, Zn to be positive effect on all of the animals and iron content in the leaf.

Key words: Sorghum-Sudangrass Hybrids, Nitrogen, Zinc, Yield

1. Introduction

Deficiencies of Fe, Zn, I and vitamin A in human populations are widespread, affecting up to two billion people (Word Health Organization, 1992; Graham and Welch, 1996).

Over the life of a cow, the majority of her nutrient intake comes from forages, growing, dormant or harvested and stored. This is how God designed her and one of the reasons cattle productions is a viable enterprise. In the light of this, it is reasonable to assume that a large percentage of the minerals in her diet are from this source since the majority of the cow's nutrient source is from forages (Blezinger, 2002). Zinc (Zn) is involved in the necessary functions of plant growth. It helps produce auxins, a growth-promoting substance that controls growth of shoots. Zn also forms enzyme systems, which regulate plant life.

Suggested N rates for dry land forage sorghum, sudan and sorghum x sudan hybrids are lower than those for irrigated forages because of lower plant populations and expected yields.

Sorghum is mainly grown in temperate areas as a part of the regular feeding program for livestock to supplement the short fall in pasture production during summer and fall months or as an emergency crop to provide

* *Corresponding author* / Haberleşmeden sorumlu yazar: Tel.: +90 3223340055; E-mail: erap_kizil@hotmail.com

forage, after winter kill of perennial grasses or after failure of a main crop. It is a cheaper feed than corn with less fertilizer requirement, less pest control and one third less water. Sorghum grows well on all type of soils. The plant can reach over four feet in height and produces several tillers. Forage sorghum is drought and heat tolerant but frost sensitive.

Sorghum-Sudan grass hybrids fit best in summer feeding programs. They are thick stemmed and hard to dry for hay but they can supply ample yields of silage, green chop and pasture when perennial grasses are slowing down or going dormant. Once Sorghum-Sudan grass begins to head out, the quality and feeding value drop drastically. It is difficult to meet nutrient requirements of high production or early lactation milking cows when Sorghum-Sudan grass is a large part of the forage intake. It is more suited to rations for dry cows, replacement heifers over 12 months of age, and beef cows and calves.

This study was carried out in order to determine the most suitable N and Zn fertilizer for sorghum-sudangrass hybrids in the Çukurova Region.

2. Materials and methods

This study was carried out in order to determine the most suitable N and Zn fertilizer doses for sorghum-sudangrass hybrids grown as main crop in the Çukurova Region during 2001-2002 at Çukurova Agricultural Research Institution. Grazer cultivar of Sorghum-Sudangrass hybrids and as pure fertilizer doses 0, 7, 14, 18, 24 kg/da nitrogen and 0, 0.5, 1.0 kg/da zinc were used in the study.

The trial was split-split plot block design with three replication. In the trial cuttings form main parcels,nitrogen doses form sub parcels, and zinc doses form sub-sub parcels. The plants were established in plots of 2.8 x 5 m and each parcel was planted in 4 rows at 0.75 m spacing.

Leaf was analyzed for N using the micro-Kjeldahl technique Minerals were dry ashed, and solutions were analyzed for P by colorimeter, for K by flame emission spectrophotometer and for Ca, Mg, Cu, Fe, Mn and Zn by atomic absorption spectrophotometer.

In this study, the obtained data was statistically analyzed by MSTAT-C statistical program through using split-split plot block design with three replication.

3. Results

N Content in the Leaf from Different N and Zn Fertilizer Doses at Sorghum-Sudangrass Hybrids in the Çukurova Region are shown in Table 3.1.

Table 1. N Content (%) of the Leaf fertilized with Different Nitrogen and Zinc Fertilizer Doses in Sorghum-Sudangrass Hybrid.

	N-0	**N-7**	**N-14**	**N-18**	**N-24**	**Mean**
Zn-0	2,28	**2,41**	2,34	2,33	2,36	2.34
Zn-0.5	2,38	**2,23**	2,29	2,36	2,34	2.32
Zn-1	2,26	2,32	2,36	2,31	2,34	2.32
Mean	2.31	2.32	2.33	2.33	2.35	2.33

According to results given in Table 3.1., sorghum N content in the leaf had significantly higher N concentration at all N levels. Muchow and Davis (1988) reported total N content was increased significantly with the application of N up to the highest level in all crops and the highest amount was obtained in maize with the highest N level. Langetal. (1989) reported a significantly higher ear leaf N concentration in corn when N was applied. They determined no differences in leaf N concentrations at three N rates (34, 67 and 134 kg N/ ha).

