

THE EFFECT OF CERTAIN PRE-SOWING SEED TREATMENTS AND EARLY
PHOSPHORUS SUPPLEMENT ON MINERAL COMPOSITION OF CORN

(Zea mays L.) PLANTS GROWN UNDER SOIL

MOISTURE STRESS CONDITIONS

By

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I. INTRODUCTION

Certain trials aiming to raise the drought resistance of plants are met with in literature. In this area of research, the effective use of such methods as Henckel's seed treatment (e.g. Henckel, 1963), early fertilization with phosphorus supplements (Samuilov and Maslova, 1963), seed soaking in salt solution of Zn (Matukhin *et al.*, 1962) or Mn (e.g. Novitskaya, 1958) has been reported. All these methods, together with seed-soaking in a Ca salt solution alone or followed by a hardening treatment according to Henckel, were generally shown by El-Zeiny (1972) to be of benefit in raising the drought resistance of corn plants through increasing the grain yield.

It seems necessary to get information about the metabolic

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Plants treated in such ways, the data thus obtained helpful in accounting for the raised drought resistance. the metabolic aspects that could be concerned, is the composition of plant tissues, particularly that related to nitrogen, phosphorus and potassium.

should be recognized that, in literature, data dealing influence exerted upon the content of any of these minerals in corn plants due to treatments used to increase drought resistance are conspicuously deficient. The present accordingly carried out to throw some light upon the shown under such conditions. The soil moisture stress and either to be maintained throughout the growth or to be restricted to the period starting from tasselling. moisture deficit during such period was revealed to be influencing in decreasing the yield of corn plants (see et al., 1963 and El-Saidi, 1969).

II. MATERIAL AND METHODS

The present work was conducted during the 1968 season in my Laboratory, National Research Centre, Cairo, using a Maize L., variety Giza hybrid 67. Plants were grown "banks from tin", measuring 30 cm in diameter x 50 cm. t. The inner surface of pots was coated with three of bitumen to prevent direct contact between soil and

metal. Every pot contained 30 kg. of air-dry Nile-clay soil, and a special drainage system was employed, so that water movement was from the base upwards.

The scheme of experiment is presented in Table (1). The maize grains were subjected before sowing to different treatments, then the plants were grown at any of three soil moisture levels, an additional dose of P being supplied to seedlings in certain cases. For each soil moisture level in any given treatment, 9 replicates were used. The pre-sowing soaking of grains was maintained for 24 hours. CaCl_2 solution was 0.25 M; whereas each of the ZnSO_4 and MnSO_4 solutions was 0.05 %. In both series II and III, the soaked grains were exposed to a hardening process according to Henckel (1964). In this process, the soaked grains were kept in Petri-dishes in an incubator at 32°C for 24 hours.

Sowing was always carried out at the rate of 5 grains per pot, and the seedlings were thinned to two after one week. Phosphorus and potassium fertilizers were added to soil before sowing at the rate of 5 g. P_2O_5 per pot in the form of calcium superphosphate for the former and 2 g. K_2O in the form of potassium sulphate for the latter. Nitrogen fertilizer was added at the rate of 5 g. N per pot in the form of ammonium nitrate at three portions : 2, 2 and 1 g. during seedling stage, at the

: Types of treatments before and after the sowing of corn grains.

ts	Type of pre-sowing seed treatments	Sub-treatments	Soil moisture (% of water holding capacity)	
			Seedling-tasseling stage	Tasseling-maturity stage
	Distilled water	A	65	65
		B	30	30
		C	65	30
I	Distilled water ²	A	65	65
		B	30	30
		C	65	30
II	Distilled water + hardening	A	65	65
		B	30	30
		C	65	30
I	CaCl ₂ + hardening	A	65	65
		B	30	30
		C	65	30
V	CaCl ₂	A	65	65
		B	30	30
		C	65	30
V	ZnSO ₄	A	65	65
		B	30	30
		C	65	30
C	MnSO ₄	A	65	65
		B	30	30
		C	65	30

In this series were soaked, as in control, in distilled water but the plants were supplied at the seedling stage with additional dose of superphosphate; thus the total phosphorus was not reached (total phosphorus ...)

appearance of 10th leaf, and at the start of tasseling respectively.

Sampling was carried out four dates : at the appearance of 10th leaf (after 23 days from sowing), almost at the time between the appearance of the 10th leaf and beginning of tasseling, at the beginning of tasseling, and at the start of milky stage. Each sample consisted of three plants from three pots; rethinning being carried out after the first sample to leave one plant per pot. Such sampled plants were separated into different organs. Both leaves and stems are dried at 70°C for 48 hours, then the dry materials of the three replicates were finely ground, mixed together and kept for the following analysis:

- 1) Total nitrogen content : being determined coulourimetrically as described by Yuen and Pollard (using Nessler reagent.
- 2) Total phosphorus content as P_2O_5 : being determined coulourimetrically by the hydroquinone method, as described by Snell and Snell (1954).
- 3) Potassium content as K_2O : being determined using Beckman flame photometer, as described by Brown and Lilleland (1946).

