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DEPARTMENT OF AGRICULTURE, SOUTH AUSTRALIA

Agronomy Branch Report

PRINCIPLES, PRACTICES & NEW DEVELOPMENTS IN PLANT PROTECTION

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Report No.

47.

FARM HYGIENE

FARM HYGIENE AND WEED CONTROL

by

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Weed seeds or plant parts which are capable of reproducing new individuals whether they be proclaimed noxious or otherwise can move onto, around, and off the farm in many different ways.

A primary producer must concern himself with all 3 aspects as although he may recognize that movement onto and around the farm will affect his own production, he must accept a moral obligation to insure that those people trading with him, or his neighbours are protected from receiving a serious weed infestation from him.

Farmers of today must be aware of the many possible methods of spread of weeds and they must aim to minimize the risk of spread by management and sound agricultural practice which includes farm hygiene.

Weed seeds are spread mainly by man's activities although many seeds are well adapted to a particular method of spread.

Some seeds or their pods, have appendages which make them well suited for wind dispersal, e.g. the parachute like pappus attached to the skeleton weed seed. Wind dispersal is common in seeds from the plant family, Compositae. Wind dispersal does not necessarily mean that the seed becomes airborne. Colocynth melons dry, still contain the seed, and the papery shell blows along the soil surface. Some weeds beak off at ground level at maturity, and roll along shedding seed as they go.

A number of proclaimed weeds have hocks or spines on their fruits or on bracts around the seed and this means that these seeds are readily distributed by mechanical means. Pneumatic tyres, bags, stock and clothing can carry the seeds of such plants as Khaki weed, Caltrop, Spiny Emex, Noogoora, Californian, Bathurst Burr and Innocent weed. There are of course, many other weeds that use this method of spread.

Weed seeds can be dispersed in ground waters and a seed which floats and grows along the sides of creeks or rivers obviously has this method at its disposal. Michael in 1956 showed that the presence of river systems was an important factor in determinig the distribution of sour-sob.

A few weedy species have an explosive mechanism which shoots the seed from the pod, and enables spread over short distances.

Some seeds are coated with a sticky mucilage which makes them well suited for dispersal by birds. Birds and animals may carry seeds externally or internally.

Farm and road making machinery can spread weeds either as seeds inside it or in mud on wheels or seeds physically embedded in tyres, or as plant parts, entagled on discs or shares or other parts. Manure, silage, hay, animal bedding materials and parcels of large grains or small grains can all be agencies for the spread of weed seeds.

What steps then can the farmer take to prevent weeds invading his property, to prevent an isolated outbreak from spreading around the property or when an infestation is well established, how can he meet his obligation in respect to his neighbours and those people trading with him?

<u>To Prevent a New Infestation</u>

(1) Farmers should be encouraged to look for new plants on their farms and should be informed through the local press that an identification service is available. Early identification and classification of the threat of any new plant on a property is essential.

(2) Machinery movement particularly headers, balers, trailers or contractors machinery or machinery from such bodies as E.T.S.A., and P.M.G., should be watched. See that it is washed before hand and check tyres for spiny seeds if it comes from a suspect area.

(3) Care is necessary when buying hay, small or large seeds or stock to ensure that you are not buying a weed problem. A farmer should be aware of the Hay flora and get the sellers assurance that the material does not contain proclaimed weeds or parts thereof before purchasing, e.g.
Salvation Jane
Three Corner Jack
Innocent weed
Yellow Burr weed
Sheep weed
Thistles

A farmer should buy his seeds from a recognized source either from a registered grower or buy certified seed. Any other seed should be sent for analysis for weed seed inspection. The small seeds flora can be:-

Horehound
Onion weed
Mignonette
Melilotus
Buchan weed
Innocent weed
Bladder Campion
Docks
Thistles

Cereal seeds can contan such weed seeds as:-

Wild Oat
Mignonette
Spiny Emex
Melilotus

(4) A farmer should buy stock from a market where he knows a regular inspection for weed seeds on stock is taking place.

The wool flora:-

Horehound
The Burrs
Innocent Weed
Silver leaf nightshade
Yellow Burr weed

Stock should be given the opportunity to clean out if they have recently come from a property where they may have injested noxious weed seeds. Little information is available on the viability of weed seeds passing through stock but experience indicates that Sheep weed, Silver leaf nightshade and Yellow Burr may move onto property in this manner.

(5) He should inspect his boundaries and creeks or river banks in his travels around his property recognizing that this is where a potential problem may begin.

<u>The farmer who wishes to prevent an isolated outbreak from spreading around his property must</u>:-

(a) Understand the biology and ecology of the weed. He should ask the Department of Agriculture advice on these matters e.g.,

(i) Dry cultivation may be a useful method of control, if wet, the result could be disastrous.

(ii) Lifting fertility and better pest control on pasture management may be a method of restricting any further spread.

(b) Decide if he is to restrict vehicle, stock or machinery access.

(c) Decide if he should mark the area, how far he should go with this and if chemical control should be attempted.

(d) Decide how long the area must be given special attention. 1 years weed 7 years seed. When properties change hands it is his moral obligation and yours to inform the new owner.

(e) Decide if pigs or poultry have a place in a control programme.

(f) Be given the opportunity to see this weed when it is well established on other properties so that he can appreciate the seriousness of the threat to his own.

(g) Scratch his head and decide how the infestation arrived on his property.

When a serious agricultural weed first invades a property these management decisions can be vital to the productivity of that property for years to come.

What of the Farmer who has a Well Established Problem?

To me this man has both a moral and legal obligation to see that he does not hand on his problem. Nevertheless few people worry about these aspects and hay, sheep and seeds travel around our countrysides contaminated with noxious weeds.

In the future I forecast that more attention will be focussed on this aspect of weed control in this state than has been the case in the past.

The Seed Act and Weeds Act contain the legal deterrrents to prevent this form of spread.

As our markets become more demanding in the quality of produce they require, growers must look at the quality of the products they are producing and they will strive to maximize profits.

Under such a system there is little room for the producer who accepts a weed problem as something he can do little about and who makes no effort to restrict the spread of his problem by taking care with his produce.

People are already becoming more critical of the quality of hay and seeds they bring onto the farm and in one area of the state they are agitating for a declaration of freedom from proclaimed weeds to accompany hay and farm grains. This will it is hoped give some protection to the buyer.

The day may come when the produce from a farm that is contaminated with a serious agricultural weed is quarantined and restricted in its market ability. In the meantime this producer should be controlling his infestation using the best methods available to him.

Depending on the method of spread he may be able to contain the problem on the farm by treating boundaries and he should be seeing that farm produce that could be contaminated is used on the farm or if not it goes into situations which render it innocuous.

As previously pointed out I think it is in this last area the Departments of Agriculture throughout Australia have a new role to play in the future.

In this talk I have tried to indicate to you that farm hygiene, and management play a more important role in weed control today than they did 40 years ago. The speed and distance at which produce can move across our contrysides, or across nations should make us more conscious of the problem, the ever present threat of new problems. Hygiene and management have their part to play along with herbicides in weed control.

BIOLOGICAL CONTROL

Sitona Weevil - Parsites and Resistance

by

MRS. J. MOULDEN

Research Officer (Entomology)

1. INSECTICIDES

Insecticidal control of adult sitona weevil is unsatisfactory because the insecticides are relatively expensive and short lived and Sitona are active insects so that treated areas become rapidly reinfested. Insecticidal control can only be recommended where high value crops are being protected.

Hence the Department has looked more towards other control techniques.

2. PLANT RESISTANCE

Two of the plant breeders in the Department have been looking for resistance to adult feeding. Several lines have shown relative resistance. The present methods for screening lines are slow and time consuming and might be greatly improved if we knew the reason for resistance in particular lines.

3. DISEASES

The fungal disease Beauvaria bassiana is known to attack sitona weevil in South Australia but does not appear to be offering economic control.

4. PARASITES

4.1 Why parasites?

4.1.1 Sitona weevil is an introduced pest in South Australia and it is likely that its parasites were not brought into Australia.

4.1.2 A survey of the literature shows 4 parasites of sitona weevil; 3 wasps and a fly.

4.1.3 John Doolette has not observed sitona attacking medic in Tunisia. We know that the strains of sitona occurring in Tunisia and South Australia are similar and if the sitona in Tunisia are being kept in check by parasites these could be particularly useful in South Australia.

4.2 Problems

4.2.1 Which parasites?

A survey must be carried out to select parasites which will attack the strain of *Sitona humeralis* found in South Australia and will also survive in our climate.

Dr. Aeschlimann has just begun work with C.S.I.R.O. at Montpellier and has begun such a survey. Both parasites of the adult and larval stages need to be considered.

4.2.2 Will our sitona maintain the parasites?

The over-wintered adults of sitona weevil will have to survive into spring so that a quick "build-up" generation of the parasites can occur in spring. This year we will study the rate at which the population of over-wintered adults declines.

4.2.3 Will the parasites attack other insects?

If parasites are to be introduced we shall have to ensure that no beneficial or native insects are attacked. However, the parasites could act as an "insurance policy" against other pests such as Alfalfa weevil which have not yet gained entry into Australia.

4.2.4 Rearing parasites

It is desirable that parasites be multiplied in the laboratory to permit most rapid build up and release in South Australia. This will probably be the responsibility of the Department of Agriculture.

4.2.5 Assessing value of control

To assess whether parasites and/or resistant varieties are being of value we must be able to measure the population both before and after the introduction of control. In 1972 initial work was carried out on assessing populations at Roseworthy and in 1973 it is intended to expand this and to compare populations between the different medic growing areas of the State.

5. INTEGRATED CONTROL

Growing plants which offer a degree of resistance will probably not be the complete answer to the problem. Parasites too, may not be totally effective. The combination of both approaches may then provide a complete solution.

If the combination is still not good enough careful reintroduction of limited insecticidal treatment may be possible to give complete population control.

BIOLOGICAL CONTROL

Biological control of Skeleton Weed

by

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Since 1965, C.S.I.R.O. Division of Entomology has been engaged in a programme of biological control of skeleton weed, *Chondrilla juncea*. A team of research workers has been operating in Europe using Montpellier in France as a base. The costs of setting up facilities were provided by the Wheat Industry Research Council. To date the programme has cost over $500,000 and annual running expenses are now being borne by C.S.I.R.O.

The programme has met with considerable success and several organisms which keep skeleton weed populations low in their native areas have been introduced to Australia. The attached notes give details of the three most promising which have undergone field releases.

The skeleton weed rust has now spread throughout the Murray Mallee and has been detected on skeleton weed plants as far west as Cleve. During the past summer the rust has become difficult to detect even in the irrigated areas along the Murray. I suspect that higher than normal summer temperatures have been responsible for the decline in the rust population. The mean maximum temperatures for December and January of the past summer were some 3°C greater than the previous summer. The maxima of the hottest days for these months were also 4-5°C greater than the previous summer. Due to the drought there was also considerably less green skeleton weed tissue present in the dryland areas for the rust to attack.

