

SECTION 3: Agriculture Assessment

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1. Introduction

As part of the review process the NRA is obliged to ensure that a chemical when used as directed is effective and complies with current NRA efficacy assessment standards.

In order to obtain information on the actual use of aldicarb in the field the NRA developed a survey which targeted large and small-scale users, commodity organisations and other representative groups, chemical companies and State agricultural authorities requesting advice regarding areas in which change may have taken place since the chemical was first registered. The changes that could have occurred include the standards of efficacy applied by the regulatory authorities, the pest complexes in existence, emergence of resistance or phytotoxicity, new crop uses or more effective alternatives.

Chemical management issues are examined together with chemical application methods and assessments of the field performance of the chemical. Comparisons of the performance over the period the chemical has been used in the industry or by the farmer are also made.

2. Registration and use pattern information

Aldicarb was first registered in Australia in the early 1970's and has remained registered since that time. It has proved to be a useful chemical, particularly in relation to nematode control in sugar cane, citrus and ornamentals and control of various insect pests of cotton.

There are currently only 2 registered products containing aldicarb. These are:

- *Farmoz Touche 150G Systemic Insecticide/Nematicide (48089)* – Farmoz Pty Ltd
- *Temik 150G Insecticide/Nematicide (48937)* – Aventis CropSciences Pty Ltd

At the initiation of this review a number of permits had been issued by the NRA for aldicarb use.

- An off-label permit for the control of bulb mite in Freesias in Tasmania (no longer current)
- A trial permit for mandarins which is now a registered use.

However, it should also be noted that in some States under certain conditions, chemicals can be used off-label without a permit. In this regard, it is noted that aldicarb has been used in vineyards in Victoria for the control of nematodes permitted under State legislation.

2.1 Current Label Use Patterns

The following information is sourced directly from the approved product labels for aldicarb products.

Crop	Pest	Rate kg ai/ha	Critical Comments
Plant and Ratoon Cane (Qld, NSW,	Root-knot nematodes Root-lesion nematodes Burrowing nematodes Spiral nematodes	17 kg product/ha (2.55 g ai)	Apply no later than the 3 to 5 leaf stage. Use microfeed applicator to apply across width of drill. Lightly incorporate with rakes, discs or tynes. Irrigate with 12 to 25 mm within 24

Crop	Pest	Rate kg ai/ha	Critical Comments
WA, NT only)		OR 24 g product/10m row (150 g/kg ai)	hours of application. DO NOT make more than one application per crop.
Cotton (Qld, NSW, WA, NT only)	Aphids Jassids Mites Thrips Wireworm (<i>Agrypnus variabilis</i>) False Wireworm (<i>Pterohelaeus darlingensis</i>)	3 to 7 kg product/ha (0.45 to 1.05)	Apply into the seed furrow at seeding. Distribute granules to the seed furrow or bed through outlets from granule applicators attached to the cultivation bar. DO NOT apply unless adequate soil moisture is present at seeding. Planting into moist soil will allow a greater and faster take up of aldicarb by the cotton seedling, DO NOT apply under cloddy soil conditions. The higher dose rates will provide longer control.
	Green Mirids	5 kg/ha (0.75 g ai)	Apply as above. If control of mirids diminishes by early squaring, apply a suitable foliar insecticide spray.
Non-Bearing Citrus (Qld, NSW, Vic, SA, WA, only)	Citrus leaf miner	<u>Area</u> 7g product/m ² (1.05 g/m ²) OR <u>Band</u> 30g product/tree (4.5 g/tree)	<u>Area Treatment:</u> Apply prior to or as pests appear. Repeat applications may be necessary if new leaf mines are found. DO NOT treat within three months of transplanting. <u>Band Treatment:</u> Apply in bands 20 to 50 mm wide and 1150 to 300 mm long. Apply along the rows on either of the tree, at a distance of 200 mm from the trunk. Apply prior to or as pests appear. Incorporate to a depth of 30 to 50 mm. Repeat applications may be necessary if new leaf mines are found. DO NOT treat within 3 months of transplanting.
Oranges (Non trifoliata rootstocks only) and mandarins (Qld, NSW, Vic, SA, WA, only)	Citrus nematode Soft brown scale (<i>Coccus hesperidum</i>) Mealy bug (<i>Pseudococcus longispinus</i> and <i>Pseudococcus calceolariae</i>)	2.1 to 11.55 (14 to 77 kg product/ha)	Apply once only each year from August to November after the crop has been harvested and any out of season (second crop) fruit have been removed. Apply in a band along each side of the row, as close as possible to the drip line. Incorporate into the soil immediately to a depth of 30 to 80 mm and irrigate to a minimum of 10 mm unless rain follows. The dose rate and treated band widths depend on tree canopy size and row interval. Refer to table under <u>General Instructions.</u> DO NOT treat within three months of transplanting.

