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Effect of urea and ammonium sulphate on some physiological aspects and chemical compositions of *Pennisetum glaucum* plants

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Abstract

A research experiment was carried out to study the effect of soil application of urea and/or ammonium sulphate on some physiological aspects and biochemical composition of pearl millet (*Pennisetum glaucum*) plants during the vegetative growth period. The parameters analyzed were dry weight, water content, polysaccharides, total carbohydrates, phosphorus content, nitrogenous content and proline in roots and shoots as well as photosynthetic pigments content in the leaves. The results for roots indicated significant increases in dry weight, water content and direct reducing value due to the combination of urea with ammonium sulphate at 0.5% during the first and second periods and urea with ammonium sulphate at 0.3% in the third one. Total carbohydrates significantly increased due to application of ammonium sulphate at 0.5% in the second and third samples. Organic and total phosphorus significantly increased due to application of urea at 0.3% in the first and second samples. Applying urea at 0.5% achieved the highest value in total soluble N, protein-N, total-N and proline in first sample. Meanwhile, the combination of urea and ammonium sulphate at 0.3% resulted in high increases in total- N and protein - N in the second and third samples. Likewise, application of urea with ammonium sulphate at 0.5% caused the highest significant value in total soluble - N in the second sample compared with control and other treatments in roots.

Key words: *Pennisetum glaucum,* Ammonium sulphate, Photosynthetic pigments, Urea

Introduction

Pearl millet (*Pennisetum glaucum*) is the most widely grown type of millet and one of the major field crops in Yemen. In 1999, the total cultivated area of millet is 649551 hectare and the total production was 464240 tons. The crop is principally produced for both human and animals.

Nitrogen is one of the most important nutrients for the growth and yield of several crop. Nitrogen is the most limiting nutrient for cereal crops production. Also, it is an essential component of structural amino acid, amides, nucleotides, nucleoproteins and is essential to cell division, expansion and nonstructural components of plant cells (Mengel and Kirkby, 1979). Ammonium (NH_4) and urea in soils are the two main sources of available N for plant growth. Although other nitrogen sources such as fertilizer applications have noticeable effects on growth of *Pennisetum glaucum* plants (Powell et al., 1991; Youngquist et al., 1992; Hassanein, 1996). Nouret al. (1989) found that among different nitrogen forms, urea gave the highest mean values of seedling growth parameters. Iptas and Brohi (2011) observed that the N rate had no significant effect in the first and third cutting, but in the second one dry matter yields, crude protein content and yield, increased significantly with the increase in N rate. The highest yield of 9.1 ton/ hectare was obtained with 80 kg N/hectare for the average of 2 years at the second cutting.

Allen (1984) noted that small grain absorb large amount of nitrogen early in their growth cycle, store it in leaves, and transfer it to the developing seed, which results in very efficient use of rapidly available nitrogen fertilizer. Therefore, the main objective of this study was to determine the effects of urea and ammonium sulphate applied separately or in combinations (at 0.3% and 0.5% solution), to the soil at seedling stage on some physiological aspects and chemical compositions of *Pennisetum glaucum* plants.

Materials and Methods

A pot experiment was carried out in a greenhouse at the Experimental Station, Department of Biology, Faculty of Education,

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Sana'a University, Yeman during the growing season of 2011, to study the effect of soil application of urea and/or ammonium sulphate on some physiological aspects and biochemical composition of *Pennisetum glaucum* plants, during the vegetative growth period. The grains were obtained from crops market in Sana'a city, the capital of Yeman Republic.

