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Uptake and Removal of Potassium by Maize and Effect of Potassium Sulphate on Yield[1]

Die Aufnahme und Verfügbarkeit von Kali bei Mais und die Auswirkung von Kaliumsulfat auf den Ertrag

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1 Introduction

Maize is one of the major grain crops in Egypt. Recently the national campaign for improving maize production could double the yield in its working areas (from 3 – 4 t/ha up to 8 t/ha) through using high yielding cultivars and appropiate inputs and pratices (ASHOUR, 1984). However, input is still only N and P.

ARON (1975) and LOUE (1980) reviewed the nutrition of maize and indicated the considerable high amounts of K removed under conditions giving higher yields. From own experience, it was recorded that leaf analysis of maize in different Governorates in Egypt showed remarkable percentage of analysed saples with K-contents less satisfactory (EL-FOULY, 1984).

In view of these findings and considering the information on K research in Egypt (SAURAT and EL-FOULY, 1980), the short growth period of maize in Egypt (110 – 120 days) and the high yielding potential of the new cultivars, it was found necessary to study the uptake and removal of K by maize as well as the effect of potassium fertilizers on yield under farmers conditions.

2 Material and Methods

1. Removal experiment:
The experiment was carried out in 1981 in Kafr el-Khadra village, Menoufia Governorate using the maize cultivar Pioneer 514. Area of the experiment: One feddan (2400 m^2). The grains were sown on 3.6.81 in distances of 25 cm and on 65 cm apart ridges, thus having

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Table 1: Soil characters of experimental sites (0 – 30 cm)

	Removal experiment	Fertilizer experiments 1	2	3
Sand %	47	15	15	47
Silt %	26	40	40	26
Clay %	28	45	45	28
$CaCO_3$ (total) %	2.9	1.3	0.8	2.0
O.M. % (Walkley and Black)	1.6	1.1	1.2	1.4
pH (1 : 2.5 water)	8.5	8.5	8.3	8.1
EC mmhos/cm (1 : 2.5 water)	0.3	0.3	0.2	0.9
K mg/100 g (ammonium acetate)	27	58	45	14
P mg/100 g (Olsen)	2.3	0.7	0.6	0.5
DTPA extractable (ppm)				
Fe	35	11	10	4
Mn	16	35	28	10
Zn	0.8	1.8	1.3	0.8
Cu	4.3	3.0	2.0	1.7

about 20.000 plant/feddan. Soil characteristics are given in Table 1 and fertilizers used in Table 2. Total experimental area was divided into four parts considered as replicates. Plant sampling started 11 days after sowing and was taken for 64 days till 24.8. Samples were divided into shoots (stems + leaves) and roots for analysis and later, the ears into grain and cobs. Each replicate was analysed in dublicate, thus each daily figure consists of 8 individual analyses. For representation of results, averages of 5 – 7 days (40 – 56 analyses) were taken and drawn on the figures. Harvest took place on 23.9.

Table 2: Fertilizers added to the removal experiment (Kafr-el-Khadra) per Feddan. Sowing date 3.6.

Dates	Fertilizers added
before ploughing	25 m^3 Organic manure
3.6.	100 kg Superphosphate – Mixed with soil
25.6.	200 kg Calcium Nitrate – side dressing
	100 kg Superphosphate – side dressing
	100 kg Potassium Sulphate – side dressing
13.7.	250 kg Calcium Nitrate – side dressing
	100 kg Potassium Sulphate – side dressing
24.7.	180 kg Calcium Nitrate – side dressing

Total amounts kg/ha (chemical fertilizers) N: 270, P_2O_5: 74, K_2O: 230

2. Fertilizer experiments

Soil characters for the experimental sites are given in Table 1. Potassium sulphate was used in a rate of 180 kg K_2O/ha in all experiments as side dressing on ridges, 35 days after germina-

tion. Potassium sulphate was used alone or in combination with a micronutrient treatment as foliar spray using a compound 4.5% Mn + 3% Zn + 1.5% Fe EDTA chelated form in amount of 2.0 kg/ha. In all experiments, N and P_2O_5 were 225 and 78 kg/ha respectively and 50 m^3/ha organic manure were added. All trials have been conducted in farmers fields under their farming conditions. Plots ranged between 1000 and 3000 m^2. Yield was determined by the respective farmer under the control of the researcher for each plot/replicate.