III. RESULTS

Effect of presowing seed treatments and early phosphorus supplement on:

- 1) Total nitrogen content of stem and leaves of corn plant:

the relative content of nitrogen in corn plants (mg./g. dry wt.) at different developmental stages as influenced by pre-soaking seed treatments followed by a special water regime.

Sub-treatments	Sample 1		Sample 2		Sample 3		Sample 4	
	Stem	Leaves	Stem	Leaves	Stem	Leaves	Stem	Leaves
A	2.15	2.52	1.94	2.23	1.55	1.97	1.55	1.72
B	2.38	2.91	2.24	2.75	1.83	2.37	1.87	2.15
C	-	-	-	-	-	-	1.55	1.67
Mean	2.25	2.72	2.09	2.49	1.70	2.17	1.47	1.91
A	2.35	2.80	2.10	2.51	1.75	2.29	1.61	2.11
B	2.68	3.20	2.41	2.97	2.03	2.55	1.80	2.27
C	-	-	-	-	-	-	1.70	2.14
Mean	2.52	3.10	2.28	2.79	1.88	2.42	1.70	2.17
A	2.32	2.75	2.06	2.55	1.59	2.25	1.54	2.10
B	2.64	3.14	2.56	2.80	2.01	2.45	1.72	2.17
C	-	-	-	-	-	-	1.55	2.12
Mean	2.48	2.95	2.21	2.75	1.85	2.35	1.64	2.13
A	2.50	2.75	2.01	2.70	1.65	2.21	1.58	2.12
B	2.58	2.95	2.55	2.79	1.95	2.38	1.71	2.17
C	-	-	-	-	-	-	1.62	2.13
Mean	2.44	2.84	2.18	2.75	1.81	2.30	1.64	2.14
A	2.33	2.74	2.07	2.68	1.71	2.20	1.59	2.09
B	2.55	3.12	2.29	2.85	1.97	2.45	1.66	2.18
C	-	-	-	-	-	-	1.64	2.11
Mean	2.50	2.93	2.18	2.76	1.84	2.35	1.64	2.15
A	2.27	2.71	2.15	2.68	1.85	2.20	1.55	2.09
B	2.54	3.05	2.25	2.81	1.90	2.41	1.72	2.16
C	-	-	-	-	-	-	1.65	2.10
Mean	2.41	2.89	2.20	2.75	1.78	2.31	1.63	2.12
A	2.25	2.69	1.97	2.44	1.60	2.05	1.45	2.00
B	2.50	2.97	2.50	2.63	1.86	2.47	1.70	2.21
C	-	-	-	-	-	-	1.60	2.07
Mean	2.38	2.83	2.14	2.64	1.74	2.26	1.59	2.09
A	2.28	2.71	2.04	2.57	1.66	2.17	1.53	2.05
B	2.57	3.05	2.36	2.63	1.94	2.44	1.71	2.19
C	-	-	-	-	-	-	1.60	2.08

stress led to an increase in the nitrogen percentage in both stems and leaves, comparing with the case of normal irrigation. Such a trend was found to be consistent in all treatments and for the whole growth season. The extent of increase shown in this concern for a given plant organ was a function of the type of treatment used, the time of sampling and the duration of drought.

The data presented in Table (2) revealed further that the employment of any of the studied treatments led to higher values, comparing with control, for the relative content of nitrogen in either stems or leaves, irrespective of the soil moisture level used, and the stage of development concerned. The treatment of early phosphorus supplement appeared generally to be the most effective in this concern; whereas the converse tendency was shown in most cases when soaking the seeds in $MnSO_4$ solution.

2) Total phosphorus content of stem and leaves :

From Table (3), it could be shown that the exposure of plants to drought led generally to a rise in phosphorus percentage in both stems and leaves, comparing with the case of normal irrigation. Such a trend appeared to be consistent,

P₂₅

the relative content of phosphorus in corn plants (mg./g. dry
 .) at different developmental stages as influenced by pre-
 sowing seed treatments followed by a special water regime.

