REVIEW OF FIELD TRIALS AND GROWER USE OF METRIBUZIN PRODUCTS IN CEREAL (AND OTHER) CROPS

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Summary. An account is given of practicalities in use of metribuzin and metribuzin plus methabenzthiazuron (Sencor T) arising from development work and commercial use in the last decade. Pertinent properties of metribuzin, soil moisture, soil type, weather and the place of metribuzin products in crop protection are discussed. The benefit of early removal of weeds from cereal crops is mentioned along with the contribution of metribuzin products to this end. Early application by aircraft can be more economical than waiting for wet soil to dry sufficiently for ground equipment to be used. Broad spectrum weed control, sufficient survival of legumes, safety to follow-up legume crops and freedom from fear of phenoxy herbicide damage make metribuzin products attractive in both conventional and conservation tillage systems.

INTRODUCTION

Metribuzin was first registered in Australia in 1975 for early post-emergence weed control in potatoes and then in peas (1976). At the same time a mixture of metribuzin 140g kg^{-1} plus methabenzthiazuron 560g kg^{-1} (^{R} Sencor T) was being developed. The mixture was registered in N.S.W., Victoria and South Australia in 1980 for weed control in wheat. This year, 1984, metribuzin was registered for use in barley crops in Victoria, South Australia and Tasmania. It has also been registered for weed control in furrows between tomato rows in northern Queensland and for spot treatment of Bathurst and Noogoora burrs (*Xanthium spinosum* and *X. pungens*) near crops sensitive to phenoxy herbicides.

The aim of this paper is to present a review of experiences gained from trials (detailed in submissions to T.C.A.C. and from recent unpublished work) and also commercial use over the past decade.

PROPERTIES AND FACTORS IN PERFORMANCE

Metribuzin kills weeds by interrupting photosynthesis, thus preventing carbohydrate production. It is taken up by plants through both roots and leaves. It is soluble to 1,200 ppm in water and is adsorbed onto clay and organic particles in soils. Persistence depends on microbial activity, physical properties of the soil, leaching and temperature. Like many herbicides, efficacy depends on sufficient soil moisture at, and for a time after, application.

Soil moisture. Although field trials indicated variation in weed control according to soil moisture, it was not until after several years' commercial experience that the importance of soil moisture became clear. Even today, it is questionable whether its importance (in use of virtually all herbicides) is sufficiently recognised by farmers and a number of their advisers.

There are numerous cases where spraying has been interrupted by rain and the task finished some 18 hours later. With both metribuzin and methabenzthiazuron, clearly better weed control has been obtained on the "after rain" part of the paddock. The need for moisture which is sufficient for good plant growth is common to many herbicides and not a peculiarity of metribuzin alone.

Whatever the mechanism may be, soil must be moist on the surface when metribuzin is applied if subsequent root uptake or pre-emergence effect is to occur. If soil surface is dry at spraying, metribuzin is not taken to the root zone by subsequent rain or irrigation in sufficient quantity to be fully effective. This has been observed, particularly on krasnozem soils, but also on other soils. Thus for maximum weed control and consequent return on investment soil must be moist on the surface at spraying. The alternative is reliance almost solely on leaf uptake, which may be entirely satisfactory if all weeds have emerged, but is less satisfactory if there are subsequent germinations.

Soil type. The first metribuzin (^{R} Sencor 70) labels made allowance for influence of soil type by embracing a range of rates according to silt plus clay content of soils in which processing peas were grown. Subsequent spread of use into dry pea crops and of Sencor T into wheat increased the range of soil types to which metribuzin products were applied. The lower the clay and organic matter content of soil, the greater the availability of metribuzin in soil solution and consequent increase in effect on plants,including the crop. Thus where soils approach pure sand, use of metribuzin products was precarious. Rates of use were amended downwards, and in Western Australia development in the main wheat areas ceased. Variation in soil type requires a degree of freedom in rate of use not readily catered for by product labels. Witness of this can be found in Mallee areas where rates of Sencor T below label recommendation are used by farmers on wheat,and very satisfactory weed control is obtained.

The more permeable the soil is to water, the greater the leaching of metribuzin as rain or irrigation increases. Leaching can affect the period for which weed control is maintained. Under most circumstances, this has not resulted in weed control failure. However, there have been two separate occasions in Tasmania in krasnozem soils when 100mm rain fell within 5 to 7 days, and metribuzin was leached below the root zone (Black, 1984). Subsequent weed germination survived within a month after spraying. Another but less dramatic case occurred on a deep loamy sand on the Bellarine Peninsular in Victoria.

