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## INCREASING POTATO YIELD WITH GLYCEROLTRIACETATE AND GLYCEROLDIACETATE

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### INTRODUCTION

Several fatty esters, triglycerides and monoglycerides promote growth of excised pea stems (4). In 1966, the second author (1) sprayed potato plants of the late variety 'Libertas' twice with  $10^{-2}$  M glyceroltriacetate, a triglyceride. Significant increases in fresh weight of foliage (19%) and tuber yield (27%) were observed in this field experiment.

This experiment was repeated in 1967. Two varieties, 'Libertas' and 'Eersteling', an early variety, were sprayed with glyceroltriacetate and glyceroldiacetate at two concentrations,  $10^{-2}$ M and  $2 \cdot 10^{-2}$ M.

In 1968, potatoes of the late variety 'Woudster' were sprayed with these chemicals at three concentrations,  $10^{-2}$ M,  $5 \cdot 10^{-3}$ M and  $2 \cdot 10^{-3}$ M.

The results of these field experiments are reported here.

### MATERIAL AND METHODS

Pre-sprouted 35–45 mm seed-potatoes of the varieties 'Eersteling' and 'Libertas' were planted on April 19, 1967. For each treatment, 25 plants were spaced  $50 \times 50$  cm apart. Plants were sprayed 44 days after planting on June 1, when the plants were about 30 cm high, and 15 days later on June 16, when the soil was nearly covered. 'Eersteling' potatoes were harvested 25 days after the last spray date on July 11, and 'Libertas' potatoes 50 days after the second spray date on August 5. The plants were sprayed to the dripping point with solutions of glyceroltriacetate  $10^{-2}$ M, glyceroldiacetate  $10^{-2}$ M and  $2 \cdot 10^{-2}$ M. All spray solutions contained 0.1% by volume wetting agent (250 g nonylphenoethylene-

oxyde condensate per liter water). Data on the weather conditions during the growth period were supplied by the Laboratory of Physics and Meteorology of the Agricultural University, Wageningen. These observations were made about two kilometers away from our experimental plot.

In 1968, a similar experiment was carried out at another location, on the island of Texel. Data on the weather conditions were obtained from the meteorological station at Den Helder, at about ten kilometers distance from the experimental plot.

The potatoes were planted April 24, 1968 and the plants were sprayed with solution on June 15, 1968, when the plants were about 40 cm high. Foliage had died completely in the first week of September and the tubers were harvested in the last week of September. Each treatment consisted of 50 plants in three different plots, which were located at random on the experimental field.

## RESULTS AND DISCUSSION

The results of the field experiment of 1967 are summarized in table 1. As in 1966, potato yield was increased in some of our treatments. A spray of glyceroltriacetate ( $10^{-2}\text{M}$ ) and glyceroldiacetate ( $10^{-2}\text{M}$ ) increased tuber yield of 'Eersteling' significantly up to 21 and 20% respectively. The corresponding increase in foliage was smaller, 5 and 16% respectively with only the 16% statistically significant. A spray of glyceroldiacetate at double concentration ( $2 \cdot 10^{-2}\text{M}$ ) reduced yield slightly. This shows that a yield increasing effect may be expected with solutions of  $10^{-2}\text{M}$  or lower. The results of this experiment with 'Eersteling' are similar to those of the experiment with 'Libertas' in 1966.

A spray of glyceroldiacetate did not affect yields of foliage and tubers of 'Libertas'. Treatment with glyceroltriacetate ( $10^{-2}\text{M}$ ) reduced yield of tubers and foliage of this variety down to 73 and 54% respectively. The question now arises why this treatment of glyceroltriacetate increased yield of 'Libertas' significantly in 1966, while a reduction of yield was observed in 1967.

