Pakistan J. Sci. Ind. Res., Vol. 30, No. 8, August 1987

EFFECT OF VARIOUS CONCENTRATIONS OF POTASSIUM ON THE GROWTH OF SORGHUM PLANT

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(Received March 9, 1986)

To see the effect of various concentrations of potassium on the growth of plant and potassium content in sorghum crop, an experiment was designed and carried out in the glass house, Department of Agriculture, University of Queensland using conventional still culture method. Five nutrient levels of potassium were evaluated (1, 10, 90, 850 and 8000 μM K). Results of the experiment show that, on fresh weight basis potassium concentration ranged from 18 to 129 μ mol/g fresh weight in tops of the plant and 5 to 30 μ mol/g fresh weight in roots. When these results expressed on dry weight basis these values comes to 0.37 to 3.87 g/100 g dry weight in tops and 0.33 to 1.47 g/100 g dry weight in roots. Critical concentration when expressed on dry weight basis comes to 0.8% K in tops and on fresh weight basis 80 μ mol/g fresh weight. Increasing the potassium concentration in nutrient solution increased the growth of plant and potassium content in tops and roots.

Key words: Sorghum crop, Concentrations of potassium; Critical K limit.

INTRODUCTION

Critical nutrient levels have been established for a number of crops for various essential plant nutrients. The critical nutrient level is the lowest tissue concentration that gives near maximum growth and it is considered at the point of inflexion of the curve relating to growth or yield to tissue concentration [1].

Critical nutrient concentration levels, for corn were established in 1940 and 1950 by several research workers. These values were critically reviewed in 1960 [2]. These critical nutrient levels for corn were established for the sixth corn leaf which is the leaf immediately below the ear leaf.

Research workers and others concerned with fertilization and nutrition of grain sorghum plant have often used plant analysis as a diagnostic tool in interpretting the results of research and nutrient status of plant and soil. Sampling procedures usually consisted of sampling the second leaf or the first leaf below the flag leaf. To interpret these results it was generally assumed the critical nutrient level established for corn leaf would also be applicable for grain sorghum.

Results of analysis of the leaf samples of corn and sorghum by Bennett [2] show that the nutrient composition of the leaves of corn and grain sorghum were consistently different for most nutrients. The differences were sufficiently great to strongly suggest that the critical nutrient levels need to be established for grain sorghum instead of using diagnostic criteria established for corn.

The main objective of the experiment was, therefore, to see the effect of various concentrations of K on the growth of sorghum plant and K concentration in the plant (tops and roots) in order to work-out critical nutrient level of K in sorghum crop.

MATERIAL AND METHODS

To study the effect of various concentrations of K on the growth of plant and K content in the sorghum plant (tops and roots) and in order to determine critical nutrient concentration of K, an experiment was designed and carried out in the glass house of Department of Agriculture, University of Queens'land using conventional still culture method. Concentration of basal nutrients other than K were (μM) N 15000, P 500, Ca 5000, Mg 2000, S 2000, Na 2050, Iron as EDTA 100 initially which was supplemented by 100 more, Cl 130, B 50, Mn 25, Zn 10, Cu 5, Mo 1.75 and Si 500 respectively. Five nutrient concentrations of K were tried and they were:

Treatment No.	1,	1 μM K
	2,	10 μM K

3, 90 μM K
4, 850 μM K
5, 8000 μM K

Seedlings of sorghum plants were transplanted on 4-3-1982 and harvested on 8-4-1982 (34 days). Yield data of fresh and dry matter (roots and tops) was recorded. The material was ground and the samples prepared for chemical analysis. Sub samples digested in HNO_3-$HClO_4$ mixture [3]. After dilution of digests the K was determined by Atomic Absorption Spectro-photometer. K concentrations were calculated on both fresh weight and dry weight basis.

