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The treatment of potato tubers with sprout inhibitors

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Summary

Working with the sprout inhibitors IPC and CIPC we compared 3 treatment methods: (1) a 10 ppm dosage of powder distributed over the tubers, (2) a Swingfog treatment (atomizing a solution in the air duct, dosage up to 20 ppm), (3) a porous cartridge containing the inhibitor placed in the air duct. To obtain good sprout inhibition in connection with accumulated IPC/CIPC residue values below the legal level of 0.5 mg per kg peeled tubers we advise the powder treatment only for relatively long storage (up to May–June); a 10 or 20 ppm Swingfog treatment for short storage (up to January–February) or longer storage respectively.

With the cartridge system we obtained promising results; good sprout inhibition and satisfactorily low residue values.

Introduction

Of the compounds we meet in the nearly thirty-year history of sprout inhibitors the herbicides isopropyl-N-phenylcarbamate (propham, IPC) and isopropyl-N-(3-chlorophenyl) carbamate (chloropropham, CIPC) have the most important practical significance and are the only inhibitors used in our country. They have proved to be very effective in practice, also at higher storage temperatures (7–10 °C), which are important for potato processing. These inhibitors can be used as a powder (containing 1 % IPC and CIPC) or as a liquid (containing 25 % or more active agent, mostly CIPC). The powder is distributed over the tubers while loading the bin. The CIPC solutions are atomized by means of special equipment (Swingfog, Pulsfog, Sprout-Nip) in the ventilation duct and distributed through the potatoes by internal ventilation. The dosage is expressed as grammes IPC and or CIPC per 1000 kg tubers (ppm) and normally amounts to 10 ppm for the powder treatment and to 20 ppm for an atomized solution (in our case Swingfog) treatment. Swingfog-like systems also enable us to divide the dosage over different treatments during storage. Our Pesticides Law allows the use of IPC-CIPC as sprout inhibitors if the inevitable accumulated residue at the moment of consumption does not exceed 0.5 mg (IPC + CIPC) per kg peeled tuber (0.5 ppm).

If the powder treatment is used in the case of a longer storage it will generally be possible to keep the residue below this value in applying the described treatments (van Vliet and Hertog, 1968). Nevertheless it remains very important to study the

possibilities of achieving a satisfying inhibition of sprouting with residue values that are as low as possible. From small-scale experiments we know that a sprout inhibiting effect is obtained if tubers are stored in air containing traces of IPC/CIPC in the gaseous phase.

We were therefore interested to know whether an IPC- or CIPC-containing porous cartridge in the ventilation duct could produce a satisfying sprout inhibiting action and to compare this with the treatments previously described.

Methods

The storage experiments described here were with the variety *Bintje* in the 'Coöperatieve Bewaarplaats' at Numansdorp and the Experimental Farm 'De Eest' at Nagele. In the first case the potatoes were stored in 50 ton bins on the practical scale; in the second case 15 ton bins, on a somewhat more experimental scale, were used. Sprout inhibition was obtained by the described 10 ppm powder and up to 20 ppm Swingfog treatments and also by using a CIPC-cartridge in the ventilation duct. Such a cartridge was prepared for a maximum 20 ppm treatment in a 15 ton bin and contained mainly CIPC: 260 gram CIPC and 40 gram IPC. A concentrated methylene chloride solution[1] of this amount was absorbed in sheets of filterpaper, which were dried at room temperature afterwards. The loosely rolled-up sheets were placed in open-ended plastic cylinders. These were placed as a cartridge in the ventilation duct, so the air could pass freely over the surface covered by CIPC. This treatment was started with a 3–4 week period of internal ventilation, to be sure that all evaporated CIPC should be kept by the bulk of potatoes to build up a starting-residue. Later on the normal ventilation system was operated, by which the air passed through both cartridge and tubers and was eventually recirculated if this was useful in the ventilation programme.

The following numbers give an idication of the ventilation programme used: In the period of September 20th to November 10th in the case of a normal Swingfog-treated bin, 8 hours internal and 170 hours external ventilation were given. Using our 'cartridge' system, however, 375 hours internal and 175 hours external ventilation were given. In the period from November 10th till April 20th in both cases 90 hours internal and 130 hours external ventilation were given. We have yet to study whether such an extreme internal ventilation in the starting period is really necessary to distribute the CIPC vapour through the bulk.

If we want to follow the sprout inhibitor residue during storage only sampling from the top layer is possible; a bad, but unavoidable way of sampling. It would be much better to take samples from the conveyor belt while unloading the bin to determine a representative value of the end residue.

The IPC/CIPC residues were determined by gas-liquid chromatography after extraction in methylene chloride (van Vliet and Hertog, 1966). As methylene chloride is very corrosive to the flame-ionisation detector we now evaporate nearly to dryness and redissolve in methylethylketone. Before the analysis the tubers were washed inten-

[1] Luxan (Elst-Overbetuwe) Anti Spruit S.C.

sively to remove attached inhibitor, and peeled by hand (peeling losses 15%). IPC and CIPC were determined separately in the peelings and in the peeled tubers. The residues are presented as mg (IPC + CIPC) in 1 kg unpeeled tubers and in these tubers after peeling.

The samples studied were also inspected for sprouting and particularly for internal sprouting.

