SPRAY ON PROFITS

ONLY HEALTHY CROPS GIVE OPTIMUM YIELDS. YET IN THE TIME BETWEEN PLANTING (OR RATOONING) AND HARVESTING, SUGARCANE IS EXPOSED TO MANY THREATS: APHIDS, THRIPS AND ELDANA FEED ON IT, FUNGAL DISEASES SUCH AS RUST DECREASE VIGOUR AND WEEDS COMPETE FOR LIGHT, WATER AND NUTRIENTS. GROWERS CAN COMBAT 'BIOTIC' STRESS FACTORS LIKE THESE WITH PESTICIDES, FUNGICIDES AND HERBICIDES, BUT WATER SHORTAGES, HEAT OR EXCESSIVE RAINFALL ALSO PLACE THE CROP UNDER STRESS AND DECREASE VIGOUR.

New crop protection chemistries combine direct fungicidal activity with beneficial plant physiological effects

The strobilurin fungicides are derived from a natural antifungal substance, and are apparently not only successful in controlling harmful fungi, but also increase resistance to stress in several crop species. During the development of this class of fungicide it was noticed that crops protected by them yielded considerably more than untreated ones, especially when there was a shortage of water.

Strobilurins are highly effective disrupters of fungal respiration. To a lesser extent, they also slow down plant respiration. This triggers several different beneficial effects in the plant, which together result in increased yield, especially during drought. Because less sugar is respired, there is a net stimulation of carbon assimilation and also nitrogen assimilation, the latter due to increased activity of the nitrate reductase enzyme (Figure 1). Plants which have been treated with strobilurins have been shown to be able to utilise nitrogen especially well, even when there are reduced levels in the soil.

A 'stay green' effect is often observed, suggesting that strobilurins slow down the ageing process of plants. This seems to be important during drought, because

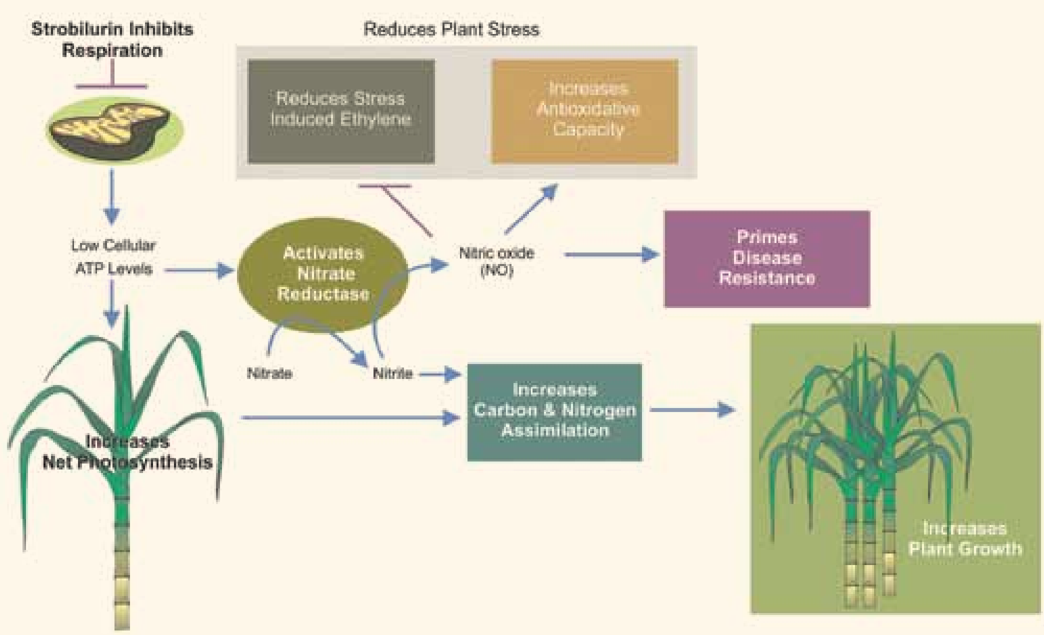

Figure 1: The cascade of plant physiological effects induced by strobilurin fungicides