No signification differences in N content in the leaf were observed Zn application. In addition, the lowest N content in the leaf was obtained with 2.23% value from N-7, Zn-0.5 application while the highest N content in the leaf was obtained with 2.41% value from N-7, Zn-0 application.

P Content in the Leaf from Different Nitrogen and Zinc Fertilizer Doses at Sorghum-Sudangrass Hybrids in the Çukurova Region are shown in Table 3.2.

Table 2. P Content in the Leaf Applied Different N and Zn Fertilizer Doses at Sorghum-Sudangrass Hybrids in the Çukurova Region (%).

	N-0	**N-7**	**N-14**	**N-18**	**N-24**	**Mean**
Zn-0	**0.29**	0.28	**0.29**	**0.27**	**0.27**	0.28
Zn-0.5	**0.29**	0.28	0.28	**0.27**	0.28	0.28
Zn-1	0.28	0.28	0.28	0.28	0.28	0.28
Mean	0.29	0.28	0.28	0.27	0.28	0.28

Phosphorus (P) has been long recognized as an essential mineral for bone development, reproduction and energy transfer (Hidiroglou1979; Minson 1990).

In regard to Figure 3.2., no signification differences P Content in the Leaf were observed N application. However, especially N-18 and N-24 application together Zn application increased P Content in the Leaf. In addition, while the highest P Content in the Leaf was obtained with 0.29% value from N-0, Zn-0 and N-0, Zn-0.5 and N-14, Zn-0.5 applications, the lowest P Content in the Leaf was obtained with 0.27% value from N-18, Zn-0 and N-18, Zn-0.5 and N-24, Zn-0 applications. Menser (1985) reported the uptake and distribution of P in plants was influenced by Zn treatment. It is known that at normal Zn concentrations in the nutrient medium the content of inorganic P decreases, whereas the organic (acid-soluble) form increase.

Stoyanova and DonchevaBraz (2002) reported the roots and leaves showed decreasing P contents up to 70 µM Zn and increasing P content from 70 µM Zn onwards. The accumulation of P was greatest in the stems of Zn-treated plants. The addition of succinate to the nutrient solution increased P accumulation by roots in plants treated with higher Zn concentrations compared with Zn treatment alone.

K Content in the Leaf from Different N and Zn Fertilizer Doses at Sorghum-Sudangrass Hybrids in the Çukurova Region are shown in Table 3.3.

Table 3. K Content in the Leaf Applied Different Nitrogen and Zinc Fertilizer Doses at Sorghum-Sudangrass Hybrids in the Çukurova Region (%).

	N-0	**N-7**	**N-14**	**N-18**	**N-24**	**Mean**
Zn-0	0,88	**0,86**	0,88	0,95	0,92	0.90
Zn-0.5	0,94	0,90	0,89	0,93	0,97	0.93
Zn-1	1,00	**1,05**	1,03	1,03	0,99	1.02
Mean	0.94	0.94	0.93	0.97	0.96	0.95

According to results given in Table 3.3, No signification differences in K Content in the Leaf were observed N application. However, Zn application had the most efficient impact on K Content in the Leaf especially at the application of Zn-1.

In addition to, while the greatest K Content in the Leaf occurred with 1.05% value from application of N-7 and Zn-1, the littlest K Content in the Leaf occurred with 0.86% value from application of N-7 and Zn-0.

However, Stoyanova and DonchevaBraz (2002) reported the K content of the stems and leaves was not significantly affected by higher concentrations of Zn. A continuous increase in K accumulation was detected in the roots from the 350 µM Zn treatment onwards. The addition of succinate to the nutrient solution did not affect the K content of Zn-treated plants.

Mg Content in the Leaf from Different N and Zn Fertilizer Doses at Sorghum-Sudangrass Hybrids in the Çukurova Region are shown in Table 3.4.

Table 4. Mg Content in the Leaf Applied Different Nitrogen and Zinc Fertilizer Doses at Sorghum-Sudangrass Hybrids in the Çukurova Region (%).

