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POTENTIAL FOR THE USE OF ANTITRANSPIRANTS IN SWEET CORN PRODUCTION

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ABSTRACT

The general principles governing the application of antitranspirants are reviewed and results of research work with antitranspirants on sweet corn (**Zea mays** L. var. **saccharata** Sturt.) carried out in the Faculty of Agriculture, University of the West Indies, are discussed. Phenylmercuric acetate (PMA) and Vaporgard are identified as two promising chemicals for use in sweet corn production under dry Trinidad conditions.

INTRODUCTION

Sweet corn (**Zea mays** L. var. **saccharata** Sturt.) production in Trinidad and Tobago is limited to the rainy season. Its production has been confined mainly to semi-commercial activity at the now closed University of the West Indies-Texaco Food Crops Farm (Cropper and Brathwaite, 1977; Brathwaite, 1979) and the University Field Station of the University of the West Indies (Brathwaite, 1985). On the other hand, consumption of imported frozen and canned sweet corn has been increasing. The country imported 154.0, 264.9 and 280.2 tons of frozen and canned sweet corn in 1982, 1983 and 1984, respectively (Republic of Trinidad and Tobago Central Statistical Office Reports 1982, 1983 and 1984).

Although there are few reports on sweet corn production and processing in Trinidad and Tobago (Vlitos and Davies, 1964; Cropper, 1976; Cropper and Ferguson, 1977) the potential of the crop has been demonstrated by Cropper (1972) and Brathwaite (1985).

In 1983 a study on the effectiveness of water conservation methods in sweet corn cultivation was initiated under the Cereal and other Grains Research Programme of the Faculty of Agriculture, Trinidad and Tobago. One of the major objectives of the study was the identification of antitranspirants which might allow the growing of sweet corn under dry season conditions with minimum irrigation. This paper summarizes the general principles governing the application of antitranspirants and highlights the main results from work with sweet corn under dry Trinidad conditions.

THE PRINCIPLES OF ANTITRANSPIRANTS APPLICATIONS

An antitranspirant is any chemical which, when applied to transpiring plant surfaces, reduces water loss form the plant (Davenport and Hagan, 1975). Approximately 99% of the water taken up by plant roots is transpired to the atmosphere through stomatal pores in the leaves. Since stomata are located at a point in the water pathway where the vapor-pressure gradient is steepest, i.e., between the leaf and the atmosphere, the stomata-bearing leaf surfaces are the most strategic sites for antitranspirant application (Begg and Turner, 1976). Although reduced transpiration is the primary objective of applying antitranspirants, that objective may be sought for different reasons such as the conservation of water supplies, particularly where water is scarce and costly or to obtain improved plant performance via an increase in plant water potential. In such situations, the onset of the damaging effects of water stress can be delayed (Davies et al., 1978).

A number of different chemicals have been used to retard transpiration and these may be grouped according to their mode of action, as follows: those that close stomata, those that are film forming, or those that increase plant reflectivity (Gale and Hagan, 1966).

Stomata Closing Antitranspirants: These are metabolically active chemicals, usually applied at extremely low concentrations, which cause partial closure of stomata probably by preventing guard cells from attaining complete turgidity (Davenport et al., 1969). It has long been observed that many chemicals commonly applied to plants close stomata and reduce transpiration. Such effects have been reported for herbicides (Smith and Buchholtz, 1962; 1964, fungicides (Thorn and Minshall, 1964), metabolic inhibitors (Stoddard and Miller, 1962) and growth hormones (Kelley, 1955). A good stomata closing antitranspirant should be of low mobility within the plant and ideally should be confined to the leaf epidermis to avoid toxic side effects to other systems (Gale and Hagan, 1966).

Film Forming Antitranspirants: These chemicals include emulsions of plastic, wax or latex that form a film on the leaf surface and produce an external physical barrier to retard the escape of water vapour from plants (Gale, 1961). The provision of a physical barrier over some, if not all of the leaf increases the resistance to water vapour diffusion and reduces transpiration. Leaf water potential is thus increased even though stomata remain open under the film (Davenport et al., 1974).

Reflecting Antitranspirants: These chemicals are applied as a reflective pigment which dries to form a coating that increases the albedo and thus decreases the transpiration by reducing the net radiation load and the leaf temperature (Abou-Khaled et al., 1970).