3 Results and Conclusions

Potassium concentration in shoots and roots increased with growth up to the 30th growth days, then decreased gradually till the end of growth period. The 2nd dose of potassium sulphate given 40 days after germination caused a slight increase in K concentration. It took place after the peak of K concentration and during its falling phase (Fig. 1).

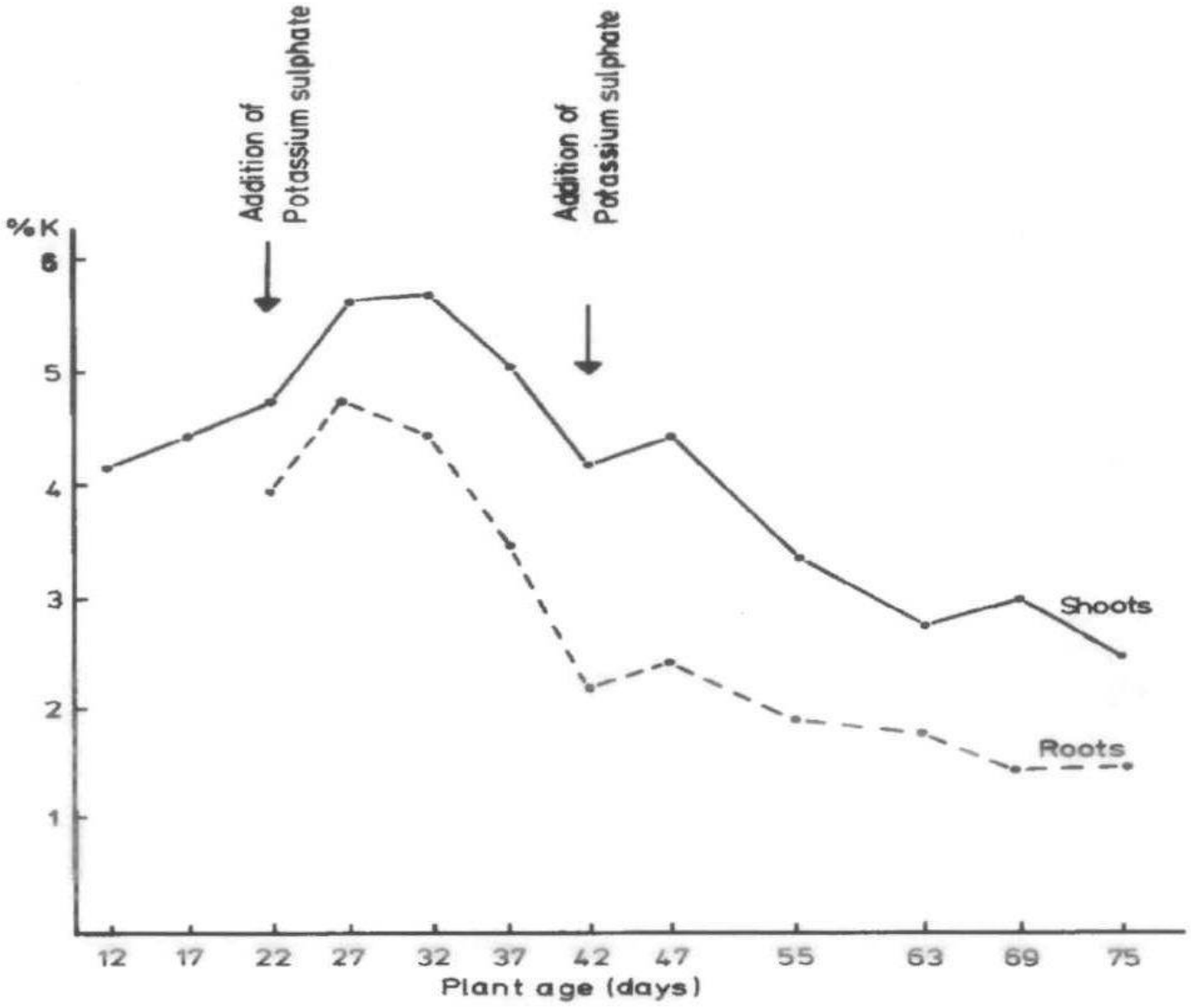

Fig. 1: Changes in Potassium content of maize Roots and Shoots

Total uptake during growth in both roots and shoots was parallel to dry matter development and showed its peak around 70 days after planting. Thereafter all parameters decreased (Fig. 2).