	N-0	**N-7**	**N-14**	**N-18**	**N-24**	**Mean**
Zn-0	0,24	0,22	0,24	0,22	**0,21**	0.23
Zn-0.5	0,22	0,22	0,23	0,22	0,24	0.23
Zn-1	0,23	0,23	0,24	**0,25**	0,23	0.24
Mean	0.23	0.22	0.24	0.23	0.23	0.23

In regard to Figure 3.4, N application had a no positive impact on Mg Content in the Leaf, but Zn application had the most efficient impact on Mg Content in the Leaf. Especially at the application of Zn-0.5 and Zn-1 with N-7, N-18 and N-24 caused the most efficient impact on Mg Content in the Leaf.

In addition to, while the greatest Mg Content in the Leaf occurred with 0.25% value from application of N-18 and Zn-1, the littlest Mg Content in the Leaf occurred with 0.21% value from application of N-24 and Zn-0.

However, Stoyanova and DonchevaBraz (2002) reported the increase in Zn concentration above 70 µM led to an enhanced quantity of Mg in both the leaves and stems, accompanied by a drastic decrease in the Mg concentration in the roots. A change could not be detected for Mg concentration in Zn-treated plants after treatment with Na-succinate.

Zn Content in the Leaf from Different N and Zn Fertilizer Doses at Sorghum-Sudangrass Hybrids in the Çukurova Region are shown in Table 3.5.

Table 5. Zn Content in the Leaf Applied Different Nitrogen and Zinc Fertilizer Doses at Sorghum-Sudangrass Hybrids in the Çukurova Region (mg/kg).

	N-0	N-7	N-14	N-18	N-24	Mean
Zn-0	**24,69**	32,91	26,74	26,11	31,22	28.33
Zn-0.5	30,50	26,15	26,60	33,77	27,96	29.00
Zn-1	29,86	27,62	27,51	**37,08**	29,38	30.29
Mean	28.35	28.89	26.95	32.32	29.52	29.21

Zn is an essential element for both plants and animals, accepted. It plays an important role in several plant metabolic processes; it activates enzymes and is involved in protein synthesis and carbohydrate, nucleic acid and lipid metabolism (Marshner, 1986; Pahlsson, 1989). However, like other heavy metals (Doncheva et al., 1996; Doncheva, 1997, 1998) when Zn is accumulated in excess in plant tissues, it causes alterations in vital growth processes such as photosynthesis and chlorophyll biosynthesis (Doncheva et al., 2001) and membrane integrity (De Vos et al., 1991). An excess of Zn has been reported to have a negative effect on mineral nutrition (Chaoui et al., 1997). Toxic levels of Zn for different varieties of crops have very wide limits - from 64 $\mu g.L^{-1}$ Zn for sorghum to 2000 $\mu g.L^{-1}$ Zn for cotton (Ohki, 1984).

In regard to Figure 3.5., no signification differences in Zn Content in the Leaf were observed N application. However, especially N-18 application increased Zn Content in the Leaf. Zn application had the most efficient impact on Zn Content in the Leaf. Especially at the application of Zn-0.5 and Zn-1 with N-18 caused the most efficient impact on Zn Content in the Leaf.

In addition to, while the greatest Zn Content in the Leaf occurred with 37.08 mg/kg value from application of N-18 and Zn-1, the littlest Zn Content in the Leaf occurred with 24.69 mg/kg value from application of N-0 and Zn-0.

Cu Content in the Leaf from Different Nitrogen and Zinc Fertilizer Doses at Sorghum-Sudangrass Hybrids in the Çukurova Region are shown in Table 3.6.

Table 6. Cu Content in the Leaf Applied Different N and Zn Fertilizer Doses at Sorghum-Sudangrass Hybrids in the Çukurova Region (mg/kg).

	N-0	N-7	N-14	N-18	N-24	Mean
Zn-0	4,49	4,86	5,06	4,97	4,07	4.69
Zn-0.5	4,86	**4,00**	5,36	5,33	4,66	4.84
Zn-1	**5,99**	4,04	5,39	4,62	4,66	4.94
Mean	5.11	4.30	5.27	4.97	4.46	4.82

Copper (Cu) is an essential element for ruminants and its deficiencies occur in grazing animals in many parts of the world. Cu joins in formation of many enzyme systems and thus its deficiencies may result in is reflected in those metabolic and clinical symptoms related to these enzymes. Cu deficiency causes infertility in ruminants. (Hidiroglou, 1979; Minson 1990). Copper is contained in several important enzymes in plants and is involved in photosynthesis and chlorophyll formation (Aganga et all.; 1996).