The gall midge and gall mite have established themselves at most of the sites where releases were made in October, 1972. The spread from these is still very limited. In the irrigated areas however the midge has spread over remarkable distances since the releases were made in January 1972. Throughout the Loxton and Renmark areas the midge galls can be readily found on skeleton weed plants. The debilitating effects are quite obvious. The gall mite however, has not spread a great distance as yet but it is well established at the release sites at Paringa, Cooltong, Loxton and Waikerie.

At this stage I believe optimism is in order but it will be several years before a real assessment of the overall effects of the biological agents can be made.

A fourth predator, a moth with root-feeding larvae, may be released later this year providing rearing difficulties can be overcome.

A spin-off of the programme has been its extension to the search for agents to control Salvation Jane and Potato Weed as the first steps in looking at biological control of other Australian weeds of Mediterranean origin.

<u>Skeleton weed rust (Puccinia chondrillina)</u>

<u>Origin</u>: Portugal to Hungary in Europe (Also occurs in America where it was introduced from Europe with skeleton weed). Distributed right through the Murray Mallee.

The rust fungus is specific to skeleton weed. The spores will readily infect green tissue of leaves or stems providing moisutre is available for germination of the spores. In mid-winter the generation time from infection to production of uredo-spores could be as long as five weeks. With warm spring and early summer temperatures this could be as short as six days. The spores are produced in small pustules called uredosori. These are dark brown in colour and appear on the surface of stems or leaves. The spores are dispersed by rain drops falling on the pustules and releasing spores which may then be carried by the wind to infect other plants. Because the fungus requires green tissue it can only attack the above ground parts of the weed and does not grow into the root system. The large regeneration capacity of the skeleton weed root system will thus only be weakened over many years of constant fungal attack on the stems and leaves. Survival of the rust in the late summer period when the top of the plant dies is the critical factor.

The total effect of the rust in Europe is to kill some plants and cause severe physiological stress to others.

<u>Chondrilla gall mite (Aceria chondrillae)</u>

<u>Origin</u>: Greece. Occurs throughout the Mediterranean from southern Russia to France and Spain. The mite which has been released is very specific to our strain of skeleton weeds. It was introduced into Australia in April, 1971, and released in the field in October, 1971. Widespread releases through the Murray Mallee were made in October, 1972.

The mite, which is not an insect, feeds on the tissue of growing points. This tissue produces a gall, without the protection of which the mite cannot reproduce. The mature mite has eight legs and no wings. The nymph stage has six legs. The larva looks like a minature pink or orange carrot. En mass the larvae are visible to the naked eye, but individually they are not. The mites are delicate organisms which dehydrate easily. They can be blown to other plants, but not as easily as the rust fungus spores. The life details of the mature adults are not known as they live within the gall. However, only females are produced. The adults chew, scrape and suck at stem and flower initials and the plants respond by producing a gall 3-4 weeks after initial attack. Eggs are laid only in the gall which senesces after about 2 months. The life cycle from egg through nymph to adult takes about 1 week. Mites spew out of the gall during the period it is green and before it senesces they all get out. The cycle can go on until growing point tissue becomes unavailable in late autumn. The mites then over-winter on the rosette and rise with the growing point in the spring and summer.

The main and most important effect of the gall mite is to prevent or severely inhibit the production of seed by the weed.

Chondrilla gall midge (Cystiphora schmidtii)

Origin: Greece. Occurs in Europe, but is not as widespread as the mite. Introduced into Australia in August, 1971 and released in the field late in 1971. Widespread releases were made in the Murray Mallee in October 1972.

The midge is a true insect and the adults are winged. The adults are delicate and do not survive very long - one day for the male and no more than two for the female - because they do not feed probably lacking mouth and anus. They can be seen with the naked eye and have grey markings on the organce abdomen. After mating the female lays 150-200 eggs per day under the epidermis of stems or of the under side of the leaf. The larvae emerge after about six days and are very small. They survive for about twelve days and chew on the mesophyll tissue of the leaf. Ten days after egg laying a spot appears on the stem or leaf. The spot increases in size, thickens and becomes a small white or purple gall. The larvae are orange in colour and about $\frac{1}{8}$" long when fully fed. A cocoon forms and the larvae pupate. The pupae can be resistant in the cocoon on the ground. The adults on emerging attack the green skeleton weed tissue. The amount of green tissue and the likelihood of ants eating the emerging midge can regulate the numbers of adults.

The main effect of the gall midge is to reduce the amount of photosynthetic tissue in the plant and to disrupt the translocating mechanisms by physical damage.

BIOLOGICAL CONTROL

New Concepts in Insect Control

by

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While we have in the past relied quite heavily on chemicals for insect control, problems of resistance to insecticides and problems with pesticide residues, together with a desire to devise even better pest control measures have led to many new techniques being developed. Many of these have attracted a good deal of publicity, few of them have yet reached the stage of significant practical application, and the reasons for this are multitude. In this section I want to very briefly mention most of these techniques and indicate some of the problems that limit their application, particularly in our field of agronomy.

1. Insect Sterilization

Probably the most widely publicised, and a real success story has been the sterile male release technique. In principle - if the natural population of an insect is swamped with sterilized insects there will be very little chance of two fertile insects meeting and mating. The next generation will be smaller than the original. If again repeated, then it becomes successively easier to swamp each generation. This is the reverse situation to the insecticide system where the fewer insects, the harder it is to get the last few.

This technique has been applied to eradicate screw-worm from at first small, and then larger areas in U.S.A. It has been used to control, rather than eradicate screw-worm in Mexico. It has also been used to eradicate a fruit fly from Hawaii. There have been many attempts to use it on other insects, and so far no real successes.

It cannot be used very well for some insects for some of these reasons. The wild population needs to be swamped by about ten fold, although this varies depending on whether the females mate more than once. It then has some limitations where the adult stage of the insect causes damage, e.g. grasshoppers, cf moths.

Sterile insects can be produced either by irradiation or by using chemosterilants. However, if these treatments interfere or change the physiology or behaviour of the treated insects in any way other than reducing fertility, then problems may occur.

It has not been possible to produce sterile males of the Mediterranean fruit fly which are fully competitive with the wild population. They get beaten in the race, and so normal fertile insects meet too often.

Other limitations are, the pest species must be easily and cheaply reared in the laboratory. Populations of millions per day are required. This can be overcome where specific attractants can be found to lure wild individuals into chemosterilant bait stations - let nature rear her own. This can be even more effective where booby-trapping females can be used i.e. the sterilized female mates with a series of males, and renders each sterile for his efforts. The problems are many. Not all species have scent-attractants, or not strong enough to be of practical application. Chemosterilants as we know them today are highly dangerous and they do not limit their action to insects, nor do they only affect fertility. Many are strongly carcinogenic.

The whole concept must be considered in relation to an insects' distribution and mobility. Small isolated situations are easy. However, insect movement of 40 miles or more into "isolated" areas has ruined many experiments. The $1M per year experiment of pink bollworm eradication in California is one such case. We are now starting to realise that many of our insects move hundreds of miles as a regular occurrence. Bushflies migrate into Southern Australia in spring. Even our own <u>Heliothis</u> probably does not over-winter in our latitudes.

Last August we learnt from Dr. Knipling, the "father" of sterile male release on screw-worms that there were in excess of 30,000 outbreaks in Mexico at that stage. - A breakdown had occurred. This was either due to changes in the "factory" culture of screw-worms they were using, or equally possibly the selection of a strain of screw-worms which were "resistant" to the wiles of the factory culture. Basically sterile insect release is more suited for total eradication rather than for continuing control, but large area or continental eradication is very difficult.

2. <u>Ionising Radiation</u> - A Sterilization Technique

Experimental radiation disinfestation of grain has been very seriously considered. At present the cost of getting a very even dose is mechanically expensive. Thereafter large scale treatment at a central site could be economic. Our scattered grain belt and numerous terminal ports also prevents the early introduction of this technique to S.A.

3. <u>Pheromones</u>

Pheromones are special types of hormones, or chemical messenger substances. Increasing numbers of these are being discovered. For example ants and termites use chemical messenger substances to mark their galleries and tracks. The best known pheromones are the sex attractments and in some species these are highly evolved so that a male can detect a receptive female from a distance of several miles. Other chemicals are part of alarm systems such as in aphids reacting to the presence of a parasite.

Sex attractancts can be used in either of two main ways. They can either be used to bait traps loaded with insecticide or perhaps chemosterilant, or they can be used to swamp the population. Even where these messenger substances occur and can be identified and even synthesised, there are many tricks and traps in using them. For example having identified and manufactured a sex attractant, we might anticipate loading a trap with a nice heavy dose to call in all the males for miles. We find we catch none. On looking closer we find that instead of accumulating at the 1,000 female concentration centre, all the males are spread out at a distance where they get a "one female" dose - and they are vainly looking there for the object of their quest.

To substantially reduce an insect population with pheromone bait traps, it is necessary to kill some 80-90% of the males. If the scent is active over a small distance, or if the insects are highly mobile and migrate in - often after mating, then failure is likely. It is also important to recognise that it is quite possible for insects to develop resistance to these matural chemical messenger substances.

4. Feeding Behaviour

In a sense dung bettle introductions made to reduce the food of buffalo flies in Northern Australia are removing a pests food. They may achieve a similar effect with bushflies in Southern Australia. There is however further hope that anti-feedant chemicals may be developed for some pests. They wont kill pests or their parasites - only convince them not to eat sprayed crops. They are not highly toxic materials, but neither yet are they very near commercial development. Repellants are in a similar situation - thousands of materials are tested, none are yet very promising.

5. Genetic Manipulation - Meiotic Drive

The possibility of eradicating an insect population by forcing a lethal gene through the wild population has created much interest and been achieved with one species of mosquito. A suitable lethal recessive gene developed usually by irradiation or chemical mutagenic agents can be closely linked with another gene which does not segregate normally when the gametes, (eggs and sperms) are developed. If we cross AA normals with Aa where a is a lethal recessive, we would expect $\frac{1}{2}$ the progeny AA and $\frac{1}{2}$ Aa. If instead of this we get say 1 AA to 5 Aa then the frequency of the lethal gene in the population will steadily increase.

Regarding prospects for using this approach - first find the right sort of genes.

6. <u>Pathogens</u>

We are all familiar with the use of parasites in what we call biological control. That is quite promising where we have a pest which is not a pest in its country of origin. A closely related approach is with insect pathogens, or organisms which produce disease in insects.

<u>Bauvaria</u>, a fungus disease of insects has been considered to have some potential, but it generally takes so long for infection to develop that the insect completes its damage before it begins to sicken.

The bacteria <u>Bacillus thuringiensis</u> and <u>B. popilliae</u> have been tried with some success. They act more rapidly because of the action of toxins they release. They are not however self regenerating in the sense that they only need be applied once. They are biological pesticides, and must be sprayed on very frequently. They are hard to formulate, but a considerable amount of work is going into such programmes as encapsulating formulations to increase their effectiveness. Generally they are not very promising in hot dry environments.