Nitrogen sources

Two nitrogen sources i.e. urea and ammonium sulphate were used and applied at two levels 0.2 and 0.4% solution alone or in combination. The treatments were as follows: (1) without any addition (control) (2) urea at 0.3% (3) urea at 0.4 % (4) ammonium sulphate at 0.3% (5) ammo sulphate at 0.5% (6) combination between urea and ammonium (0.20 : 0.30%) (7) combination between urea and ammonium (0.40 : 0.40%). Plastic pots of 20 cm in diameter were packed with about 3 kg mixtures of clay and sand (1: 1 v /v), Phosphorus and potassium fertilizers were added to the soil before sowing. Before planting the grains selected were surface sterilized by sooking in 0.01 M HgCh solution for 3 minutes and washed thoroughly with distilled water. Ten grains were sown at 1st of March in the season 2011 in each pot. The pots were kept in a greenhouse in which plants were subjected to normal day/ night conditions and watered for 20 days. Then, the seedlings were thinned to 5 uniform plants per pot for the subsequent study. At day 30, the pots were divided randomly into 7 groups and the treatments were added to the soil of each pot in one dose. Irrigation was conducted every 4 days in the first 2 weeks then every 7 days in the second 4 weeks. The experiment continued for period of 60 days. The treatments were arranged in a completely randomized design with 12 replicates (12 pots) for each treatment.

Sampling and collecting data

Three samples were taken from each treatment during vegetative growth period at three times 30, 40 and 50 days after sowing. At each sampling date, ten plants of each treatment were randomly taken for different measurements. The plants were cleared and separated into roots and shoots. The samples were then dried at 70°C. Fresh and dry weights of roots and shoots systems, water content and direct reducing value of roots and shoots were recorded, or calculated.

Data concerning growth and chemical compositions were subjected to statistical analysis according to Snedecor and Cochran (1980).

Chemical analysis

Fresh and dry samples of the two organs were used for the following determinations:

1) Photosynthetic pigments: The chlorophylls a, b and carotenoids were determined in the fresh leaves using the spectrophotometer method recommended by Nornai (1982).

2) Phosphorus compounds: The different phosphorus compounds were extracted and determined according to the method described by Chapman and Parker (1961).

3) Carbohydrates contents: Polysaccarides and total carbohydrates were determined using the method adapted by Doubis et al. (1956).

4) Nitrogenous compounds: Total soluble nitrogen fractions and total nitrogen were determined using the method described by Horneck and Miller (1998). The subtraction of total soluble N from total- N multiplied by 6.25 (gave the value for protein- N (A.O.A.C. 1980).

5) Proline: Free proline concentration was determined according to Bates et al. (1973).

Data concerning growth and chemical compositions were subjected to statistical analysis according to Snedecor and Cochran (1980).

Results and Discussion

The effects of applying different nitrogenous treatments on dry weight, water content and carbohydrate contents in roots of *Pennisetum glaucum* plants are presented in Table 1 for the first sample. The combination of urea and ammonium sulphate at 0.5% solution significantly increased dry weight, total reducing value, polysaccharides and total carbohydrates of *the* roots. Differences among the seven treatments in dry weight and water contents percentages were significant. Similar results were found in sample 2. The combination of urea and ammonium at 0.5% solution also resulted in the highest values of dry weight, water content and direct reducing value (DRV) in the second sample. In addition, the combination of urea and ammonium at 0.3% solution had the highest value of TRV compared with the control. The results of the sample showed that the combination of urea and ammonium at 0.3% solution significantly increased dry weight, water content % and DRV compared with the control. However, urea alone at 0.5% solution gave the highest value of polysaccharides 15.16 g/100g.

Table 1. Effect of urea and ammonium sulphate (0.3%, 0.5%) and their combination on dry weight, water content, direct reducing value (DRV), total reducing value (TRV), polysaccharides and total carbohydrates of *Pennisetum glaucum* roots.