The following withholding periods apply for currently registered products.

All crops

Do not allow stock to graze in treated area

Do not cut treated crop for stock for food

Plant and Ratoon Cane

Do not apply later than 17 weeks before harvest.

Citrus

Do not apply later than 26 weeks before harvest.

The following limitations are also specified on approved labels:

- DO NOT sow any edible crops for 6 months after the last application
- DO NOT sow or plant any edible crop between rows of crop treated with aldicarb for 6 months after the last application
- DO NOT harvest any vegetation from treated areas for human or animal consumption for 6 months after last application
- DO NOT apply aldicarb within 15 m of drinking water wells
- DO NOT clean or load application equipment within 15 m of drinking water wells

Because of the toxicity of aldicarb the following statement also appears on labels: *Aldicarb is too hazardous for use in the home garden.*

2.2 Methods of Application

Aldicarb is a soil-applied, granular, systemic insecticide/nematicide. It is relatively soluble in water and is released into the soil by moisture. Irrigation is recommended following application where soil moisture is low to ensure release of aldicarb from the granules. Aldicarb remains in solution in the soil and follows the soil moisture profile moving through the root zone of plants and beyond to control soil pests. It is absorbed through the roots to control various sucking and chewing pests of plants.

Granules are usually placed in one of the following ways:

- broadcast and then incorporated into the soil
- banded and then incorporated into the soil
- banded above or below the seed
- as a side-dressing during planting or later,

Aldicarb application is carried out using tractor-mounted applicators (for smaller areas ATVs are sometimes used) which can either feed granules directly into a furrow, behind a cultivating tyne, along a row of planted seed or established plants or they can broadcast granules by means of a spinning disk. In any case, applicators which do not grind the granules are required.

The exception to this type of application was use under permit of aldicarb in greenhouses for control of bulb mite in freesias (Tasmania). In this instance the granules were either dissolved and applied as a soil drench through overhead sprinkler systems or manually applied to the soil surface and watered into the soil with overhead sprinklers. This permit is no longer current.

2.3 Individual crops and application methods

Sugarcane

Application to sugarcane (plant and ratoon) uses a microfeed applicator to apply granules at 17 kg/ha (or 24 g/10 m row). Application is followed by light incorporation with rakes, discs or tynes, and by 12-25 mm irrigation within 24 hours. A single application per crop is allowed, up

to the 3-5 leaf stage. Aldicarb is nemastatic rather than nematicidal, and nematode activity usually resumes after 4-6 weeks.

Sugarcane is grown in small areas of mainly alluvial soils along the Queensland coast, on river flats of the Clarence, Tweed and Richmond Rivers in northern NSW, and increasingly in the Ord River Irrigation Area in WA however only small volumes of aldicarb are used in sugar production with approximately 1.5 tonnes used in 1996.

Cotton

In Australia, aldicarb is used in cotton at planting and remains effective for 6 - 10 weeks, providing residual control of both soil dwelling insects such as wireworm and above ground pests such as thrips, aphids, mites and mirids. It is thus effective in the early part of the growth of the cotton crop prior to squaring

Application to cotton occurs in furrow at seeding, at rates of 3-7 kg/ha (450-1050 g/ha aldicarb). The preferred placement, just below the seed line, can be achieved by attaching the granule delivery chute so that granules are released just before the seed chute. Treatment should only occur where there is adequate soil moisture to allow uptake into the plant, and not under cloddy soil conditions.

Temik is promoted for use with Ingard cotton, where its early season control (up to 50 days) of sucking pests complements the activity of the Bt gene against *Helicoverpa* spp.