ANTITRANSPIRANT STUDIES ON SWEET CORN AT UNIVERSITY OF THE WEST INDIES

Barkley (1986) reported the effects of antitranspirants on growth and yield and water relations of sweet corn under stressed greenhouse conditions and the authors are presently investigating the effects of these chemicals under field conditions. Four weeks after application of Alachlor (10, 20 and 40 mg a.i./l), Kaolinite (3, 6 and 12%) and Vaporgard (2.5, 5 and 10%) to 6 week old stressed greenhouse grown plants, the leaf area was increased by more than 50% (Table 1) (Barkley, 1986). Under field conditions smaller increases in leaf area were obtained (Tables 2 and 3). In one trial PMA (15 mg/l) and Alachlor (20 mg a.i./l) increased leaf area by 19 and 8%, respectively, and in a second trial increases of 13.9 and 7.4 were obtained in response to PMA (20 mg/l) and Vaporgard (6%), respectively (Skekour et al., Unpublished data). Similar increases in leaf area in response to antitranspirants have been reported in many crops, including field corn (**Zea mays** L.) (Santakumari et al., 1977).

Table 1. The effect of Alachlor, Kaolinite and Vaporgard on growth, yield and water relation parameters of sweet corn grown under dry greenhouse conditions (Data from Barkley, 1986).

Treatments		Leaf area/ plant (m^2)	Fresh ear weight/plant (g)	Leaf water potential (Mpa)
Control		0.28	52.1	-0.35
Alachlor	10mg a.i./l^{-1}	0.94	56.3	-0.22
	20mg a.i./l^{-1}	1.73	67.9	-0.16
	40mg a.i./l^{-1}	1.03	94.3	-0.35
Kaolinite	3%	0.17	46.3	-0.30
	6%	0.43	39.4	-0.46
	12%	0.80	48.1	-0.50
Vaporgard	2.5%	0.89	102.8	-0.36
	5%	0.45	73.1	-0.34
	10%	0.38	52.3	-0.75
L.S.D.	(P=0.05)	0.911	29.90	0.300

Table 2. The effect of PMA (15mg/l), Alachlor (20mg a.i./l) and Vaporgard (5%) on different growth, yield and water relation parameters of sweet corn grown under dry field conditions. (Data from Shekour et al., unpublished).

Treatments	Leaf area (m^2)	Fresh ear yield/ha (mg)	Total dry matter/ha (mg)	Leaf water potential (Mpa)
Irrigated control	0.37	3.50	11.73	-0.88
Non-irrigated control	0.26	2.00	5.84	-1.23
PMA	0.31	2.63	8.81	-1.09
Alachlor	0.28	2.23	7.06	-1.22
Vaporgard	0.32	2.35	8.79	-1.13
L.S.D. (P=0.05)	0.0229	0.097	0.839	-0.3786

Table 3. The effect of PMA (20mg/e) and Vaporgard (6%) on different growth, yield and water relation parameters of sweet corn grown under moisture stressed conditions. (Data from authors, unpublished).

Treatments	Leaf area/ plant (m^2)	Fresh ear yield/ ha (Mg)	Total dry matter yield/ha (Mg)	Leaf water potential (Mpa)
Irrigated Control	0.405	10.06	15.0	-1.0
Non-irrigated Control	0.323	7.01	10.8	-1.4
PMA	0.368	7.69	13.2	-1.2
Vaporgard	0.347	7.85	13.0	-1.2
L.S.D. (P=0.05)				
(a) between antitranspirants and antitranspirants and non-irrigated Control	0.0150	0.345	0.15	0.13
(b) between antitranspirants and irrigated control	0.0160	0.386	0.17	0.14

In two field trials on sweet corn the antitranspirant treatment resulted in significantly higher leaf water potential (Tables 2 and 3) despite the increase in leaf area in agreement with earlier reports on other crops (Davenport et al., 1974; Begg and Turner, 1976; Agarwal and De, 1976; 1977; 1979). Fresh ear yield was also increased probably as a result of the increase in leaf area and leaf water potential. Barkley (1986) reported an increase of 97 and 81% in response to Vaporgard (2.5%) and Alachlor (40 mg a.i./l), respectively, in his greenhouse studies and the authors (unpublished) have obtained increases of 12, 18 and 12 and 32 and 10% in response to Alachlor (20 mg a.i./l), Vaporgard (5 and 6%), and PMA (15 and 20 mg/l), respectively, in field trials (Tables 2 and 3). Increase in yield in other crops has also been reported (Dae et al., 1977; Fuehring, 1979) under field conditions. Total dry matter production was also significantly higher in antitranspirant treated plants (Tables 2 and 3).

CONCLUSION

Results obtained in greenhouse and field trials on unirrigated sweet corn grown in Trinidad under dry conditions indicate that significant increases in growth and yield occur in response to PMA (20 mg/l) and Vaporgard (6%) treatment. These results suggest that antitranspirant treatment may allow the crop to be grown in the dry season in Trinidad with less irrigation and minimum yield reduction. Further studies are needed, however, to evaluate antitranspirants, and rate and time of application, as well as an economic analysis of antitranspirant practices.

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