BENEFICIAL EFFECTS OF CHLORMEQUAT (CCC) ON ROOT CROPS UNDER EGYPTIAN FIELD CONDITIONS

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SUMMARY

Potato plants grown both in winter or in summer, treated with CCC produced more tubers and higher yield. This also occurred in preliminary studies on the sweet potato. Leaves of treated plants had higher chlorophyll content, a higher dry matter content and had higher amylase activity than controls. Increases in amylase activity are not considered to be a direct effect of CCC but to be a response of the plant to greater sink strength resulting from increased tuberization. Protein and carbohydrates composition in tubers and roots were not affected. Residues were found in potato tubers under high treatment rates in both winter and summer seasons, and also at the two lower rates in the summer seasons.

RESUME

La patate cultivée en hiver ou en été donne plus de tubercules et assure un rendement plus élevé lorsqu'on la traite avec du CCC. La même chose a été observée lorsque des études préliminaires ont été effectuées sur la patate douce. Les feuilles des plantes traitées ont une teneur en chlorophylle plus élevée et une activité d'amylase plus élevée que chez les témoins. L'augmentation de l'activité dans l'amylase n'est pas directement attribuée à l'effet du CCC, mais à la réponse de la plante à une plus grande force de pénétration dûe au renforcement de la tubérisation. La protéine et la composition des hydrates de carbure dans les racines et tubercules ne sont pas affectées. On trouve des résidus dans les tubercules de la patate lorsque les taux de traitement sont élevés que ce soit en hiver ou en été et aussi aux deux taux plus bas en été.

RESUMEN

Plantas e papa cultivadas tanto en invierno como en verano, trata as con CCC, produjeron más tubérculos y más alto rendimiento. También ocurrió esto en estudios preliminares con camote. Las hojas de las plantas tratadas tuvieron un contenido más alto de clorofila, de materia seca y una mayor actividad de la amilasa en comparación con los testigos. No se considera que el incremento en la actividad de la amilasa sea un efecto directo del CCC, sino una respuesta de la planta a la mayor capacidad de almacenaje resultante del incremento en la producción de tubérculos. La composición de los tubérculos y raíces en cuanto a proteína y carbohidratos, no fué afectado. Se encontraron residuos de CCC en los tubérculos de papa en los tratamiento más elevados, tanto en la temporada de invierno como en la de verano, así como en la temporada de verano, en los tratamientos más bajos.

INTRODUCTION

In Egypt potato is becoming an important export crop, and sweet potato cultivation is increasing both for direct human consumption and starch production. Potato is planted in Egypt twice a year, in February–March for harvest in May and June and in October–November for harvest in February–March.

WINTER AND SUMMER GROWTH OF POTATOES

Growth patterns and yield potential vary according to the climatic differences of the two seasons within any location. The summer season is characterised by higher mean temperatures, warmer nights and longer day length. The day length in the Egyptian summer is shorter than that in temperate areas, but the winter day length is longer than that further North. Growth patterns for cultivar Alpha, which is the commonest Egyptian cultivar, for both seasons are shown in Table 1. Data are tabulated for observations at seven and eleven weeks after planting.

Although the summer plants became much taller, they still produced lower dry matter per plant than the winter plants. The distribution of dry matter in favour of tubers is influenced by the winter climate. These growth patterns explain the higher tuber yield per plant obtained in winter than in summer.

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EFFECT OF CCC ON POTATOES

Chlormequat (CCC) retards stem elongation and leads to earlier tuberization in potato[1,6,11]. Papadakis[8] suggested that growth retardants like CCC could help in increasing yields of tuber and root crops under conditions of long warm nights. This was confirmed in Argentina, where higher yields were achieved when potato plants were sprayed with CCC[9]. In Italy CCC is being used to promote tuberization in potatoes.[6] Field trials with CCC in different root and ruber crops under Egyptian conditions have been carried out since 1967[2,4,5,10]. In general, CCC treatment increased yields but to different degrees in different crops, and depending on the dose rate and the time of application.

The inhibition of stem elongation by CCC increased with doses (Table 2). Winter plants which were naturally shorter than the summer plants, were relatively more affected by CCC.

Dry matter accumulation in the foliage was enhanced by a CCC dose of 2.5 1/ha in winter as well as in summer. The 5 1/ha dose in both seasons induced leaf chlorosis and necrotic spots and reduced dry matter accumulation.

Tuberization and tuber dry matter accumulation increased by treatment with 1.25 or 2.50 1/ha CCC at the apparent expense of foliage. Leaves of treated plants were darker green. Preliminary studies indicated increased amylase activity in leaves of treated plants, but in vitro experiments gave inconclusive results. The effect of CCC on tuberization occurs before any change in amylase activity in observed, suggesting that the latter may occur as a response to the development of the greater physiological sink of the tubers.[3]

Field trials (Table 3) tended to support the increase of potato yield by the use of CCC. In one experiment carried out in North Delta in WS (exp. 7), a higher incidence of *phytophthora infestana* was observed in CCC treated areas than in untreated.