Insects are subject to many viral ailments, and some of these, especially the polyhedrosis viruses, offer considerable promise for the future. They again have to be applied relatively frequently, like pesticides, they are not particularly effective at low pest densities, often requiring a stress factor, such as occurs in crowding, for them to be effective. They are biologically rather unique viruses, offering very little chance of troubling other organisms. The shabdion or pox viruses of insects however are a special problem.

At present there are still major problems in commercial production of viruses, but tissue culture successes are helping. Formulation difficulties are very great still, but even greater is the problem of testing and producing a non-patentable product. Where chemical pesticides cost $3-5M each, to produce viruses cost some $10 each, and so are not commercial prospects for private industry. One of the first we are likely to use is the <u>Heliothis</u> virus developed in U.S.A. and now being considered for import and release in Australia.

7. <u>Other Techniques</u>

Light traps. There has been an upsurge in interest in the possibilities of using modern light traps to control pest species. Results have been disappointing - light does not attract moths, it only confuses them, habituation develops and limits their effectiveness even where enough traps are used.

Brief flashes of bright light during the night can upset the physiology of insects and prevent them going into diapause (e.g. winter hibernation) and so be used to reduce the local population. The benefits are of course easily undone by flying immigrants.

Sound

Very low or very high frequency sound can be used. However, they too, are not showing much hope for commercial application. Moths, for example, hit the deck in response to bat sounds. Surrounding a field with bat sounds however has failed to produce control because of habituation by the insects.

RESISTANT VARIETIES

USE OF RESISTANCE IN CONTROL OF PLANT PATHOGENS

by

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1. Introduction

There will probably always be a demand for cereal and pasture varieties with resistance to the more economically important diseases. Alternative methods of disease control such as chemical spraying or the modification of farming management practices are often more expensive and they usually require more expertise for effective disease control. Sometimes these methods may not be used because some farmers may be unaware of the economic importance of diseases or are reluctant to adopt new and perhaps more complicated farming methods.

2. Definition of Terms

2.1 Resistance

Resistance is the prevention or retardation of the infection of an organism in a plant. The resistance can vary from slight where the plant is quite easily infected, i.e. the plant is quite susceptible, to a maximum where the plant is not infected at all, i.e. the plant is immune. Resistance is the inverse of susceptibility.

2.2 Tolerance

Tolerance is the ability of a plant to yield when infected. It is not necessarily related to resistance but is often confused with the concept of resistance. A variety has a high tolerance if the yield reduction is slight even though the plants may be quite heavily infected. The tolerance is low if the yield reduction is great even though the plants may be only slightly infected. Clipper barley, for example, has a low resistance but quite a high tolerance to cereal cyst nematode whereas Avon oats has a relatively high resistance but a low tolerance to this pathogen. There are also examples of high resistance and high tolerance and of low resistance and low tolerance as well as of the many grades in between.

2.3 Physiologic races of the pathogen

Physiologic races are groups within a species of a pathogen each of which causes a different reaction on a set of host varieties known as differentials. Each differential variety has a different gene or set of genes for resistance to the pathogen. The different races have different genes for virulence and these enable the races to overcome the matching genes for resistance in the differentials. Twelve varieties of wheat which together contain the known resistance genes to stem rust are used to differentiate the races of the pathogen which cause stem rust in wheat (*Puccinia graminis tritici*). So far in the world approximately two hundred races of stem rust have been identified.

Physiologic races are usually morphologically indistinguishable but usually differ in their nutrient requirements for growth and development, i.e. in their physiology. Often the word "race" is used instead of "physiologic race".

2.4 Resistance "breakdown"

Resistance "breakdown" is usually the arrival in a crop of a race of the pathogen which can infect the previously resistant variety. In these cases the host does not "breakdown" but rather the race of the pathogen contains genes for virulence that previous races in contact with the crop did not. The new race may have been produced by a genetic change in an existing race or by a new race being shifted into the area from elsewhere, by man or wind for example.

In some cases the cause of resistance "breakdown" may be in the host. For example, exposure to a high temperature may cause some wheat varieties to change from being resisant to stem rust to becoming susceptible.

3. How Resistance Works

There are two main types of disease resistances which can occur in plants. These two types are specific resistance and general resistance and each controls the disease in a different way.

3.1 Specific resistance

A variety has specific resistance against a disease if the variety is more resistant to some races of the pathogen than it is to others. The number and type of genes for resistance in the variety will determine which races cannot infect the variety very well. The variety will show little or no disease if the only races present are those which cannot infect or can only slightly infect the plant.

If, however, races to which this variety has no specific resistance appear and conditions for disease spread and development are favourable, then the crop will become heavily diseased. The chance of this resistance "break-down" occurring depends on

(1) the likelihood of the pathogen forming new virulent races,

(2) the proximity of these virulent races (on cultivated crops or wild hosts) to the crop, and

(3) the ease with which the pathogen can be shifted from one locality to another.

When this "breakdown" occurs the rate of disease development in a crop of the variety with specific resistance is the same as that in a crop of a variety with no resistance to the disease at all. The only difference in the level of disease of the two crops is that in the former case the "progress" of the disease has been delayed. This is because there was some delay in the arrival of races which could attack this variety. There would of course be no delay if the variety with specific resistance was sown on an area where races which could infect this variety were already present.

The effect of specific resistance of the disease progress is shown in Figure 1.

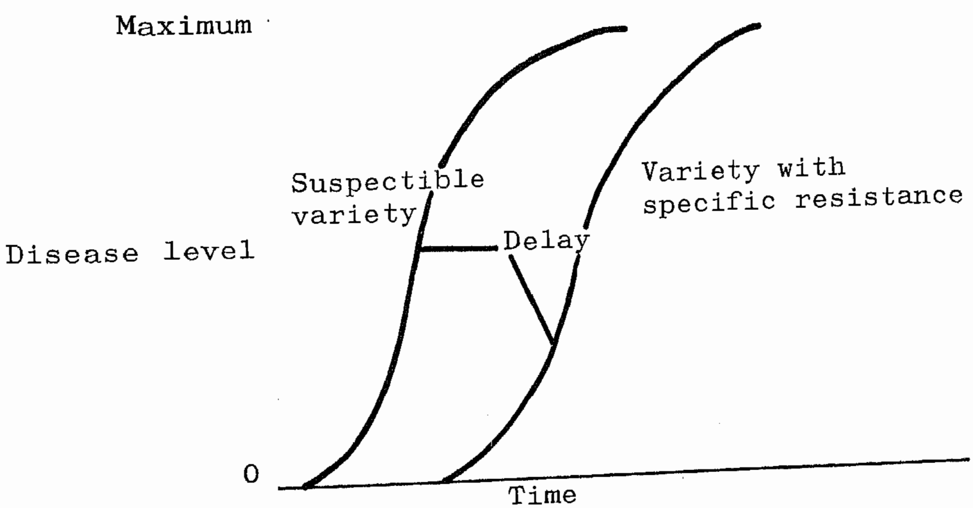

Figure 1.

The shape of the disease progress curve and its position on the time axis will vary and depends on the type of crop and disease as well as on the environmental conditions.

Often the crop is infected early in the growing season and the disease continues to increase through to the end of the growing season, e.g. Septoria leaf blotch on wheat and leaf scald on barley. Sometimes the crop is quite heavily infected early on but the disease does not continue to increase very much later in the growing season, e.g. powdery mildew on barley. In other cases the disease may not start to increase in severity until very late in the growing season, e.g. rusts on cereals.

The delay shown in Figure 1 depends on the rapidity of resistance "breakdown". The factors which affect this have already been listed above.

3.2 General resistance

Plants with general resistance show the same amount of resistance to all races of the pathogen. The "breakdown" of general resistance is rare whereas it may be quite common with specific resistance. Also with general resistance there is no delay in the start of an epidemic, if the pathogen is present, and the disease increases at a slower rate.

The effect of general resistance on the disease progress is shown in Figure 2.

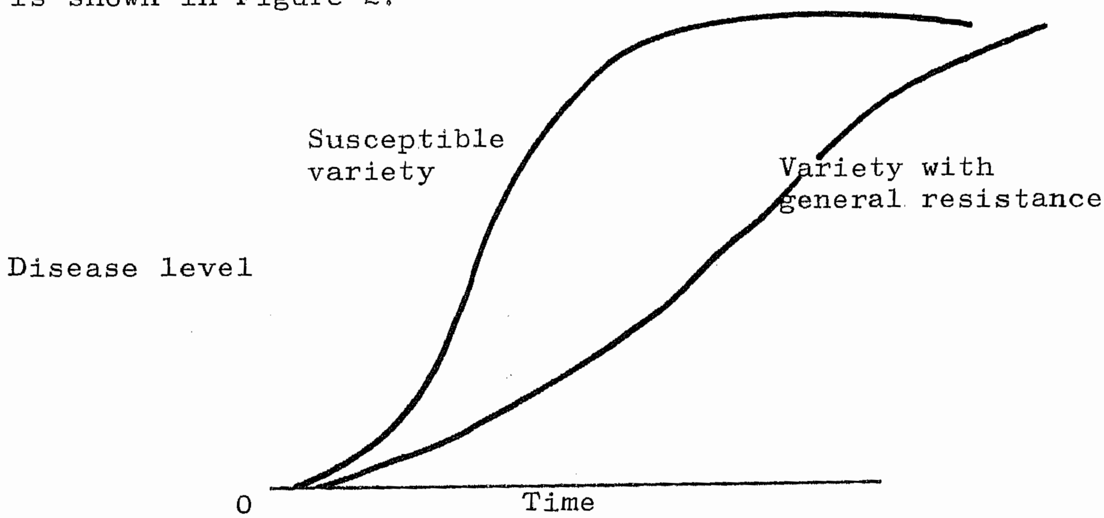

Figure 2.

The factors affecting the shape and position of the curves are the same as those outlined for specific resistance. The effect of the general resistance is similar to that of unfavourable weather conditions for the disease, i.e. the rate of increase in the disease slows down.

The most effective disease control using resistance is obtained when both specific and general resistance are combined into the one variety. The effect of the combined resistance on the disease progress is shown in Figure 3.

