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FREE AMINO ACIDS OF MAIZE SEEDLINGS*

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Key Word Index—*Zea mays*; Gramineae; maize seedlings; free amino acids.

Abstract—The free amino acids were determined in different parts of maize seedlings (seeds, roots and shoots), 0, 2, 4 and 6 days after sowing.

INTRODUCTION

SINCE nitrogen assimilation does not take place in seedlings of maize growing in the dark, free amino acid pools arise almost exclusively from protein hydrolysis of the endosperm tissues.[1] Although during the last decade the technique of qualitative and quantitative determination of amino acids has been greatly aided by auto analysers, we have been unable to find work concerned with the free amino acids during the early stages of growth in dark. Most papers concerned with the determination of amino acid pools during germination concentrate only on certain parts of the growing seedling and especially on the germinating seed.[2–6] It is our opinion that the early stages of development have failed to gain the attention they deserve. In the present work the free amino acids of the seed, root and shoot were determined during early stages of development.

RESULTS AND DISCUSSION

A gradual increase in whole plant fresh weight of the maize seedlings was observed, while the dry weight was slightly decreasing, mainly because of respiration and exudation (Table 1). In the seed there was a dry weight decrease due to respiration and transport of seed components to root and shoot. On the other hand seed fresh weight was highest on the 2nd day, when water uptake through imbibition was highest (compare seed water contents at different ages), and while transport is insignificant (as indicated by dry weights of root and shoot).

Table 2 gives the quantities determined for the amino acids for each section of the plant of different ages. These quantities may be expressed on a fresh or dry weight basis; also as molarities and percentages of the total free amino acids by reference to Table 1. For the whole plant the total free amino acid concentrations in μg/g fr. wt were: 663 (0 days);

* Part I in the series "Growth Chemistry in Maize".

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TABLE 1. MAIZE GROWTH EXPRESSED AS INCREASE IN FR. WT, DRY WT AND LENGTH

	0 Days		2 Days			4 days			6 Days		
	Fr. wt (mg)	Dry wt (mg)	Fr. wt (mg)	Dry wt (mg)	Length (mm)	Fr. wt (mg)	Dry wt (mg)	Length (mm)	Fr. wt (mg)	Dry wt (mg)	Length (mm)
Seed	287	262	386	251		358	190		364	147	
Root			22	3	10	220	24	105	308	30	170
Shoot			21	2	15	428	27	100	819	51	225
Lower segment						328	19	80	539	30	170
Upper segment						100	8	20	280	21	55
Plant	287	262	429	256	25	1006	241	205	1491	228	395

4040 (2 days); 2430 (4 days); 2430 (6 days). The free amino acid content of the whole plant was high on the 2nd day and then fell to a constant value on the 4th and 6th days. Free amino acid pools of seeds in μg/g fr. wt are: 663 (0 days); 3690 (2 days); 3910 (4 days); 2220 (6 days). The high concentration at the 4th day is probably due to the fall of the imbibition rate rather than to an increase in the rate of hydrolysis or a decrease of transport from the seed.

Table 2 shows a gradual increase in the total free amino acids of the root with age. However, there is a steep decrease from 12200 (2 days) to 1670 (4 days) and 1340 (6 days) μg/g

