A REVIEW OF GRASS GRUB CONTROL WITH DIAZINON

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Summary

Several organophosphate insecticides have given excellent control of grass grub (*Costelytra zealandica*) larvae under defined moisture conditions. This paper discusses the relative moisture dependence of diazinon when applied by different methods.

INTRODUCTION

BECAUSE OF insect resistance, and residues in export products, the use of residual organochlorine insecticides such as DDT for control of grass grub (*Costelytra zealandica*) in forage crops has become unacceptable.

Of the organochlorines, only lindane leaves acceptably low residues in animal tissues and is permitted for grass grub control, and the conditions under which it can be applied have been severely limited so that minimum residue levels can be achieved. Its continued use will be dependent on international tolerance levels being maintained in export produce.

A large number of alternative organophosphate and carbamate insecticides have been evaluated for control of grass grub larvae. Of these, the organophosphate materials diazinon, fensulfothion, parathion and more recently "Mocap" are commercially available. Carbamates are generally readily hydrolysed in the soil and are therefore insufficiently stable for soil treatment.

Fenemore and Perrott (1963) were first to establish that diazinon in a liquid formulation, if sprayed on to the pasture and washed into the soil by spray irrigation, gave excellent results in both grub reduction and pasture response, but the authors concluded the method was impractical for general use, and suggested further trials with granular formulations. Subsequently rainfall or its equivalent has been used as the most practical method of incorporating surface applications of organophosphate insecticides into the surface layer of the soil. As organophosphates have a relatively short residual life, treatment can only be curative, and application must be made under conditions favourable to bring the insecticide into contact with the larvae before chemical breakdown occurs.

This paper discusses methods of applying diazinon and other organophosphate insecticides that have been evaluated commercially together with their limitations and relative reliability.

GRANULE FORMULATIONS

Trial workers subsequent to Fenemore used granule formulations to overcome the more immediate restrictions of liquids, namely, the risk of large amounts of toxicant being retained on the foliage, and to place the toxicant as close as possible to the soil surface, in anticipation of soil

incorporation by rainfall. Granules were also more stable if rain was delayed, and easier to apply, particularly by aircraft. From many trials, Rastrick and Mason (1966) and other workers have concluded that diazinon gave highly effective grass grub control if 12 mm of rain, or its equivalent in overhead irrigation, fell within 7 to 10 days of application. Control was less reliable if this period was exceeded. Subsequent commercial usage has confirmed the importance of this rainfall requirement for acceptable pasture response. Moisture requirements for parathion and "Mocap" are similar to diazinon, but less critical for fensulfothion. Where available, overhead or flood irrigation has been satisfactorily used for insecticide incorporation.

It is generally accepted that moisture tends to bring the larvae to the soil surface, increasing the possibility of exposure to insecticide. Recent trial work in Canterbury and southern Hawke's Bay (Woon and Forgie, unpubl. data) indicates that, probably for this reason, soil moisture at the time of application may be almost as important as subsequent rainfall. At 20 to 25% soil moisture, 5 mm or more of rain within 21 days of application has been sufficient to give pasture responses equal to those obtained from application to dry soil, followed by 12 mm of rain within 7 to 10 days. This moisture factor affected fensulfothion and "mocap" as granule treatments, and diazinon and chlorpyrifos as granule and jet stream treatments, to varying degrees in these trials.

Various methods have been evaluated for placing diazinon granules so that moisture dependence is less critical. For broadcast application accurate placement of granules is essential. Box type topdressers are highly accurate but slow for treatment of large areas and can only be used for applying insecticide mixed with fertilizer. McLean (1970) has discussed the high degree of accuracy of reciprocating spreaders, and stressed the need for accurate bout markers. Accuracy of spinning disc applicators can be considerably increased by double application at half the recommended dose rate, using parallel passes at half the normal swath width. This method is also recommended for aerial application. Double application at right-angles or diagonals does not increase accuracy of coverage. Recent work by Davies (1972) discusses calibration of spinning disc applicators, and suggests practical methods by which their accuracy can be improved. The use of band application of granules to established pasture has not been extensive. Bands can be laid by dragging the coulters of a standard drill across the pasture giving 50 mm bands of granules at 180 mm centres in which the high concentration of chemical would reduce the significance of amount and delay in subsequent rainfall. The more promising development has been oversowing of pasture with disc drills to incorporate seed, fertilizer and insecticide. A considerable acreage of South Taranaki dairy pastures has been successfully treated over the last two seasons but only limited application has been done elsewhere.