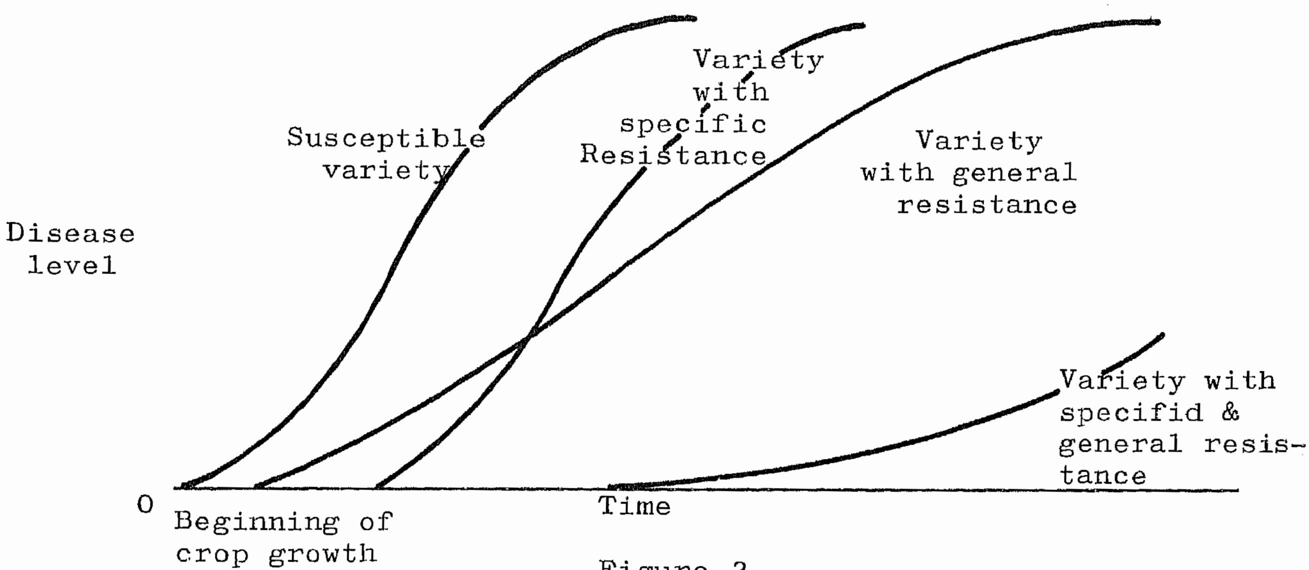

Figure 3.

The combined resistance will be more effective where the disease develops later in the growing season, e.g. for cereal rusts, because the disease will have less chance of reaching a maximum before the end of the season.

4. The Current and Potential Disease Resistance of Some Agronomic Crops to Some of their Common Diseases

4.1 Wheat

4.1.1 Cereal cyst nematode (*Heterodera avenae*)

All of the currently recommended varieties are quite susceptible. Sources of resistance are known and are being crossed into the commercial varieties. This work is being done by cereal breeders at the Waite Agricultural Research Institute.

4.1.2 Stem rust (*Puccinia graminis tritici*)

Halberd is the only recommended variety with resistance to stem rust. This resistance appears to be both specific and general. Of the approved varieties Timgalen and Gamut have a strong specific resistance. Eagle also has some resistance to stem rust; this resistance came from a distantly related grass species *Agropyron elongatum*.

Most of the resistance in wheat to stem rust has been of the specific type. With most of these resistant varieties races of the fungus have appeared causing the resistance to "breakdown". Some recent examples of this are shown in Table 1.

Variety	Number of genes for resistance to stem rust	Year of release	Probable year of resistance "breakdown"
Gabo	1	1942	1948, 1956*
Gamenya	1	1958	1960
Festiguay	1	1963	1969
Mendos	3	1964	1967
Gamut	4	1965	still effective
Timgalen	5	1967	still effective

* A more virulent race than the one found in 1948.

Plant breeders in New South Wales are looking at general resistance to see if this could be effective in controlling stem rust of wheat.

4.1.3 Septoria leaf blotch (*Septoria tritici*)

Most of the currently recommended varieties are susceptible to *Septoria* leaf blotch.

Plant breeders in Western Australia have identified sources of resistance and these are being crossed into their commercial varieties.

Teal, a variety recently released in New South Wales, is listed as being resistant to this disease.

4.1.4 Flag smut (*Urocystis tritici*)

Of the six recommended varieties Halberd, Summit and Pinnacle are resistant to the local races of flag smut. Of the approved varieties Timgalen, Falcon and Eagle are resistant to this disease.

4.1.5 Bunt (*Tilletia foetida* and *T. caries*)

Raven is the only one of the recommended varieties with resistance to bunt although the other varieties appear to vary in their susceptibility to the disease. Other sources of resistance are known, e.g. Heron and

Yande (previously known as Dirk 51) but no breeding work is being done in South Australia on this disease at present.

4.2 Barley

4.2.1 Cereal cyst nematode (H. avenae)

Clipper and Ketch are both quite susceptible but relatively tolerant to this disease.

Current breeding work at the Waite Institute is aimed at crossing resistance from some North African varieties into Clipper.

4.2.2 Leaf scald (Rhynchosporium secalis)

Both Clipper and Ketch are quite susceptible to this disease. Sources of specific and possibly general resistance are known for this disease. There appears to be many different races of the fungus in South Australia and so general resistance is probably the most useful type to use with this disease. Work at the University of Western Australia, the Waite Agricultural Research Institute and the South Australian Department of Agriculture is aimed at finding resistance and transferring it into commercial varieties.

4.2.3 Powdery mildew (Erysiphe graminis hordei)

Clipper was initially resistant to this disease but is now susceptible. The fungus appears to form new races relatively quickly since resistance in the field usually does not last any more than two years.

As for leaf scald, probably the best approach with this disease is to concentrate on general rather than specific resistance.

4.3 Oats

4.3.1 Cereal cyst nematode (Heterodera avenae)

The recommended varieties vary in susceptibility with Early Kherson being the most susceptible, then Irwin, Kent and Swan, and Avon bing the least susceptible. All of these varieties have a relatively low tolerance of the disease.

Work is being done at the Waite Agricultural Research Institute on the identification of sources of resistance to this disease.

4.3.2 Smuts

Avon and Ballidu are resistant to both covered smut (*Ustilago hordei*) and covered smut (*Ustilago avenae*).

4.3.3 Barley Yellow Dwarf Virus

Of the recommended varieties, Swan, Irwin and Avon are listed as being tolerant to this disease.

4.4 Lucerne

4.4.1 Bacterial wilt (Corynebacterium insidiosum)

All of the currently recommended varieties are susceptible to bacterial wilt.

There are known sources of resistance in winter dormant North American varieties but this is difficult to incorporate into a vigorously growing Mediterranean type variety.

4.4.2 Root rot (Rhizoctonia sp.)

All of the currently recommended varieties are susceptible to this disease but sources of resistance have been found elsewhere. These will be tested against the disease in South Australia.

4.4.3 Stem nematode (Ditylenchus dipsaci)

All of the currently recommended varieties are susceptible to this disease.

Sources of resistance are known in varieties which may be suitable in our growing conditions.

4.5 Clover

4.5.1 Clover scorch (Kabatiella caulivora)

The currently grown varieties vary in their susceptibility from being very susceptible, e.g. Yarloop, to being moderately susceptible, e.g. Daliak.

No species of the *Trifolium* genus from the many species tested has shown complete resistance.

5. Summary and Conclusions

Many of our currently recommended varieties are susceptible to quite a few diseases. Sources of resistance are known for a lot of these diseases and this resistance is being transferred into some of our commercial varieties. The type of resistance, whether specific or general or a combination of both, is not known in many cases because little is known about the races of the pathogens in South Australia. Although general resistance is more difficult to detect it appears to be a necessary form of resistance in order to obtain a reduction in the severity of most of our diseases. Despite advances in disease control by chemical means and by the modification of farming management practices, disease resistance should continue to be a useful and practical means of controlling diseases.

SECTION III

NEW DEVELOPMENTS

AGRONOMY BRANCH MINI CONFERENCE

NEW DEVELOPMENTS

New Developments in the Horticultural Usage of Agricultural Chemicals

by

MR. R.L. WISHART

Senior Horticultural Adviser

1. Introduction

Today I want to introduce the use of horticultural examples of Pest Management or Integrated Pest Control. Finally I will go over some of the problems encountered with using agricultural chemicals in horticultural crops.

2. Scope of Chemicals

Horticultural chemicals cover nutrition, pest and disease control, crop regulation and soil management. All these are interrelated.

Our objectives in using agricultural chemicals are:-

"To manipulate with due care the vineyard and orchard environment to the benefit of the whole community."

3. Recipes Versus Educational Role

The strong demand our horticultural advisers receive for recipes, is a reflection that growers see their problems too much in isolation and do not consider enough the interrelationships involved.

It is essential therefore that the educational role of our extension work be given additional emphasis, so that growers can make more of their own decisions, and with less reliance on recipes. Pest management for example which manipulates the whole spectrum of pests and beneficial insects through the use of a combination of chemical and biological means is now being applied in horticulture, both in citrus and peaches.

Our role must therefore be one of training the necessary technicians to service groups of growers to guide them through pest management. A commercial insectary which provides for a fee a supply of parasites, and a technical advisory service to growers now supplements the Department's programme.

4. Diagnosis

Before chemicals are used the problem must first be diagnosed correctly, e.g. rather than spraying because the neighbours are spraying.

5. Methods of Application

The method of application can determine the effectiveness of the chemicals used. In horticulture, spraying is widely used, but, dusting, fumigating, broadcasting and baiting all have a role.

6. Choice of Chemicals

Economics, safety, availability of biological control agents and other environmental restraints are involved in the choice of a chemical and method of application.

Let us look at these factors and relate them to the management system as a whole.

6.1 Economics

6.1.1 The value of the crop.
With horticulture there is more latitude in expenses that may be incurred. Gross returns may be over \$1,000/acre. The average for 1970/71 was \$514/acre for all fruit and vegetable crops.

The gross value of horticultural crops for 1970/71 was \$70M.

6.1.2 Cost benefits.
Spraying costs for 1970/71 were \$265,000 for grapes. Gross value of grape production in that year was \$14M. 1.89% of gross value was spent on spraying. For all tree and vine crops the cost of spraying (excluding herbicides) was over \$1.6M.

6.1.3 Combination treatments.
Considerable savings in costs accrue through judicious combination of sprays.

6.2 Safety

6.2.1 Spray operator

6.2.2 Consumer

6.2.3 Beneficial species

6.2.4 Crop (phytotoxicity)

6.2.5 Environment in general

6.3 Availability of biological methods in preference to chemicals.

6.3.1 Parasites and predators.

6.3.2 Fungi, bacteria, virus.

6.4 Other environmental factors which can be manipulated to achieve control without chemicals.

6.4.1 Irrigation method - timing.

6.4.2 Training systems - trellising, pruning.

6.4.3 Dust control.

6.4.4 Clean cultivation

7. Interdependence of Management Systems

A particular example of interdependence between pests and the various citrus orchard management systems follows.

Foliar salt absorption problems in citrus arising from increased irrigation water salinity was solved by introducing low throw sprinklers, and changing from clean cultivation to the use of herbicides to allow sprinkler movement.

Unfortunately the changed soil management has brought a new set of problems - fruit rind injury from light brown apple moth and snails. Other undesirable side effects resulted in "escape" weeds, and a "tie-up" in nitrogen affecting fruit quality.

There is in this situation a complete interplay between the management systems of the soil, the tree, the irrigation and the pests.

Solution of the light brown apple moth/snail problem involves consideration of all this interplay of the management factors.

The solutions are not clear cut and require more than recipes.

