SUGARCANE RIPENING IN SOUTH AFRICA: REVIEW OF PAST DECADE

R. A. Donaldson
South African Sugar Association Experiment Station,
Private Bag X02, Mount Edgecombe, 4300, South Africa

ABSTRACT

The area treated with ripeners doubled in South Africa between 1995 and 1997 due to improved weather conditions and better information transfer. The recognition by millers of the potential benefits of ripening and their subsidising of some of the costs thereof have also contributed to the wider use of ripeners. It is anticipated that the extension of harvesting/milling of crops into summer months and the expansion of the industry in the irrigated areas could see further increases in the use of ripeners. The introduction of payment schemes that take cognisance of better quality cane will also boost the use of chemical ripeners. Reasons for poor responses to Fusilade Super (fluazifop-butyl) are thought to be associated with stress-induced metabolic changes and the differences between varieties in responding to imminent stress. It is suggested that in wet cold weather the metabolism and translocation of fluazifop-butyl is slower and may cause severe stunting of the next crop. The use of the combination treatment (Ethephon and Fusilade) on selected varieties is also expected to provide further benefit from ripening with chemicals. The benefits from using drying-off as an alternative method of ripening sugarcane is expected to be more consistent, following better guidelines derived from detailed analysis of 105 experiment results. Future improvements may be expected from creating chemical ripening schedules based on growing degree-days and from incorporating the ripening of sugarcane through the use of chemicals and drying-off into growth simulation models.

Keywords: Sugarcane ripening, drying-off, chemical ripening, sucrose

INTRODUCTION

The use of ripeners has become a standard practice in some parts of the South African sugar industry during the past ten years. About 80% of the crop in South Africa is not irrigated, and thus good rainfall distribution and soils with good water holding characteristics largely dictate the area sprayed from year to year. The recent renewed interest in ripeners stems from improved weather conditions, a larger choice of good varieties and improved technology transfer. The transfer of up-to-date technology has been achieved through several avenues. Information sheets, written by specialists, are distributed to the farmer with updated and concise information on specific aspects of sugarcane production. These are supplemented by newsletters sent to growers by the Extension division at critical times of the year. Articles on topical issues are compiled by specialists at different times of the year in a widely circulated newsletter. Contact with growers is often through talks presented by extension personnel and specialists. Farmer's days and road shows where short and less formal presentations of the most recent research developments are presented also serve to expose farmers to the technology most applicable to their region. The sugarcane technology courses run at Mount Edgecombe and talks presented by agro-chemical representatives are two additional avenues through which information is transferred. The impact from better information transfer is seldom easily quantified, but for chemical ripeners the area treated when weather conditions are favourable may be a good indication of this. During the past three seasons the total area sprayed by commercial aircraft has more than doubled, from 18,614 hectares during 1995 to 38,605 hectares in 1997. It is estimated that an additional 31,000 tons of sucrose may have been produced during 1997 through chemical ripening.
Millers have for some years been aware of the benefits from chemical ripening. Besides the gain in sucrose yields, the higher purity of ripened cane explains the better recovery of sucrose. In recognition of this, some millers subsidise part of the costs of the chemical and its application as an incentive to farmers to use ripeners. The current negotiations around payment related to cane quality have also brought chemical ripening into reckoning where it may not have been considered before. Millers are also contemplating milling for longer periods than usual. Extending the milling season by opening earlier or crushing later will increase the immature portion of the crop and should therefore favour more extensive use of chemical ripening.

**DRIYING-OFF AND CHEMICAL RIPENING-OPTIONS TO RIPEN SUGARCANE**

Before the technology of chemical ripening was developed, irrigated sugarcane was ripened through regulating the amount of irrigation water applied close to harvesting - a process known as drying-off (Clements, 1962). Numerous studies on this subject have been done in southern Africa with conflicting results, consequently some farmers dry off for periods during which potential evaporation is four times the plant available water capacity (PAWC = total available soil moisture). This is far in excess of the rule-of-thumb of twice PAWC. The data from these studies, which were drawn from 35 experiments, were analysed to provide benchmarks for productivity increases that can accrue from drying-off (Robertson and Donaldson, 1998). The results of this analysis are being linked to crop simulation models that assess the risk and profitability of drying-off strategies (Robertson et al, 1998).

