POST-HARVEST CONTROL OF AFLATOXIN PRODUCTION IN IN-SHELL MOIST PEANUTS WITH SODIUM ORTHO-PHENYLPHENATE: III. STORAGE TESTS

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ABSTRACT: The present experiment aimed to evaluate the effect of sodium ortho-phenylphenate (SOP) application to in-shell moist peanuts for the control of aflatoxin production. Previous studies showed the need to improve the SOP solution distribution on peanut pods to evaluate the product. Thus, in this experiment the place of the spray system was the bag filler pipe of the pre-cleaning machine in the warehouse. In the 1989 rainy season two lots of 120 bags of in-shell moist peanuts were sprayed with 0.5 and 1% SOP solutions and aflatoxin production was not controlled. In the dry season of 1989 and in the rainy season of 1990, in-shell moist peanuts were sprayed with 5% SOP solution. The coverage of pods with the solution was efficient, allowing a uniform distribution of SOP solution on the pods. The results showed that only the 5.0% concentration of SOP solution utilized controlled the external fungal growth when a naked eye observation was made, however did not control aflatoxin production when applied to in-shell moist peanuts, probably due to the internal presence of Aspergillus flavus and because the fungicide could not penetrate inside to reach the kernels.

Key words: aflatoxins, peanuts, chemical control, sodium ortho-phenylphenate, post-harvest.

INTRODUCTION

Deterioration of peanuts by fungi is partly due to conditions that favor molding after windrowing and during storage. Peanut contamination with aflatoxins, a toxin produced by Aspergillus flavus and A. parasiticus, is a great problem in Brazil, mainly when climatic conditions are adverse during the harvest period, what turns a rapid and efficient drying impossible. Application of fungicides at the beginning of windrow or storage periods may reduce this problem (JACKSON, 1965). The chemical treatment efficiency depends on the ability of the sprayed substances to cross the shell barrier. Studies made by JACKSON (1964) showed the presence of considerable fungal contamination on kernel surfaces within intact pods, most probably resulting from the growth and penetration of shell surface inhabitants into lobular spaces.
Healthy plant tissues can become infected if fungal growth spores become attached to the stigma of developing flowers. The spores may germinate and germ tubes penetrate into the developing seed tissue without causing visible damage (SMITH & MOSS, 1985).

Mature and freshly harvested peanut pods, sprayed with chemicals, under field conditions, were prevented of A. flavus invasion and formation of aflatoxins in kernels (BELL & DOUPNIK JUNIOR, 1971, 1972; MADAAN & CHOHANN, 1978). FONSECA et al. (1992,1994), studied during 3 years the spray of sodium ortho-phenylphenate (SOP) solution on moist in-shell peanuts, under field conditions, to verify its effect on the control of aflatoxin production. The results showed that although aflatoxin production was controlled fungal growth was not and it was necessary to improve the coverage of peanut pods with the solution, in order to verify the real efficiency of the SOP.

The aim of this paper was to test the efficiency of SOP sprayed on in-shell moist peanuts during the pre-cleaning operation, when it is believed that the coverage would be better.

MATERIAL AND METHODS

This experiment was conducted in the peanut producing region of Marília, SP., Brazil, during the rainy and dry seasons of peanut crops in the years of 1989 and 1990.

Peanuts were dug, windrowed and harvested according to the usual agricultural practices of the region. Daily, after digging and windrowing, samples were taken to monitor moisture content until 14-18%.

In the 1989 rainy season, three lots were submitted to a pre-cleaning operation in a ventilation machine. Two of them were sprayed with SOP solution at concentrations of 0.5% and 1.0 % and the third, without treatment, was considered as control. The spraying operation was made in the bag filler pipe by an adapted cross spraying system. In the dry season of 1989 and rainy season of 1990, two lots were used per season. One was treated with 5% SOP solution and other considered as the control. Throughout the whole experiment, after the spray operation, stacks of 120 bags of 3 x 4 x 10 bags high were built for each lot. Fifteen samples from each lot were drawn to check moisture and aflatoxin contents to determine the initial conditions of the lots. Sixteen external samples, from each lot, were taken after one month of storage and moisture contents.

In order to measure peanut moisture content a resistance type portable moisture tester (ELOTTEST) was utilized in the field. In the laboratory, the oven method (BRASIL, 1976) was used. The modified methods of PONS JUNIOR et al. (1966) conjugated with VELASCO & MORRIS (1976) were utilized to measure aflatoxin content. The modifications were: a) the ratio: peanut kernels /water in the slurry was 1:1.5; a total of 50 g of the slurry, was transferred to 250 ml Erlenmeyer flask and 100 ml acetone was added for extraction; b) the clean up procedure was made with a 20% lead acetate solution, without boiling (PONS JUNIOR et al., 1972); c) the chloroform amount for partition was 2 x 25 ml (STOLOFF & SCOTT, 1984).