According to result given in Figure 3.6, generally, no signification differences in Cu Content in the Leaf were observed N application. However, Zn application had the most efficient impact on Cu Content in the Leaf.

In addition to, the littlest Cu Content in the Leaf occurred with 4.00 mg/kg value from application of N-7 and Zn-0.5 while the greatest Cu Content in the Leaf occurred with 5.99 mg/kg value from application of N-0 and Zn-1.

References

Aganga, A.A., Tsopito, C.M., Mwandamena. M. 1996. Growth and Nutritive Value of Some Varieties of Sorghum and Millet as Forage Crops in Botswana. Tropical Science 36:86-91.

Blezzinger, S.B. 2002. Improve Your Herd Health Status Through Nutrition. 1998-2002 Cattle Today, Inc.

Chaoui, A., Mazhoudi, S., Ghorbal, M.H., Elferjani, E. 1997. Cadmium and Zinc Induction of Lipid Peroxidation and Effects on Antioxidant Enzyme Activities in Bean (Phaseolus vulgaris L.) Plant Sci. 127:139-147.

De Vos, C.H.R., Schat, H., De Waal, M.A.M., Voorja, R., Ernst WHO (1991). Increased Resistance to Copper-Induced Damage of Root Cell Plasmalemma in Copper Tolerant Silene Cucubalus. Physiol. Plant. 82:523-528.

Doncheva, S., Nikolov, B., Ogneva, V. 1996. Effect of Copper Excess on the Morphology of the Nucleus in Maize Root Meristem Cells. Physiol. Plant. 96:118-122.

Doncheva, S. 1997. Ultrastructural Localization of Ag-NOR Proteins in Root Meristem Cells After Copper Treatment. J. Plant Physiol. 151:242-245.

Doncheva, S. 1998. Copper-Induced Alterations in Structure and Proliferation of Root Meristem Cells. J. Plant Physiol. 153:482-487.

Doncheva, S., Stoyanova, Z., Velikova, V. (2001). The Influence of Succinate on Zinc Toxicity of Pea Plant. J. Plant Nutr. 24:789-806.
Graham, R.D., Welch, R.M., 1996. Breeding for Staple Food Crops with High Micronutrient Density International Food Policy Research Institute, Washington, D.C.
Hidiroglou, M. Trace Element Deficiencies and Fertility in Ruminants. A Review. J. Dairy Sci. 62: 1195-1206, 1979.
Lang, T.A., Overman, D.L., Gallaher, R.N. 1989. Yield and Ear Leaf Nitrogen Status in No-tillage Second Crop Temperate and Tropical Corn. pp. 3638. In 1989 Southern Conservation Tillage Conference. LD. Teare (ed.). North Fl. Res. Educ. Center, Quincy, FL.
Marschner, H. (1986). Mineral Nutrition of Higher Plants. Academic Press, New York.
Menser, H.A., Sidle, R.C.1985. Effect of Zinc Levels on Phosphorous and Zinc Content in Sand-Cultured Soybeans. J. Plant Nutr. 8:89-97.
Minson, D.J. Forage in Ruminant Nutrition. Academic Press. Inc. London 1990.
Muchow, R.C. and Davis, R. 1988. Field Crops Research 18, 17-30.
Ohki, K. 1984. Zinc Nutrition Related to Critical Deficiency and Toxicity Levels for Sorghum. Agron. J. 76:253-256.
Pahlsson, A.M.B. 1989. Toxicity of Heavy Metals (Zn, Cu, Cd, Pb) to Vascular Plants. Water Air Soil Pollut. 47:287-319.
Stoyanova, Z., DonchevaBraz, S. The Effect of Zinc Supply and Succinate Treatment on Plant Growth and Mineral Uptake in Pea Plant. J. Plant Physiol.Vol.14 No.2 Londrina May/Aug. 2002.
Word Health Organization. 1992. National Strategies for Overcoming Micronutrient Malnutrition. WHO, Genova.

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