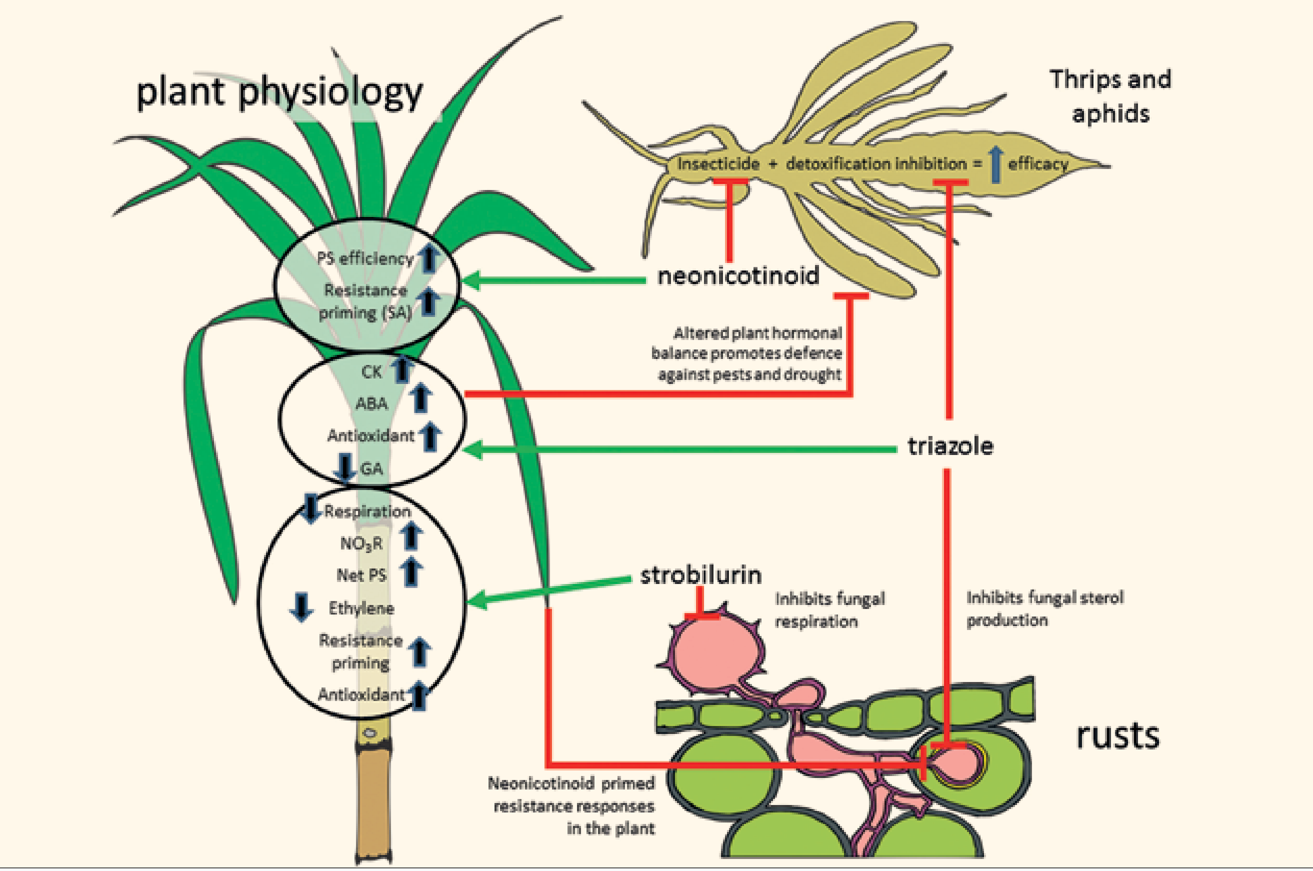

Figure 2: Possible effects of combined strobilurin, neonicotinoid and triazole chemistries on plant physiology and target pests and diseases. (PS – Photosynthesis; SA – Salicylic acid; CK – Cytokinins; ABA – Abscisic acid; GA – Gibberellins; NO_3R – Nitrate reductase; NO – Nitric oxide)

when under stress, plants start an emergency programme, producing the plant hormone ethylene, which accelerates the maturity or ripening process. However, the price for this emergency ripening may be high in younger crops: lower yields are a result, and premature leaf senescence occurs, which in sugarcane provides egg laying sites for eldana. Stressed plants produce free oxygen radicals which are poisonous to them and cause leaf senescence. However, plants have enzymes which detoxify free radicals. Nitric oxide, produced as a by-product of increased nitrogen assimilation, induces an increase in the activity of these enzymes. Nitric oxide also inhibits ethylene production, thereby allowing the plant to accelerate recovery growth when the stress level is reduced. Inhibition of ethylene production allows for improved root growth which further increases the capture of nitrate nitrogen from the soil, as well as improving access to soil moisture.

