

## Effect of acidification of insecticide sprays in pest control of sugar beet seedlings

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**Abstract.** The pH of dimethoate, formetanate and methidathion insecticide spray liquids was reduced from 8.0 to 4.0 by adding 0.1 M  $H_3PO_4$ . Acidification did not improve the effectiveness of sprays against *Lygus rugulipennis*, *Chaetocnema concinna* or *Piesma maculatum*. There were also no significant differences in root or top yields between plots treated with acidified insecticides and the insecticides alone.

The main pests of sugar beet seedlings in Finland are *Lygus rugulipennis* Popp. and *Chaetocnema concinna* Marsh. The latter is very satisfactorily controlled if necessary but control of *Lygus* bugs in sugar beet fields is often poor. Spraying with dimethoate prevents the damage to some extent and increases the yield (VARIS 1975, VARIS and RAUTAPÄÄ 1976). Because some insecticides as e.g. formetanate and methidathion, as well as dimethoate, which is mostly used by the farmers for this purpose, are more quickly inactivated in alkaline than in acid spray waters (manufacturers' bulletins) the question whether the effect of some insecticides can be improved by acidification of sprays was studied in Tikkurila. In the studies of JOHANSEN and EVES (1972) acidification of trichlorfon and carbofuran sprays increased their effectiveness against lygus bugs.

### Material and methods

*Spray solutions.* 0.15, 0.25 and 0.19 per centage solutions of 40 % dimethoate spray (Roxion), 50 % formetanate w.p. (Dicarzol 500 SP), and 40 % methidathion spray (Ultracide 40), respectively, were prepared mixing the insecticides in local tap water. The pH's of the solutions were ca. 7 when the pH curves were titrated (Fig.1). Acidified spraying solutions were prepared adding to these solutions 0.1 M (1 %) phosphoric acid until the pH of the solutions, controlled by pH meter, was 4. There was some variation in the pH of tap water; when the pH curves were titrated for these tests the pH was 7.4 and the specific conductance  $3 \times 10^{-4}$  mho/cm. 10 ml of 0.1 M phosphoric acid in 300 ml distilled water required 14.7 ml of 0.1 N NaOH when titrated to pH 7. On the days when the sprays were applied the pH was

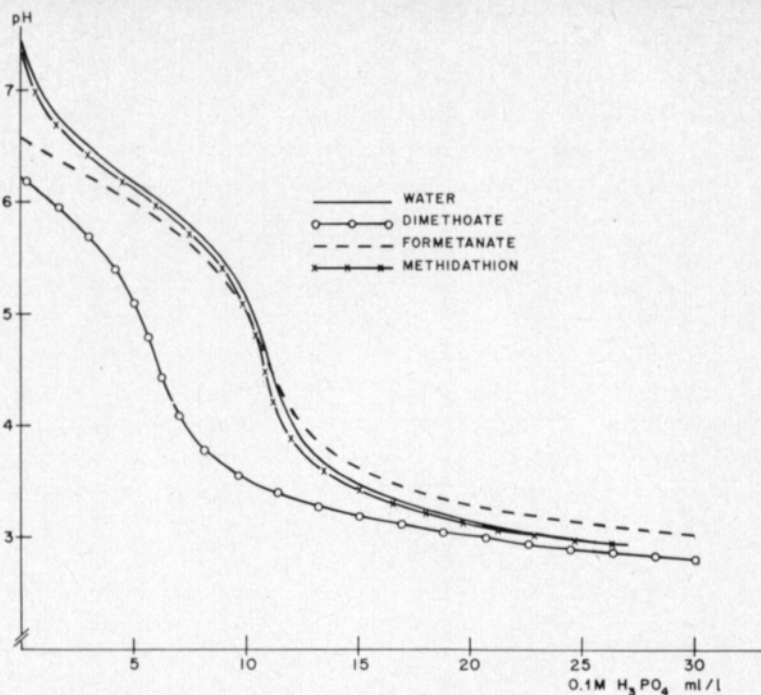


Fig. 1. The amount of 0.1 M H<sub>3</sub>PO<sub>4</sub> needed for acid spray solutions. The pH-value of water was 7,4 and conductivity 2.85 mho/cm.