The benefits from using chemicals to ripen irrigated sugarcane are mostly based on the difference in yields from sprayed and non-sprayed sugarcane that has not been dried-off. Such comparisons are not entirely correct when estimating the benefits from chemical ripening since the best alternative to ripening cane with chemicals (not dried-off) is by ripening cane through a drying-off process. Experiments conducted at Pongola, South Africa, have shown that similar sucrose yields can be achieved by drying-off as from ripening vigorously growing (not dried-off) cane with Fusilade Super (fluazifop-butyl). However, drying-off reduces cane mass substantially so that the savings from lower transport and lower irrigation costs (savings from water and electricity) weigh in favour of ripening sugarcane by drying-off (Donaldson, 1992). There is some evidence that drying-off may produce higher cane quality than a well irrigated crop ripened with chemicals. Rainfall may disrupt the ripening process induced by drying-off but the risk is very much lower for winter/spring harvesting than in summer/autumn. A high rate of photosynthesis after applying a ripener is necessary for sucrose accumulation whereas the chances of damage by infield operations during harvesting are reduced by drying-off. It is for these reasons that a short drying-off period is advocated when chemicals are used to ripen a crop.

**FUSILADE SUPER**

**Effects of stress**

Polado (glyphosate) lost favour with South African farmers soon after being registered as a ripener because it had adverse residual effects when applied to stressed cane (Donaldson and Inman-Bamber, 1982). During the same period, Fusilade (later Fusilade Super) was being tested and was proving to be a very effective alternative. The slow adoption of the chemical by farmers was in some part due to the relatively severe symptoms of leaf scorch and necrosis of stalk meristematic regions, previously not associated with chemical ripening. In time, the farmer came to believe that the severe scorching of leaves was an indication of how effectively the chemical was promoting ripening. The natural progression of this misconception was the use of higher rates that caused more severe scorching and supposedly better responses. Higher rates were also proposed (Sweet et al, 1987) to correct poor responses to Fusilade Super. However, it is quite possible that the smaller responses were due to stress that developed immediately prior to, or after, application. Dickson et al (1990) suggest that at the onset of stress Absisic acid (ABA) levels rise and esterase activity decreases in plants - both of which may decrease the activity of fluazifop-butyl. ABA regulates plant activities to maintain the integrity of plasmalemma which are partly composed of lipids. The formation of lipids is disrupted by the action of fluazifop-butyl on Acetyl Co-enzyme A carboxylase. Carboxylesterases in the plant metabolise
fluazifop-butyl to a more active acid form (Gronwald, 1991). Thus, it is possible that as stress develops less of the fluazifop-butyl is hydrolysed to the acid form due to higher ABA and lower esterase levels. During mild to moderate stress, leaf development and stalk elongation slow down but photosynthesis may be little affected. Because leaf and stalk production then demand less photosynthate, greater amounts are stored as sucrose. Under such conditions, the benefits from applying a ripener are greatly reduced. In an experiment on the varieties N12 and N16 at Mount Edgecombe, the effects of mild stress on the responses to Fusilade Super were different for the two varieties. Typical symptoms developed on N16 but on N12 only slight necrosis around the spindle and some distorted leaf growth could be seen. The sucrose yields of N12 were raised by 1.2 ± 1.0 tons while the response of N16 was 4.2 ± 1.0 tons per hectare. The variety N12 tolerates stress better than most other commercially grown varieties in South Africa. It does so by leaf rolling (Inman-Bamber, 1986) and probably adjusting ABA and esterase levels sooner to stress. The mild symptoms from Fusilade Super when applied to stressed cane have since been recorded on several other occasions. The aforementioned reasons for poor responses to fluazifop-butyl do not preclude the possibility that higher rates could be more effective under certain conditions, as is the case with the variety N14 (Donaldson, 1989; Leibbrandt, 1989).

**RESIDUAL ACTIVITY OF FLUAZIFOP-BUTYL**

As with other ripeners, with Fusilade Super there is some evidence of increased tillering in the following crop. There is, however, no evidence that this apparently greater vigour is of benefit in terms of cane yield. At the other extreme, few cases of adverse residual effects from Fusilade Super were reported before 1988 (Donaldson, 1989). Since then, several cases have been documented (Turner, 1988; Anon, 1988; Richard, 1995). A recent case of poor ratooning of a commercial field was observed in South Africa, where the vigour and growth of the crop were visibly retarded for several months after the previous crop had been sprayed with a high rate (75 g a.i./ha) of Fusilade Super. The common factors in these cases suggest that Fusilade Super may reduce yields in the following crop if high rates are applied in cold, cloudy weather when soils are saturated. Weather conditions, particularly temperature and light, affect the absorption, translocation and metabolism of fluazifop-butyl (Balinova and Lalova, 1992; Coupland, 1989). Therefore, it is possible that the under certain conditions there is slower metabolism and greater translocation of the chemical to the roots. Then, as the following crop regenerates with rising ambient temperatures, the chemical is re-mobilized into the emerging shoots where growth is disrupted. However, the hypothesis that Fusilade Super sometimes has adverse residual effects due to weather conditions and high rates on sugarcane, needs to be verified.

