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Effect of Chemical release behaviour of dust formulations of tecnazene on potato sprout suppression.

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Abstract

Vapour release patterns of tecnazene (*1, 2, 4, 5–tetrachloro–3–nitrobenzene (TCNB)*) dust formulation were determined by the chromatographic residue analysis of the formulations at various time intervals. At a storage temperature of 24^{0}C and 70 ± 2 relative humidity (RH), formulations with kaolin and molecular sieve (powder) as carriers, released rapidly (8.2 and 8.3% loss per week respectively) while release was very slow with bentonite as a carrier (1.7% per week). Triton X–405 additive was found to reduce, significantly, the rate of TCNB release from formulation with alumina as a carrier. Moderately low release rate and even distribution over the tubers were among the factors that seem to promote potato sprout suppression by the dust formulations of TCNB at 24^{0}C.

Introduction

The sprout suppressant chemicals which can be applied on post-harvest potato tubers are either volatile or non-volatile. The non-volatile chemicals are applied as liquid sprays or dips while the volatile ones are introduced as vapour. Introduction of the chemical as a vapour provides an easier, more uniform means of distribution (Talburt and Smith, 1967). If the chemical is sufficiently volatile, it can be introduced after storage has been completed. In this way, application can be deferred until proved necessary and re-application during longer storage periods will also be possible. At the end of the storage period, residues of volatile chemicals can be readily reduced by a period of ventillation (Meigh, 1969). Volatile Sprout Suppressant was employed for the present work. Rate of chemical release from formulations increases with temperature (Hartley and Graham-Bryce, 1980). High rate of chemical release may cause the early loss of activity of the formulations. Relatively low release rate is equally undersirable since the effective chemical concentration may not be reached around the tubers.

Since electricity is unreliable in Nigeria, it is unpractical to store potato tubers at 10^{0} or below being the temperature at which the present post-

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harvest potato sprout suppressant formulations are effective. It is therefore desirable to look for a potato sprout suppressant formulation which can be effective at a temperature of 20–24^{0}C which is an easily attainable storage temperature in Nigeria. Thomas et al (1979) found that storage of potatoes at high temperature increased the incidence of bacterial and fungal infection. Tecnazene (*1, 2, 4, 6–tetrachloro–3–nitrobenzene (TCNB)*) which is both a potato sprout suppressant and a fungicide is therefore suitable for use at high temperature and was employed for the present experiment.

The work reported here is on the comparison of release behaviour of the prepared TCNB formulations and determination of the effect of different release patterns on the potato sprout suppression at 24^{0}C. Triton X–405 used as an additive in some formulations had earlier been found by the author to possess no potato sprout suppression activity. (unpublished).

Materials and Methods

Triton X–405 was obtained from Sigma Chemical Company, St. Louis, Missouri, USA. TCNB was purchased from Aldrich Chemical Company Ltd., Dorset; England. Alumina was obtained from Hopkin and Williams and kaolin, molecular sieve type 5a (powder) and betonite were supplied by BDH Chemicals.

The potato sprout suppressant formulations of TCNB were prepared according to the procedure of Oladimeji et al (1981) such that 25g of each contained 625mg TCNB. The carriers employed were alumina, molecular sieve 5a (powder), bentonite and kaolin; and the additive was Triton X–405. The chemical release behaviour of formulations were determined under the environmental conditions similar to those for potatoes in storage, using similar procedure to that of Dobbs and Grant (1980). 25g of each formulation was weighed into cardboard boxes (dimensions of each : 394mm x 298mm x 152mm) and spread on the floor of the box. The loosely covered boxes were kept in ventilated rooms controlled at 24^{0}C and Relative Humidity (RH) of 70 ± 2%. Each experiment was carried out in triplicate. At intervals of time, after mixing with a spatula, 1.00g of formulation from each box was taken out for analysis. The remaining formulation was again spread uniformly over the bottom of the box. The analysis was carried out by extracting 1.00g of formulation with 100cm^3 glass distilled hexane in a chromatographic column (14cm long x 1.5cm i.d.). The additive Triton X–405 had earlier been found to be held onto the column on eluting with hexane (unpublished). Each eluant was analysed by a Gas Chromatographic method. Samples of 5ul. eluant were injected with a 10µl. glass syringe (Hamilton series 701) into a Gas Chromatograph (Becker Gas Chromatograph, model 419) equipped with a flame ionization detector. The chromatographic conditions were: Stationary phase 5% OV on 100 – 120 mesh GC Q support (supplied by Applied Science Laboratories, Inc.) in 2m x 3.2mm i.d. x 6.35mm o.d. glass column; oven temperature – 180°C isothermal, detector temperature – 250°C and injection temperature – 240°C. The mass of TCNB present in 25g formulation was calculated in each case. From the results derived from the chemical release rate pattern, some formulations were tested on potato tubers for sprout suppression activity at 24°C according to the procedure of Beveridge *et al* (1981). Tuber sprouting was assessed by measuring the longest sprout on a tuber and determining the mass of sprout per one gram mass of tuber (Godwin *et al.* 1969; Wurr, 1978).

