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Chemical ripening advances in Tucumán, Argentina

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ABSTRACT

The need to maximise potential for both the environment and sugarcane varieties has resulted in an increase in the sugarcane area treated with ripeners in Tucumán, from 3000 ha in 1997 to approximately 115.000 ha at present. This advancement was promoted by researchers at the Estación Experimental Agroindustrial Obispo Colombres (EEAOC) in Tucumán, Argentina, who issued recommendations for the use of glyphosate as a ripener in 1997. Similarly, fluazifop-p butyl was released for use as a ripener in 2001. In searching for new alternative ripeners, graminicides (clethodim and haloxyfop-r methyl) and imazapyr began to be evaluated in 2000. After these trials, only clethodim was released for commercial use in 2005. Imazapyr, despite being efficient, was discarded because of its high cost. In 2006, EEAOC scientists started evaluating trinexapac-ethyl. This plant growth regulator (PGR) has shown potential to replace herbicide ripeners. Trinexapac-ethyl is already being used as a ripener in Brazil, along with sulfometuron-methyl. The latter was evaluated in 2007 in Tucumán, but sugarcane response was highly variable and inconsistent. Since 2010, the effect of ethephon, a PGR that releases ethylene, has been evaluated with and without a graminicide. So far, sugarcane responses have been satisfactory (with average Pol% cane increments of 0.41 and 0.62, respectively). Mineral nutrients applications (phosphorus, potassium and boron) were also evaluated and showed considerable sucrose content increases in some cases. This paper is a review of extensive studies conducted since 1994 by EEAOC researchers to provide growers with a great number of products that could be used as sugarcane ripeners, under different agro-ecological conditions.

Key words: sugarcane, pre-harvest practice, herbicides, plant growth regulators, mineral nutrients.

RESUMEN

Avances en la maduración química en Tucumán – R. Argentina

La necesidad de explotar al máximo el potencial azucarero de las variedades difundidas comercialmente logró incrementar la superficie madurada de 3000 ha (en 1997) a las actuales 115000 ha. Este crecimiento fue impulsado por investigadores de la Estación Experimental Agroindustrial Obispo Colombres (EEAOC), quienes en 1997, difundieron las recomendaciones para el uso de glifosato como madurador de la caña de azúcar. Hicieron lo propio también con el producto fluazifop-p butil en 2001. En búsqueda de nuevas alternativas químicas, continuaron las experiencias con dos graminicidas, cletodim y haloxifop-r metil, y un herbicida total: imazapir. En 2005 se difundió el uso de cletodim, al no haberse obtenido resultados satisfactorios con el otro graminicida, mientras que el imazapir, a pesar de resultar muy eficiente, tuvo que ser descartado por su elevado costo. Desde 2006, se ha estado evaluando a un regulador vegetal del crecimiento (PGR), el trinexapac-etil, que demostró tener potencial para reemplazar a los productos tradicionales. Junto al sulfometuron, ya se está utilizando en Brasil como madurador. Este último producto se estudió desde 2007 en Tucumán, pero las respuestas registradas en el cultivo han sido variables. Desde 2010 se evalúa el etephon, un PGR que libera etileno, solo y en combinación con un graminicida, con respuestas que han sido satisfactorias (con incrementos promedio de Pol% caña de 0,41 and 0,62, respectivamente). Otra alternativa en estudio es el uso de nutrientes minerales (fósforo, potasio y boro), que generó incrementos interesantes del contenido sacarino en algunos casos. Este trabajo es una revisión de los estudios realizados por la EEAOC desde 1994, con el fin de encontrar un mayor número de productos que puedan ser utilizados como maduradores de caña de azúcar en diferentes condiciones agroecológicas.

Palabras clave: caña de azúcar, estrategia pre-cosecha, herbicidas, reguladores de crecimiento, nutrientes minerales.

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INTRODUCTION

Chemical ripening hastens crop maturity, thus making high quality sugarcane available for its milling at an earlier growth stage. This is particularly important in achieving the goal of expanding the sugarcane production area into regions not traditionally planted with sugarcane, especially those with high probability of freeze occurrence.

In Tucumán, chemical ripening is the only pre-harvest practice available that leads to significant increases in sugar recovery levels, bringing about important economic benefits (Leggio Neme *et al*., 2009). This technology has been studied and promoted by researchers at the Estación Experimental Agroindustrial Obispo Colombres (EEAOC) since 1994, with excellent results. Adoption of chemical ripening technology has resulted in an increase in the sugarcane area treated with ripeners, from 3000 ha in 1997 to 115.000 ha presently, in Tucumán.