Cotton is a well established crop in NSW and Queensland but is also being grown in the Ord River. Aldicarb itself plays an important role in early season pest protection of cotton. It currently offers the longest early season in-furrow protection for a number of key pests. In integrated pest management systems it allows greater retention of early season beneficial insects as well as preventing early broad spectrum insecticide applications that may be responsible for flaring of secondary pests.

Citrus

New South Wales grows approximately 35% of total Australian citrus output. South Australia follows with 33%, Victoria 20%, Queensland 10%, Western Australia 2% and a small but growing industry in the Northern Territory.

A single yearly band application is recommended for non-trifoliata rootstock oranges. Some concern has been expressed that band application (as opposed to broadcast application into the root zone of the trees) is not the most effective method of treatment for nematode control in orange orchards using aldicarb. However, repeat broadcast applications are far more costly than a single band application. In addition, there is a much higher likelihood of residues resulting from this type of use than from the single band application. In conditions of adequate soil moisture and active growth aldicarb is translocated throughout the tree in 2 to 4 days.

Control of citrus leaf miner in non-bearing citrus uses an area rate of 7 g/m² (equivalent to 70 kg/ha product), with repeat applications if new leaf mines are found. Alternatively, banded treatment at 30 g/tree may be used, with granules applied in 20-50 mm wide bands extending 150-300 mm along the rows on each side of the tree, some 200 mm from the trunk. This

equates to an area rate in the order of 9 kg/ha product for planting rates of 300 trees/ha. Banded treatments should be incorporated to a depth of 30-50 mm.

Oranges (non trifoliata rootstocks only) may also be treated once at 14-77 kg/ha product from August to November as a band near the drip line for control of citrus nematode, with immediate incorporation to a depth of 30-80 mm and minimum 10 mm irrigation or rain. Citrus should not be treated within 3 months of transplanting. Non-trifoliata rootstock is in decline in Australia.

Use in citrus comprises less than 10% of all aldicarb use in Australia.

2.3 Temik Accreditation Program

Aventis Crop Science has established a comprehensive training and accreditation program for the distribution and use of their aldicarb product (Temik 150G). The focus of the field component of the program is the education, training and accreditation of distributors and end-users. The main principles of this program are:

- (a) All distributors of *Temik* must be Agsafe accredited and complete the training course and exam for accreditation by Aventis.
- (b) All product users must complete the training course and successfully complete the exam prior to purchase and use of the products
- (c) Specialised application equipment is recommended.

For use of Temik 150G in both cotton and sugarcane the above training and accreditation conditions apply. There are approximately 150 trained and accredited cotton growers and 20 sugarcane growers who purchase and use this product annually.

The conditions for Temik 150G use in citrus are slightly different to that in cotton and sugarcane due to the unique differences in the crop to be treated. Application is only carried out by contract applicators who have been trained and accredited through the Aventis course. No product is stored on farm or sold directly for use by growers. There are approximately 5 accredited contract applicators in this market. Specialised application equipment has also been purpose built for application of Temik 150G in citrus.

2.4 Control Programs Recommended by State Agricultural Authorities

One of the measures of a chemical's importance in agriculture can be the way in which it is recommended by State agricultural authorities. A number of these authorities have included aldicarb in recognised control programs as listed below:

State	Spray Program
VIC, SA	Nematodes control in citrus
WA	IPM in cotton
QLD	Irrigated cotton – seedling pests (aphids) Nematodes in sugarcane

2.5 Variations to Use Patterns from Grower Usage

Generally there appeared little variation to the registered use patterns notified during the review. Because of the nature of the product (soil applied granule) the scope for variation to registered use patterns compared to, for example, concentrate and high volume orchard spraying, is limited.

2.6 Evaluation of efficacy

All respondents to the review of aldicarb indicated that it is still efficacious for the purposes claimed when used as directed. Complaints of failures of aldicarb treatments were not received during the review.

There was some doubt expressed about whether the withholding period restrictions and the requirement for aldicarb to be only used in non-bearing, non-trifoliata rootstock oranges were being observed in practice. In this regard, it is noted that the only commodity in which aldicarb residues have been detected (below MRL) is oranges.

In general, the effectiveness of any granular application is affected by soil conditions (moisture, temperature and soil type) and by the preparation and placement methods used and aldicarb is no exception.