Results and Discussion

Sprout measurement:

In order to determine the more suitable measure of extent of potato sprouting, length and total mass of sprouts were measured. The results as shown in figure 1 indicate that there is a linear relationship between the length of the longest sprout per tuber and the mass of fresh sprout per one gram mass of tuber. Both methods are therefore adjudged suitable for the assessment of tuber sprouting.

Formulations kept at 24°C

Formulations with kaolin and molecular sieve 5a (powder) as carrier respectively released TCNB rapidly with an average of 8.2 and 8.3% per week respectively (Table 1). This indicated that these formulations will not give a persistent TCNB release. Formulation with bentonite as carrier gave very low TCNB release rate of 1.7% per week. Triton X–405 as additive reduced the rate of release in a formulation with alumina as a carrier from 5.2% to 3.6% per week.

Potatoes kept at 24°C

Formulation with kaolin as carrier produced greater sprout growth inhibition than formulation with bentonite as carrier (Table 2). The two formulations did not however produce good sprout growth inhibition. The formulations could evenly be spread over the tubers. That the two carriers failed to give better TCNB inhibition at 24°C may be due to the fact that kaolin does not release very efficiently while bentonite holds onto the chemical too tightly as indicated in table 1. Triton X–405 (15%W/W) may not improve inhibition by alumina as a result of its high proportion in the formulation (Table 3). Lower proportions therefore need to be tried. On considering the rate of TCNB release, kaolin which released more rapidly

