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YIELD RESPONSE AND MINERAL CONTENT OF POTATOES UNDER SALINE CONDITIONS

(Response du rendement et de la Composition minérale de la Pomme de Terre a des conditions salines)

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SUMMARY

Aim of the experiments was to determine ion specific and complex effects of different salts on the development of the canopy, tuber formation yield and mineral content of potatoes. Yield formation was taken as an important parameter of salt tolerance.

During two vegetation periods NaCl and Na_2SO_4 were applied in 4 concentrations. The experiment was carried out under semi-controlled conditions in pots.

To get detailed informations about the development phases of the plants during the vegetation period, samples were harvested 39, 53, 74 and 95 days after planting.

Increasing salt concentration reduced the total yield and changed significantly the number of tubers, tuber size and tuber weight. The mineral content showed also differences in the reaction to both salts and salt concentrations as measured in the yield formation.

A significant shifting of the content of cations was observed especially in the canopy. The shifting of the cation content was not so distinct in the tubers. The starch content of the tubers was significantly reduced by increasing concentrations.

RESUME

Durant deux périodes de végétation, différentes concentration de chlorure de sodium et de sulfate de sodium ont été appliquées. Ces expérimentations ont été conduites en pots, en conditions semi-contrôlées.

Selon le niveau de concentration saline et la nature des ions, la surface foliaire a été significativement réduite et l'élaboration du rendement retardée.

L'augmentation de la concentration saline a réduit le rendement final et changé significativement le nombre, la taille et le poids des tubercules. La composition minérale a aussi montré des différences dans la réaction aux deux sels et à leurs concentrations.

Des changements significatifs de composition cationique ont été observés surtout dans les parties aériennes.

Le contenu en amidon et en azote total a été significativement influencé par des concentrations croissantes.

INTRODUCTION

Hitherto, only few investigations are reportedly made on salt tolerance of the potato crop. But with a remarkable increase in the production of this crop in semiarid regions in the last ten years, it seems imperative that a considerable attention should be given to this specific problem area.

BERNSTEIN et al. (1951) reported that at higher irrigation frequencies, an ECs of 6.2 mS/cm reduced the yield of the potato variety "White Rose" by 50 per cent, whereby size and number of tubers played an important role. BOUAZIZ (1980) found a 30 per cent yield loss in variety "Spunta" at 8 mS/cm, which he said was attributed to a reduced single tuber weight. It was also observed that high salt concentrations lead to different cation and anion contents in various plant organs. ABDULLAH and AHMAD (1982) said that in varieties "Multa" and "Atom" salt concentrations ranging from 8-10 000 ppm cause a decrease in chlorophyll and protein content whereas lower concentrations favor their production.

In connection with fertilization, BUCHNER (1951), LATZKO (1955), LEMPITZKAJA (1960), and HAEDER (1975) observed a shift in the profile of carbohydrates, disturbance and inhibition of translocation of assimilates from leaves and stems which was caused by accompanying elements.

It is also known that different plants and varieties within a plant react differently to salinity depending on their stages of development (GREENWAY 1962, EL-GIBALY and GOUMAH 1969, RUSITZKA 1982, DORING 1985). The objective of this study was therefore to determine the effect of salt treatments at different phases of potato development.

MATERIALS AND METHODS

A two-year pot trials were conducted under partially controlled conditions in a growth house. The plants were grown in 10 lt-pots containing a mixed medium of fine sand, compost and peat. The water capacity amounted to 18 per cent by volume, the moisture of the soil was kept at its field capacity throughout the growing period. Immediately after planting of the pre-sprouted seed pieces, 150, 300, 450 and 600 meg/pot of NaCl or Na_2SO_4 were applied. Data on the aboveground plant parts were collected weekly. Sample plants were harvested 39, 53 and 74 days after planting and after senescence.

RESULTS AND DISCUSSION

The applied concentrations were chosen in such a way that salt injuries with combined effects could occur at all levels of treatments.

In this study the development of potato plants will be discussed through the formation of dry matter, starch and some mineral elements.

Formation of dry matter

39 days after planting, all treated plants formed significantly lower DM than the control plants. The latter have already produced tubers 53 days after planting, there was no difference between the DM content of the foliages of plants treated with 150 meg of either NaCl and Na_2SO_4 and the control plants. Generally, plants treated with Na_2SO_4 produced more DM than those treated with NaCl. Leaf and stem DM production of control plants decreased after 74 days from planting, as a result of which, plants treated with 150 meg of either salts produced significantly more leaf mass than those of the control plants.