Results

1. An example is given of the course of the residue during storage after a 10 ppm powder or a 10 or 20 ppm Swingfog treatment in the bins of the storehouse at Numansdorp. Storage was started in the second half of September 1966, the Swingfog treatment was given within a week after the start. The decision to store was based on commercial grounds. During storage samples were taken on the same place in the top

Table 1. Residue values (ppm) during storage of *Bintje* in the 'Coöperatieve Bewaarplaats' at Numansdorp.

Data	10 ppm powder	10 ppm Swingfog treatment	20 ppm Swingfog treatment
19.10 (1966)	1.7 (3.6)[1]	0.2 (1.2)	0.5 (2.0)
4.11	1.3 (2.9)	0.2 (1.2)	0.8 (2.9)
16.11	2.0 (4.6)	0.3 (1.4)	0.9 (4.4)
29.11	1.7 (3.5)	0.2 (1.3)	0.7 (5.8)
20.12	1.7 (3.2)	0.3 (1.1)	0.5 (1.1)
14.20-(1967)	0.7 (1.6)	0.3 (0.6)	0.5 (0.7)
4.4	0.3 (0.7)	0.1 (0.4)	
18.5			0 (0)

[1] If 1 kg washed tubers were peeled 1.7 mg (IPC + CIPC) was found in the peeled tubers and 1.9 mg in the peelings. So 3.6 mg was present in the unpeeled tubers.

layer. The residue values are collected in Table 1. The sprout inhibition was satisfactory (10 ppm Swingfog) to good (10 ppm powder). Internal sprouting was not observed after the described storage at temperatures of 7–10 °C.

2. The results of storage experiments in the Experimental Farm 'De Eest' indicated that a 10 ppm powder treatment or a 20 ppm Swingfog treatment, followed by storage at temperatures up to 10 °C, generally gave a good result.

After storage up to May-June the residues analysed in a representative sample of the bulk were in general not higher than 0.3 mg per kg peeled tuber. The same results were obtained in the case of a Swingfog dosage divided over two or three treatment times in the storage programme.

3. The first experiments on the described CIPC-cartridge in the air duct was at 'De Eest' in the 1968–'69 season. On account of harvest troubles we could not start with storage at 7–10 °C earlier than December 23. After 4 weeks of internal ventilation storage was continued up to February 28. Although a sprout inhibiting effect was evidently present this was not enough to make this storage satisfactory in practice. That some depression was observable is in accordance with residue values of nearly 0.2 mg per kg unpeeled tubers on January 20th at the end of the storage. In the 1969–1970 season the experiment was repeated and started at September 8th at a storage temperature of 5–7 °C. After a 3 weeks period of internal ventilation storage was continued with a normal ventilation programme up to April 28th. The sprout inhibiting effect was good, only in a 20 cm top layer serious sprouting was observed at the end of the storage, while internal sprouting did not occur in the bulk. Generally the storage result was nearly as good as in comparable bins where a Swingfog treatment was applied.

Table 2 shows the residue values determined during storage and after unloading the bin.

Discussion

If we compare a 10 ppm powder and Swingfog treatment the residue values in the first case are evidently higher. We have the idea that the active substance in the case of powder is safe-guarded against evaporation by the inert carrier, so that a larger amount remains on the tuber. In the case of a 20 ppm powder treatment the residues will be rather high, even after long storage. Therefore such a treatment is not allowed in our country. During storage we observe that the residue orginally built up in the tuber is decreasing by evaporation, and possibly also by chemical changes.

In the sequence 10 ppm powder, 20 ppm Swingfog, 10 ppm Swingfog the accumulated residues are lower and the storage time to reach a low residue value of for example 0.3 mg per kg peeled tuber is shorter. Of course, the duration of a good sprout-inhibiting effect is also shorter in this order. If we want to use the powder treatment it seems good to reserve this for a rather long storage at a relatively high temperature. Good storage results with an atomizing system, like Swingfog, are generally possible and we can choose the dosage in accordance with the expected storage time: a 10 ppm treatment if storage will end in January-February; a dosage up to 20 ppm in case of a longer storage at 5–10 °C. If the storage time is still unknown it is wise to start with a 10 ppm treatment and to give repeatedly small (for example 3 ppm) dosages afterwards, until the end of storage is in sight. This method will enable the combination of a satisfying sprout inhibition with a low residue value.

As presented in Table 2 the CIPC-cartridge system was very promising: also in this case interesting low residue values were combined with good sprout inhibition. An advantage of this treatment is that at the moment the residue (in samples from the top layer) has reached a satisfactory value, the cartridge can be removed and also replaced later on.

Table 2. Residue values (ppm) during storage of *Bintje* in the Experimental Farm 'De Eest' at Nagele, using a 20 ppm CIPC 'cartridge' in the air duct.

Data	Residue values
6.10 ('69)	0.1 (0.3)
20.10	0.2 (0.4)
5.11	0.1 (0.3)
15.1 ('70)	0.1 (0.2)
28.4	0.05 (0.2)[1]

[1] At the end of the storage a representative sample was taken while unloading the bin. All other values are from samples taken from the top layer.

In the coming storage season we hope to study whether the relatively long time of internal ventilation to build up a starting residue is really necessary and also whether it is possible to replace the described filter papers (chosen for the big surface exposed to the ventilation air) by a simpler cartridge containing powdered IPC/CIPC in a porous packing.

References

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