RESULTS AND DISCUSSION

The moisture content and aflatoxin contamination of peanuts in treated and control lots are presented in Table 1.

1989 CROPS - Rainy season: The 0.5 and 1.0% SOP solutions were not efficient to control aflatoxin production. The initial aflatoxin mean values (B1 + G1 aflatoxins) of the lot treated with 0.5% and 1.0% SOP solution was 114 and 61 µg/kg, respectively. After one and two months of storage the mean values increased to 42,258 and 49,170 µg/kg for 0.5% SOP and 6,482 and 4,326 µg/kg for 1.0% SOP solution. Control lots were initially contaminated with a mean value of 3,335 µg/kg and after one and two months the mean values were 16,466 and 16,606 µg/kg, respectively. In this season heavy rains occurred during the harvest and it was difficult to obtain non contaminated peanuts to start the experiment and thus, the lots were initially contaminated with aflatoxins. SOP solution did not control aflatoxin build up, although was uniform, and the mean values of aflatoxin increased along the storage period.

Dry season: The 5% SOP solution was used and the results showed that only one sample of the treated lot (after two months of storage) was contaminated with aflatoxins (37 µg/kg), however, also in the control lot, none of the samples were contaminated. Probably the environmental conditions were not favorable to aflatoxin production. It was observed that the peanut pods of
<table>
<thead>
<tr>
<th>Treatments</th>
<th>Before storage</th>
<th>After 1 month of storage</th>
<th>After 2 months of storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOP (8.5%)</td>
<td>analyzed sample</td>
<td>15 14 11 4 16 90</td>
<td>16 16 42 358 9.73</td>
</tr>
<tr>
<td>Raining/89</td>
<td>mean moisture</td>
<td>16 6 61 14 20</td>
<td>16 16 46 82 10.25</td>
</tr>
<tr>
<td>SOP (1.0%)</td>
<td>analyzed sample</td>
<td>15 15 3535 15 80</td>
<td>16 16 16 466 9.91</td>
</tr>
<tr>
<td>Raining/89</td>
<td>mean moisture</td>
<td>16 0 0 0 9.08</td>
<td>16 0 0 14.81</td>
</tr>
<tr>
<td>Control</td>
<td>analyzed sample</td>
<td>15 15 3535 15 80</td>
<td>16 16 16 466 9.91</td>
</tr>
<tr>
<td>Dry/89</td>
<td>mean moisture</td>
<td>16 0 0 0 9.08</td>
<td>16 1 14.81</td>
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<tr>
<td>SOP (5.0%)</td>
<td>analyzed sample</td>
<td>15 15 3535 15 80</td>
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</table>

the treated lot did not show external fungal growth by naked eye observation, nevertheless, peanut pods of the control lot showed an intense external fungal growth. This observation could indicate that the SOP solution controlled the external fungal growth. An identification of the fungi that grew on the external surface of the pods was not made.

1990 CROP

Rainy season: For the 5% SOP solution used it was observed that the external fungal growth was again controlled, however aflatoxin contamination not. Initially the samples of the treated lot did not show aflatoxin contamination. After one month of storage, 14 samples, out of the 16 analyzed (representing 87.5%) were contaminated with a mean value of 1,471 µg/kg of aflatoxins and after two months, 24 samples, out of 30 (80%), were contaminated with a mean value of 2,628 µg/kg. After one month of storage the control lot showed only one sample, out of 16 (6.25%), contaminated with 162 µg/kg of aflatoxins, and after two months 5 samples, out of 30 (17%), were contaminated with a mean value of 24 µg/kg, both levels and percentage of contaminated samples lower than the treated lot. It may be assumed that the aflatoxin contamination probably occurred because of the possibility of the presence of aflatoxigenic fungi inside the sound pods (DIENNER, et al., 1987; JACKSON, 1964; SMITH & MOSS, 1985) and the shell could have been a barrier for the fungicide to reach the kernels. Other possibility that could have contributed to this contamination is the control of the fungal population on the external surface of the pod and then eliminating the fungal competition. It is known that fungal competition inhibits Aspergillus flavus growth and aflatoxins biosyntheses (NOUT, 1989) and, therefore, the aflatoxigenic fungi that probably were inside the pod could grow intensely and produce large amounts of aflatoxins.

CONCLUSIONS

The authors conclude that only the 5.0% SOP solution controlled the external fungal growth when a naked eye observation was made, but did not control aflatoxin production in moist in-shell peanuts probably due to the internal presence of Aspergillus flavus and because the fungicide could not penetrate inside the the pods to reach the kernels.

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