8.0 (except in the laboratory test in 1974 when it was 7.2). This lead to slight variations in the amounts of H<sub>3</sub>PO<sub>4</sub>. The amount of 0.1 M H<sub>3</sub>PO<sub>4</sub> needed was about equal for water, formetanate and methidathion spray solutions, but considerably smaller for dimethoate spray.

*Laboratory tests.* Sugar beet seedlings growing in pots 15 cm in diameter were treated with insecticides mentioned above. In each treatment both acidified insecticide and the insecticide alone were used. The amount of spray solution was 40 ml/m<sup>2</sup>. Untreated lygus bugs were released in PVC rearing cages placed over each pot approximately 4 hours after spraying. There were 10 pots with 10 plants in each treatment. 5 male and 5 female bugs were released in each pot. Two similarly arranged tests were conducted at an interval of two weeks in August 1973.

The mortality of the bugs was checked 3 days and injury to the plants 7 days after treatment. The percentage control was calculated by Abbot's formula.

Weather conditions were very different during the two tests. Mean temperature of six days following the treatment was 16.9° C in the first experiment while it was 9.4° C in the second one.

In 1974 a laboratory trial was arranged according to the same plan as in the previous year, however, without bugs. The purpose of this trial was to show whether acidification of spray liquids had any effect on the plants themselves. In this trial vigour of growth was estimated using a scale of 0-10 5 and 14 days after treatment, the plants were weighed and the length of their roots was measured 2 weeks after treatment.

*Field trials.* Two similar polyfactor field trials were arranged in 1973. The seedlings were treated twice: 28.5. and 4.6. Both acidified insecticide and the insecticide alone were used in each treatment. The control plots were treated with acidified and nonacidified water, respectively. The amount of spray solution was 40 ml/m<sup>2</sup>. Plot size was 10 m<sup>2</sup> and there were 4 replicates.

The experiments were inspected at the end of June for injury by *L. rugulipennis* and *C. concinna*. The number of piesmid eggs (cf. VARIS 1974) attached to the plants was also counted and the vigour of stands evaluated plot by plot using a scale 0–10. In the autumn the plots were harvested, and the total plant-weight as well as the root weight were determined.

In 1974 a field test was arranged according to the same plan as in the previous year. In this test 0.5 % ammonium sulphate was used as acidifier. The pH of rain water was 6.0 and that of sprays acidified with ammonium sulphate was 5.6. Thus the difference between the two acidity levels was very slight in this trial.

## Results and discussion

*Laboratory tests.* The effect of insecticides on lygus bugs was slightly decreased by acidification (Tables 1 and 2). The effect of dimethoate and formetanate was somewhat better in test 1 (warm weather) than in test 2 (cold weather).

There was no significant difference between acidified and neutral sprays in regard to the root length ( $F = 0.38$ , Table 3).

The interaction pH x treatment was significant in plant weight ( $F = 3.17^*$ , Table 3), which was higher in formetanate treatment when the spray liquid was neutral than in acidified sprays of the same treatment. This was also to

Table 1. Percentage control of *Lygus rugulipennis* on sugar beet seedlings treated with acidified (a) and non acidified (n) insecticide spray liquids 3 days after treatment. Laboratory tests.

	Test 1		Test 2		Mean	
	a	n	a	n	a	n
Dimethoate .....	89	98	79	90		
Formetanate .....	52	60	42	47		
Methidathion .....	96	100	99	98		
Mean	79	86	73	78	76	82

Table 2. Injury (0–10) caused by *L. rugulipennis* to sugar beet seedlings treated with acidified (a) and non acidified (n) insecticide spray liquids, 7 days after treatment. Laboratory tests.

	Test 1		Test 2		Mean	
	a	n	a	n	a	n
Dimethoate .....	5.9	5.6	5.5	5.3		
Formetanate .....	6.8	4.6	5.1	5.4		
Methidathion .....	4.8	4.4	4.5	3.8		
Mean	5.8	4.9	5.0	4.8	5.4	4.8

Table 3. Effect of acidification of spray liquids on sugar beet seedlings. a = acidified, n = non acidified.

	Vigour of growth (0-10), days after treatment				Root length cm		Plant weight g	
	5		14		a	n	a	n
	a	n	a	n				
Control .....	8.7	8.4	8.9	8.4	8.1	7.9	3.8	3.4
Dimethoate .....	7.9	8.2	8.0	8.5	8.8	7.9	3.3	3.5
Formetanate .....	7.4	8.1	7.2	8.0	6.9	7.9	2.6	3.2
Methidathion .....	8.5	7.3	8.7	7.6	8.3	7.9	3.6	3.4

be seen in the poorer vigour of growth in acidified formetanate treatment compared with that with formetanate alone.