The chemical must reach the root zone both for control of nematodes and for absorption into the plant for its systemic insecticidal activity. Aldicarb is soluble in water and follows the soil moisture profile into the plants' root zone where it is absorbed into the plants or comes into contact with nematode pests. Thus label instructions include reference to use of the granules in association with adequate soil moisture.

Residual control of pests for 6 - 10 weeks can be expected, irrespective of soil type or pH. Aldicarb is fast acting with effects noticeable in 48 hours.

It is usually assumed that systemic insecticides such as aldicarb have a minimal effect on Integrated Pest Management (IPM) programmes. This expectation is based on the fact that the chemical is not sprayed onto the target as an overall spray and therefore does not contact beneficials and cause disruption to IPM programmes. However, advice from the Queensland Department of Primary Industries indicates that they have experienced disruptions to IPM programmes in oranges with use of aldicarb. Beneficials have been affected both at initial application in particular and on the leaves through systemic activity.

Cotton

Respective agricultural authorities in the States where cotton is cultivated endorse the efficacy of aldicarb for control of early pests such as thrips and mirids in cotton. However, matters such as the necessity of application and the severity of the treatment relative to the problem posed by these early season pests may require some exploration. In 'orthodox' cotton production, an assessment in relation to economic damage thresholds would be made before application of an insecticide treatment. Application of an appropriate insecticide would then be made in accordance with the resistance management strategy. However, with an application of aldicarb a certain level of pest activity is assumed at planting.

Citrus (Non-bearing and non-trifoliata rootstock oranges)

The effectiveness of aldicarb as a nematicide in citrus is supported by respective State agricultural authorities, growers and registrants. Repeat broadcast applications are not actually approved for bearing citrus at the moment. Aldicarb is recommended for application in a band along either side of the row, but there is some doubt that this is the best way to apply nematicides. Researchers consider that repeat broadcast application under the trees in the drip zone may be of more benefit, but trial work is needed to confirm. If there was to be a change of use pattern to encompass repeat broadcast applications, the situation with MRLs would need to be checked.

In addition, there was some concern that farmers may not be observing the 26 week withholding period partly because of the difficulty in tracking the time involved.

2.7 Advantages of product

The advantages of aldicarb are associated with its soil application, its systemic activity, its granular formulation and its effectiveness as a nematicide. It is not unique in these advantages, being only one of a number of soil applied, granular, systemic insecticides.

The fact that one of the manufacturers has specified training courses and a container management system which minimise operator exposure is also a significant advantage in the use of this product.

Cotton

Because aldicarb is soil applied in granular form, its use can minimise the number of sprays applied to crops and thereby eliminating drift and other complications associated with the application of insecticide by boom spray or aircraft.

Another advantage of aldicarb is that it is not as harmful to beneficials since both predators and parasites of insects which attack the above ground portion of the plants do not come into direct contact with the insecticide. There is some secondary exposure because of exposure to affected insects and in some cases predators can also feed on the plants to a limited degree. Nevertheless, in general, beneficial insect numbers are able to increase with use of aldicarb.

Registrants of aldicarb also indicate that their own and independent trials show that there can be a yield increase associated with the use of aldicarb in cotton. Better early establishment of the cotton is said to be one of the contributing factors to this yield increase. Early plant vigour is a critical factor in obtaining maximum yields from dryland cotton and it has been shown that aldicarb can help establish and maintain early plant vigour by providing continuous protection against soil pests and sap-sucking pests.

Citrus

Aldicarb is also a very effective nematicide, and as well as providing systemic control of citrus leaf miner, it provides effective nematode control in citrus.

Sugar Cane

The Bureau of Sugar Experiment Stations (BSES) has advised the NRA that it considers that the use of aldicarb is a significant part of the management of nematode pests of Australian sugar cane. This is based on trial work carried out in Queensland in the late 1970s and early 1980s. As the principal RD&E provider to the Queensland sugar industry, the BSES has considerable expertise in the use and management of aldicarb and considers that it is important that aldicarb continue to be available to Queensland canegrowers.

2.8 Alternatives

Cotton

There are quite a number of soil applied systemic alternatives for control of early pests in cotton but none of these include the same range of pests as aldicarb. Among these are phorate, imidacloprid and carbofuran.

Seed dressings are also alternatives (thiodicarb, imidacloprid, and furathiocarb), but these do not provide the duration of protection afforded by aldicarb. Alternative foliar sprays such as omethoate and dimethoate are effective but disruptive to IPM aims of preserving beneficials.