RESULTS

Yield data of sorghum (g/plant) grown in solution culture experiemnt is given in Table 1. Potassium concentration in tops and roots calculated on (μ mol/g) fresh weight basis and (g/100 g) dry weight basis and root weight ratio are presented in Table 2. The data of experiment show that maximum growth recorded in 8000 μM K treatment (96.39 g/plant tops) which was followed by 850 μM K treatment (73.9 g/plant tops). Upto the concentration of 90 μM K, the root growth was marked more as comapred to shoot growth. At 850 μM K, shoot growth increased and at 8000 μM K shoot growth was more as compared to root growth. The data suggests that under K deficiency potassium has least effect on root development but rather shoot development was affected more. Similar was the condition with potassium concentrations in tops and roots i.e. under deficiency of K roots were rich in K content than shoots. In lower concentration (upto 90 μM K), potassium concentration in roots was more than shoots. Potassium concentration increased with increase in K supply. At 1 μM K treatment K content in tops was 0.37% which increased to 3.87 in 8000 μM K treatment. The second highest growth was with 850 μM K treatment where potassium concentration in tops was 0.56% and in roots 0.43%.

Table 1. Yield data of sorghum (g/plant) grown in solution culture experiment.

Nutrient concentration in solution	Fresh weight (g/plant)		Dry weight (g/plant)		Dry matter (g/100g)	
	Tops	Roots	Tops	Roots	Tops	Roots
1 μM K	3.76	3.98	0.71	0.27	19	7
10 μM K	2.83	4.50	0.62	0.25	22	6
90 μM K	5.32	9.47	1.08	0.59	20	6
850 μM K	73.97	54.21	10.98	3.82	15	7
8000 μM K	96.39	42.71	12.60	3.41	13	8

Table 2. Potassium concentration in tops and roots grown in solution culture experiment.

Nutrient concentration	Dry weight basis: K concentration (g/100g)			Fresh weight basis: K concentration (μ mol/g)		
	Tops	Roots	Root weight ratio	Tops	Roots	Root weight ratio
1 μM K	0.37	0.33	0.28	18	5	0.51
10 μM K	0.42	0.43	0.29	24	7	0.61
90 μM K	0.34	0.40	0.55	18	6	0.64
850 μM K	0.56	0.43	0.26	21	8	0.43
8000 μM K	3.87	1.47	0.21	129	30	0.31

Critical concentration of potassium in tops on fresh weight basis is illustrated in Fig. 1. On fresh weight basis, the curve is not clearly indicating the position of transition zone due to lack of sufficient data. However, the data show the approximate level of 80 μ mol/g as critical concentration in tops. In case of dry weight basis as the lowest concentration of 0.56% K gave growth of 87%, this curve show clear transition zone and the critical value for K content (at 10% reduction in growth) comes to 0.8% K in tops (Fig. 1).

DISCUSSION

From the results it is obvious that tissue K concentration in maximum healthy growth treatment is 129 and 30 μ mol/g fresh weight basis for tops and roots respectively. The tissue potassium concentration required by maize for healthy growth is reported as 68 and 24 μ mol/g fresh weight for tops and roots respectively. These results are, therefore, in agreement with the resutls of spear *et. at.* [4].

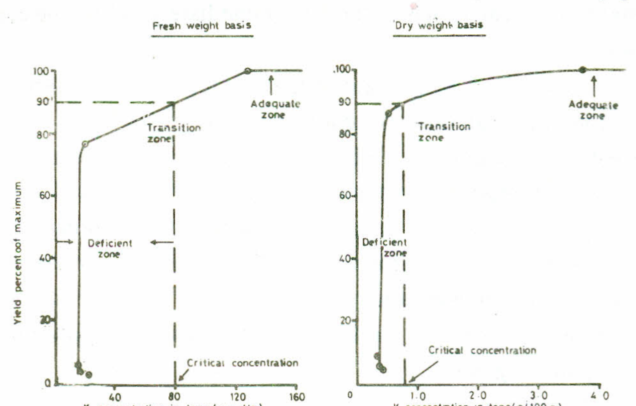

Fig. 1. Relationship between yield of Sorghum and concentration of potassium in tissues.

