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Effect of dusts on tomato production

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ERRATA

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Table 4 - page 6

The above table to read:

Table 4 - Effect of dust on harvested and marketable yields.

Dust type	Yield+ t ha^{-1} Harvested		Marketable	
	Daily	Weekly	Daily	Weekly
Control	123 bcd+	121 bcd	64 b	74 bcd
Bauxite	115 b	138 cd	75 bcd	82 cd
Cement flue.	68 a	115 b	42 a	67 bcd
Alumina	142 d	177 bc	90 d	71 bc
Koalin	127 bcd	137 bcd	76 bcd	82 cd

EFFECT OF DUSTS ON TOMATO PRODUCTION

by D. Phillips, L. T. Jones and W. J. Cox

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SUMMARY

The phytotoxicity of bauxite, cement flue, mud lake, alumina and kaolin dusts were examined on tomatoes grown at Medina Vegetable Research Station.

Mud lake white dust caused severe leaf scorch, affected plant growth and resulted in no harvestable yield. Flue dust applied daily (total application 12.8 t ha^{-1}) depressed market yield of fruit from 64 t ha^{-1} (control) to 42 t ha^{-1}. Flue dust applied at 3.1 t ha^{-1} had no effect. There was no phytotoxic effect from bauxite, alumina or kaolin.

Plant damage and reduced yields resulting from flue dust and mud lake white dust appeared to be associated with the high pH and salt content of these materials and their specific constituents.

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INTRODUCTION

Following the introduction of mining and industrial activity into traditional vegetable growing areas in the outer Perth metropolitan regions, there have been a number of claims of pollution damage in vegetable crops (Jones 1976). Gaseous emissions such as sulphur dioxide and fluoride, dusts and factory emmissions have been implicated (Jones 1976).

Dust materials thought to pose a potential hazard to market gardening include bauxite dust from mining operations at Jarrahdale, alumina dust from the alumina refinery at Kwinana, flue dust from the cement factory at Munster and caustic dust from the alumina disposal ponds at Medina.

Damage from dust has been associated with reduced photosynthesis or from soluble constituents of the dust (Anon 1967). In either case there may be economic loss from reduced yields or impaired quality. In many cases, dust may form an undesirable deposit on vegetation which detracts from its aesthetic value and consequently its market value, resulting in reduced returns for producers (Darley 1972).

This study examined the phytotoxicity of a number of common dust materials on tomatoes.

MATERIALS AND METHODS

Five dust types (Table 1) were applied daily or weekly and compared with two undusted controls. A randomised block design with five replications was used. The experiment was located at Medina Vegetable Research Station on a Spearwood sand. Each plot consisted of 13 plants with 30cm between each plant, 11 of which were harvested. There were 12 treatments per row, each row being a block.

Tomatoes (cv. Burnley Bounty) were transplanted on November 14, 1977 and grown by normal commercial methods (Hawson 1979), except that plants were watered by Reed bi-wall irrigation in combination with surface black polythene mulch to avoid removal of dust from leaves through washing. Sprinkler irrigation is the normal commercial practice on sandy metropolitan soils.

The dust treatments were applied using a Rega "Bonza" duster commencing on December 12, 1977. The rates of application per plant increased during the period of the experiment as leaf area increased to maintain a complete cover of dust on the leaves. Application was discontinued on March 22, 1978 except for the mud lake treatments which were discontinued on December 27, 1977 because the plants were close to death.

The total amounts of dust applied in each treatment are summarised in Table 1 and some chemical properties in Table 2.

Table 1—Total amounts of dust applied

Dust type	Daily application	Weekly application
	t ha^{-1}	
Control	0	0
Bauxite	29.4	8.0
Mud lake	1.7	0.6
Cement flue	12.8	3.1
Alumina	30.0	7.5
Kaolin	16.6	3.7

Description of dusts—

Bauxite— yellow/red dust produced at Jarrahdale during blasting and overburden removal of bauxite mining operations.

Mud lake—white edge dust on alumina disposal ponds at Medina. The material deposited in these ponds is a mixture of red mud and caustic soda which on evaporation of water leaves a white surface deposit.

Flue dust—collected from the cement factory. It is collected in the electrostatic precipitators (and can be used commercially as a soil applied potassium fertiliser).

Alumina— white dust produced by chemical treatment of bauxite at the alumina refinery at Kwinana.

Kaolin— white clay that underlies bauxite deposits. It was included as a known inert material.

Table 2—Chemical properties of bauxite, mud lake, cement flue, alumina and kaolin dusts

Dust type	pH	Total soluble salts by weight %	choloride by weight %
Bauxite	6.1	0.07	<0.01
Mud lake	10.8	21.7	0.14
Cement flue	11.9	41.4	7.92
Alumina	8.5	0.95	0.01
Kaolin	5.8	0.40	0.19

The plots were hand harvested weekly from January 18 to March 30, 1978. Gross and marketable fruit numbers and yields were determined.

On April 10, 1978, 10 mature leaves around the last or second last bunch and 10 old leaves adjacent to the first and second bunch were collected, dried, gristed and a 1:20 plant-water suspension analysed for pH, specific conductivity, chloride salt and potassium.

RESULTS AND DISCUSSION

The mud lake dust was particularly phytotoxic and application was discontinued on December 27, 1977 as all plants showed severe leaf scorch and stem scald. At this stage only 0.6 and 1.7 t ha^{-1} had been applied on the daily and weekly treated areas (Table 1). No fruit was harvested from these treatments. The only other treatment to show visual plant damage was cement flue dust. This material showed no effects initially but following several dews, mild leaf scorch developed. Both these dusts contain very high total soluble salts and have a high pH (Table 2). The extent of damage does not appear to be related to the total soluble salt content alone (Table 2) and could be associated with specific constituents. All other treatments were comparatively healthy although all were affected by a mild infection of tobacco mosaic virus.