Sub- treat- ments	Sample 1		Sample 2		Sample 3		Sample 4	
	Stem	Leaves	Stem	Leaves	Stem	Leaves	Stem	Leaves
1	1.20	1.10	0.82	0.98	0.73	0.91	0.57	0.83
2	1.42	1.26	0.92	1.19	0.68	1.01	0.75	0.96
3	-	-	-	-	-	-	0.71	0.87
mean	1.51	1.18	0.87	1.09	0.62	0.95	0.71	0.89
1	1.54	1.27	0.95	1.14	0.84	1.07	0.75	0.97
2	1.61	1.40	1.14	1.23	0.96	1.17	0.85	1.04
3	-	-	-	-	-	-	0.80	0.99
mean	1.48	1.34	1.05	1.19	0.90	1.12	0.79	1.00
1	1.29	1.25	0.92	1.17	0.82	1.03	0.71	0.95
2	1.50	1.35	1.03	1.21	0.90	1.11	0.79	0.98
3	-	-	-	-	-	-	0.74	0.98
mean	1.40	1.30	0.98	1.19	0.85	1.07	0.75	0.98
1	1.22	1.26	0.85	1.17	0.78	1.01	0.68	0.95
2	1.48	1.51	0.95	1.20	0.90	1.08	0.77	0.97
3	-	-	-	-	-	-	0.72	0.95
mean	1.35	1.29	0.90	1.19	0.84	1.05	0.72	0.96
1	1.27	1.24	0.92	1.19	0.81	1.02	0.69	0.94
2	1.53	1.36	0.97	1.22	0.91	1.12	0.75	0.98
3	-	-	-	-	-	-	0.73	0.95
mean	1.40	1.30	0.95	1.21	0.86	1.07	0.72	0.96
1	1.27	1.23	0.90	1.18	0.80	1.02	0.69	0.95
2	1.48	1.29	0.94	1.21	0.88	1.08	0.76	0.98
3	-	-	-	-	-	-	0.74	0.95
mean	1.38	1.26	0.92	1.20	0.84	1.05	0.73	0.96
1	1.26	1.21	0.87	1.06	0.78	0.99	0.68	0.91
2	1.45	1.29	0.93	1.21	0.89	1.06	0.76	0.99
3	-	-	-	-	-	-	0.73	0.93
mean	1.36	1.25	0.90	1.14	0.84	1.03	0.72	0.94
1	1.26	1.22	0.89	1.13	0.81	1.01	0.69	0.93
2	1.49	1.32	0.98	1.21	0.90	1.09	0.78	0.99
3	-	-	-	-	-	-	0.74	0.94

duration of drought, appeared to determine the extent of rise obtained in this regard for a given organ. Furthermore, it was revealed that the phosphorus percentage in either organs was generally increased, comparing with control, whenever the studied treatments, particularly that of early phosphorus supplement, were employed. Such picture was noticed throughout the growth season irrespective of the soil moisture level used.

3) Potassium content of stem and leaves :

From Table (4). it appeared that the potassium percentage in stems and leaves of corn plants was raised due to the exposure to drought, comparing with the case of normal irrigation. Such a trend was consistent throughout the growth season for each of the treatments employed. As in case of the relative contents of either nitrogen or phosphorus, the extent of rise in potassium percentage in a given organ due to exposure to soil moisture stress was shown to be dependent upon the kind of treatment used, the stage of development and the duration of drought. In addition, it appeared that the employment of any of the studied treatments led to higher values, comparing with control, for the potassium percentage in either stems or leaves irrespective of the soil moisture level used.

The relative content of potassium in corn plants (dry wt.) at different developmental stages as influenced by pre-sowing seed treatment followed by a special water regime.

Sub-treatments	Sample 1		Sample 2		Sample 3		Sample 4	
	30th Leaves							
A	5.51	3.24	4.71	3.24	2.35	2.47	1.87	1.99
B	5.73	3.60	5.33	3.42	2.57	2.71	2.09	2.13
C	-	-	-	-	-	-	1.92	2.05
Mean	5.62	3.37	5.03	3.18	2.46	2.69	1.96	2.06
A	5.85	3.41	4.95	3.32	2.52	2.58	1.89	1.99
B	5.91	3.43	5.48	3.31	2.68	2.95	2.11	2.11
C	-	-	-	-	-	-	2.00	2.05
Mean	5.88	3.42	5.21	3.32	2.60	2.83	1.97	2.05
A	5.75	3.37	4.81	3.27	2.45	2.39	1.84	1.99
B	5.83	3.75	5.33	3.45	2.63	2.54	2.01	2.13
C	-	-	-	-	-	-	1.92	2.05
Mean	5.81	3.56	5.12	3.36	2.54	2.71	1.91	2.05
A	5.65	3.39	4.73	3.31	2.40	2.31	1.89	1.99
B	5.87	3.72	5.37	3.44	2.61	2.71	2.10	2.13
C	-	-	-	-	-	-	1.93	2.05
Mean	5.75	3.53	5.03	3.38	2.51	2.71	1.97	2.05
A	5.78	3.35	4.82	3.29	2.41	2.62	1.89	1.99
B	5.80	3.76	5.39	3.48	2.64	2.64	2.11	2.13
C	-	-	-	-	-	-	2.00	2.05
Mean	5.81	3.56	5.21	3.37	2.53	2.73	1.99	2.05
A	5.84	3.38	5.20	3.28	2.41	2.60	1.89	1.99
B	5.88	3.68	5.34	3.44	2.61	2.78	2.09	2.09
C	-	-	-	-	-	-	1.98	2.05
Mean	5.86	3.53	5.27	3.37	2.51	2.69	1.99	2.06
A	5.67	3.34	4.77	3.30	2.38	2.57	1.87	1.99
B	5.81	3.65	5.35	3.46	2.58	2.80	2.09	2.13
C	-	-	-	-	-	-	1.92	2.05
Mean	5.74	3.50	5.03	3.38	2.48	2.69	1.96	2.06
A	5.72	3.34	4.86	3.25	2.42	2.60	1.89	1.99
B	5.84	3.71	5.38	3.45	2.62	2.62	2.11	2.11
C	-	-	-	-	-	-	1.98	2.05