The soils for the experiments in 1966 and 1967 are entirely identical. Weather during the growing season of 'Libertas' potato however was very different in the two years (table 2). In summer 1966, especially after the second spray, daily temperature and sunshine were rather low, compared with summer 1967. Most strikingly different was rainfall: during the growth period in 1966, 581 mm of rain fell and 125 mm in 1967, while the normal rainfall is 203 mm. Our data therefore suggest that treatment of 'Libertas' potato plants with glyceroltriacetate increases yield under cool and humid weather conditions and that no effect or even a yield reducing effect may be observed under dry weather conditions.

This suggestion can be checked against our data of the experiment on Texel in 1968. The growing season was again unusually wet, 419 mm of rainfall against an average of 211 mm measured over this growth period. Because of the location at the seaside, the irradiation is high. This year again a significant stimulation of tuber production was observed when sprays of glyceroltriacetate

TABLE 1. Effect of glyceroltriacetate and glyceroldiacetate on leaf growth and tuber yield of 'Eersteling' and 'Libertas' potatoes.

Variety	Compound	Conc. in M	Fresh weight foliage			Significance in %	Effect
			g/plant	%	Stand. dev. of mean		
Eersteling	water		234	100	21	-	-
Eersteling	glyceroltriacetate	10 <sup>-2</sup>	246	105	17	-	none
Eersteling	glyceroldiacetate	10 <sup>-2</sup>	272	116	21	P = 90	stimulation
Eersteling	glyceroldiacetate	2.10 <sup>-2</sup>	237	101	22	-	none
Libertas	water		764	100	76	-	-
Libertas	glyceroltriacetate	10 <sup>-2</sup>	412	54	34	P > 99	reduction
Libertas	glyceroldiacetate	10 <sup>-2</sup>	816	107	60	-	none
Libertas	glyceroldiacetate	2.10 <sup>-2</sup>	697	91	60	-	none
Tuber yield							
Eersteling	water		517	100	48	-	-
Eersteling	glyceroltriacetate	10 <sup>-2</sup>	627	121	43	P = 95	stimulation
Eersteling	glyceroldiacetate	10 <sup>-2</sup>	622	120	39	P = 95	stimulation
Eersteling	glyceroldiacetate	2.10 <sup>-2</sup>	451	87	36	-	none
Libertas	water		845	100	58	-	-
Libertas	glyceroltriacetate	10 <sup>-2</sup>	616	73	41	P > 99	reduction
Libertas	glyceroldiacetate	10 <sup>-2</sup>	873	103	36	-	none
Libertas	glyceroldiacetate	2.10 <sup>-2</sup>	877	104	74	-	none

TABLE 2. Weather conditions during growth period.

Year	1966	1967	1967	1968
Potato variety	Libertas	Libertas	Eersteling	Woudster
Date of seeding	May 10	April 19	April 19	April 24
Dates of spraying	July 6 and 28	June 1 and 16	June 1 and 16	June 15
Dates of harvest	August 16	August 5	July 11	September 23-30*)
Rainfall in mm	581	125	108	419
Normal rainfall in mm	201	204	137	211
Average irradiation per day in cal/cm <sup>2</sup>	334	352	349	410
Same during July	295	361	-	-
Average temperature in daytime in °C during May	14.7	14.2	14.2	10.9
June	18.6	16.2	16.2	15.4
July	16.8	20.3	20.3	16.5
August	17.1	17.7	-	17.4

\*) The foliage of the plants in 1968 was allowed to die. Growth period ends September 1.

or glyceroldiacetate were applied to the foliage, supporting the suggestion that these chemicals increase tuber yield under humid weather conditions. Treatment with glyceroltriacetate was most favorable and an increase in tuber weight of 21.5, 12.5, and 32.3% was observed at the three concentrations applied (table 3). Treatment with glyceroldiacetate was in general less favorable, an increase in tuber weight of 17.9% was only observed at  $5.10^{-3}\text{M}$  concentration. Application of a spray of  $2.10^{-3}\text{M}$  glyceroldiacetate was ineffective, and even a reduction in yield was observed when the plants were sprayed with a  $10^{-2}\text{M}$  solution.