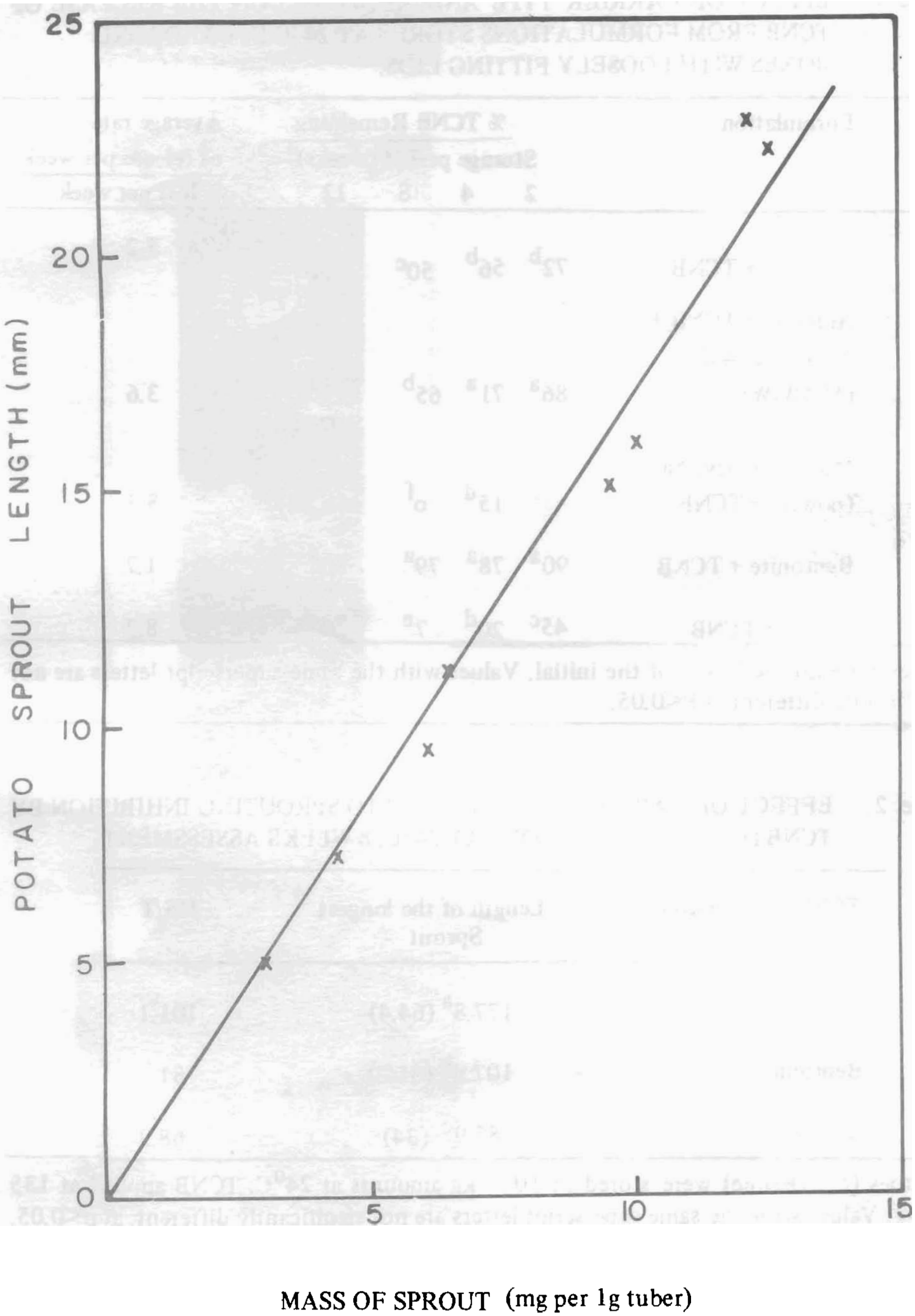

Fig. 1: Comparison of the length of the longest sprout per tuber with the mass of fresh sprout per one gram of tuber for potatotes var. King Edward, store at 24°C. TCNB present in different formulations applied at 135mg/kg.

Table 1: EFFECT OF CARRIER TYPE AND ADDITIVES ON THE RELEASE OF TCNB FROM FORMULATIONS STORES AT 24°C IN CARDBORD BOXES WITH LOOSELY FITTING LIDS.

Formulation	% TCNB Remaining Storage period (weeks) 2	 4	 8	 12	Average rate of release per week % lost per week
Alumina + TCNB	72^b	56^b	50^c	38^c	5.2
Alumina + TCNB + Trition X–405 (15%W/W)	86^a	71^a	65^b	57^b	3.6
Molecular sieve 5a (power) + TCNB	45^c	15^d	0^f	0^e	8.3
Bentonite + TCNB	90^a	78^a	79^a	80^a	1.7
Kaolin + TCNB	45^c	20^d	7^e	2^e	8.2

Values are expressed as % of the initial. Values with the same superscript letters are not significantly different at P<0.05.

Table 2: EFFECT OF CARRIERS ON THE POTATO SPROUTING INHIBITION BY TCNB DUST FORMULATIONS AT 24°C. 8 WEEKS ASSESSMENT

TCNG Formulation	Length of the longest Sprout	MS/T
Control	177.8^a (64.4)	101.1
Bentonite	107.9^b (31.2)	81
Kaolin	85.9^c (34)	68.9

Potatoes (cv. Desiree) were stored in 10 – kg amounts at 24°C. TCNB applied at 135 mg/kg. Values with the same superscript letters are not significantly different. at p<0.05. Figures in parenthesis are standard deviations with (n–1) degrees of freedom. MS/T denotes mass of sprout (mg) per 1 g mass of tuber.

Table 3: EFFECT OF CARRIERS AND TRITON X–405 ADDITIVE ON THE POTATO SPROUTING INHIBITION BY TCNB DUST FORMULATIONS AT 24°C. 8 WEEK ASSESSMENT.

TCNB formulation	Length of the longest sprout (mm)	MS/T
Control	42.9^{a} (10.7)	13.7
Kaolin	15.1^{c} (10.5)	9.6
Alumina	22.2^{b} (14.1)	12.6
Alumina + Triton X 405 (15%W/W)	22.8^{b} (13.5)	12.2

Potatoes (cv. King Edward) were stored in 10 – kg amounts at 24°C. TCNB applied at 135mg/kg. Values with the same superscript letters are not significantly different at $P<0.05$. Figures in parenthesis are standard deviations with (n–1) degrees of freedom. MS/T denotes mass of sprout (mg per 1 g mass of tuber.

was expected to inhibit sprouting less than alumina formulation but a contrary result was observed. This may be due to the difference in physical form, for kaolin formulation spreads better and sticks more tightly to the tuber surface than alumina formulation.

Conclusion

Formulation with bentonite, as a carrier, has a low release rate (1.7% per week) while that with kaolin has a high release rate (8.2% per week). Both formulations were found not to produce high potato sprout suppression. This indicates that formulations with very low or very high TCNB release rates were found not to produce high potato sprout suppression. Formulation with kaolin as a carrier, even though of a higher TCNB release rate, suppressed sprouting better than that of alumina formulation with or without additive. In a similar manner, the alumina formulation with additive produced inhibition of the same magnitude as that for the formulation with no additive, despite the fact that the latter has higher TCNB release rate (5.2% per week).

The fact that slow rate of release did not improve some formulations may be due to either too slow a release rate at certain periods or that the physical form of some formulations did not allow them to spread uniformly and widely over the tubers. The present results therefore indicate that the inhibition activity of a dust formulation is dependent on both the chemical release rate and on the extent to which the tuber surface is covered by the formulation.

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