8. Examples of Agricultural Chemical Misuse

A number of examples of problems arising from the incorrect use of agricultural chemicals in horticultural crops follow:-

8.1 Off target damage due to:-

8.1.1 drift

8.1.2 overdose

8.1.3 herbicide spillage

8.1.4 incorrect usage of wetters

8.1.5 incorrect usage of application equipment

8.1.6 incorrect usage of herbicide

8.2 Phytotoxicity of some emulsifiers.

8.3 Application of chemicals at the wrong time.

8.4 Incompatibility of some chemicals.

8.5 Defective application equipment.

8.6 Hard water may affect sprays.

NEW DEVELOPMENTS

Spray-seed, an I.C.I. Technique

by

MR. M. McKAY

Market Development Officer, I.C.I. Australia

1. THE BACKGROUND

It has long been established that the most effective cultivation implement for killing weeds is the mould-board plough. Yet the mould-board plough is rearely used these days because of the small area which it can cover in a day's work.

The usual alternative machines, disc ploughs, disc harrows, cultivators and scarifiers, rely on the rupturing of the plant root systems and the drying out of the soil to achieve weed control. With such implements, the later in the season that the cultivation occurs, the larger are the weeds, the weaker are the sun's rays, the moister is the soil and consequently the less effective is this method of killing weeds.

This results in an increase in the number of cultivations required to achieve the required results, with the attendant probabilities of "bogging" and soil structure damage and of course an increase in the length of time spent sitting on the tractor seat, day and night in the least pleasant weather conditions.

This normal pattern of weed control suggest that any system which kills off weeds by a quicker, less physically exhausting and more effective method must find ready acceptance among cereal growers.

Rainfall variability, in terms of both monthly distribution and total seasonal precipitation, has a profound influence on the availability of feed from year to year, and consequently the farmer's ability to make the best use of his pasture growth. The current methods of weed control by cultivation lack that flexibility which would enable farmers to make the best use of pasture growth from year to year.

At present, stocking rates are geared to the below average season's winter growth pattern, so that in these years when an early break or unusually good autumn growing conditions provide a surplus of stock feed, it is generally not possible to grow extra areas of cereal crop due to the inability to cultivate effectively because of the wet soil conditions.

Surveys conducted by the S.A. Department of Agriculture have shown the importance of timeliness in sowing cereal crops. Throughout the cropping areas of the State it has been found that wheat yields are reduced by up to 1/3 bushel per acred for every day that seeding is delayed after the optimum date. The optimum date will of course vary from district to district and from season to season but the variation is far less than is generally believed.

If one were able to eliminate other variable factors such as weed infestations, diseases, pests, and plant nutrients, it seems that the optimum seeding date for wheat over most of South Australia is between the 3rd week of May and the 2nd week of June. In a few very early wheat growing areas Mid-May will generally be the optimum seeding time; while in certain isolated pockets, e.g. Bordertown, Saddleworth, the 3rd week in June appears to be the optimum time for sowing wheat.

Any technique which could ensure a completely effective weed-kill and the sowing of the crop early enough to obtain the maximum cereal yields would overcome the present practical limitations to the sowing of extra areas of cereals in the years when good feed supplies provide real opportunities for increasing farm income.

With such a background of farmer needs in mind, and using the experience gained in scores of direct drilling trials of cereals in Europe, and maize in North America, ICI commenced trials at Trayning in Western Australia in 1968 to work out a practical method of cereal establishment with minimum soil cultivation. From this research work has now emerged the 'Spray-Seed' technique of crop establishment with minimum soil cultivation.

2. THE PRODUCT

'Spray-Seed' is a formulation of two of the Bipyridyl herbicides and a non-ionic surfactant. The active ingredients are:-

10% w/v Paraquat - present as Paraquat dichloride

10% w/v Diquat - present as Diquat dibromide

9% w/v Non ionic surfactant

The application of 'Spray-Seed' at 1 pint per acre is equivalent to the use of:-

'Gramaxone' at ½ pint per acre, plus

'Reglone' at ½ pint per acre, plus

'Agral' 60 at 1½ pints per 100 gallons of spray mixture

At the recommended rate of 1 pint of 'Spray-Seed' per acre in not less than 10 gallons of clean water per acre there will therefore be no need for any further wetting agent.

2.1 'Spray-Seed' when applied to green growing plants will cause rapid desiccation of all fresh green vegetation.

2.2 'Spray-Seed' acts on green plant tissue by causing the formation of peroxide radicals or hydrogen peroxide within the cell structure, so producing the rapid deaths of these plant cells.

2.3 This desiccant effect on green plant tissue is activated during photosynthesis so the herbicidal action develops most rapidly in bright light and at high temperatures.

2.4 The rapidity of this action reduces the translocation of bipyridyls within the plant structure so it is essential that the 'Spray-Seed' mixture fully covers the plant leaves during the spraying application.

2.5 'Spray-Seed' is quickly absorbed into the green leaves and rain falling shortly after application will have no effect on its effectiveness.

2.6 Unless the plants to be sprayed are under stress (because of drought, cold, etc.), the ultimate action of 'Spray-Seed' is not influenced by soil type or soil organic content, level of soil moisture, or the weather conditions prevailing during application.

2.7 'Spray-Seed' is inactivated rapidly on contact with the soil

2.7.1 Dirt or dust covered plants will therefore severely reduce the effectiveness of 'Spray-Seed'.

2.7.2 Because 'Spray-Seed' is a non residual herbicide, crops may be sown as soon after spraying as seeding conditions appear suitable.

3. THE TECHNIQUE

3.1 Paddock Selection

3.1.1 Soils

The 'Spray-Seed' system has been successfully used on all types of soils, from sands to heavy clays. It may be found on some heavy soils that the combine will not penetrate unbroken soil effectively enough to produce an even placement of the grain at seeding. If this occurs it is recommended that the combine be used for a cultivation, after spraying and immediately before the seeding operation.

It must be emphasised that this pre-seeding cultivation, when shown to be necessary, should not be deeper than the seeding depth of $1\frac{1}{2}"-2"$.

On normal loams and on sandy soils there is no need for pre-seeding workings, and crops can be sown after spraying directly into the unbroken soil.

Experience has shown that the spring-release combine is much better on heavier soils than the spring-tyne combine but both are quite effective on loams and sandy soils.

3.1.2 Weeds

The 'Spray-Seed' system will kill all annual weeds normally found in paddocks prior to seeding, including Barley grass, Brome grasses, Silver grass, Spear grass, Geranium and Capeweed. It is not recommended for use in paddocks where ryegrass is a problem.

3.2 Paddock Management

'Spray-Seed' acts through plant leaves, so a full germination of weeds should be allowed to take place prior to spraying.

Paddocks to be sown to crop should be hard grazed from the break of the season so that leaf growth and plant root development are both restricted.

3.2.1 Hard grazing of the pasture will ensure that there is no development of a dense canopy of growth to prevent the spray material from fully covering all the plant foliage.

3.2.2 Hard grazing also effectively restricts the normal development of the plant root system in the plants to be killed by 'Spray-Seed'.

Plants in which the root systems have been allowed to make vigorous growth possess quite extensive plant food reserves and therefore considerable recuperative ability. If great enough, these reserves may enable a plant to recover even though apparently adequate desiccation has been achieved. The larger the plant food reserves in the plant system, the greater is the amount of 'Spray-Seed' which must be used to achieve an acceptable plant kill.

3.3 Spraying

As 'Spray-Seed' acts only on contact with the fresh green foliage of plants, it is essential that livestock be removed from the hard grazed pastures some 3-7 days before spraying takes place. This gives time for the appearance of fresh growth free of dirt or dust, the presence of which, on the older growth, would inactivate 'Spray-Seed' and inhibit its herbicidal action.

As stated earlier, it is on fresh, rapidly growing green vegetation that the Bipyridyl herbicides are most effective.

3.3.1 Equipment

'Spray-Seed' should be used through a boom spray only. Good results cannot be expected with misters, cluster jets, boomless jets or by aerial application.

Because under normal South Australian conditions the Bipyridyls are poorly translocated in plant leaves it is essential that 'Spray-Seed' be applied evenly to fully cover the whole of the foliage of the plant growth to be killed.

The boom spray should therefore be accurately calibrated to see that each jet is giving an equal output over a given period. Worn jets should be replaced.

The spray-pump should be capable of maintaining a working pressure of at least 30 lbs. per square inch.

Flat fan jets only should be used and set at a slight angle to the boom line (say 10^{o}). The boom jets should be set high enough above ground level to give a complete double overlap of the jet swathes.

3.3.2 Application Technique

Use not less than 1 pint of 'Spray-Seed' per acre on paddocks which have been managed according to recommendation since the break of the season.

Pastures which have not been hard-grazed and where growth is dense and vigorous will require $1\frac{1}{2}$ pints of 'Spray-Seed' per acre to achieve the required kill.

Because of the necessity to fully cover the plant foliage with 'Spray-Seed' it is essential that not less than 10 gallons per acre of spray material be applied, and where possible greater amounts of spray material should be used.

Clean water only should be used in preparing the spray mix. Water from streams or dams containing silt or suspended clay is not suitable for use with 'Spray-Seed', but where no other water is available it may be 'tested' for suitability by a 'clarity' assessment. If the arm is extended into the water supply to the elbow and the hand can be clearly seen the water can be used without an acceptable loos of effectiveness of the 'Spray-Seed'.

All 'mains' water in South Australia is quite suitable for use. 'Tod Water' presents no problems and it can be assumed that any bore water which can be used by ewes or cattle is also satisfactory.

No further wetting agent is required to be added to that already incorporated in the 'Spray-Seed' formulation and because of the risk of reaction between 'Spray-Seed' and non-compatible wetters the use of extra surfactants should be discouraged.

Although the greatest translocation of 'Spray-Seed' in plants takes place under low light intensity there are practical limitations to the application of 'Spray-Seed' only on dull days or in late afternoon.

At the recommended rate of 1 pint of 'Spray-Seed' per acre sufficient margin exists to allow application under all light conditions at seeding time.

As with any herbicide application, spraying under windy conditions should be avoided. Loss of spray material from spray drift on windy days can be very high and will certainly seriously reduce the effective rate of application of 'Spray-Seed'.

'Spray-Seed' should not be applied to dew-covered plants:-

Wait until the foliage dries before spraying is carried out.

Plants under stress are not easily killed by herbicides of any kind. It is therefore essential that any growth which has been severely checked by drought, frost, insect pests, disease or plant food shortages should be permitted to recover and make fresh new growth before 'Spray-Seed' is applied.

3.3.3 Seeding Technique

Following the use of 'Spray-Seed' sufficient time should be allowed for the effective desiccation of plants to occur before seeding takes place. Depending on growing conditions this will normally take from 3-5 days in the South Australian cereal areas.

The use of a correctly adjusted combine at seeding time will cause the complete rupture of existing plant growth and result in the 'complete kill' of all annual paddock growth.

The combine is then obviously a very important part of the 'Spray-Seed' system. In addition to ensuring that a second knock to the weed growth is achieved after spraying it also has two other functions:-

1. To place the seed and fertilizer at the correct depth in the ground

2. To make certain that a seed bed is formed which provides that most suitable germinating and growing conditions for the young cereal plants.

