Inhibition of flower opening and its relation to fusariosis on pineapple fruit.

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INHIBITION DE L'OUVERTURE DE LA FLEUR ET SON RAPPORT AVEC LA FUSARIOSE SUR FRUIT D'ANANAS.

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Fruits, Jun. 1987, vol. 42, n° 6, p. 353-355.

RESUME - L'acide 2-chloroethylphosphonique étant capable d'empêcher l'ouverture de la fleur d'ananas, un essai a été réalisé afin de déterminer l'effet de son application sur des inflorescences du cultivar Perola dans la lutte contre la fusariose dans la région de Coraçao de Maria-Bahia (Brésil). Les applications, à des intervalles de 4 et 8 jours et à des concentrations de 1000 et 2000 ppm (m.a.) débutèrent juste avant l'ouverture de la fleur et se poursuivirent jusqu'à la fermeture des dernières fleurs du témoin. Le produit empêcha l'ouverture des fleurs et réduisit, d'une façon significative, l'incidence de la fusariose sur le fruit, de 100 à 25 p. 100. La qualité des fruits ne fut pas altérée par les traitements, mais il n'y eut pas de production de rejets. On en conclut que cette technique peut être utilisée pour réduire l'incidence de la fusariose sur ananas.

The fusariosis *(Fusarium moniliforme* var. *subglutinans)* is still the main problem in the pineapple cultivation in Brazil. Research data suggest that the fusariosis occurs in the fruit as a consequence of the fungus penetration through the floral cavity, during flower opening (MATTOS and CALDAS, 1978 ; BOLKAN *et al.*, 1979) and, possibly, in some cases, through the galeries opened by the fruit borer, *Thecla basilides* (CHALFOUN and CUNHA, 1984).

It is known that flowers in pineapple open from the base to the top of the inflorescence, each flower staying opened for just one day. However, flower opening in each plant takes 2 to 3 weeks with 10 flowers opening daily, aproximately.

The fungus, transmitted by insects (AGUILAR and SANCHES, 1982 ; VENTURA and MAFFIA, 1980) and by wind (MATTOS *et al.*, 1981), among other factors, penetrates through the opened flower, causing the destruction of the internal tissues and, later on, the external symptoms, characterized by gum exudation, which depreciates the fruit considerably for marketing and consumption.

Researches carried out in Malaysia (LIM and LOWINGS, 1979) and in Brazil (CUNHA, 1980) showed that the 2-chloroethylphosphonic acid, in concentrations from 400 to 1200 ppm and from 1000 to 3000 ppm, respectively, is able to inhibit flower opening in pineapple, without influencing fruit development, since that fruit is parthenocarpic.

Based on those results and also on the perspective that this effect could reduce the incidence of fusariosis on the pineapple fruit, researches were conducted in Bahia State, Brazil, in order to help in the control of this severe disease.

MATERIALS AND METHODS

This trial was carried out at the Pineapple Experimental Field - EMBRAPA/CNPMF, in Irará, Bahia, Brazil, during

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the year of 1985.

The 2-chloroethylphosphonic acid was used in the concentrations of 1000 and 2000 ppm (a.i.) sprayed directly on inflorescences of plants of pineapple cv. Pérola, 10 months old. Those plants were induced to flower with calcium carbide in April/85, in order to assure the presence of open flowers in a season favourable to fusariosis incidence.

The applications were done at 4 and 8 day intervals, starting when the inflorescences were 3-5 cm high, before opening. i.e., aproximately 50 days after artificial floral induction, and continued until the closing of the last flowers in the control plot. There were 40 plants per treatment.

The evaluation was based on the observation of the number of inflorescences without opened flowers (counted each 2-4 days for a period of 6 weeks), and on the influence of flower opening suppression on the incidence of fusariosis on the pineapple fruit and also on its quality.

RESULTS, DISCUSSION AND CONCLUSIONS

Flower opening inhibition.

The 2-chloroethylphosphonic acid suppressed pineapple flower opening in the concentrations and application intervals used (Table 1). All treatments were efficient, promoting 100% of inhibition, except in the case of 1000 ppm/8 days, which presented 2 to 3 inflorescences with 1 to 2 opened flowers during the first days, just after the beginning of the applications.

Fusariosis incidence on the fruit.

Flower opening suppression caused a significant reduction of the disease on the fruit. While in the control the infection reached 100% of the fruits, in the plots treated with the 2-chloroethylphosphonic acid the incidence varied from 0 to 25% (Table 1). This reduction may be due to the fact that the primary infection sites for fusariosis on the pineapple fruit are the opened flowers (MATTOS and CALDAS, 1978 ; BOLKAN *et al.*, 1979).