**COMBINATION RIPENER TREATMENT**

During the past decade, it has become more apparent that varieties react differently to chemical ripening. Much of the earlier research had been done on the variety NCo376 (Donaldson and van Staden, 1989). It is now clear that this variety responds better to ripeners than the more recent commercial varieties. The slightly higher rates of Fusilade Super needed to ripen the variety N14 (Donaldson, 1989) and the erratic responses of N14 to ethephon (Leibbrandt, 1989) are evidence that varieties need to be screened individually for each chemical. Some of the more recent varieties are either more sensitive to stress or accumulate sucrose very rapidly during the first 9 to 10 months. Consequently juice purities are high and often more than 50% of the stalk dry matter is in the form of sucrose. With such characteristics (variety CP66/1043) the good responses to chemical ripening that are common to NCo376, are less likely to be achieved. Although responses to Fusilade Super are also smaller in these varieties, they are mostly still economically beneficial. When a variety, such as N19, responds differently to ethephon and Fusilade Super from one season to the next, despite conditions being conducive to both ripeners, the matter of recommending a chemical becomes more complicated. It is fortuitous that N19 responds consistently to the combination of ethephon followed by Fusilade Super. Like N19, both NCo376 and N25 respond better to the combined ripener treatment than to any of the single treatments. The gains from the combination treatment in some varieties, however, are sometimes not sufficient to offset the additional costs of the chemicals and their application (Donaldson, 1996). Distinguishing between these two groups of varieties is important in optimising the inputs and returns from this husbandry practice.
POTENTIAL FOR WIDER USAGE?

About 37% of the irrigated crop and about 2% of the non-irrigated crop were ripened with chemicals in South Africa during 1997. The estimated average gain of 0.8 tons of sucrose per hectare (Rostron, 1996) is conservative when compared with the average 3.2 tons gained over three crops (Donaldson and Inman-Bamber, 1982) from glyphosate at Pongola. It may, however, be a realistic average response under commercial conditions, which include irrigated and non-irrigated sugarcane. This expected average sucrose yield response translates to a gain of R25 million at current price of sugar and costs of chemicals and spraying. It does not take into reckoning the benefit from more efficient milling performance. While a substantial part of the irrigated crop could be ripened by drying-off, there is still scope for greater chemical usage when sugarcane is harvested annually during months of high rainfall. Much of the non-irrigated sugarcane is grown on terrain that makes application by fixed wing aircraft or by ground rigs very difficult. The purveyors of the chemicals do not condone using mistblowers, microlight aircraft and overhead sprinklers to apply ripeners because the chances of maldistribution, drift and/or volatilisation of the chemical are greatly enhanced by these methods. However, formulations of the chemicals are being developed specifically for ultra-low volume application and are being tested commercially. The unpredictable rainfall and older age at which cane is harvested are additional reasons for the limited use in these areas. It is anticipated that the greater usage of chemical ripening will therefore largely come from the present expansion of irrigated areas, longer milling seasons and possibly from cane payment schemes that reward better quality cane.

FUTURE RESEARCH

Gallant Super (haloxyfop-R methyl ester) has recently been registered for ripening autumn harvested sugarcane in South Africa. Little is known about the responses of the present commercial varieties to this chemical. However, since it has the same mode of action as Fusilade Super it is likely that the efficacy of the product will be governed by similar factors.

Sugarcane is increasingly being milled during the summer months when crops cannot be crushed within the usual milling period. During the summer months, growth is particularly vigorous and ripeners applied 35 to 40 days before harvesting has sometimes reduced cane yields to the extent of negating the possible gain in sucrose yields. A schedule based on growing degree-days needs to be developed to accommodate all possible growing conditions throughout the South African sugar industry.

An analysis of the changes in the components of the sugarcane stalk caused by ripeners may be needed to elucidate the process of dry matter partitioning that favours the accumulation of sucrose. Such an analysis can also provide benchmarks of the possible gains that can be accrued from using ripeners. Quantifying the changes to the components may be an essential step for incorporating chemical ripening into growth simulation models.