Treatments sample		Dry weight	Water content	DRV	TRV	PoIysaccharides	Total carbohydrates
		(g)	%	(g/100g)	(g/100g)	(g/100g)	(g/100g)
				First (30 days after sowing)			
Control		0.13	1.90	10.62	14.32	12.24	26.56
Urea 0.2%		0.14	1.89	8.09	11.14	12.16	23.30
Am Sulphate 3%		0.14	1.69	9.92	11.22	11.19	22.41
Urea 0.4%		0.13	1.56	9.04	20.34	10.19	30.43
Am Sulphate 5%		0.16	2.55	9.12	21.36	12.22	33.58
Urea + Am. Sulphate 0.3%		0.22	3.20	10.16	20.33	13.24	33.47
Urea + Am. Sulphate 0.5%		0.23	3.40	9.19	22.16	13.16	35.32
LSD at	0.05	0.017	·0.321	0.272	0.092	0.188	1.76
	0.01	0.022	0.451	0.880	0.120	0.255	2.360
				Second (40 days after sowing)			
Control		0.62	3.12	9.45	15.24	13.08	28.32
Urea 0.2%		0.66	4.42	8.95	22.25	16.09	38.21
Am Sulphate 0.3%		0.52	3.13	8.85	20.15	14.09	34.24
Urea 0.4%		0.64	3.62	8.84	15.16	13.18	28.34
Am Sulphate 0.5%		0.56	7.00	8.74	22.16	16.19	38.33
Urea + Am. Sulphate 0.3%		0.64	6.59	9.96	23.22	15.18	38.30
Urea + Am. Sulphate 0.5%		0.69	7.23	10.23	20.18	15.36	35.54
LSD at	0.05	0.031	0.060	0.081	0.289	0.326	1.860
	0.01	0.042	0.810	0.120	0.401	0.436	2.621
				Third (50 days after sowing)			
Control		0.94	6.11	8.15	12.12	12.19	24.31
Urea 0.2%		1.22	5.66	8.04	14.14	11.19	25.33
Am Sulphate 3%		0.46	4.94	8.13	15.09	14.22	29.31
Urea 0.4%		1.16	6.86	8.33	20.08	15.16	35.04
Am Sulphate 5%		0.92	7.70	9.02	22.25	13.13	35.38
Urea + Am. Sulphate 0.3%		1.84	9.59	9.14	12.17	11.13	23.30
Urea + Am. Sulphate 0.5%		0.89	7.66	8.99	22.19	12.04	33.23
LSD at	0.05	0.047	0.044	0.081	0.311	0.316	2.101
	0.01	0.062	0.056	0.111	0.404	0.412	2.221
LSD at	0.05	0.030	0.104	0.070	0.280	0.328	1.811
	0.01	0.042	0.140	0.092	0.361	0.421	2.112

Am = Ammonium

The impact of applying different nitrogenous treatments on dry weight, water content and carbohydrate contents in roots are presented in Table 2 for the first sample. Urea at 0.3% solution significantly increased dry weight and water content of shoots at 30 days from germination over the control. The combination of urea and ammonium sulphate at 0.5% resulted in the best DRV TRV g, polysaccharides and total carbohydrate compared with other treatments. In addition, significant differences between urea 0.3% and 0.5% and combination of urea and ammonium sulphate solution at 0.5% in polysaccharides.

As per the second sample, urea 0.3% led to obtain the highest value of DR V 9.32 g/100g. Am. sulphate 0.3% produced the highest values of dry weight 3.46 g TRV 18.45 g/100g, polysaccharides 15.40 g/100g and total carbohydrates 33.85 g/100g. However, ammonium sulphate 0.5% resulted in the best water content 20.15%.

The treatments significantly increased dry weight over the control treatment of shoots. Ammonium sulphate at 0.5% had the highest value of dry weight, whereas, the combination of urea and ammonium sulphate at 0.5% resulted in the highest water content, DRV, and total carbohydrates. Treatment of urea at 0.5% solution produced the highest polysaccharides content. The effects of the combination of urea and ammonium sulphate added at 0.5% solution on dry weight and water content in the three samples in both root and shoots systems could be attributed to their effect on several physiological factors such as, cell division, uptake of elements, photosynthetic pigment