Dry matter production of tubers after 53 and 74 days from planting was reduced in plants treated with both salts and this reduction was highly significant between all different treatment levels. But after senescence, no significant difference was found in DM content of untreated and with 150 meg treated plants of Na_2SO_4. This was not the case with NaCl at 150 meq concentration.

These observations confirm on one hand the different influences of both salts, on the other hand, the occurence of additive osmotic and ionspecific effects.

The development of the DM formation (Fig.1) shows that a delay caused by salt treatment at early stages of

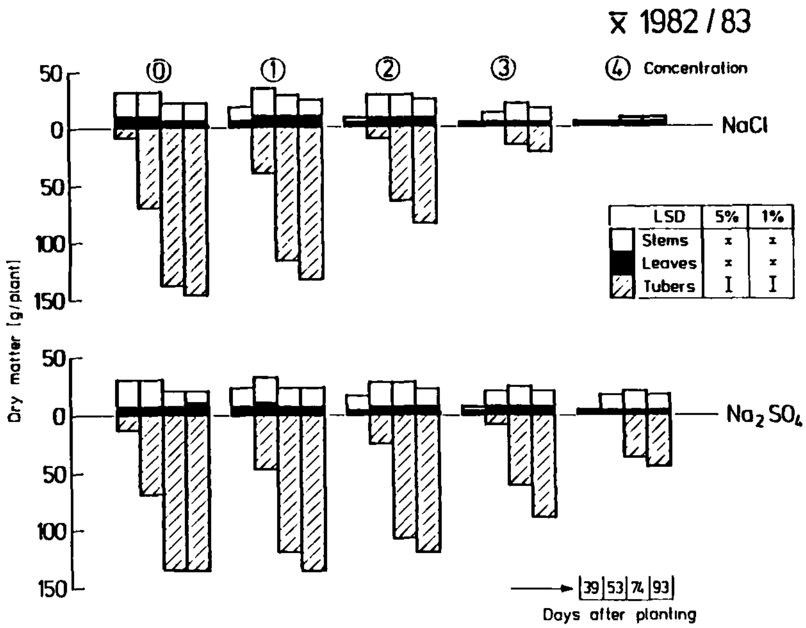


Fig.1 : Dry matter development

growth can be compensated in the course of the vegetation period under the given circumstances. This holds true not only to the formation of the above-ground plant parts but also - with some restriction - to the formation of tubers.

The premature dealth of plants, observed by other authors, cannot be confirmed in this case ; probably due to the optimum water supply throughout the growth period.

Starch content of tubers

The influence of the two salts on starch formation 73 days after planting was different. As shown in Table 1, at concentration greater than or equal to 300 meq, the negative influence of Na_2SO_4 was significantly less than that of NACl. After senescence, a certain compensation took place, nevertheless, there is a clear difference between years. Here also a shift in development phases and a possible compensation are to be anticipated.

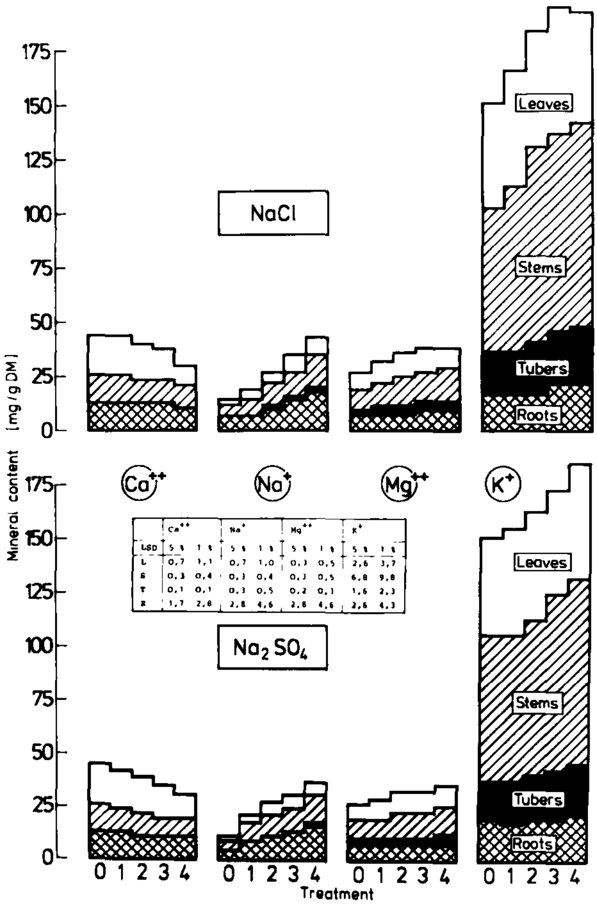
Table 1 changes in relative values of starch content as a result of NaCl and Na_2SO_4 in 4 concentrations, at two harvest