When expressed on dry weight basis, these values comes 3.87 and 1.41 g/100 g dry weight potassium for tops and roots respectively. These values are also in consistent with the values found by various research worker in sorghum crop (2,5,6,7,8 and 9).

The relationship between the yield of grain sorghum tops and K concentrations in leaves from green house nutrient solution study [5] show that the weight of plants increasd steadily with increased potassium content until maximum was reached at 1.5% K in the leaves. Plants grown with 5 ppm K in solution contained 0.64% K in the leaves but did not exhibit any visible potassium deficiency except reduction in size.

In the present study when 850 μM K was used the potassium content in tops reached at 0.56%. Symptoms of potassium deficiency were also observed in this nutrient level, which shows that this level of nutrient concentration is not sufficient to raise the potassium content to sufficient level. In case of 8000 μM treatment, K in tops was 3.87% which seems very high as compared to 1.5% K in tops as worked out by Billy and Thomas [5]. Therefore, from their data and the data of this experiment it can be concluded that the nutrient level of 0.8% K is the critical concentration of K in sorghum tops.

Results described on dry weight basis versus fresh weight basis. The potassium concentration expressed on a dry weight basis are very sensitive to variation in dry matter percentage at low dry matter content (less than 10%) but are relatively insensitive to such variation at high dry matter content (more than 20%). As indicated [4] differences in dry matter percentages among tissues can be large enough to preclude the use of K concentration data expressed on dry weight basis to indicate the distribution of potassium concentration among fresh tissues at the time of harvest.

The results of this study show that dry matter percentage in tops was 22% (10 μM K), 20% (90 μM K), 15% (850 μM K) and 13% (8000 μM K). In roots it was 6% (10 μM K), 6% (90 μM K), 7% (850 μM K) and 8% (8000 μM K). In case of 1 μM K treatment there seem some error (Table 1). Since the dry matter content is mostly less than 20%, therefore, as indicated by [4] differences in dry matter percentages among tissues can be large enough to preclude the use of potassium concentration data expressed on dry weight basis to indicate the distribution of potassium concentration among fresh tissues at the time of harvest.

Further more, when these results are expressed on dry weight basis (Table 2) it is quite obvious that upto 90 μM K the potassium content in roots is more as compared to tops but when these figures are expressed on fresh weight basis it is quite clear that the potassium concentration are higher in tops than roots which is the accepted fact that potassium in tops is more than in roots.

Again when expressed on fresh weight basis the difference between critical concentration of potassium and the concentration at which the yield was high it seems that the values i.e. the difference in values is low (80-129 μ mol/g fresh weight) as compared to (0.8-3.87 g/100 g dry weight) which seems too large difference.

The use of "Cell sap" basis instead of conventional dry weight basis is also supported by [10] in reporting plant content of water soluble constitutents such as chloride ion and potassium ion.

REFERENCES

1. A Ulrich, Ann. Rev. Plant Physiol, **3**, 207 (1952).
2. W.F. Bennett, Soil Sci. and Plant Analysis, **2**, 399 (1971).
3. C.M Johnson and A. Ulrich, Calif. Agri. Exp. Stn. Bull., No. 766 (1959).
4. S. N. Spear, C.J. Asher and D.G. Edward, Field Crops Res., **1**, 347 (1978).
5. W.H. Billy and G.W. Thomas, Agron., **60**, 467 (1968).
6. J.C. Brown and W.E. Jones, Agron., **69**, 412 (1977).
7. R.R. Duncan, J.W. Dobson and C.D. Fisher, Soil Sci. and Plant Analysis, **11**, 699 (1980).
8. B.L. Raymond, Soil Sci. Plant Analysis, **3**, 271 (1972).
9. J.B. Weber and A.C. Caldwell, Soil Sci. Amer. Proc., 28, 663 (1964).
10. N.G. Cassidy, Plant and Soil, **25**, 372 (1966).