content, carbohydrate and protein content and cytokines content in roots. Hence, such mechanism results in increasing the growth of roots and shoots system. Similar results were obtained by Powell et al. (1991), Youngquist et al. (1992) on *Pennisetum glaucum* plants and by Nouret al. (1989) and Khedret al. (2000) on wheat and by Iptas and Borhi (2011) on *Pennisetum glaucum* plants. In addition, the superiority of urea on vegetative growth may be due to continuous and slow release of N to *Pennisetum glaucum* plants as a result of transforming of Nll, to $N0_3$ or extended NH_4 nutrition. Also, it was reported by Zhou et al. (1997) that high N inputs (270 kg N ha) increased both DM production and N uptake by corn.

Concerning carbohydrates content, the higher increment of carbohydrate fractions in roots than in shoots with the application of urea and ammonium at 0.5% alone or their combination, could be attributed to the active translocation of different photosynthesis from source organs (leaves) to the sink organs (roots) during vegetative growth. Also, NH4 assimilate into organic compounds in roots before translocation to the shoots this process requires energy and a flux of carbohydrates from the photosynthesized tissues to roots. Fentem et al. (1993a) and Marschner (1995) indicated that the high demand of carbon skeletons for ammonium in roots is reflected on sugar and carbohydrate content in roots.

Table 2. Effect of urea and ammonium sulphate (0.3%, 0.5%) and their combination on dry weight, water content, direct reducing value (DRV), total reducing value (TRV), polysaccharides and total carbohydrates of *Pennisetum glaucum* shoots.

Treatments sample		Dry weight	Water content	DRV	TRV	PoIysaccharides	Total carbohydrates
		(g)	%	(g/100g)	(g/100g)	(g/100g)	(g/100g)
				First (30 days after sowing)			
Control		0.69	4.26	7.28	14.42	12.66	26.68
Urea 0.2%		0.97	6.25	8.79	15.54	15.42	30.96
Am Sulphate 3%		0.76	5.23	7.62	13.49	13.32	26.81
Urea 0.4%		0.58	4.25	7.99	14.52	14.40	28.92
Am Sulphate 5%		0.59	4.47	8.52	17.42	13.33	30.75
Urea + Am. Sulphate 0.3%		0.59	5.22	9.33	14.33	11.54	25.87
Urea + Am. Sulphate 0.5%		0.66	4.24	9.42	18.29	14.62	32.91
LSD at	0.05	0.068	0.151	0.122	0.282	1.212	1.082
	0.01	0.101	0.212	0.214	0.432	1.721	2.271
				Second (40 days after sowing)			
Control		2.18	12.22	8.24	14.40	13.23	27.63
Urea 0.2%		2.14	14.30	9.32	15.32	14.33	29.55
Am Sulphate 0.3%		3.56	12.34	8.45	18.45	15.40	33.85
Urea 0.4%		1.89	11.50	7.63	17.38	14.22	31.60
Am Sulphate 0.5%		2.61	20.45	9.34	15.34	14.37	29.71
Urea + Am. Sulphate 0.3%		2.43	17.64	8.63	14.22	15.26	29.48
Urea + Am. Sulphate 0.5%		1.99	19.50	8.55	13.25	13.23	26.48
LSD at	0.05	0.110	0.212	1.021	1.521	1.421	2.122
	0.01	0.156	0.362	1.341	2.121	2.002	3.563
				Third (50 days after sowing)			
Control		3.22	30.24	7.28	13.87	12.26	26.13
Urea 0.2%		4.23	31.34	8.35	14.96	13.38	25.34
Am Sulphate 3%		3.52	28.40	7.22	16.28	13.28	29.46
Urea 0.4%		3.64	33.54	8.61	17.70	14.49	31.99
Am Sulphate 5%		4.22	28.95	9.23	14.46	12.50	26.96
Urea + Am. Sulphate 0.3%		4.25	30.41	8.42	13.35	13.60	26.95
Urea + Am. Sulphate 0.5%		3.95	34.33	9.24	18.22	12.30	30.52
LSD at	0.120	1.522	0.429	0.687	1.596	1.567	0.120
	0.221	2.321	0.712	0.992	2.100	2.120	0.221
LSD at	0.101	1.021	0.267	0.419	1.460	2.012	0.101
	0.132	1.212	0.399	0.594	1.607	2.212	0.132