TABLE 2. FREE AMINO ACID POOLS

	0 Days	2 Days				4 Days		
Amino acids	seed	seed	root	shoot	plant	seed	root	shoot
Cys A*	—	—	—	0·3	0·3	—	—	3·0
Asp	41·6	63·5	19·4	1·3	84·2	32·0	8·7	30·5
Thr + Ser								
Asn + Gln	35·4	241·8	49·3	10·0	301·1	193·4	138·7	247·5
Glu	30·3	146·1	51·4	3·4	200·9	105·2	19·9	63·8
Gly	3·6	22·9	9·7	1·6	34·2	14·1	19·1	23·2
Ala	16·4	83·0	31·6	5·6	120·2	65·0	46·7	59·0
Val	1·0	15·3	7·3	3·1	25·7	16·5	25·9	40·0
Cys	5·9	105·2	23·3	0·3	128·8	119·5		
Met	trace	43·1	—	—	43·1	54·6	—	3·1
Ile	2·4	44·0	4·1	1·2	49·3	48·8	14·0	15·3
Leu	2·8	150·2	3·7	2·1	156·0	156·4	18·2	29·2
Tyr	4·0	106·2	7·2	2·7	116·1	139·0	13·0	32·9
Phe	2·3	104·5	6·2	1·6	112·3	135·1	9·8	28·4
γ-AbA†	—	—	10·1	—	10·1	11·8	3·1	2·1
NH_3	19·2	69·0	11·1	0·4	80·5	49·6	2·4	9·7
Orn†	4·6	21·6	4·5	0·3	26·4	7·9	6·5	12·4
Lys	5·4	80·7	4·6	1·8	87·1	73·0	17·8	34·3
His	5·4	79·5	19·4	3·5	102·4	98·9	17·3	40·9
Arg	9·9	47·1	5·8	1·6	54·5	77·8	5·8	4·6
Total	190·0	1420·0	270·0	41·0	1730·0	1340·0	367·0	680·0

* In Asp equivalents.
† In Phe equivalents.
‡ Amounts in μg in each tissue.

fr. wt. The value of 12200 μg/g fr. wt in the 2-day-old root is strikingly high, since next higher concentration is 3910 μg/g in the 4-day-old seed.

EXPERIMENTAL

Plant material. Zea mays L., IΣ 400, seeds (germination higher than 95%) were grown in wet sand in the dark, at 25 ± 1° and 100% humidity; 2 samples of 20 seedlings were collected, each experiment replicated 3× (4- and 6-day-old shoots were divided into upper and lower segments at the level of the node).

Preparation of EtOH extracts. Dry seeds and parts of growing seedlings were extracted 5× with boiling EtOH (80, 80, 50, 50 and 80% resp.).

Free amino acid determination. Since the quantity of the total free amino acids determined from the 6 extracts of the same part and age did not differ significantly, the final determination of the individual amino acids was carried on the combined extracts (mixture of 6 extracts), using a Technicon Auto Analyser.

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DURING EARLY STAGES OF DEVELOPMENT‡

			6 Days					
lower segment	upper segment	plant	seed	root	shoot	lower segment	upper segment	plant
—	3·0	3·0		—	4·4	—	4·4	4·4
23·1	7·4	71·2	6·8	11·6	62·8	24·2	38·6	81·2
221·6	25·9	579·6	120·0	145·2	1396·0	846·0	550·0	1661·2
50·0	13·8	188·9	40·7	25·5	83·9	53·3	30·6	150·1
20·6	2·6	56·4	5·5	24·5	102·1	72·9	29·2	132·1
54·1	4·9	170·7	38·0	30·1	112·6	76·5	36·1	180·7
37·2	2·8	82·4	3·1	35·2	35·9	10·3	25·6	74·2
—	—	119·5	105·0	—	—	—	—	105·0
3·1	—	57·7	14·7	—	—	—	—	14·7
14·7	0·6	78·1	53·7	21·3	71·6	57·3	14·3	146·6
27·3	1·9	203·8	111·4	31·3	73·3	61·9	11·4	216·0
31·9	1·0	184·9	93·9	10·2	55·2	37·2	18·0	159·3
26·8	1·6	173·3	106·2	11·4	47·5	31·2	16·3	165·1
1·7	0·4	17·0	12·5	2·2	12·3	6·7	5·6	27·0
8·1	1·6	61·7	32·3	3·4	28·6	23·4	5·2	64·3
8·1	4·3	26·8	6·9	6·5	15·4	8·4	7·0	28·8
29·2	5·1	125·1	16·9	31·6	135·2	94·6	40·6	183·7
34·6	6·3	157·1	28·2	19·8	157·0	111·4	45·6	205·0
3·9	0·7	88·2	13·4	3·9	13·2	6·6	6·6	30·5
596·0	84·0	2450·0	809·0	414·0	2410·0	1520·0	885·0	3630·0