The most probable explanation is that the experimental field, including a plot of 10 control plants, was not completely equal. Possibly, few of the experimental plots were influenced by a nearby alder hedge. If one omits the plots closest to the hedge, a sufficient number of plants of each treatment is still available for statistical evaluation. The remaining plants treated with glyceroldiacetate showed a stimulation of tuber production at all three concentrations applied, though again less than the comparable treatment with glyceroltriacetate. The increases in tuber yield for  $10^{-2}\text{M}$ ,  $5.10^{-3}\text{M}$  and  $2.10^{-3}\text{M}$  glyceroldiacetate were 8.4, 15.3 and 8.7% respectively, from which the 15.3% was the only increase with a significance of more than 95%.

Further experiments under controlled climate conditions may prove or disprove a correlation between effect of sprays and weather conditions.

We do not have these data for potato, but experiments on the effect of glyceroldiacetate on growth of young bean plants in climate controlled growth rooms demonstrated the importance of air temperature and humidity of the air (unpublished experiments of the first author). When glyceroldiacetate was added to the roots ( $4.10^{-4}\text{M}$ ) growth of the first pair of leaves was reduced to 12% of that of the control value. The plants were grown at  $25^{\circ}\text{C}$  in relatively dry air. Other plants were grown at  $20^{\circ}\text{C}$  in air of low and high humidity. Under these conditions growth of the treated plants was reduced to only 38 and 52% of the corresponding control values respectively. Evidently, the growth reduction induced by glyceroldiacetate depends on air temperature and humidity of the air, and the greatest reductions were observed under high transpiration conditions. A similar interaction between the effects of NaCl and atmospheric humidity on the growth of beans has been observed by NIEMAN (3). NaCl stimulates growth of some crop plants at low concentration (2).

In summary, our field experiments of 1967 and 1968 suggest that an interaction between the effect of a spray of glyceroltriacetate or glyceroldiacetate and the weather conditions exists and an increase in potato yield induced by these lipids might be expected in several cases, specifically under cool and humid weather conditions during the growing season.

#### SUMMARY

In a field experiment in the dry year 1967, a spray of glyceroltriacetate ( $10^{-2}\text{M}$ ) and glyceroldiacetate ( $10^{-2}\text{M}$ ) increased tuber yield of an early potato variety, 'Eersteling', up to 21 and 20% respectively. A spray of glyceroldiacetate did not effect yield of a late potato variety, 'Libertas'. Treatment with

TABLE 3. Effect of glyceroltriacetate and glyceroldiacetate on tuber yield of 'Woudster' potato.

Compound	Conc. in M	g/plant	%	Stand. dev. of mean	Significance in %	Effect
Water		999	100	50	-	-
Glyceroltriacetate	$10^{-2}$	1215	121.5	72	P > 99	stimulation
Glyceroltriacetate	$5 \cdot 10^{-3}$	1125	112.5	54	P > 95	stimulation
Glyceroltriacetate	$2 \cdot 10^{-3}$	1323	132.3	60	P > 99.5	stimulation
Glyceroldiacetate	$10^{-2}$	880	88.0	56	P > 90	reduction
Glyceroldiacetate	$5 \cdot 10^{-3}$	1180	117.9	67	P > 97.5	stimulation
Glyceroldiacetate	$2 \cdot 10^{-3}$	974	97.3	66	-	none

glyceroltriacetate reduced tuber yield of 'Libertas' to 73%, contrary to the experimental result of the wet 1966 growing season, when a significant increase in tuber yield induced by this chemical was observed.

In 1968, a rather wet year, potatoes of the late variety 'Woudster' were sprayed with the lipids at  $10^{-2}$ M,  $5.10^{-3}$  and  $2.10^{-3}$ M. A significant increase of tuber yield by glyceroltriacetate at all three applied concentrations was observed, as well as by glyceroldiacetate at  $5.10^{-3}$ M. Comparison of the weather data of different years suggest that treatment of potato plants with glyceroltriacetate will increase yield under cool and humid conditions and that no effect will be observed under dry weather conditions.

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