In general, the positive effects of nitrogen fertilizer on sugar and carbohydrates content may be due to its influence on photosynthetic efficiency. Similar effects were nearly found by Khedr et al. (2000) on wheat and Abo El- Ghait (1993) who found that urea and ammonium nitrate at 80 and 120 kg N/fed significantly increased total carbohydrate content in leaves of *Strelitzia reginae*. In addition, Marschner (1995) indicated that, when the nitrogen supply is suboptimal, ammonia assimilation increases both protein content and leaf growth and correspondingly the leaf area index which correlated with an increase in net photosynthesis.

The effects of different nitrogenous treatments on photosynthetic pigments are presented in Table 3. Treatment of 0.3% urea resulted in the highest chlorophyll A and B, while ureaat 0.5% resulted in the highest value of carotenoids in the first sample. Similarly, the results of the second sample showed that application of urea at 0.3% resulted in the highest chlorophyll A. Urea 0.5% solution resulted in the best chlorophyll A in the third sample.

The results obtained in this study are in agreement with those results obtained by Abo EI-Ghait (1993) and Khedr et al. (2000) and Riedell and Kiechefer (1993) who found that the content of chlorophyll A and B significantly increased by increasing nitrogen rate. In this connection, Marschner (1995) reported that nitrogen supply causes an enhancement of protein synthesis and chloroplast formation leads to an increase in the lipid content of leaves as well as to an increase in chloroplast constituents such as chlorophyll and carotenoid.

Table 3. Effect of urea and ammonium sulphate (0.3%, 0.5%) and their combination on chlorophyll a, band carotenoids of *Pennisetum glaucum* leaves.

Treatments sample		Chlorophyll (a)	Chlorophyll (mg/g fresh wt)	Carotenoids
		First (30 days after sowing)		
Control		6.22	4.26	5.61
Urea 0.3%		7.42	5.55	6.37
Am. Sulphate 0.3%		7.32	4.43	6.27
Urea 0.5%		6.67	4.52	7.23
Am. Sulphate 0.5%		5.56	5.35	5.16
Urea + Am. Sulphate 0.3%		5.26	4.52	4.18
Urea + Am. Sulphate 0.5%		6.53	5.26	5.26
LSD at	0.05	0.168	0.101	0.163
	0.01	0.232	0.132	0.224
		Second (40 days after sowing)		
Control		5.32	4.22	4.20
Urea 0.3%		7.25	5.34	7.37
Am. Sulphate 0.3%		6.32	5.12	4.22
Urea 0.5%		6.29	4.31	3.10
Am. Sulphate 0.5%		7.22	4.24	4.38
Urea + Am. Sulphate 0.3%		5.65	5.26	5.27
Urea + Am. Sulphate 0.5%		6.24	5.62	3.22
LSD at	0.05	0.122	0.124	0.202
	0.01	0.286	0.201	0.301
		Third (50 days after sowing)		
Control		5.10	3.75	3.17
Urea 0.3%		6.22	4.26	5.22
Am. Sulphate 0.3%		5.25	3.26	4.16
Urea 0.5%		6.36	3.26	3.29
Am. Sulphate 0.5%		4.31	4.68	2.21
Urea + Am. Sulphate 0.3%		5.20	3.38	3.37
Urea + Am. Sulphate 0.5%		6.12	3.22	2.76
LSD at	0.05	0.132	0.118	0.106
	0.01	0.212	0.102	0.150
LSD at	0.05	0.167	0.101	0.151
	0.01	0.213	0.144	0.216

The effects of different nitrogenous treatments on phosphorus content are presented in Tables 4 and 5. The results showed that urea 0.3% caused the highest values of organic –P in both first and second samples. The combination of urea and ammonium sulphate at 0.5% resulted increase for all parameters in the first sample compared with other treatments. While combination of urea and ammonium sulphate at 0.3% solution produced the higher values for organic and organic parameters compared with the control in the second sample. These results are in agreement with those reported by Powell et al. (1991) and Khedr et al. (2000).