IV. DISCUSSION

Our results showed that soil moisture stress led generally to increased values for the relative contents of N, P or K in corn stems and leaves. Such type of observations could agree with the findings of, amongst others, El-Zeiny, (1972) on corn and Gates (1957) on tomato. It might be recognized that most of the data available in literature in this area of research dealt with the response of the content of minerals to drought whenever the seeds were normally treated. According to our results, the type of treatment appeared not to alter the manner of such response.

On the other hand, the relative contents of N, P and K in either stems or leaves appeared in our experiments, in general, to be raised due to the employment of the different treatments used for improvement of drought resistance. It might be thought that the uptake of the concerned minerals was enhanced under these conditions; such enhancement might even have exceeded that in growth. Henckel (1954) reported that hardening increases respiration, and this in turn might be considered as an indirect proof for the increased rate of mineral accumulation under these conditions, probably through the elevation of energy level. On the other hand, the stimulation of dry matter accumulation in both stems and leaves of corn

plants in certain treatments used for the improvement of drought resistance was shown by El-Zeiny (1972) to be of frequent occurrence under drought conditions. It seems that the growth of roots of our experimental plants has been similarly stimulated due to the employment of such treatments; this in turn might contribute to the possible enhanced mineral uptake. In this regard, Curtis and Clark (1950) cited that the increase in phosphorus is likely to increase root growth as well as the $\frac{\text{root}}{\text{shoot}}$ ratio in certain cases. In addition, Henkel (1964) reported that hardened plants have a greater total and absorbing surface in the root system; and also they bear more primary roots. According to the same author, the stimulative effect of seed treating with CaCl_2 on the development and growth of the root system has been met with in literature.

7. SUMMARY

The present investigation aimed mainly to study the effect of certain methods used for increasing the drought resistance on the relative contents of nitrogen, phosphorus and potassium in both stems and leaves of corn plants. The following results were obtained :

- 1) Whatever was the type of treatment used, the relative content of nitrogen, phosphorus or potassium in either corn stems or leaves appeared generally at all developmental stages to be higher under drought conditions, comparing with the case of normal irrigation.

whatever was the level of irrigation, the relative content of nitrogen, phosphorus or potassium, in either corn stems or leaves appeared generally at all developmental stages to be raised, comparing with control, due to the employment of special treatments, particularly that of early phosphorus supplement.

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تأثير بعض معاملات البذرة قبل الزراعة والامداد الفوسفورى المبكر على محتوى
العناصر المعدنية فى نباتات الذرة الشامية النامية تحت ظروف نحر الماء فى التربة

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اجرى هذا البحث بهدف دراسة تأثير بعض الطرق المستخدمة لزيادة مقاومة
الجفاف على المحتوى النسبى لكل من النيتروجين والفوسفور والبوتاسيوم فى سوق
وارراق نباتات الذرة الشامية .

وقد اوضحت النتائج ما يلى :

مهما كان نوع المعاملة المستخدمة ، فقد ادى الجفاف عموما خلال جميع
مراحل النمو الى زيادة فى المحتوى النسبى لكل من النيتروجين والفوسفور
والبوتاسيوم فى سوق وارراق نباتات الذرة الشامية (بالمقارنة بالمستوى العادى
للرطوبة الارضية) .

مهما كان مستوى الرى فى اثناء الطرق المستخدمة فى هذا البحث لمقاومة الجفاف ،
خصوصا المعاملة التى استخدمت فيها جرعة اضافية مبكرة من الفوسفور ، فقد
ادت عموما خلال جميع مراحل النمو الى زيادة فى المحتوى النسبى للنيتروجين
والفوسفور والبوتاسيوم فى سوق وارراق نباتات الذرة الشامية (بالنسبة لنباتات
المقارنة) .

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