CONCLUSIONS

The correct use of chemical ripeners has proven to be an essential practice in maximising profits of sugarcane farming. This is particularly true for irrigated crops that are harvested annually at times when weather conditions are conducive to rapid growth. The possibility that Fusilade Super can affect the growth of the next crop adversely when applied in cold wet weather, needs to be confirmed. The recent studies of the drying-off process should improve the success from using this alternative ripening practice. Employing this practice during winter and spring may enhance the quality and yields of crops that will not benefit from chemical ripening in South Africa.

REFERENCES


MADURACION DE LA CAÑA EN AFRICA DEL SUR EN LA DECADA PASADA

R. A Donaldson
South African Sugar Association Experiment Station,
Private Bag X02, Mount Edgecombe, 4300, South Africa

RESUMEN
El área aplicada en Africa del Sur con maduradores se ha duplicado en el periodo de 1995 a 1997, debido a buenas condiciones de clima y la adecuada transferencia de tecnología. Los ingenios han reconocido los beneficios potenciales de los maduradores y la participación en los costos de la aplicación ha contribuido para una amplia adopción de los maduradores. Se anticipa que al prolongar el periodo de cosecha/ molienda a los meses de verano y la expansión de la industria hacia zonas bajo riego también ayudará a una mayor adopción de los maduradores. La introducción de sistemas de pago que tienen en cuenta la mejor calidad de la caña también impulsará el uso de los maduradores. La baja respuesta al Fusilade Super (fluazifop-butyl) se cree que está asociada con cambios metabólicos inducidos por condiciones de estrés, como también por la respuesta diferencial de las variedades al estrés. Se sugiere que en condiciones frías y húmedas el metabolismo de translocación del fusilade es más lento y puede provocar estancamiento severo del cultivo siguiente. El uso combinado de Ethephon y Fusilade también puede proporcionar beneficios adicionales a las cañas tratadas con maduradores químicos. Los beneficios de someter las cañas a periodos de agostamiento como una alternativa para forzar la maduración se espera que sea más consistente, después de encontrar mejores pautas lograda con el análisis de 105 experimentos. Se esperan mejoras hacia el futuro como resultado de la creación de programas de maduración basados en los grado-días de calor y por la incorporación de la maduración de la caña en los modelos de simulación del crecimiento de la caña.

MATURATION DE LA CANNE EN AFRIQUE DU SUD - UNE REVUE DES DIX DERNIÈRES ANNÉES

R. A. Donaldson
South African Sugar Association Experiment Station,
Private Bag X02, Mount Edgecombe 4300, Afrique du Sud

RÉSUMÉ
Les superficies traitées aux maturateurs dans les années 1995-1997 en Afrique du Sud ont doublé avec de meilleures conditions climatiques et la dissémination de l’information technique aux planteurs. Les usiniers ayant reconnu les bénéfices possibles avec les maturateurs et ayant accepté de ramener à la baisse les coûts de l’application à travers des subsides, ont aussi contribué à une augmentation de la superficie traitée. Le prolongement de la période de récolte jusqu’aux mois d’été et l’expansion de l’industrie dans les terres irriguées aideront aussi à une utilisation accrue des maturateurs. L’introduction d’un mode de paiement qui prendrait en compte la qualité de la canne aura le même effet. Les raisons émises pour les faibles réponses au Fusilade Super (fluazifop-butyl) sont associées au changement métabolique dû au stress hydrique ainsi que la réaction variétale erratic dans vis à vis d’un stress imminent. Il est suggéré que des conditions froides et humides affectent le métabolisme et, ainsi la translocation du fluazifop-butyl est réduite et peut causer un sévère rabougrissement dans la repousse suivante. On espère réaliser plus de bénéfices en utilisant des produits chimiques pour le mûrissement, particulièrement à travers le traitement combiné de l’éthephon et le fluazifop-butyl sur des variétés choisies. On peut s’attendre à des bénéfices plus conséquents en utilisant un sevrage à la place des maturateurs et en suivant les indications d’une analyse détaillée des résultats obtenus dans 105 essais. D’autres améliorations sont attendues en introduisant des programmes de maturation artificielle basés sur des degrés-jours (degree-days) et en l’incorporant, ainsi que le sevrage, dans des modèles de simulation.

Mots-clés: maturation de la canne à sucre, sevrage, maturation artificielle, saccharose