The impacts of different nitrogenous treatments on TSN, protein, total N and Proline contents of roots and shoots are presented in Tables 6 and 7, respectively. Urea at 0.5% solution caused a significant increase in total soluble N (TSN), protein- N, total - N and proline of roots for the first and second samples, while the combination of urea and ammonium sulphate at 0.3% solution resulted in the highest values of protein - N and total – N, compared with other treatments in the third sample. As per shoots, ammonium sulphate at 0.3% solution increased TSN in the first sample. The urea at 0.5% solution resulted in higher value for total N as compared to other treatments in both second and third samples.

Table 4. Effect of urea and ammonium sulphate (0.3%, 0.5%) and their combination on inorganic phosphorous, organic phosphorous and total phosphorous of ***Pennisetum glaucum*** roots.

Treatments Sample		Inorganic -P	Organic-P	Total-P
		(g/100g d.wt)		
		First (30 days after sowing)		
Control		0.25	0.65	0.90
Urea 0.3%		0.29	0.86	1.15
Am. Sulphate 0.3%		0.32	0.65	0.97
Urea 0.5%		0.25	0.64	0.89
Am. Sulphate 0.5%		0.25	0.63	0.88
Urea + Am. Sulphate 0.3%		0.13	0.56	0.75
Urea + Am. Sulphate 0.5%		0.18	0.64	0.82
LSD at	0.05	0.021	0.062	0.120
	0.01	0.039	0.101	0.148
		Second (40 days after sowing)		
Control		0.43	0.92	1.35
Urea 0.3%		0.65	0.98	1.63
Am. Sulphate 0.3%		0.14	0.96	1.10
Urea 0.5%		0.16	0.83	0.98
Am. Sulphate 0.5%		0.64	0.66	1.30
Urea + Am. Sulphate 0.3%		0.19	0.68	0.87
Urea + Am. Sulphate 0.5%		0.12	0.86	0.97
LSD at	0.05	0.042	0.092	0.020
	0.01	0.063	0.122	0.028
		Third (50 days after sowing)		
Control		0.24	0.79	1.31
Urea 0.3%		0.22	0.66	0.88
Am. Sulphate 0.3%		0.23	0.59	0.82
Urea 0.5%		0.16	0.72	0.88
Am. Sulphate 0.5%		0.19	0.61	0.80
Urea + Am. Sulphate 0.3%		0.19	0.75	0.95
Urea + Am. Sulphate 0.5%		0.17	0.76	0.93
LSD at	0.05	0.041	0.106	0.044
	0.01	0.052	0.146	0.062
LSD at	0.05	0.026	0.068	0.071
	0.01	0.049	0.112	0.095

Table 5. Effect of urea and ammonium sulphate (0.3%, 0.5%) and their combination on inorganic phosphorous, organic phosphorous and total phosphorous of *Pennisetum glaucum* shoots.