*Field trials.* (Table 4). The pH-value of spray liquid did not affect the amount of injury caused by *C. concinna*. The incidence of injury was very heavy. There were also no significant differences between acidified and neutral sprays in the effect on either *L. rugulipennis* or *Piesma maculatum*. The incidence of damage of these two species was very slight. Only 4 % of the seedlings were injured by *L. rugulipennis* and even these plants were injured later than at cotyledon stage. The mean number of piesmid eggs in the control was 0.1 per seedling.

Neither root nor top yield was significantly affected by the pH of the spray liquid. ( $F = 0.05$  for root yield, 0.33 for top yield).

In 1974, when the differences in pH between acidified and neutral spray liquids were only slight, there were likewise no significant differences in the respective figures.

Table 4. Injury caused by *L. rugulipennis* and *C. concinna* and number of piesmid eggs in sugar beet seedlings treated with acidified (a) and non acidified (n) spray liquids. Field experiments 1973.

		Injury caused by		Number of eggs of <i>Piesma maculatum</i> per 50 plant
		<i>Chaetocnema concinna</i> No. of feeding holes per plant	<i>Lygus rugulipennis</i> %	
Control .....	a	49	4.1	5.7
	n	48	4.5	4.3
Dimethoate .....	a	38	4.8	4.3
	n	43	4.5	4.7
Formetanate .....	a	41	4.2	1.7
	n	44	3.5	2.2
Methidathion .....	a	46	4.3	4.5
	n	44	4.3	4.2
F pH .....		0.002	1.79	0.24
Insecticide x pH .....		0.30	0.57	0.66

Acidification did thus not improve the efficiency of insecticides known to be rather quickly inactivated in alkaline spray waters as was the case in studies made by JOHANSEN and EVES (1972). The insecticides were, however, different in these studies as also were the acidifiers. Perhaps the adding of some buffer in solutions used in the present study might have had some effect on the results. The spray waters used by JOHANSEN and EVES (1972) were more buffered judging by the NaOH requirement of the solutions. On the other hand the slight differences between the effect of acidified and non acidified spray liquids in the present study seemed to point in favour of non acidified solutions.

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#### SELOSTUS

### **Ruiskutusnesteen pH:n vaikutus eräiden insektisidien tehoon sokerijuurikkaan taimia voittavien tuholaisten torjunnassa.**

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Jotkut tuhoeläintorjunta-aineet, kuten esimerkiksi sokerijuurikkaan taimien tuholais-torjuntaan yleisesti käytetty dimetooatti ovat huomattavasti pysyvämpiä happamassa kuin alkaalisessa liuoksessa. Tässä tutkimuksessa pyrittiin selvittämään voitaisiinko sokerijuurikkaan taimien tuholais-torjunnassa ruiskutusten tehoa parantaa tekemällä ruiskutusneste happameksi. Tutkitut torjunta-aineet olivat 40 %:n dimetooattiruiskute, 50 %:n formetanaattiruiskutejauhe ja 40 %:n metidationiruiskute.

Ruiskutteet sekoitettiin vesijohtoveteen. Happamuuden aikaansaamiseksi lisättiin liuokseen 0.1 M fosforihappoa kunnes nesteen pH oli 4. Laboratoriokokeissa ruukuissa kasvavat sokerijuurikkaan taimet käsiteltiin insektisideillä. Kun ne olivat ruiskutuksesta kuivuneet, käsittelemättömiä luteita päästettiin ruukkujen päälle asetettuihin PVC-lieriöihin. Näistä tarkastettiin luteiden kuolleisuus ja taimien voittuminen. Kenttäkokeista tarkastettiin pelto-luteen ja kirppojen voitus sekä juurikas-luteen munien luku. Kasvuston rehevyys arvioitiin ruuduttain. Koe korjattiin syksyllä normaaliin aikaan ja sato punnittiin.

Ruiskutusnesteen pH:n alentaminen ei parantanut tehoa luteisiin eikä kirppoihin. Se ei myöskään vaikuttanut juuri- eikä naattisadon määrään.