SODIUM NITRATE WITH AND WITHOUT SORBITOL IN *BACILLUS THURINGIENSIS* FORMULATIONS: SPRAYABILITY, WATER RETENTION AND CRYSTALLIZATION BEHAVIOUR

by

Wm. Haliburton

Report CC-X-128

Chemical Control Research Institute
Canadian Forestry Service
Department of the Environment
Ottawa, Ontario

July, 1976

SODIUM NITRATE WITH AND WITHOUT SORBITOL IN BACILLUS THURINGIENSIS FORMULATIONS: SPRAYABILITY, WATER RETENTION AND CRYSTALLIZATION BEHAVIOUR

by

Wm. Haliburton

INTRODUCTION

In forest spraying with *Bacillus thuringiensis* Berliner (B.t.), commercial concentrates of spores and crystals are usually further formulated with various diluents, adjuvants and protectants to enhance sprayability, deposit efficiency and persistence. Sorbo (70% sorbitol in water) has been used for its droplet loading and moisture retention properties but is expensive. Dr. W.A. Smirnoff of the Laurentian Forest Research Centre (personal communication), has been examining more economical substitutes and has suggested sodium nitrate. Samples of two nitrate formulations with Sorbo (5% and 10%), and one without, supplied by Dr. Smirnoff, were examined for sprayability, moisture retention and crystallization behaviour. The resulting information, largely qualitative, is reported here for others who may formulate and spray B.t.

MATERIALS

The three B.t. formulations of Dipel® 36B (Abbott Laboratories) are detailed in Table I.

METHODS

Sprayability was examined by spraying the materials into a small wind tunnel and observing the deposit on a strip of Kromekote paper on its floor. The three mixes (dyed red, green or black) were sprayed successively through a small pneumatic nozzle at the same air pressure, into a small tower from which a portion of the spray fell through a slot into the wind tunnel. At airspeed *ca.* 15 cm/s, the drops are deposited at various distances downwind according to their size and fall rate. Evaporation rates could be roughly compared by noting the relative positions of the zones of transition from liquid condition when deposited, to essentially dry spheres. Water loss vs. relative humidity was observed in gross samples in petri dishes. Relative crystallizing behaviour was observed in air-dried gross samples.

RESULTS

1. All three formulations sprayed satisfactorily with good atomization, with a tendency to slightly coarser break-up of the liquid with increasing Sorbo content.
2. At lab relative humidity (RH) *ca.* 33%, the zone of transition of the deposit from liquid droplets to solid spheres was 30-35 cm downwind, with the high Sorbo mix doubtfully extending farther than the other two, perhaps indicating slightly retarded drying out of the drops of that mix. Although the dried spheres of the $NaNO_3$ mix broke up easily when crushed, they did not disintegrate readily when flooded with water. Spheres of the 10% Sorbo mix remained a bit gummy and perhaps more adherent, but disintegrated

in water. This would affect physical persistence of the deposit and redistribution by rain, etc. The 5% Sorbo mix was intermediate in behaviour.

3. No gross crystal structure was visible in the deposited drops. In the gross samples (petri dishes) crystals, although large, were smallest in the 10% Sorbo mix.

4. The deduced make-up of the three mixes in terms of water and dry ingredient weights is listed in Table I, leading to estimates of densities and dry weight percentages. These dry weight values differ somewhat from those derived by oven-drying small samples. Loss of bound water and/or pyrolysis from excessive oven temperature is suspected.

5. Results of allowing samples to equilibrate at various humidities after oven drying were unsatisfactory. It is to be expected that moisture retaining ability of a mix would be related to the hygroscopic behaviour of the sorbitol and $NaNO_3$ components. A saturated solution (48% w/w) of the salt would be in equilibrium with atmospheric moisture near RH 70% (?). As the mixes contain less $NaNO_3$ than that required to saturate the water in them (see items 10 and 11 in the Table I), they can be expected to evaporate considerably even at quite high RH values. Samples evaporated at 94% RH lost 37-43% of their weight (see Table II).

6. It is difficult to evaluate the humectant effects of Sorbo vs. $NaNO_3$, as they are "confounded". When together, each lays claim to some of the available water. An increase in the sorbitol content apparently increases water retention (63% vs. 57% residual wt. for 10% vs. 5% Sorbo) (Table II), though the observed effect is probably reinforced

by the higher percent saturation of $NaNO_3$ in the 10% Sorbo formulation (Item 11, Table I). On the other hand, 43% salt saturation in the absence of Sorbo (Item 11) resulted in lower residual weight (61%), than 37.5% salt saturation in the presence of 10% Sorbo (63%). But apparently, 5% Sorbo was not enough to balance out the lessened water retention related to 33.7% salt saturation, 57 vs. 63% residual weight associated with 43% saturation!

7. We can make no recommendation regarding the suitability of $NaNO_3$ as a constituent in B.t. spray formulations on the basis of these few tests. It does "load" the drops and retain some water at high humidities. Probably twice as much could be loaded into the mixes and be that much more effective, but its interaction with other adjuvants, protectants etc. in relation to deposit persistence and redistribution is not readily predictable.

8. As for fertilizing effect, the proposed quantities amount to only about one pound per acre (1 ± kg/ha) containing only about 16% elemental nitrogen, which is infinitessimal when compared with usual fertilizer application rates.

9. Although the mixes may be eminently sprayable, there is no guarantee that they will be acceptable to the aerial spray operators. We have no specific information on the corrosive properties of $NaNO_3$ to aluminum and other metals used in aerial spray equipment.

Table I

Constitution of three B.t. - $NaNO_3$ formulations

	II	XIV	XII
Smirnoff Code	II	XIV	XII
CCRI Code	75-078	75-079	75-080
Dipel 36B	50% v/v	50% v/v	50% v/v
$NaNO_3$	35% w/v soln. (50% v/v)	30% w/v soln. (45% v/v)	35% w/v soln. (40% v/v)
Sorbo (70% Sorbitol)	0	5% v/v	10% v/v
1) Est. density	1.138 g/ml	1.128 g/ml	1.142 g/ml
200 ml -theoretical contents:-			
2) Dipel (dry)	14.6 g	14.6 g	14.6 g
3) Sorbitol	0	9.1 g	18.2 g
4) $NaNO_3$	44.0 g	32.8 g	35.2 g
5) Total solids	58.6 g	56.5 g	68.0 g
6) H_2O	169.0 g	169.1 g	160.4 g
7) Total wt.	227.6 g	225.6 g	228.4 g
8) % H_2O	74.25	75	70.2
9) % dry ingredients	25.75%	25.0%	29.8%
10) % $NaNO_3$ in H_2O	20.7%	16.2%	18.0%
11) $NaNO_3$ % saturation (in H_2O)	43%	33.7%	37.5%

Table II

Evaporation analysis of small samples

Small Sample:-			
Oven Dry Wt. %	22.0	22.5	26.0
Pyrolysis (?) loss	3.8%	2.5%	3.8%
(= Item 9, Table I)	25.8	25.0	29.8
Equilibrium % of fresh wt. @ 94% RH	61%	57%	63%
% fresth wt. lost (H_2O)	39%	43%	37%
% of water content lost @ 94 RH	52.5%	59%	52.9%
Est. saturation of $NaNO_3$ @ 94% RH	82%	57%	71%