So that these requirements are fully met it is necessary that the combine operates in an efficient manner. On lighter soils spring-tyne combines are quite satisfactory, but on heavier soils, or where pasture swards prior to spraying had been very dense, spring release combines have been found to be superior and adequate for all conditions.

To ensure that all plant roots are ruptured it is necessary that the combine tynes cut completely across the whole width of the cultivated area. Experience has shown that tynes fitted with at least 4" points in good condition are necessary to achieve this complete 'cut'.

It is also necessary for each combine point to be set to produce a level seed bed. This can be achieved by a pre-sowing adjustment of the combine.

By standing the combine of 1½" to 2" blocks (equal to the seeding depth) on an even and level floor it is possible to adjust each tyne to the same level so that when working an even and level soil penetration is achieved.

When these adjustments are being made it is essential that the combine frame be level and that it operate at the same 'attitude' during seeding or soil working.

On most soils of satisfactory fertility and structure, resulting from good legume pasture histories, it will be found that the combine will achieve the production of a satisfactory seed bed and placement of the seed at the correct depth in unbroken soil at the recommended period of 3-5 days after applying 'Spray-Seed'.

However, if adequate penetration by the combine is not possible due to either:-

1. exteme compaction of the soil, or

2. the presence of a dense impenetrable mass of dying vegetation

then a cultivation with the combine <u>at the seeding depth of $1\frac{1}{2}$"-2"</u> should be carried out immediately prior to sowing the crop.

The depth of seeding is most important, and numerous trials throughout South Australia have proved that cereals should be sown at not more than $1\frac{1}{2}$"-2" deep to produce both early germination and rapid seedling growth. Both these factors are desirable in reducing the effect of diseases and pests on crop establishment and yield.

Deeper cultivations or seeding operations may produce a 'cloddy' unsatisfactory seed bed and also fail to repture cleanly the roots of the sprayed weed growth, resulting in an incomplete kill.

If, even with adequate soil penetration and sowing of the seed at the recommended depth of $1\frac{1}{2}$"-2" the seed bed seems too rough and the soil appears to be not closely surrounding the cereal grains to provide good germinating conditions, a fast heavy harrowing 1-3 days after the seeding operation will considerably improve the physical condition of the seed bed and also the final weed kill.

NEW DEVELOPMENTS

Ultra Low Volume Spraying, a New Tool for Insect Control

by

MR. P. BIRKS

Senior Research Officer (Entomology)

1. The Principle

Spray application techniques have evolved from high volume application of 100 gallons per acre or more, to low volume application of 5 to 10 gallons per acre with booms, to misters applying 1 to 2 gallons per acre. Now a further step to near the ultimate has been made with ultra low volume (ULV) spraying. Quantities of spray are a pint per acre or less.

The production of finer droplets has allowed a reduction or even a complete discarding of the liquid carrier, replacing it with air as the carrier. However, to use very fine droplets, low volatility sprays are required. Very small droplets have a large surface area in relation to their mass, and therefore are very prone to evaporating. Insecticides which are normally liquid and which are of low volatility, such as technical maldison and fenitrothion are easily used by ULV spraying. Other insecticides, including those which are normally solids, can be formulated with low volatility solvents. However, only relatively low toxicity insecticides should be used because of the drift hazard.

A ULV application aims at 40 to 120 droplets per square inch. Droplet-sizes vary from 30-200 microns.

2. Aerial Application

ULV spraying was first developed by the Desert Locust Control Organisation of East Africa. They used both exhaust sprayers and aircraft with Micronair rotary spray equipment to apply dieldrin to locusts. Subsequently American Cyanamid adapted the principle to crop spraying using technical maldison and aircraft fitted with flat fan nozzles on the boom. They established the need for a bleed-off line from the ends of the boom, for a special bypass line to remove the excess volume pumped without frothing, and for the need to incline the nozzles 45° into the wind to produce finer droplets. The overall spray droplet spectrum produced was more variable than with rotary equipment, but it was cheap and it worked.

We have used the Cyanamid system in Australia to successfully control plague locusts, wingless grasshoppers, field crickets, pea weevil, redlegged earth mite and lucerne flea, Oriental fruit moth and mosquitos using technical maldison and omethoate (RLEM-LF). Technical maldison was recommended for control of Heliothis in Western Australia, but results have been very variable.

Extensive use of ULV aerial application has been made overseas, especially in U.S.A., and the main changes which have evolved have been a reduction in spraying altitudes from 15-30 ft. to now 6-12 ft., with a corresponding reduction in swathe from 100 ft. to 50-80 ft. Application is not recommended when wind speeds exceed 10-12 m.p.h.

Various types of spinning disc units have been developed and although all produce a smaller range of droplet sizes than flat fan nozzles, they all tend to produce droplets from 50-70 microns which we find too small to hit the target except in dense crops with minimal wind conditions. Suitably adjusted they promise better results than flat fans. We prefer 100-120 micron droplets under most conditions.

The main advantages of aerial ULV spraying is in reduced ground equipment and staff required for mixing etc., and the wider swathe and reduced ferrying time and costs. These advantages apply only in large jobs, and have no advantage for jobs of less than 100 acres.

3. Ground Application

Ground equipment is required where relatively small areas are to be treated, and here ULV spraying promises very considerable advantage to individual landowners, making it easier and quicker to treat relatively large areas. Equipment is the main problem.

Various types of ground units have been developed, varying from a simple hand wand with a battery operated spinning disc, suitable for small plots, to various adaptations of motorised knapsack sprayers. There have also been many developments with motorised fan-spinning disc combinations, generally producing droplets of 60-70 microns.

The simplest, moderately large unit suitable for broad acre use is the locally made (Western Aust.) unit the Terra ULV mister. It uses the flat fan nozzle - like the Cyanamid System to determine the flow rate and to assist with atomisation. It uses the conventional mister design for air flow and droplet production and propulsion. The droplets produced vary in size, but are of the order 100-150 microns and this has been found particularly suitable for spraying sparse foliage (Dense crop foliage and small flying insects are more effective in picking up finer droplets).

The Terra ULV mister has been widely used for grasshopper control in both Western Australia and South Australia. They have quite a number of faults such as dangerous siting of the pressure regulator, leaking taps and hose connections, problems with engine mounts etc., but in spite of this they have been remarkably successful even when used on a rental basis to landowners not normally using spray equipment. Some 9,000 acres was sprayed last spring near Orroroo, and not only has the grasshopper kill been very satisfactory, but the relative ease of spraying quite large areas has moved the Orroroo Council to purchase more units for their own use against grasshoppers. Each unit has a theoretical capacity to spray 96 acres/hour. In operation the average daily use during 1972 spring was 350 acres per unit. When a 5 gallon drum is the only liquid required to spray 120 acres this is highly attractive in dry areas, and wetter areas alike.

4. Calibration

While calibration of low volume equipment is important, calibration of ULV equipment is critical. A mistake of a pint in 10 gallons is of little concern whereas a mistake of 1 fl. oz. can be very serious or very expensive with ULV spraying. The only real complaint last year from Orroroo was from one landowner who did not calibrate, and he payed for it.

Because of the very fine nature of the spray it is extremely difficult to see what is going on with ULV spraying. It is therefore important to follow instructions. With the Terra ULV unit we have very definite instructions relating to:-

(1) Calibration - check it.

(2) Swathe width - 1½-2 chains

(3) Spraying speed - 6 m.p.h. maximum

(4) Wind speed - 12 m.p.h. maximum

We do not recommend spraying 3-5 chains as in the manufacturers manual, and we do not recommend they be used for herbicides because there is a too wide a range of application rates across a swathe.

5. Application

While the Terra ULV unit can be used against quite a number of pests, it is not applicable to all problems yet. New formulations of other pesticides may extend its use to pests such as Heliothis and pink cutworm. The cost of a ULV mister is currently about $575, a relatively high figure for a specialised piece of equipment for say red-legged earth mite control. After using ULV equipment, conventional spraying is tedious. It may be that a follow on from grasshopper control in the north will be some adoption of ULV spraying for red-legged earth mites.

SECTION IV

THE APPLICATION OF PESTICIDES

AGRONOMY BRANCH MINI CONFERENCE

THE APPLICATION OF PESTICIDES

CALIBRATING GROUND SPRAYING EQUIPMENT

by

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Agricultural Adviser

No matter what piece of equipment is used for broadacre chemical spraying of our agricultural lands, it must be in good working order and accurately calibrated for it to apply the correct dose rate. This is assuming of course that in liquid applicators the correct amount of chemical is added to the tank.

1. TYPES OF GROUND SPRAYING EQUIPMENT

1.1 The Low Volume Boom Spray

A very popular, effective broadacre unit for both weed and insect control. Coverage seldom exceeds 15 metres (about 50 ft.) per run and liquid application normally varies from around 57 litres/hectare (about 5 gallons/acre) to 227 litres/hectare (around 20 gallons/acre). The higher the liquid rate per hectare, the longer the jobs will take. This is why some owners apply a liquid rate of 57 litres/hectare but it's not always suited to some chemicals for best results. A better rate is 114 litres/hectare (about 10 gallons/acre). Units are either engine or power take-off driven.

1.2 The Standard Misting Machine

Quite a popular and effective broadacre unit particularly for insect control. While some herbicides can be applied with this machine, it's not considered as accurate as the low volume boom spray. Irregularities in the spray pattern are not as critical for insect control, as insects will more than likely wander into treated areas and die. Considered a disadvantage, misting is best done in the cooler part of the day so as to avoid evaporation of some of the chemical which is likely to occur under hot conditions. Drift could also be considered a problem. On the other hand, coverages of up to 31 metres (around 100 ft.) or more can be obtained in one run under favourable conditions. This is largely dependant on the strength of the wind. Liquid application normally varies between 11 and 89 litres/hectare (about 1 and 8 gallons/acre) dependant on the amount of growth per hectare, type of chemical and weather conditions.

Units are also either engine or power take-off driven.

1.3 The Ultra Low Volume Mister

Not many in use in this State. Main use of this broadacre unit is in insect control e.g. plague grasshopper (Austriocetes cruciata) and plague locust (Chlortoicetes terminifera). The advantage of this unit is that it uses chemical concentrate alone; no water is required. For this reason, it's particularly useful in dry areas. There are also obvious savings in t erms of man power and machinery. Successful use of a mister particularly this type of unit depends largely on it being adjusted to allow for the strength and direction of the wind, if there is any. Wind behaviour is best noted with a wind direction indicator. This need only be a simple arrangement such as a piece of tissue fastened to the end of a length of wire. By adjusting the elevation of the spray nozzle (high elevation for light breezes, low elevation for strong breezes) the correct spray pattern can be maintained, when ground speed is a constant 6.5 k.p.h. (about 4 m.p.h.). Here again, coverages of up to 31 metres (around 100 ft.) or more can be obtained in one run under favourable conditions. (It largely depends on the strength of the wind). This type of unit is usually mounted on a utility or trailer and is engine driven.

Ground speeds for misters should not be in excess of 8 k.p.h. (about 5 m.p.h.) while for low volume boom sprays 11 k.p.h. (about 7 m.p.h.) is fast enough.