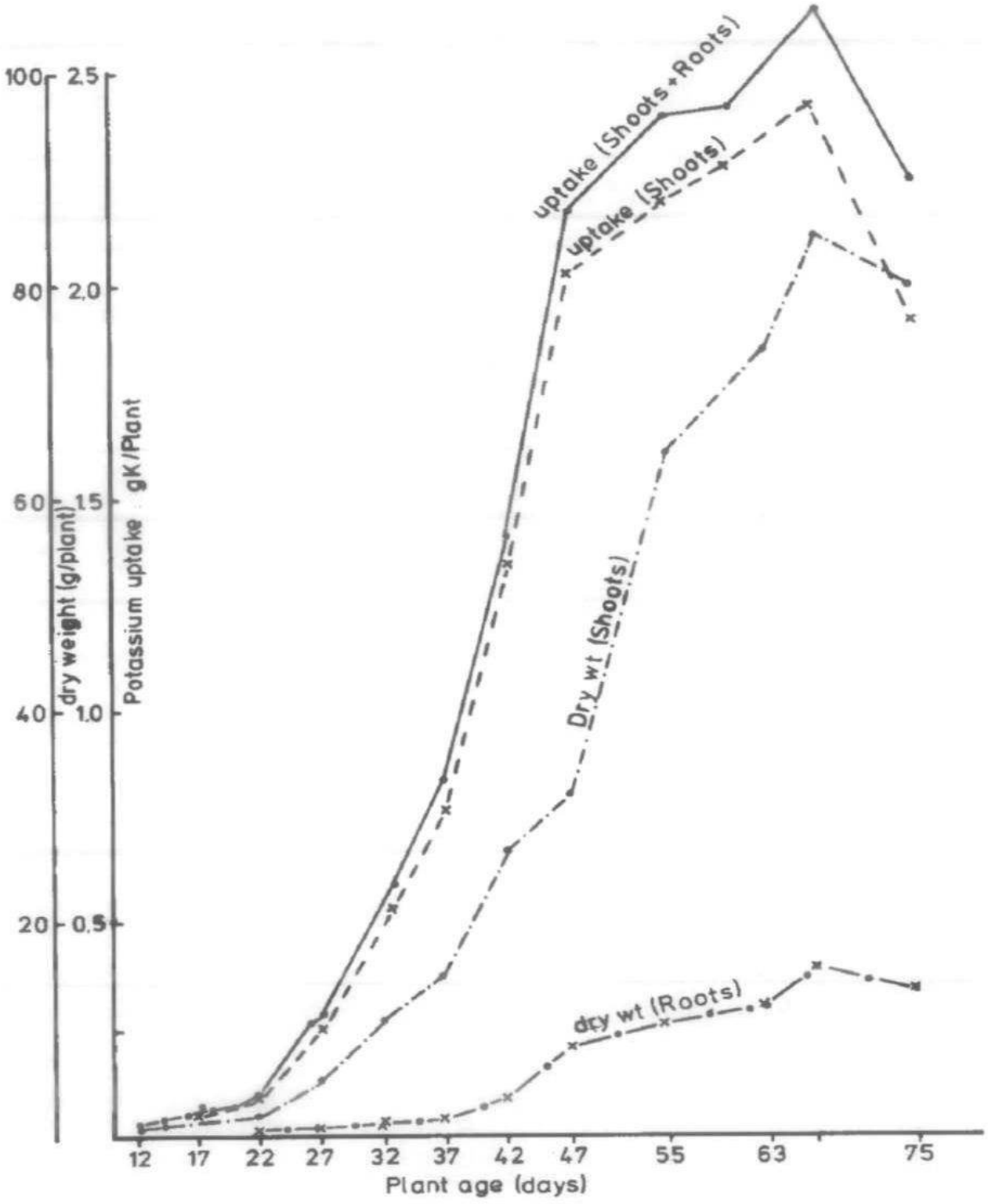

Fig. 2: Potassium uptake by maize

The daily uptake, however, showed its peak with over 7 kg K/day/ha during the period 42 – 47 days after sowing and decreased sharply after that (Fig. 