RESIDUES IN POTATO TUBERS

The chemical composition of tubers was not affected due to CCC treatment, however, considerable amounts of residues were detected, especially in summer (Table 4).

TRIALS OF CCC ON SWEET POTATOES

Trials with sweet potato in 1970 (Table 5) indicate a positive effect on yield which will be followed up.

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TABLE 1

Growth patterns of potato grown in different vegetation seasons.

Cultivar: Alpha Location: Giza	Summer	Winter
Date of planting	2.3.1967	10.10.1967
Date of harvesting	30.6.1967	18.2.1967
Planting - harvesting (days)	120	130
7 weeks after planting		
Height (cm)	30.0	34.0
Dry matter/plant(g)		
Leaves	7.5	14.8
Stem	4.5	6.0
Total foliage	12.0	20.8
Tubers	3.0	10.0
Total plant	15.0	30.8
Leaves: tubers	2.50	1.48
Foliage: tubers	4.00	2.04
Eleven weeks after planting		
Height (cm)	86.5	51.5
Dry matter/plant (g)		
Leaves	21.5	17.5
Stem	20.5	15.5
Total foliage	41.0	40.0
Tubers	24.0	56.0
Total plant	65.0	96.0
Leaves:tubers	0.90	0.31
Foliage:tubers	1.71	0.71
Yield g fr/plant	286	424

TABLE 2

Effect of CCC on potato growth (spraying 49 days after planting)

Days after spraying		CCC dose (l/ha) (Cycocel 40% sol.) 0	1.25	2.50	5.0
		Summer			
14	Height(cm)	48	45	44	43
	Dry matter/plant(g)				
	Leaves	19	17	22	13
	Stem	14	15	15	9
	Total foliage	33	32	37	22
	Tubers	8	12	14	5
	Total plant	41	44	51	27
	Leaves:tubers	2.38	1.42	1.57	2.60
	Foliage:tubers	4.13	2.67	2.64	4.40
	Amylase activity(%)	100	100	100	100
28	Height(cm)	86	70	65	58
	Dry matter/plant(g)				
	Leaves	22	22	33	18
	Stem	19	21	27	17
	Total foliage	41	43	60	35
	Tubers	23	24	46	26
	Total plant	64	67	106	61
	Leaves:tubers	0.96	0.92	0.72	0.69
	Foliage:tubers	1.78	1.79	1.30	1.35
	Amylase activity(%)	100	233	1166	1208
	Yield Fr.Wt. g/plant	286	294	390	408
		Winter			
14	Height(cm)	46	40	39	34
	Dry matter/plant(g)				
	Leaves	17	19	21.5	14
	Stem	13	9	10.5	6
	Total foliage	30	28	32	20
	Tubers	38	48	42	40
	Total plant	68	76	74	60
	Leaves:tubers	0.45	0.40	0.51	0.35
	Foliage:tubers	0.79	0.58	0.76	0.50
	Amylase activity(%)	100	109	100	100
28	Height(cm)	52	42	39	37
	Dry matter/plant(g)				
	Leaves	17.5	18.5	21.5	14
	Stem	12.5	9.5	10.5	6
	Total foliage	30	28	32	20
	Tubers	55	76	70	65
	Total plant	85	104	102	85
	Leaves:tubers	0.32	0.24	0.31	0.22
	Foliage:tubers	0.55	0.36	0.22	0.31
	Amylase activity(%)	100	140	122	98
	Yield Fr.Wt.g/plant	424	526	466	478

TABLE 3

Effect of CCC on potato yield

No.	Year	Season	Cultivar	Days from planting to spraying	Yield tons/ha CCC dose l/ha 0	1.25	2.50	5.0
1	1967	SS	Alpha	49	20.4	21.0	27.9	29.2
2	1967	SS	Alpha	64	20.4	26.2	28.7	33.4
3	1967	WS	Alpha	49	30.3	37.6	34.9	34.2
4	1967	WS	Alpha	64	30.3	44.1	35.0	36.8
5	1969	SS	Alpha	63	18.7	-	22.8	22.2
6	1969	WS	Alpha	53	32.1	-	-	34.1
7	1969	WS	Alpha	55	20.8	-	-	18.3
8	1971	SS	Condia	60	11.9	12.2	12.0	10.8
9	1971	SS	Condia	75	11.9	13.0	14.0	14.3

1 - 4 are calculated from small experimental plots
SS = Summer Season
WS = Winter Season

TABLE 4

Chemical composition and residue analysis of tubers from CCC-treated plants

Dose	Protein %	Carbohydrate %	CCC-residue ppm SS	WS
0	100	100	0	0
1.25	107	102	1.50	-
2.50	98	107	2.82	-
5.00	95	105	6.82	2.55

TABLE 5

Effect of CCC on sweet potato yield (Cultivar: Mabroaka) Giza: 1970

CCC dose l/ha	Days from planting until spraying. Yields. 75	90
C		
0	17.8	17.8
0.75	21.1	20.6
1.50	23.8	20.9
3.00	21.3	19.1