2. CALIBRATION

There are many ways of calibrating ground spraying equipment. In the first place, one must make sure that the equipment is in good working order and that any worn parts that could possibly cause a significant difference in output, are replaced.

2.1 The Low Volume Boom Spray

2.1.1 Remove and wash nozzles and filters. Wash through spray lines with nozzles removed and pump operating. Reassemble and fill tank with clean water.

2.1.2 Set the machine running at desired pressure (normally between 171 and 342 kilopascals or 25-50 p.s.i.)

2.1.3 Measure the output in millilitres (fluid ounces) from each jet separately over 60 seconds. Record output figure for each jet. Clean or discard any jets showing a significant difference in output. Mark one nozzle with average output.

2.1.4 Measure 167.7 metres (550 ft.). Set markers for start and stop points. Select ground speed to suit desired pressure.

2.1.5 Travel the 167.7 metres (550 ft.) from a running start and record exact time taken to travel the distance. If incorporation is necessary, pull incorporation equipment on the timing run if all is to be done in the one operation.

2.1.6 Using a jug, measure the output of the nozzle previously marked over the time taken to travel the 167.7 metres (550 ft.). Be accurate to one millilitre (ounce) in this measurement.

2.1.7 Measure the distance between nozzles in centimetres (inches) - centre to centre.

Formulas:-

$$\text{litres (galls.)/hectare (acre)} = \frac{\text{6 x nozzle output millilitre (ozs.) over time required to cover 167.7 metres (550 ft.)}}{\text{nozzle spacing in centimetres (ins.)}}$$

$$\text{chemical to be added to tank in litres (pints)} = \frac{\text{Tank cap. (litres(galls.) x chemical rate per hectare(acre) (litres(pints)}}{\text{litres(galls.) spraying/hectare(acre)}}$$

Other Formulas:-

$$\text{gallons/acre} = \frac{\text{10 x pints of water used during a 550 ft. run}}{\text{length of boom in ft.}}$$

$$\text{gallons/acre} = \frac{\text{495 x output in gallons/minute}}{\text{width of spray application in ft. x speed m.p.h.}}$$

2.2 Misting Machines

2.2.1 Measure the effective swathe width under the prevailing conditions by laying down white paper sheets at 10 feet intervals for the first 20 feet from the unit and thereafter at 20 foot intervals.

2.2.2 Obtain the number of yards to be travelled to cover one acre by dividing 4840 by the swathe width in yards.

2.2.3 Partly fill the tank with solution and mark the level. (The machine must be level when this is done).

2.2.4 Having selected a ground speed, mist a measured area large enough to use a measurable amount of solution in the tank, (e.g. 2 acres).

2.2.5 Add a measured quantity of solution to the tank to bring the level back to the previous mark to obtain the actual usage.

2.2.6 Increase or reduce the output setting if the usage rate is less or more than required,

<u>OR</u> having completed steps 1 and 3 of the previous method - select a ground speed and operate for one minute. Repeat step 5 and use the following formula:-

$$\text{Galls./acre} = \frac{495 \times \text{output in galls./minute}}{\text{width of spray application in feet} \times \text{speed m.p.h.}}$$

Then repeat step 6.

Having obtained the output/acre and if resetting is necessary then:-

2.3.1 Decide on what output in gallons/acre is required for the situation.

2.3.2 Work out the time taken (in minutes) to mist 1 acre by using the formula:-

$$\text{Time (mins./acre)} = \frac{495}{\text{speed(m.p.h.)} \times \text{swathe(feet)}}$$

2.3.3 From the gallons/acre to be applied and the time taken/acre the <u>regulator</u> setting can be obtained by first using the formula:-

$$\text{Output required (gallons/min.)} = \frac{\text{gallons/acre}}{\text{time in mins./acre}}$$

and then referring it to the instruction book.

THE APPLICATION OF PESTICIDES

THE AGRICULTURAL PESTICIDE MARKET AND THE ROLE OF THE RESELLER IN ENSURING PROPER APPLICATION

by

MR. P.S. GURNER

Director, Agchem Pty. Ltd.

The present era of pesticides commenced in Australia in about 1950 with the advent of "hormone" herbicides.

These compounds were considered subject to an end use patent and the Australian licensee of the 24D patent set up a distributor and restricted reseller pattern, and which though tattered, is still discernable in most areas to this day.

The licensee was of course Agricultural Services Ltd., later Agserv. The distribution system set up at this time now seems the ideal, but the task to reconstruct it will be slow and painful, and may well only come as a consequence of regulatory legislation.

At the time this marketing system was established, the chemicals were indeed novel, bordering on miraculous in the farmer's judgement, and the agricultural chemical industry was well received. Unofrtunately for the market place, but fortunately for the industry, companies with products under development and requiring a position in the marketing, set out to duplicate the available compounds, test and break patents and to establish alternative outlets. There was no marketing precedent to follow here or elsewhere in the world - the brand conflicts fragmented the available chemical business as rapidly as it expanded.

Price competition between basic manufacturers resulted in rapid price reductions of raw materials and this in turn was passed along to the farmer, and in many cases, despite the modest volumes sold in early years, many chemical resellers never exceeded their early gross sales figures. In efforts to gain more of the available business, discounts were offered to the farmer.

Thus we saw a readily selling product which was still profitable to the farmer, diminish in price rapidly to about 25% of its introductory price. The farmer became a gullible though wary buyer; price became the primary consideration - quality beyond the mandatory requirements was impossible to maintain. Opportunists without thought for long term establishment, advertised the volume products such as 24D and DDT at "once in lifetime" prices.

The chemical reseller was very much the meat in the sandwich. They became cynical as merchandising wrangles disrupted established business relationships of longstanding. Remember, in these times, we had DDT in confusion with 20% total DDT, 20% ppi DDT and 25% DDT total and 25% DDT ppi. 24D came from 30% to 80% concentration per gallon and in powder form. The liquids were sometimes in different coloured drums but differentiation between qualities was difficult - they not only looked similar regardless of strength, they worked in a similar manner by the standards of the day.

One pint of 30% 24D per acre was visibly as effective as one pint of 80% 24D per acre. Daily after spraying you may have noted a variation, but after a week or so the turnips were all dead anyway. We now use a quarter pint of 50% 24D amine per acre to perform this miracle, and we believe that many mallee farmers are still scientifically reducing the quantity of 24D per acre by diminishing the level in their "measure" each year. The measure is probably an open-topped prune tin, squashed to form a lip for easy pouring. Recommended rates in the mid-fifties to the early sixties for 24D cause envy in today's herbicide salesman. Perhaps weed susceptibility has changed with increasing fertility. The experimental work of those times was not sufficiently critical to resolve this argument.

In South Australia, it was generally in May that advertisements appeared for "Country representatives - preferably with agricultural experience". The selected person was given a descriptive price list and a list of agents or potential agents, an area, and most importantly, a motor vehicle.

He was shown a weed and a red-legged earthmite, and sent out to advise the farmer how his particular brand of product could benefit the farmer's income. It says a lot for the latitude of the early insecticides and herbicides in human and crop safety that we have a race of farmers left to whom to market today.

With an industrial chemical background, and having a rural upbringing, my own introduction to agro-chemical marketing was gained in this fashion.

Representation was frequently dispensed with at the advent of the summer season, but usually with the novelty of a car to drive having worn off, the demands of rural representation, cold canvassing farmers on a once or twice a year basis, seldom getting to know them personally, and in all weathers - in fact praying for wet days when the farmer had time to talk in the shed instead of impatiently shouting beside a noisy diesel tractor in a blizzard with dust - the representatives opted for more congenial employment. This waste of early experience can never be retrieved. The opportunity to impress with miracle first applications will seldom occur in our more recent techno-chratic age.

These relationships established by those of us who have remained in the trade, even at executive level, with customers who have retained contact for eighteen or more years, are very important to our ego and faith during the difficult economic periods this industry has experienced.

The chemical industry has continued to rely on a fragmented reseller situation, or what is perhaps worse, frequently a stock firm as a reseller of plant protection products. The reseller objective has been to minimise the chemical expenditure to his farmer client to avoid losing business to another supplier.

The chemical industry has upgraded its representation and began a power struggle to win a dominant position in the available volume of business to justify the representation that they had advocated. This effort has foundered, and perhaps the major reason was that rural representatives only begin to have real value when they know and have some confidence from the farmer and reseller, and become expert regionally in the product range.

At this time they seek more congenial situations - hopefully by advancement in their company to a position where he can counsel his replacement.

Rural recession and drought were the straws that broke the power struggle. Representative territories have been expanded to be thinly covered, and you are aware that the number of chemical representatives has been reduced.

So much for the history until this time.

I quote now from "The Chronicle" of February 23rd.

"Report on training needs"
"Call for improved extension service"
"Growers and stock and station branch managers claim that extension service of the Department of Agriculture should be improved"
"This is one of the points made in a survey of training needs in industry, commerce and Government in S.A. The report of the survey released this week was the work of a research group of three and was issued by the Director of Further Education (Mr. M.H. Bone) and the secretary for Labour and Industry (Mr. L.B. Bowes). In the section dealing with rural production the research group said: "Growers require training in analysing and defining animal and crop problems and developing appropriate solutions. Because it is not possible for them to make continual reference to the extension officers they need training to enable them to make greater use of printed information. It was repeatedly emphasised that agriculture

is becoming an increasing technical operation making greater demands on cost control and management skills."

"On the point of education, the report said companies were almost unanimous in their opinion that tertiary education authorities were uninformed about their particular education and training needs. Growers and agricultural service companies said that they received only indirect benefits from tertiary education courses available at the University of Adelaide, Waite Institute, Roseworthy College and the S.A. Institute of Technology".

"Growers thought the most urgent education needs were for courses in management techniques and the application of science and technology to their operations", the research group said.

"For their supervisors and utility workers, units of instruction are needed in building, propagation a nd cultural practices, irrigation, spraying, basic mechanics and maintenance, together with record keeping, sales procedures, bookkeepping and packaging."

"Agriculture service companies would like to have courses suited to the needs of their salesmen."

From the same "Chronicle", Richard Campbell in consultation with Keith Bicknell wrote -

"Jack of all trades, and master of most of them - that's probably the best way to describe an ag. adviser.

"As a group of people servicing farmers, Department of Agriculture advisers are probably unique.

They are expected to know about and be able to advise on practically all aspects of agriculture; and most of their knowledge is self-taught, coming from experience.

Their work covers crops, pastures, pests, weeds, soils, sprays, fertilizers and farm management and associated fields."

"Advisers don't pretend to know everything, and frequently make use of other experts within the Department of Agriculture and organisations such as the Waite Institute or the CSIRO."

"The basis for a job like this is experience", Keith said last week. "It's largely a job of teaching yourself, with the aid of in-service training schools and other courses".

Master of some is no disgrace. We are living in an age of technology and even the agricultural specialists to whom our "Jack of All Trades" needs to refer has difficulty being familiar with the latest experiences. By the time the problem is related by telephone or letter to the specialist, it is modified by interpretation, and the answer is frequently modified in return so that the full value of the available knowledge is seldom realised.