Thus, aldicarb is considered to be the most effective (including cost effective) of the chemicals used for control of seedling pests in cotton.

Citrus

There is some ambivalence among State departments of agriculture entomologists and nematologists regarding use of aldicarb in citrus. It is recognised that nursery stock is susceptible to pests such as citrus leaf miner which can be controlled with aldicarb. However, it is considered that there are other less toxic chemicals which could be used for this purpose and once the trees are older the need for such control diminishes.

The extent of the nematode problem in oranges which do not have trifoliata rootstocks is not clear. However, it appears that there may be responses in a wider range of soil types and situations than has been previously thought. However, once again there are other nematicides which could be used. In general, the industry is replacing non-trifoliata rootstock trees with the resistant rootstocks and this will largely remove the problem over time.

Fenamiphos is already a registered alternative for control of nematodes in oranges and investigations are continuing in relation to nematode control in citrus. As well as investigation of actual chemicals, alternative methods of application (including for aldicarb) are also being considered. Thus, application of alternative nematicides by repeat, broadcast application under trees (as opposed to band application) is being considered. However, one of the major factors influencing the practicality of this work is whether or not the alternative chemical/method is of comparative economic benefit to the current band application recommendation for use of aldicarb.

Sugar cane

The major alternatives for use in sugar cane are ethoprofos, cadusafos, carbofuran and fenamiphos. Of these, the Bureau of Sugar Experiment Stations (BSES) considers that ethoprofos is probably the most widely used as an alternative. It is considered to be not as effective as aldicarb and it is likely that availability of ethoprofos will be reduced as its use in bananas diminishes in favour of fipronil (a commercial decision by the manufacturer of both products). Fenamiphos is the next most favoured alternative.

2.9 Usage Trends

Overall, it would appear that there may be an increase in the use of aldicarb. This expectation is largely based on the increasing use of the chemical in cotton. In this crop it is applied at seeding and is usually effective until just prior to squaring (6 – 10 weeks). One of the reasons for the increase in application to this crop is that granular application at seeding minimises the number of early sprays required for cotton. Growers are seeking to reduce the number of sprays being applied to crops. In fact spraying for thrips or mirids is not normally required up until squaring following application of aldicarb at seeding. One of the registrants has also produced some data which supports an increase in yield associated with the use of aldicarb. It is not clear from the data whether the increase is associated with the destruction of pests alone or whether the production of healthier plants through destruction of pests at this stage of crop growth produces plants with a higher production capacity at harvest.

Approximately 1055 ha were treated with nematicides in 1996 (aldicarb is the nematicide of choice for most growers) which represented approximately 1.6% of the total area under cane. However, recent research indicates that it is likely that nematode damage is affecting another 10,000 – 20,000 ha in the sandy soils of central and southern Queensland.

In addition, research has shown that there may be an increased requirement for nematicides in the sugar industry and research is continuing using higher than label rates to assess yield loss due to nematode activity. The expansion of production into more marginal sandy soils is likely to require the use of nematicides, while there are also areas on which cane is already grown which could benefit from the application of nematicides. Since aldicarb is the nematicide of choice in this industry it is expected that use of aldicarb would increase from this quarter as well.

Generally, there has been little activity to extend the use of aldicarb beyond the currently registered situations. In fact, use of aldicarb in ornamentals has been removed by one of the registrants. Nevertheless, the NRA is aware of activity on the part of one registrant in conjunction with an industry group to extend the use of aldicarb to one other crop and it is expected that this application will be resolved prior to the finalisation of the review.

2.10 Phytotoxicity

Aldicarb is only available in Australia as a soil applied granular formulation and does not therefore come into contact with plant foliage. Seed germination is not inhibited at recommended use rates. However, one reference notes that when applied in the furrow with acid delinted cottonseed during extremely wet weather conditions, the plant stand may be slightly reduced.

2.11 Resistance Management

Advice of resistance in pest populations to aldicarb was not received. However, a report of enhanced microbial degradation of aldicarb from South Africa was noted. This information suggested that regular use of aldicarb each season and/or regular use of other carbamate or organophosphate pesticides for other pests may result in reduced results with this chemical. This has not been observed in Australia.