3). Total uptake at harvest reached, by a yield of 10.4 t/ha, over 182 kg K/ha (Table 3).

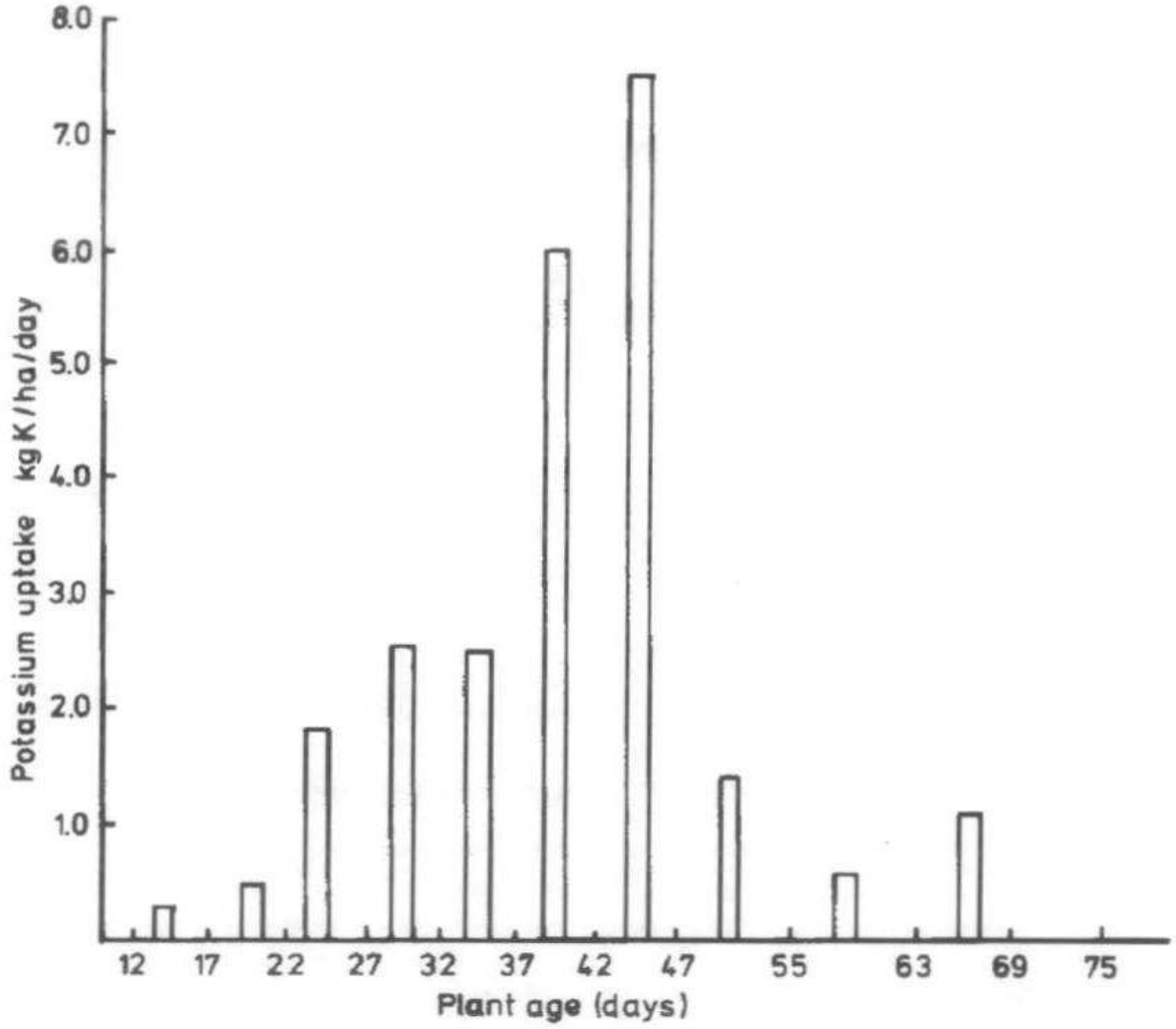

Fig. 3: Daily Potassium uptake by maize

Table 3: Total potassium uptake at harvest (yield 10.4 t/ha)