New pesticides also have combined beneficial effects on plant physiology

Neonicotinoids are the newest of the three major classes of insecticides, which include the organophosphorous compounds and pyrethroids. Neonicotinoids are among the most effective insecticides for the control of sucking insect pests such as aphids, leaf- and planthoppers and thrips. Like strobilurin fungicides, they have been reported to enhance plant vigour and stress tolerance, independent of their insecticidal function. They do this through the physiological activity of their breakdown products in the plant which prime salicylic acid (SA)-associated plant defences for a rapid response to attack. SA is a plant hormone best known for its role in plant defence against pathogens such as rusts and smut; however, it can also modulate abiotic stress responses especially to heat which commonly accompanies drought (Figure 2).

Combined modes of action delay the appearance of resistance in the target pest or disease

Strobilurins are typically combined with another class of fungicide, the triazoles, which have a different mode of fungicidal activity. The fungicidal properties of triazoles depend on inhibition of fungal sterol biosynthesis. However, as shown in the accompanying diagram, triazole-based fungicides also induce changes in the hormonal balance in plants which could act synergistically with the changes induced by strobilurins and neonicotinoids allowing plants to tolerate a broad range of environmental stresses.

Synergies are also likely between direct and indirect effects against target pests and diseases. Triazole fungicides have been shown to inhibit the ability of insects to detoxify some insecticides so increasing insecticidal efficacy. They can also elevate insect resistance in the plant. Similarly in the case of pathogens, the direct effects of strobilurins and triazoles probably synergise with the indirect effects of strobilurins (mediated by nitric oxide in the plant) and neonicotinoids (mediated through SA responsive plant defences) in priming the plant for enhanced pathogen resistance when attacked.

What have we observed in sugarcane?

Much of the information presented here on the plant physiological effects of these new chemistries has been derived from effects on other crops, most notably, wheat, maize and cotton. During the advancement of these chemistries towards registration in sugarcane, for use against thrips and brown rust, a number of incidental observations have been made which suggest that beneficial plant physiological effects also occur in sugarcane.

Table 1: Trials conducted under varying levels of drought stress suggest that economic benefits could be derived from using these chemistries in sugarcane.

Drought Stress Level Observed	Chemistry applied	Untreated yield tc/ha	Treated yield tc/ha	% yield increase	Value of increased tonnage (R/ha)[a]	Cost of product + application (R/ha)[b]	Profit (R/ha)
severe	strobilurin/triazole [c]	10	20	100	3816	1348	2468
very high	neonicotinoid [d]	27	35	30	3026	430	2596
high	neonicotinoid	39	43	11	1526	430	1096
low	strobilurin/triazole	94	102	9	2549	1348	1201

[a] *Based on the 2013/14 Canegrowers estimate of R3180 per ton RV which at 12% RV would amount to R381.60 per ton cane.*
[b] *Knapsack application; 1 man-day/ha @ R150/day plus cost of product.*
[c] *Fungicide 1.6L/ha, 2 applications to canopy, 28 days apart, product cost = R1048/ha.*
[d] *Insecticide 2L/ha, one application, product cost = R280.*

In a trial testing the neonicotinoid imidacloprid for thrips control, a significant reduction in rust infection was observed (Table 1). In another, which combined imidacloprid with a strobilurin/triazole, both thrips numbers and rust infection were reduced to levels below those of insecticide and fungicide treatments alone.

Varieties that may particularly benefit from a combined treatment include N27, N31 and N41, since these are of intermediate resistance to brown rust and have been noted to harbour higher than average thrips numbers during summer.

What additional benefits could accrue?

The results presented in the table suggest that the neonicotinoid and strobilurin/triazole chemistries currently registered for use in sugarcane could be highly beneficial especially if the crop becomes stressed. Since drought stress is a major driver of eldana damage, it is also possible that treated crops could be less susceptible to eldana. This possibility is being tested by SASRI. Furthermore, reduced costs associated with weed control could accrue due to faster canopy closure that is often evident when thrips and rust are controlled.

In other crops physiological responses to treatment have been found to occur to greater or lesser extents depending upon plant variety. It is not yet known whether varietal differences in response occur in sugarcane. Nevertheless, varieties that may particularly benefit from a combined treatment include N27, N31 and N41, since these are of intermediate resistance to brown rust and have been noted to harbour higher than average thrips numbers during summer. Other rust intermediate varieties could also benefit (N16, N35, N37, N39, N50 and N51).

The way forward

Whilst there is no substitute for the scientifically rigorous trials that SASRI conducts in investigating variety and treatment combinations across stress environments, the potential for increasing profits through the use of these registered chemistries already exists. On-farm observation trials planned with the assistance of your Extension Specialist and with the input of SASRI specialists can go a long way towards demonstrating the profitability of any new practice under local conditions.

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