To date the most reliable and commercially significant use of granules has been their inclusion in mixture with fertilizer when sowing crops into land cultivated because of serious grass grub damage. Large acreages of cereal crops and new pasture have been treated by this method in the mid-Canterbury area during the last two seasons. As for pasture oversowing, the insecticide is placed into the furrow with the seed. On a crop area basis, application rates for diazinon can be reduced to 1 kg/ha for reliable protection of cereals, young pasture, brassicas and peas, and separate application costs are avoided.

LIQUID FORMULATIONS

Liquid formulations have a considerable cost advantage over granules, but because of rainfall limitations have proved less popular commercially. Diazinon used strictly according to label directions, namely, sprayed on to moist pasture while rain is falling, has given highly reliable and rapid responses on short-grazed sheep pasture in Canterbury and southern Hawke's Bay areas. Generally this has been true of south Taranaki also, but some failures attributed to high soil absorption or the longer vegetation of typical dairy pasture have occurred. As most farmers have spray equipment, direct application costs can be avoided.

In the Leeston area of north Canterbury, liquid insecticide formulations have been introduced into sprinkler irrigation pipes after the soil is well moistened. Irrigation is then continued for sufficient time to move the insecticide into the soil (equivalent to about 15 mm rain). By using a venturi on the suction side of the pump, introduction of insecticide is fast and simple, application costs are avoided, and incorporation is reliable.

More recently, Trought and Wood (1970) have developed the systems of jet streaming and pasture injection to assist in overcoming the soil moisture problem for incorporating liquid insecticides. The jet stream system involves the use of solid stream nozzles at 100 to 180 mm spacings to place bands of high concentrate spray on the soil surface. To achieve maximum penetration to the soil surface, the pasture must be short-grazed. However, side-by-side comparisons of this method with granule treatments indicate that soil moisture and subsequent rainfall may be more critical than with granules, particularly if adequate rainfall does not occur within seven days. During the past two seasons, commercial interest in this method has increased, but present results suggest that its use under dry conditions is not effective. As an extension of the spray in the rain technique, it could be useful as rain is not necessary during actual application. Effective control can be obtained if used on wet soil soon after rain and when further rain is imminent.

The pasture injection method of application is similar to jet streaming, but the stream of liquid is injected into a shallow cut in the soil surface made by a disc or similar equipment. This technique has proved expensive with specially constructed machinery, but has been used with some success in Taranaki as an attachment to disc drills for oversowing pasture. It would probably be satisfactory for similar attachment to coulter drills for treatment of crops at planting.

Broadcast treatment with liquid or granule formulations on to cultivated ground, followed by shallow incorporation before planting has been suggested, but it has not been widely evaluated commercially. Band treatment into the drill furrow at planting has the economic advantage of reduced rates because the chemical can be accurately placed in the root zone of crops. High rates of insecticide within the band increase the soil residual (protectant) life, and application costs are avoided.

CONCLUSIONS

The limitation of presently available organophosphates is clearly their short soil residual life compared with the traditional organochlorine insecticides. They must therefore be applied when susceptible stages of the grass grub are present under conditions such that actively feeding grass grubs will come in contact with toxic doses of chemical.

Rainfall or its equivalent has traditionally proved the most practical method of incorporation of organophosphates in established pasture. The amount of rainfall required for effective larvae control with the various chemicals is reasonably accurately defined, though the exact soil moisture conditions need further specification. Spray applications of diazinon while rain is falling have proved reliable provided application is made to short pasture, and sufficient rain follows treatment to move the insecticide into the grass grub feeding zone. The jet stream application may offer some advantages in extending this use over periods when rain is not actually falling. This highly economic technique needs much greater farmer exploitation.

Protection of crops sown into cultivated or uncultivated pasture damaged by larvae, using granules placed into the furrow with the seed, is becoming widely accepted. Economic savings are considerable as application costs are avoided, and accurate placement enables significant reduction in the rate of insecticide necessary. Still further cost reductions are offered by the use of liquid formulations through the attachment of pasture injection equipment to standard drills. The accurate placement of insecticide by this method also means that minimum exposure of the toxicant to non-target organisms is possible. Fenemore (1964) has discussed the significance of "vacuum effect" with regard to less residual insecticides. For reasons of cost, annual applications of granules may not be feasible, and a high degree of control is therefore necessary. Liquid formulations of organophosphate insecticides with an acceptable mammalian toxicity rating do offer an opportunity for annual treatment at an acceptable cost.

Further work defining more accurately the relationship between soil moisture at treatment and rainfall following treatment is suggested as a method of improving reliability of larval control. Several methods offer opportunity for re-evaluating the economics of annual application if a vacuum effect cannot be obtained.

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