Fruit numbers and yield

Adverse effects on harvested fruit number (an indication of number of flowers produced and fruit set) was only observed when the dust was applied daily (Table 3). Gross fruit numbers were significantly reduced by the flue dust treatments compared with the control. Alumina dust produced higher numbers than bauxite although neither were different from the control or kaolin. Marketable numbers were reduced by all treatments and again where dust was applied daily, the number of fruit on the flue dust treated plants was significantly reduced compared to the untreated control. The numbers on the alumina treated plots were higher than on the controls. The weekly applications resulted in no significant effects.

Fruit weight yields showed comparable trends to fruit numbers with no effect on gross and marketable yields where the dust was applied weekly.

Where the dust was applied, daily cement flue dust reduced marketable yields from 64 to 42 t ha^{-1}.

All other dust treatments resulted in small marketable yield increases of which alumina was the only one significantly higher than the control. The percentage of marketable fruit on the alumina treated plants increased from 52 to 63 per cent compared with control. The yields from daily and weekly treated plants were comparable except for alumina and flue dust.

Table 3—Effect of dust on number of harvested (gross no.) and marketable tomatoes

Dust type	Fruit number $^{+}$/11 plants			
	Harvested		Marketable	
	Daily	Weekly	Daily	Weekly
Control..........	601 bc+	601 bc	304 b	350 bcd
Bauxite..........	569 b	673 c	349 bcd	394 c
Cement flue.	407 a	609 bc	220 a	331 bc
Alumina.........	677 c	622 c	406 d	361 bcd
Kaolin............	597 bc	674 c	346 bcd	389 c

+fruit numbers followed by the same letter are not significantly different at $p < .05$.

Table 4—Effect of dust on harvested and marketable yields

Dust type	Yield $^{+}$ t ha^{-1}			
	Harvested		Marketable	
	Daily	Weekly	Daily	Weekly
Control..........	123 bcd+		121 bcd	64 b
74 bcd				
Bauxite..........	155 b	138 cd	75 bcd	82 cd
Cement flue.	68 a	115 b	42 a	67 bcd
Alumina.........	142 d	177 bc	90 d	71 bc
Kaolin............	127 bcd	137 bcd	76 bcd	82 cd

+ yield numbers followed by the same letter are not significantly different at $p < .05$.

Comparison of leaf-water suspension analysis (Table 5) and yields indicated significant negative correlations between yield and pH, conductivity, chloride, sodium and potassium (Table 6). As the concentration of chloride, sodium and potassium increased, yield decreased. This either could be associated with a total salts effect or specific toxic effects of sodium and/or chloride. The potassium concentrations were not high enough to be toxic (Lorenz and Tyler 1976).

Table 5—Effect of dust treatment on composition of leaf-water suspensions

Dust type	Application	pH	Conductivity mSm^{-1}	Cl % D.W.	Na % D.W.	K % D.W.
Control		6.0	770	3.1	0.50	2.8
Bauxite	Daily	6.1	820	3.2	0.67	1.9
Mud lake	Daily	5.8	840	3.6	0.60	2.2
Cement flue	Daily	6.7	1250	5.5	1.40	4.7
Alumina	Daily	6.0	800	3.3	0.57	1.9
Kaolin	Daily	5.9	710	2.8	0.57	1.8
Bauxite	Weekly	5.6	800	3.5	0.57	2.0
Mud lake	Weekly	6.0	810	3.7	0.72	1.8
Cement flue	Weekly	6.2	1000	4.3	0.96	3.3
Alumina	Weekly	5.8	790	3.2	0.70	2.3
Kaolin	Weekly	6.0	730	3.0	0.51	2.0

Table 6—Simple regression equations between marketable yield and leaf-water suspension properties

Property	r	b	a
pH..................	0.79*	-35.3	285.5
Cl.....................	0.81**	-13.0	119.0
Conductivity	0.85**	- 0.07	130.3
Na..................	0.88**	-40.9	102.0
K.....................	0.93***	-13.1	105.8

r = correlation coefficient
b = slope
a = y axis intercept

This experiment was not designed to simulate any specific field pollution situation. It was designed to determine the relative phytotoxicity of a range of dust materials which could affect vegetable production. Although rates of application varied, the quantities applied were generally the maximum quantity tomato leaves could retain without excess shedding. As such the relative phytotoxicity of the dusts tested can be ranked as mud lake, cement flue with no negative effects from bauxite, alumina or kaolin. The yield depressions obtained here involved dust application at the rates of 0.6 to 1.7 t ha^{-1} for mud lake and 3.1 to 12.8 t ha^{-1} for flue dust. It is not known if damage would occur at lower rates of mud lake dust. In the case of cement flue dust, 3.1 t ha^{-1} had relatively little effect whereas 12.8 t ha^{-1} resulted in severe yield depressions. Flue dust is normally collected in electrostatic precipitators between the kiln and the stack which controls most emission. It is only during equipment breakdown that this material would be a potential problem or if disposed of in open pits or stacks subject to wind action.

The phytotoxicity of cement-kiln flue dust is enhanced in the presence of free moisture (Darley, 1971). An alkaline solution from such deposits is able to penetrate the leaf and cause leaf scorch. In this experiment, water was applied through trickle irrigation although commercial practice is to use sprinklers. In the latter case phytotoxicity may be greater, particularly if the pollution event followed shortly after watering when free surface water was present, but in most cases the flushing effect of overhead irrigation would be expected to reduce the risk of damage.

Alumina dust has been implicated in a number of reports of damage. In this study the heavy rate of application resulted in increased market yields. The exact reason for this effect is not known but the material being white and strongly reflective may have reduced leaf temperatures.

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