LIM and LOWINGS (1979), studying the effect of flower opening suppression on fruit collapse (*Erwinia chrysanthemi*) incidence, which also occurs through the open flower, observed a reduction of the disease from 7.0 to 2.3%, with 1200 ppm of the 2-chloroethylphosphonic acid, which also caused the smallest flower opening percentage. Such study showed a highly significant correlation between disease incidence and average number of opened flowers. In the present work, the infection observed on fruits of the treated plots was possibly due to the opening of a few flowers and/or to the pathogen penetration through fruit peel cracks, caused by the acid application or natural ones.

Fruit quality.

The treatments did not affect plant nor fruit physical and physical-chemical characteristics (Table 2). Fruit low weight, even in the control, was due to the little development of the plants, which were only 23-30 cm high at the floral induction treatment. Even so, it was noticed a reduction in the fruit weight and dimensions, with the increase in the concentrations of the acid and application frequency. On the other hand, as generally occurs with this acid, treated plants produced no slips, while the control produced an average of 4 slips/plant. Small cracks were also observed on some treated fruits, but no serious problems were detected,despite being eventually sites for fungi penetration.

The 2-chloroethylphosphonic acid application, at 1000 and 2000 ppm at 4 and 8 day intervals, on pineapple developing inflorescences during flower opening period, resulted in a significant reduction of fusariosis on the fruit, under the conditions of the present work. The acid

TABLE 1 - Effect of the 2-chloroethylphosphonic acid on flower opening and fusariosis incidence on pineapple fruit. Irará/Bahia, Brazil, 1985.

Treatments *	Number of inflorescences with opened flowers during flowering season ** Dates												Fusariosis incidence (%) ▲
	6/20 ●	6/24	6/26	6/28	7/02	7/06	7/10	7/12	7/15	7/18■	7/22	7/24	
A (1000/4)	0	0	0	0	0	0	0	0	0	0	0	0	0
B (1000/8)	0	0	3	2	0	2	0	0	0	0	0	0	25
C (2000/4)	0	0	0	0	0	0	0	0	0	0	0	0	25
D (2000/8)	0	0	0	0	0	0	0	0	0	0	0	0	0
E (control)	0	0	0	0	9	39	36	36	32	31	0	0	100

* - A : 2-chloroethylphosphonic acid, 1000 ppm, applied at 4 day intervals
B : 2-chloroethylphosphonic acid, 1000 ppm, applied at 8 day intervals
C : 2-chloroethylphosphonic acid, 2000 ppm, applied at 4 day intervals
D : 2-chloroethylphosphonic acid, 2000 ppm, applied at 8 day intervals
E : control
** - 40 plants/treatment
● - First application
■ - Last application
▲ - Average of 16 plants/treatment

TABLE 2 - Effect of the 2-chloroethylphosphonic acid on physical and physical-chemical characteristics of pineapple plant and fruit. Irará, Bahia, Brazil, 1985.

Parameters	Treatments *				
	A	B	C	D	E
Fruit weight (+ crown) (g)	937	1000	712	831	850
Fruit weight (- crown) (g)	814,6	859,0	570,7	690,6	698,1
Fruit length (cm)	13,4	14,2	11,2	12,2	12,7
Fruit diameter (cm)	8,7	9,2	8,0	8,5	9,0
Fruit core diameter (cm)	2,2	2,6	2,5	2,7	1,9
Crown length (cm)	24,6	25,8	28,3	27,4	25,3
Crown weight (g)	122,4	141,0	141,3	140,4	151,9
TSS (° Brix)	15,9	14,0	15,5	14,5	14,1
Acidity (% citric acid)	0,25	0,25	0,26	0,21	0,26
Juice (%)	69,2	69,2	63,3	71,5	66,0
Plant height (cm) **	28,2	28,5	23,5	23,5	30,0
Slips/plant (nº) •	0,0	0,0	0,0	0,0	4,0
Fruits with cracks (nº) •	4	5	4	3	0

* - Average of 4 fruits ** - Soil level to peduncle top • - Average of 16 plants/treatment

acted as an efficient anthesis inhibitor, thus preventing fungus penetration through the flower. This can be used as an auxiliary practice for the control of fusariosis on the pineapple fruit, specially when flowering occurs in periods favourable to fungus development and performance (rainy and moisty season).

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