Treatments Sample		Inorganic -P	Organic-P	Total-P
		g/100g d.wt		
		First (30 days after sowing)		
Control		0.22	0.41	0.63
Urea 0.3%		0.15	0.42	0.57
Am. Sulphate 0.3%		0.22	0.62	0.84
Urea 0.5%		0.15	0.68	0.83
Am. Sulphate 0.5%		0.16	0.42	0.58
Urea + Am. Sulphate 0.3%		0.26	0.72	0.98
Urea + Am. Sulphate 0.5%		0.26	0.72	0.98
LSD at	0.05	0.016	0.018	0.132
	0.01	0.021	0.012	0.202
		Second (40 days after sowing)		
Control		0.24	0.56	0.80
Urea 0.3%		0.28	0.56	0.82
Am. Sulphate 0.3%		0.27	0.73	0.99
Urea 0.5%		0.19	0.26	0.45
Am. Sulphate 0.5%		0.16	0.64	0.80
Urea + Am. Sulphate 0.3%		0.34	0.94	1.28
Urea + Am. Sulphate 0.5%		0.26	0.92	1.18
LSD at	0.05	0.016	0.022	0.034
	0.01	0.022	0.035	0.056
		Third (50 days after sowing)		
Control		0.22	0.44	0.66
Urea 0.3%		0.19	0.35	0.54
Am. Sulphate 0.3%		0.24	0.56	0.80
Urea 0.5%		0.19	0.76	0.95
Am. Sulphate 0.5%		0.16	1.14	2.30
Urea + Am. Sulphate 0.3%		0.24	1.52	1.67
Urea + Am. Sulphate 0.5%		0.26	0.94	1.20
LSD at	0.05	0.020	0.046	0.052
	0.01	0.031	0.062	0.075
LSD at	0.05	0.016	0.33	0.081
	0.01	0.022	0.042	0.115

These increments in protein fractions (protein - N, total soluble Nand total- N in both roots and shoots of *Pennisetum glaucum* plants in the three samples may be attributed to the stimulatory effects of urea and ammonium sulphate on proteolytic enzymes and enhancement of biosynthesis of amino acids and protein. These effects were referred to the increments in total N content in both roots and shoots in response to increased urea and ammonium sulphate at 0.3% or 0.5%concentration. The increase in ammonia assimilation in roots into amino acids which was accompanied with a marked increase in all nitrogenous fractions content parallel to increase in high level of added urea (0.5%) or the combination of urea and ammonium sulphate (at 0.5%). Also, it was accompanied by dry weight stimulation of roots and shoots as shown in Tables 1 and 2. On the other hand, the reduction in protein N of shoots system was accompanied by increment in total soluble nitrogen and unassimilated NH4, in response to the high level of urea and ammonium sulphate at 0.5%. In addition, when urea was used as N- source it can be taken up directly by the roots and it is hydrolyzed by urease after translocation to the shoots in maize plant. Meanwhile, NH_4, is toxic to plant tissue and cannot be strode. Consequently, plants assimilate it into organic compounds in the roots (amides, amines and amino acids) before translocation to shoot (Marschner, 1995).

Marschner (1995) reported that, polyamine content and free amino acids (such as proline) were particularly high in meristematic tissues, in plants supplied with high levels of ammonium and low external pH, this increases are most likely a reflection of pH homeostasis.

These results are in agreement with those obtained by Khedr et al., 2000 and Iptas and Brohi, 2003.

Conclusion

From the results, it can be concluded that there are significant increases in dry weight, water content and direct reducing value due to the combination of urea with ammonium sulphate at 0.5% during the first and second periods, and urea with ammonium sulphate at 0.3% in the third one. Total carbohydrates significantly increased due to application of ammonium sulphate at 0.5% in the second and third samples. Likewise other studied parameters also significantly increased due to application of urea and ammonium sulphate in the first and second samples.

Table 6. Effect of urea and ammonium sulphate (0.3%, 0.5%) on TSN, protein -N, Total-N and proline of *Pennisetum glaucum* roots.

