The Effects of Potassium on the B Vitamin Content of Oats

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INTRODUCTION

It is generally accepted that light and temperature markedly affect the nutrient content of plants; nevertheless, there are other factors which can exert a similar influence upon the plant composition. One of these factors is the inorganic nutrients available to the plant. Recently there have been several articles suggesting a relation between the fertility of soils and human and animal nutrition (1, 2, 4, 11). If such a relation exists, it will be necessary to understand the intimate mechanisms involved before it can be used for practical value. Previous work from this laboratory (3, 7, 8) has shown some relations between the nutrient content of oats and the inorganic ions available to the plant. The present paper is an extension of this work and was specifically designed to study the effect of increased and reduced amounts of potassium on the B vitamin and inorganic composition of oats.

Experimental Procedure

Wintok Oats, CI-3424, were the test plants studied. The details of growing the plants will not be discussed since they have been reported elsewhere (7). The seeds were germinated in pure quartz sand on January 4, 1949. When the seedlings were ten days old, they were transplanted into 4-inch glazed soil jars and were watered with their respective nutrient solutions. The composition of the nutrient solutions employed is listed in Table I.

TABLE I
Composition of Nutrient Solutions[1]

Treatment	K/12	K/6	H&A	K	2K	5K
NaCl	24.5	24.5	0	24.5	18.4	0.5
NaH_2PO_4	0.5	0	0	0	0	0
$Ca(NO_3)_2$	5.0	5.0	5.0	5.0	5.0	5.0
$MgSO_4$	2.0	2.0	2.0	2.0	2.0	2.0
KNO_3	0	0	5.0	5.0	5.0	5.0
$NaNO_3$	5.0	5.0	0	0	0	0
KH_2PO_4	0.5	1.0	1.0	1.0	1.0	1.0
KCl	0	0	0	0	6.0	24.0

[1] Salt concentrations are reported in millimoles per liter.

The potassium concentration varied in the following manner: 1/12, 1/6, 1, 2, and 5 times that of the control solution. Sodium chloride was added to produce the same osmotic pressure in all nutrient solutions. All of the solutions were based on Solution 1, Method B, of Hoagland and Arnon (5). In addition to the regular control, another control which contained no sodium chloride was employed in order that the results could be compared with previous work of this and other laboratories. For the purpose of this paper, the different treatments will be referred to in the following manner: K/12, K/6, K, 2K, 5K, and the H & A control.

During the growing period, there was no difference noted between treatments with respect to color or size of leaves. The K/12 and K/6 groups were smaller in size; however, they appeared to be healthy. The plants receiving higher amounts of potassium compared very favorably to the K and H & A treatments.

When the oats were ten weeks old, they were harvested for inorganic analysis and vitamin analysis. Preparation of the plants for analysis was the same as previously described (7), and the hog kidney conjugase was used to hydrolyze the pteroylglutamic acid conjugates. Niacin was determined by the method of Krehl, Strong, and Elvehjem described by Johnson (6). Pteroylglutamic acid analyses were made using the method of Rabinowitz and Snell (10), and riboflavin, biotin, and calcium pantothenate were assayed by McCoy and Snyder's method (9).

Results and Discussion

The results of the analyses are summarized in Table II. The percentage of potassium in the oats follows the same trend as the composition of the nutrient solutions but not in the same ratio. The K/12 and K/6 plants contain approximately 1/12 and 1/6 of the percentage of potassium when compared to the control groups, but the 5K oats contain

TABLE II

Composition of Oats

TREATMENT	K/12	K/6	H&A	K	2K	5K	$T_{0.05}S_{\bar{x}}$	N
			ELEMENTS % (DRY WEIGHT)					
K	.56	1.00	6.42	6.01	7.89	11.59	.07	44
Ca	.32	.31	.82	.44	.36	.36	.05	44
Mg	.40	.38	.62	.38	.38	.56	.04	44
N	2.66	2.50	2.50	2.51	2.30	2.22	.11	44
P	.41	.40	.53	.46	.43	.36	.03	42
			VITAMINS (γ/GM. FRESH WEIGHT)					
Niacin	68.11	70.71	70.32	76.11	76.48	99.24	5.91	37
Riboflavin	15.00	21.58	11.14	13.02	13.11	15.19	1.84	43
Pteroylglutamic acid	6.59	7.00	5.77	5.56	6.23	6.34	.50	43
Biotin	.52	.38	.48	.40	.39	.38	.04	42
Ca Pantothenate	45.45	32.52	35.77	32.14	30.41	30.38	1.73	39

only twice as much potassium as the K and H & A controls. Apparently potassium does not affect the absorption of calcium and magnesium, but it may affect the absorption of nitrogen. It can be seen that the K/12 plants contained 2.66 per cent nitrogen and the 5K group contained 2.22 per cent nitrogen. From this, it appears that there is an inverse relation between the absorption of potassium and the absorption of nitrogen. It should be mentioned that the H & A control contained more calcium, magnesium, and phosphorus than any of the other treatments. It appears that the presence of sodium may have been responsible for this phenomenon. The fact that the potassium content of the H & A group is higher than the K plants would tend to substantiate this supposition.

The niacin content of the oats seemed to increase with increasing amounts of potassium. While the only significant difference at the 5 per cent level is in the 5K group, this trend is rather consistent. The riboflavin content did not show any particular relation between treatments, while pteroylglutamic acid was not affected by varying amounts of potassium. With the exception of the K/6 group, the biotin content appeared to decrease as the potassium content increased. A similar relation can be seen with respect to the calcium pantothenate and potassium treatments.

Generally speaking it appeared that potassium inversely affected the absorption of nitrogen, but it had no effect on calcium and magnesium. While the phosphorus content of the oats was the lowest in the 5K treatment, it remained essentially the same in the remaining groups. Considering the vitamin content of the plants, increasing amounts of potassium tended to increase the concentration of niacin and decrease the biotin and calcium pantothenate contents. Apparently riboflavin and pteroylglutamic acid are unaffected by changes in potassium concentration in the nutrient substrate. While these factors may be attributed to the effects of potassium, it could possibly be attributed to the effects of nitrogen. For example, the potassium could influence the amount of absorption of nitrogen which in turn could cause the variation observed in the plant composition. The factor merits further research.

SUMMARY

Oat plants were grown in sand culture with five different concentrations of potassium in the nutrient solution. When the plants were ten weeks old, they were harvested and analyzed for potassium, calcium, magnesium, nitrogen, phosphorus, niacin, riboflavin, pteroylglutamic acid, biotin, and calcium pantothenate. Increasing concentrations of potassium in the nutrient solutions resulted in corresponding increases of potassium and decreases of nitrogen in the plant tissues. It appears that biotin and

calcium pantothenate have an inverse relation to potassium in the nutrient solution and that niacin has a direct relation to the potassium concentration. Riboflavin and pteroylglutamic acid were not affected by varying amounts of potassium.

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