	kg K/ha (50,000 plants)
Roots	12.0
Shoots	96.5
Grains	55.6
Cobs	18.0
Total	182.1

It could be concluded that; high maize yields remove high K amounts. A relatively high portion of the removed K is located in shoots. The demand for K is very high during the period 30 – 45 days after planting.

Adding potassium to maize led to yield increases ranging between 8.5 – 34,5%, and gave a higher amount of grains/1 kg K_2O (7.2 kg grains/kg K_2O, Table 4). than reported in other countries (LOUE, 1980). Response of high yielding cultivars was higher than that of low yielding unknown cultivars. This high increases due K-fertilizers inspite of high exchangeable K in the soil might be related to the relatively high clay content, which retricts the availability of exchangable K.

Table 4: Effect of potassium sulphate (360 kg/ha) on corn grain yield

experimental site cultivar (year)	El-Bagour 1 Pioneer 514 (1981)			El-Bagour 2 Pioneer 514 (1981)			El-Bagour 3 unknown (1982)		
Potassium fertilization	-	+		-	+		-	+	
yield t/ha (increase %) without micronutrient	-	-	-	7.42	10.04	(+35.4)	4.05	4.72	(+16.5)
yield t/ha (increase %) with micronutrient	7.42	9.76	(+31.5)	8.71	10.46	(+20.1)	5.25	5.70	(+8.5)
Average	7.42	9.76	(+31.5)	8.06	10.25	(+27.2)	4.56	5.21	(+12.0)

Average increase: 25.3 %, 1300 kg/ha, 7.2 kg grains/1 kg K_2O

4 Summary

A field experiment was conducted on "Pioneer 514" maize to study the uptake and removal of K as well as the effect of K on yield. Sampling started 11 days after sowing and was carried out daily. Results indicated K concentation in shoots and roots increased upto 30th days, then decreased gradually till the end of the growth period. Total uptake was parallel to dry matter development, and showed its maximum around 70 days after planting then decreased. The daily uptake, and total uptake 182 kg K/ha at harvest were also calculated. Potassium sulphate was used with the rate of 180 kg K_2O/ha in all experiments 35 days after germination, alone or with a micronutrient treatment. Yield was increased between 8.5 35.4% with the addition of potassium. The demand for K is very high during the period 30 – 45 days after planting.

Zusammenfassung

Um die Aufnahme und die Verfügbarkeit von K sowie dessen Auswirkung auf den Ertrag zu untersuchen, wurde ein Feldversuch mit der Maissorte „Pioneer 514" durchgeführt. Die Probennahme begann elf Tage nach Aussaat und wurde täglich durchgeführt. Die Ergebnisse

zeigten eine K-Konzentration in der Sproßmasse und den Wurzeln steigend bis zum 30. Tag, dann eine allmähliche Abnahme bis zum Ende der Wachstumsperiode.

Die Gesamtaufnahme verlief parallel zur Trockenmasseentwicklung, mit dem Maximum ca. 70 Tage nach Aussaat, dann zurückgehend. Die tägliche Aufnahme und die Gesamtaufnahme bis zur Ernte (182 kg/ha) wurden ebenso berechnet.

Kaliumsulfat wurde mit 180 kg K_2O/ha 35 Tage nach Saataufgang gegeben, allein oder mit Mikronährstoffzusatz.

Durch die Zugabe von Kali stiegen die Erträge zwischen 8,5 – 35,4%. Der Bedarf an K ist zwischen dem 35. und 50. Tag nach der Saat sehr hoch.

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