A review of chemical ripening in Tucumán, Argentina

The EEAOC started chemical ripening studies in 1994, and in 1997, after conducting several trials and commercial scale demonstrations, it issued a series of recommendations for the use of glyphosate as a sugarcane ripener. In 1997, research on fluazifop-p butyl as a ripener began at the EEAOC, which resulted in its recommendation (Rufino *et al*., 2001). Later, evaluations of graminicides (clethodim and haloxyfop-r methyl) and imazapyr continued. In 2005, after six years of studies, the use of clethodim was finally recommended for commercial fields (Leggio Neme *et al*., 2005). However, haloxyfop-r methyl use did not lead to acceptable results. In contrast, imazapyr was very efficient and resulted in very satisfactory results. However, there was no further research on imazapyr, as its use was not economically feasible due to its high cost (Table 1).

In 2006, a new plant growth regulator (PGR), trinexapac-ethyl, began to be evaluated as a potential ripener. Trinexapac-ethyl inhibits the synthesis of gibberellic acid (Rademacher *et al*., 2000), thus delaying growth. Trinexapac-ethyl was already being used in Brazil as a ripener, along with sulfometuron-methyl (Dalley and Richard, 2010). The latter has been evaluated since 2007, with variable and inconsistent results (Table 1).

Furthermore since 2010, the effects of ethephon, a PGR that releases ethylene (Marrero *et al*., 2004), has been evaluated when used alone or in combination with fluazifop–p butyl. Responses have been satisfactory and consistent (Table 1), so this PGR has continued to undergo evaluation to determine the ideal use rate.

The growing concern for risks posed by the use of chemical products and their effects on the environment and humans (Montano Martínez, 2002) has led to the search for other alternatives that would successfully replace these products. Since 2006, the use of mineral nutrients like phosphorus, potassium and boron has been considered as an alternative that would cause changes in the nutritional balance, favouring maturation. Generally we observed that, over five years, the use of mineral nutrients as ripeners produced considerable sucrose content increases, although in some cases significant differences were not observed (Table 1).

In Tucumán, early applications were performed between mid-March and mid-April, intermediate applications in mid to late April, and late applications until mid-May. In general, best responses were observed with early applications (period with a minimum temperature of 14.8ºC and a maximum temperature of 23.7ºC[1]), coinciding with the end of the great growth period. Under these conditions ripeners restrain vegetative growth rates, which results in increased sucrose storage (Leggio Neme *et al*., 2009).

In conclusion, this paper has reviewed the extensive work done by EEAOC researchers in order to test a great variety of products that could be efficiently used as sugarcane ripeners, under different agro-ecological conditions. This has resulted in the availability of several and various technological tools for growers and technicians, so that they can choose the most suitable ones for each situation.

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Tabla 1. Indices of response to ripeners (averages for cultivars, rates, and application stages) obtained by the Estación Experimental Agroindustrial Obispo Colombres (EEAOC) in Tucumán, Argentina, throughout the periods when they were evaluated.

RIPENER	RESPONSE INDICES				
	Total response[1] %	High response[2] %	Average absolute increment (Pol%cane)[3]	OHT* beginning (weeks)	OHT* ending (weeks)
Glyphosate (0.22, 0.24 and 0.29 l ia/ha) (1994-2000)	81.2	67.1	0.51	5.10	12.6
Fluazifop-p butyl (25, 40 and 45 g ia/ha) (1997-2000)	89.5	72.5	0.45	5.20	11.2
Imazapyr (150 and 200 g ia/ha) (2000-2007)	80.0	75.0	0.61	4.80	10.9
Clethodim (60, 72 and 96 g ia/ha) (2000-2007)	92.0	58.0	0.58	4.20	10.6
Haloxyfop-r methyl (20, 30 and 40 g ia/ha) (2000-2007)	37.0	43.0	0.57	5.25	10.7
PK (2006-2011) (3.4 and 6.8 kg/ha)	35.0	17.0	0.54	3.80	9.5
Boron (6 and 9 l/ha) (2006-2011)	19.0	0.0	0.36	5.00	10.3
Trinexapac-ethyl (0.6, 0.8 and 1.2 l/ha) (2006-2011)	66.0	29.0	0.38	4.80	9.5
Sulfumeturon-methyl (15, 20 and 25 g/ha) (2007-2008)	39.0	0.0	0.37	6.30	10.6
Ethephon (1.5 l/ha) (2010-2011)	100	67.0	0.41	4.70	9.7
Ethephon+graminicide (2010-2011)	100	67.0	0.62	2.70	9.3

(1): Total positive response tests (increases > 0.3 Pol % cane).
(2): Total high positive response tests (increases > 0.5 Pol % cane).
(3): Average increases for the following cultivars:
Glyphosate: CP 65-357, NA 63-90, TUC 71-7, LCP 85-376, TUCCP 77-42 and TUC 72-16.
Fluazifop, like glyphosate: LCP 85-384 and RA 87-2.
Imazapyr, clethodim, and haloxyfop: LCP 85-384, CP 65-357, RA 87-3 and TUCCP 77-42.
PK, B, trinexapac, sulfumeturon, ethephon and ethephon+graminicide: LCP 85-384 and TUCCP 77-42.
*OHT: optimal harvest time expressed as weeks after application.