Comparison of starch content (relative values)

Salt	Concentration	Days after planting							
		74				86/93			
		1st year		2nd year		1st year		2nd year	
		% Rel.	diff.	% Rel.	diff.	% Rel.	diff.	% Rel.	diff.
Na Cl	0 (0 meq/pot)	100	-	100	-	100	-	100	-
	1 (150 ")	96,25	- 3,75	96,39	- 3,61	96,76	- 3,24	102,41	+ 2,41
	2 (300 ")	88,66	- 11,34	87,68	- 12,32	92,49	- 7,51	92,64	- 7,36
	3 (450 ")	71,98	- 28,02	71,30	- 28,70	91,03	- 8,97	86,95	- 13,05
	4 (600 ")	-	-	62,62	- 37,38	-	-	85,10	- 14,90
Na_2SO_4	0 (0 meq/pot)	100	-	100	-	100	-	100	-
	1 (150 ")	97,49	- 2,51	98,31	- 1,69	100,99	+ 0,99	100,09	+ 0,09
	2 (300 ")	95,13	- 4,87	95,96	- 4,04	95,47	- 4,53	99,01	- 0,99
	3 (450 ")	91,02	- 8,98	91,76	- 8,24	92,92	- 7,08	87,66	- 12,34
	4 (600 ")	78,38	- 21,62	72,32	- 27,68	87,23	- 12,77	84,51	- 15,49

Contents of minerals : K^{+}, Ca^{++}, Mg^{++}, Na^{+}

Means of K^{+}, Ca^{++}, Mg^{++} and Na^{+} contents of leaves, stems and tubers of plants treated with different concentrations of NaCl and Na_2SO_4 for two years are depicted in Fig. 2. The results varied between years. The contents of K^{+}, Ca^{++} and Mg^{++} were higher in 1983 than in 1984.



LSD	Ca++ 5 %	Ca++ 1 %	Na+ 5 %	Na+ 1 %	Mg++ 5 %	Mg++ 1 %	K+ 5 %	K+ 1 %
L	0,7	1,1	0,7	1,0	0,3	0,5	2,6	3,7
S	0,3	0,4	0,3	0,4	0,3	0,5	6,8	9,8
T	0,1	0,1	0,3	0,5	0,2	0,1	1,6	2,3
R	1,7	2,8	2,8	4,6	2,8	4,6	2,6	4,3

Fig.2 : Mineral content of leaves, stems tubers and roots
Average values of 4 harvests over 2 years

Potassium

Treating plants with NaCl leads to a significantly reduced content of K^+ in the tubers as compared to those treated with Na_2SO_4.

An increase in concentration of both salts brought about a remarkable increase in K^+ content. This increase is significant in leaves even at lowest concentration (150 meq). In stems of Na_2SO_4 treated plants, however, a significant increase was first observed at a concentration of 300 meq. For any given concentration, plants treated with Na_2SO_4 had lower K^+ content as those treated with NaCl.

Any increase in K^+ content of roots was hardly observed for both salts and all concentrations.

Calcium

The Ca^{++} content of leaves and stems, but not that of tubers and roots, was differently affected by salt types only in the 2nd year.

Except for the 150 meq treatment, the Ca^{++} observation in leaves and stems was significantly inhibited with increasing concentration. In tubers, however, no difference in Ca^{++} content were seen except for the highest concentration.

The high Ca^{++} contents in the roots was reducing significantly with increasing concentrations, in Na_2SO_4 plants at 300 meq, in NaCl plants at 450 meq.

Magnesium

Generally speaking, the Mg^{++} content was not affected by salt type. A significant increase in Mg^{++} content of leaves and stems was observed with an increase in concentration. With comparable concentrations, the Na_2SO_4 plants showed significantly less Mg^{++} content, but only in the stems. In roots, Mg^{++} increased significantly only with higher concentrations. In tubers, Mg^{++} increased significantly - like in stems and leaves - with increasing concentrations.

Sodium

With increased concentrations sodium was stored more intensively in leaves and stems, the differences between concentrations were statistically significant. Though - except with 150 meq - the Na_2SO_4 plants were less enriched with Na^+ than the NaCl plants.

Sodium increased also intensively in the tubers at 150 meq, though not significantly.

The increasing of Na^+ was especially to be seen in the roots, with increased concentration of both salts.

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