This, I believe, is where the reseller must fit in Agriculture. He is a person with an investment in real estate and goodwill in a restricted area, having from forty to perhaps four hunded or more customers. He will have his customers best interest at heart, to advise them without bias as to what chemicals best suit the situation. He should have available from all companies those products which have application within his area of operation.

He should become knowledgeable in chemicals to the point where most farmers have full confidence in his directions. This knowledge he will gain by consultation with his suppliers now less numerous, but mostly better informed representatives. His field of expertise will probably be somewhat narrower, but his recurrent experience with recurrent problems on many farms will give him greater depth and greater ability to evaluate new products or application variations. He will know his local agricultural adviser. He will, I hope, be protected by a licence to recommend chemicals as a pharmacist is to dispense medicines. He will hold a certificate of approval relative to his local chemical applications. He will be somewhat protected from fragmentation of business.

Where the customer and business volume warrants, he will employ an agricultural specialist whether in his own business, or jointly with neighbouring chemical resellers.

Legislation enabling this protection or licensing will enable unbiased appraisal of chemicals to maximise the returns to the primary producer.

I hope to see this instituted and will work towards its achievement.

To summarise, I see a chemical reseller of the near future as a local business man with an area license which centralises all products, supermarket style. Mr. Chemical Supplier will be knowledgeable in chemicals required in his area, and will need hold or employ a holder of a certificate of competence in chemicals. He will be expected to advise, inspect and refer problems to appropriate referees.

He will stress legal obligations concerning safety equipment, rates of application and withholding periods for stock or produce. He will document recommendations and bear some responsibility for illegal or wrong recommendations which result in damage.

THE APPLICATION OF PESTICIDES

FUMIGATING WITH PHOSTOXIN ON THE FARM

by

MR. J.A. WRIGHT

Managing Director,
Phostoxin, Aust. Pty. Ltd.

Phostoxin is composed of aluminium phosphide and ammonium carbamate compressed into 3g tablets and 0.60g pellets.

Alluminium phosphide reacts with moisture to form phosphine, a poisonous highly penetrating gas slightly heavier than air with a carbide odour. It is practically insoluble in water, fats and oils, chemically inert and reacts insignificantly with the components of fumigated commodities. It aerates rapidly leaving negligible residues. Phosphine does react with copper, so that electrical equipment etc. should not be exposed to it.

The residue from decomposed Phostoxin is aluminium hydroxide together with a small amount of unreacted (1-2%) aluminium phosphide. Ammonium carbamate liberates carbon dioxide which inhibits flammability and ammonia which acts as a warning agent. The residue of aluminium phosphide breaks down almost immediately the grain is moved.

Phostoxin pellets are used in the treatment of bulk grain in large silo installations and are added to the grain stream through an automatic dispenser. The tablets are also used for the treatment of bulk grain and can be used on the farm during the filling of a silo or probed into the grain already there. They can also be used in flat stores through a probe. Bagged grain can be treated by covering with a plastic sheet. Phosphine, even at exaggerated dosages, does not affect germination, or palatability of grain to be used for stock feed.

Phostoxin is used to fumigate a wide variety of materials including grain, nuts, processed foods, tobacco, dried fruits, cocoa and coffee.

Fumigation Technique

While fumigation is essentially a gas concentration by time process, with Phostoxin fumigation the exposure time can not be reduced below 4 days. It can often be extended to advantage. Most failures result from inadequate sealing.

Farm silos of galvanised iron may require sealing of joints with "Hydroseal", sealing of doors with masking tape, sealing of manholes with plastic sheeting, and filling the gap between walls and roof with crumpled paper to reduce draughts.

Bagged commodities are frequently fumigated with Phostoxin. This should be carried out under plastic sheeting. Wooden floors, especially if elevated, are very porous to Phosphine, so bags should be stacked on plastic or sisalkraft.

Dosages

Precise doses are hard to define because of the variable circumstances encountered. Very large silos can use 2 tablets to 40 bushels, but on ordinary farm silos 7-10 tablets per 40 bushels should be used. Tablets should be probed into bulk grain at 4 foot centres to within 4 to 6 feet of the bottom of the grain. As an upper limit, reckon on maximum penetration to 10 feet below tablets.

Bag stacks under plastic require 30 tablets per 1,000 cubic feet of total space. Tablets can be put on paper plates or foil tray. As an extreme last resort put 1 tablet in each bag inside an enclosed shed.

Because farm fumigations are usually carried out mainly in the open air, dangers are slight. In an enclosed space, shed or mill, always wear a gas mask, and do not work alone in case of accidents. An aeration period of 24 hours is generally adequate. No person and no stock are known to have been killed by Phostoxin, some cases of slight mausea only have occurred.

THE APPLICATION OF PESTICIDES

AIRCRAFT SPRAY EQUIPMENT AND THE PLACE OF AIRCRAFT IN PESTICIDE APPLICATION

by

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Managing Director

Trojan Aerial Spraying Services

Aircraft have been used for application of pesticides since the mid-twenties but it is only since the war when large numbers of cheap surplus aircraft became available that aerial agriculture has really developed. Now-a-days, of course, aircraft are specifically designed for aerial application of fertilisers and pesticides.

1. Capabilities and Advantages

1.1 Aircraft and their associated equipment are very versatile and can rapidly change from high volume to ULV application

1.2 Speed of application varies from 50 acres/hour on vegetable crops averaging 8 acres/block to over 250 acres/hour on cereal or general broad acre work.

1.3 Optimum timing of pesticide application can be observed because of 1.2.

1.4 No damage to the crop by the equipment. This is not so with ground equipment with most crops. In cereals ground equipment may give a 5% yield loss after allowing for 50% regrowth of damaged plants. This can be worth $1-50 per acre in an 8 bag/acre crop which is twice the cost of aircraft application. Green strips at harvest caused by ground spraying equipment may also increase grain moisture content.

1.5 In irrigated areas there is no need to move irrigation equipment or even wait for the ground to dry. In repeat applications to a schedule this can be most important.

1.6 Fruit crops which need props to support heavy crops can be sprayed readily from the air whereas ground equipment would require removal of the props.

1.7 A variety of types of equipment is now available to give a far greater coverage and better results than a few years ago.

1.8 With some horticultural crops many pests are at the top where aircraft can reach them better than ground equipment.

1.9 An aircraft's wing imparts a downwash to the spray which increases penetration of the crop.

1.10 Aircraft equipment requires a lower volume of water per acre hence less total water is required to be carted to the job.

1.11 Large total volumes of pesticide are used over a period of spraying enabling it to be purchased in larger quantities and the benefit passed to the grower.

1.12 The total cost of aerial application is tax deductible.

2. <u>Limitations of Aircraft</u>

2.1 Aircraft are restricted by inclement weather more than ground application but can catch up quicker.

2.2 Aircraft are seen as a panacea when a spraying job has been left too late. Unfortunately its speed of application does not increase its effectiveness in controlling a pest that is already causing damage. Also when little notice is given it is difficult to plan to ensure availability at the correct time.

2.3 Aircraft application cost is higher than ground application and consequently due to human way of looking usually at nett rather than gross cost the aircraft is considered a luxury and priced out.

2.4 There is still a natural suspicion of aircraft due to its operation in a removed element.

2.5 The variety of sophisticated equipment available requires proper understanding by pilots and training in its use for optimum benefit.

2.6 Drift hazard can be increased if the aircraft is not operated intelligently and with proper regard for areas surrounding the area being treated. This can be particularly so in the application of 2,4-D. Happily it can be said that the average agricultural pilot is well trained and conscientious so that such occurrences are rare.

2.7 The farmer quite often forgets or does not realise that the industry has progressed tremendously both in aircraft, equipment and operational standards and also in training and expertise since the early days of a few Tiger Moths carrying out basic urgent spraying.

3. <u>Involvement of Personnel Other Than Those Supplied by the Aerial Operator</u>

3.1 Involvement usually means no more than the farmer making water available plus two human markers to mark the area to be treated. Under certain circumstances even this is not required. Companies try to ensure that the farmer is present when the job is carried out.

3.2 Human markers. The average pilot does not require any assistance to enable him to give proper coverage in paddocks of less than 20 acres. Even this size can be increased if the paddock can be approached on a sub-divided basis i.e. if it has sprinkler lines in it etc. The swathe laid down is much wider than the distance between consecutive runs made by the aircraft. In large featureless paddocks human markers are used to guide the aircraft on its runs. These men carry flags often of day glow material. Proper briefing of markers is essential as the job is only as good as the marking can make it. Marking may be carried out either head on with the aircraft aligning its centre line with the markers who move out of the way as the aircraft approaches or wing tip with the aircraft's wing tip aligned with the markers. The latter is preferred as it far safer because the pilot can see the marker at all times, there are no panic movements and the marker can move away from the drift to avoid toxic chemicals. The aircraft runs are commenced on the downwind side of the paddock and progressively more upwind to avoid flying in the pesticide and to ensure that the markers can also avoid the pesticide.

4. <u>Airstrip Requirements</u>

4.1 These are laid down by D.C.A. and are as follows:-

<u>Width</u> - Central 30' smooth such that heavily sprung vehicle can be driven at 30 m.p.h. without discomfort to the occupants.
Run off area 35' either side.
Obstruction clear area 25' either side.
Total width is thus 150'

<u>Length</u> - As required by performance charts of the various aircraft.

<u>Approach and take-off areas</u> - must be obstacle free above a 1:20 gradient for 750' from airstrip end.

Gradient - maximum overall longitudinal gradient 1:8 (above 1:50 - one way operations only)
- maximum transverse gradient of central 30' is 1:33. Higher gradients 1:20 and 1:8 permitted for run-off and obstruction clear areas respectively.

5. Application Equipment

5.1 Booms with discs and swirl plates behind the orifice in the jets.

5.2 Booms with flat fan jets.

5.3 Micronair rotary atomiser

5.3.1 Good droplet control

5.3.2 Range of application rates which can be changed rapidly.

5.3.3 Drift controlled by droplet size control.

5.3.4 Virtually blockage free.

5.3.5 High initial cost $2,500.

6 Aircraft Used

6.1 High or low wing

6.1.1 High wing e.g. Beaver, Cessna 180 or 185.

6.1.2 Low wing e.g. Piper Pawnee, Cessna Ag. waggon Snow Commander, Callair.

6.2 Size - tank capacity varies from 100 gallons in Pawnee to 240 gallons in Snow Commander.

6.3 Wing plan design varies. Basically designed to give high lift at low speeds.

6.4 Helicopters have place in specific applications such as rough terrain.

7. Summary

Aircraft used for pesticide application are now specialised machines designed purely for the job of aerial application. They are flown by pilots trained to exacting Department of Civil Avaiation standards. The aircraft are operated by companies which in the main have been carrying out aerial work for more than a decade and are run on a proper economical basis by businessmen. The companies have proved their reliability over the past few years when agriculture has been depressed. The day of the "crop duster" has long since gone.