Treatments Sample		Total soluble nitrogen (TSN)	Protein-N	Total-N	Proline
		(g/100g D.WT)			
		First (30 days after sowing)			
Control		4.32	3.18	7.50	0.44
Urea 0.3%		5.22	3.80	9.16	0.66
Am. Sulphate 0.5%		4.36	4.16	8.78	0.58
Urea 0.5%		5.62	5.22	10.66	0.68
Am. Sulphate 0.5%		4.74	5.20	9.45	0.46
Urea + Am. Sulphate 0.3 %		5.26	4.60	9.82	0.34
Urea + Am. Sulphate 0.5 %		5.22	5.44	10.88	0.48
LSD at	0.05	0.108	0.261	0.583	0.079
	0.01	0.028	0.332	0.796	0.109
		Second (40 days after sowing)			
Control		5.44	6.52	11.86	0.34
Urea 0.3%		5.34	8.67	15.16	0.68
Am. Sulphate 0.5%		5.66	8.34	13.93	0.45
Urea 0.5%		5.59	6.24	13.00	0.56
Am. Sulphate 0.5%		5.66	7.25	15.12	0.44
Urea + Am. Sulphate 0.3 %		5.86	9.26	15.15	0.46
Urea + Am. Sulphate 0.5 %		6.50	8.66	15.71	0.58
LSD at	0.05	0.016	0.169	0.891	0.096
	0.01	0.029	2.39	1.310	0.210
Control		Third (50 days after sowing)			
Urea 0.3%		4.18	5.22	9.49	0.26
Am. Sulphate 0.5%		3.36	7.68	11.38	0.28
Urea 0.5%		4.45	7.63	12.08	0.26
Am. Sulphate 0.5%		3.26	8.29	11.55	0.28
Urea + Am. Sulphate 0.3 %		5.46	7.35	12.82	0.25
Urea + Am. Sulphate 0.5 %		4.45	9.96	14.41	0.24
LSD at	0.05	3.66	6.66	10.16	0.29
	0.01	0.034	0.193	0.806	0.083
LSD at	0.05	0.037	0.297	0.917	0.129
	0.01	0.032	0.197	0.732	0.099

Table 7. Effect of urea and ammonium sulphate (0.3%, 0.5%) on TSN, protein -N, Total-N and proline of *Pennisetum glaucum* shoots.

Treatments Sample		Total soluble nitrogen (TSN)	Protein-N	Total-N	Proline
		(g/100g D.WT)			
		First (30 days after sowing)			
Control		2.32	1.44	3.76	0.56
Urea 0.3%		4.29	2.26	6.55	0.28
Am. Sulphate 0.5%		5.52	3.25	8.77	0.46
Urea 0.5%		4.28	6.19	10.47	0.50
Am. Sulphate 0.5%		5.19	3.28	8.37	0.40
Urea + Am. Sulphate 0.3 %		5.25	4.53	9.78	0.52
Urea + Am. Sulphate 0.5 %		4.18	3.29	7.44	0.60
LSD at	0.05	0.217	0.366	0.511	0.083
	0.01	0.299	0.591	0.721	0.116
		Second (40 days after sowing)			
Control		3.34	2.34	5.69	0.56
Urea 0.3%		6.42	5.47	11.89	0.69
Am. Sulphate 0.5%		6.25	6.54	12.79	0.58
Urea 0.5%		5.29	8.42	13.71	0.55
Am. Sulphate 0.5%		5.56	7.39	12.85	0.79
Urea + Am. Sulphate 0.3 %		6.66	6.28	12.94	0.78
Urea + Am. Sulphate 0.5 %		5.66	7.29	12.95	0.58
LSD at	0.05	0.246	0.526	0.633	0.081
	0.01	0.364	0.761	0.901	0.112
Control		Third (50 days after sowing)			
Urea 0.3%		1.45	4.26	5.71	0.36
Am. Sulphate 0.5%		3.42	5.36	8.78	0.48
Urea 0.5%		4.26	6.42	10.68	0.39
Am. Sulphate 0.5%		6.29	5.26	11.55	0.29
Urea + Am. Sulphate 0.3 %		4.36	4.25	8.62	0.38
Urea + Am. Sulphate 0.5 %		3.25	5.37	8.72	0.49
LSD at	0.05	3.28	6.26	9.54	0.48
	0.01	0.360	0.056	0.916	0.081
LSD at	0.05	0.432	0.769	1.261	0.099
	0.01	0.239	0.430	0.667	0.082

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