Weather. The proviso that metribuzin products be applied after rain while soil is still moist to the surface means that there will have been a period of cloudy weather. The corollary of this is that carbohydrate synthesis will have been reduced and that reserves in plants will have been depleted. The greater the number of days of cloudy weather the greater will be the herbicide effect on both weeds and crop. If a crop becomes yellowed after metribuzin and/or methabenzthiazuron very good weed control is assured. Weather preceding spraying - more particularly lack of sunshine - presents another case where experience could dictate a variation from label rate of use. The conditions for best weed control are axiomatically those conducive to greatest effect on the crop.

Comment. None of the above considerations are startling nor even new; but they are not always recognised. Greater recognition by advisers as well as farmers would be to the general good.

PLACE OF METRIBUZIN PRODUCTS IN WEED CONTROL

Each registration of metribuzin (and Sencor T) filled a gap in the time at which weeds could be controlled. Prior to metribuzin, weed control in potatoes was obtainable, with minor exceptions, only by cultivation - which damaged the crop. In peas, pre-emergence herbicides were available but the only post-emergence herbicide was dinoseb which was only suitable for use when crop and weeds were well advanced in growth. Metribuzin was developed for early post-emergence use when a weed problem could be seen to be developing. Yield benefits were demonstrated through early removal of weeds.

In cereals, weeds could be removed by appropriate use of pre-sowing soil-incorporated herbicides or by predominantly leaf absorbed herbicides. The latter required weeds to have emerged, necessitating spraying between six and ten weeks after sowing. The alternative was phenoxy herbicides, which were unsafe to use at this time. Crops had tillered, and most of the competitive effect of weeds had already taken place.

It has been well established that the earlier weeds are removed from cereal crops the greater the benefit in yield. This was a significant factor in the gradual replacement of phenoxy herbicides by products such as those containing bromoxynil. Even so, crops were seldom sprayed earlier than eight weeks after sowing - to ensure all weeds had emerged. Yield losses of up to 0.2t ha^{-1} per week due to weeds were demonstrated in the period 4 to 8 weeks after sowing in Sencor T trials. Thus each week's delay in spraying had the potential to reduce yield by a value greater than the cost of herbicide and its application. (Hoechst demonstrated comparable effects during development of diclofop methyl for annual rye grass control.) Thus Sencor T offered a benefit not previously available - it could be used before all weeds had emerged, and earlier than solely leaf absorbed herbicides. Also it could be used with little if any intrinsic effect on crop yield (even if crop yellowing did occur). Methabenzthiazuron (the major component of Sencor T) is the safest post-emergence herbicide to wheat, and the quantity of metribuzin is below the level where injury to wheat is known to affect yield. Other leaf and root absorbed herbicides do not seem to enjoy this level of crop tolerance nor affect such a wide variety of weeds.

The properties of Sencor T and metribuzin have enabled them to become the major herbicides for control of wild radish (*Raphanus raphanistrum*) in wheat (without need for potentially hazardous addition of a phenoxy herbicide), potatoes, peas and now barley. At the same time they control a wide range of other weeds. In seasons and areas of successive autumn-winter rain, and consequent,repeated germinations, metribuzin gives a period of post spraying control of a number of weeds, including wild radish, fumitories (*Fumaria spp.*), corn gromwell (*Buglossoides arvensis*), three-cornered jacks (*Emex australis*) and others. Both metribuzin and Sencor T are particularly effective against toad rush (*Juncus bufonius*) - a diminutive weed which by sheer density in wet soils can considerably deplete nitrogen available to the crop during tillering and for a time afterwards.

Tillage. Conventional mechanical fallowing results in fine tilth in the top 10cm of soil so that for a time after sowing paddocks cannot be traversed by tractor and spray equipment. This is a factor delaying post-sowing applications for weed control. Aerial application of Sencor T or metribuzin in north-eastern Victoria while paddocks are too wet or soft for ground equipment has demonstrated greater economy than delaying until ground is firm. Sencor T and metribuzin offer the facility of use as soon as it is seen that a crop is going to need spraying. Metribuzin is recommended for application pre-emergence in pea crops as well as early post-emergence.

Conservation tillage embraces a range of relatively new practices, including chemical fallow, stubble mulching, reduced tillage practices and direct drilling into chemically killed pasture. This provides new problems for in-crop weed control.

Pre-emergence weed control was observed during development of both metribuzin and Sencor T, but due to factors already mentioned little thought was given (other than in peas) to practical use of pre-emergence treatments. In 1981 and 1983 Sencor T was applied pre-emergence to wheat, barley and triticale. Weeds on which pre-emergence effect has been measured are given in the table.

Table 1. Weeds controlled by Sencor T (525 to 700g ha^{-1}) and/or metribuzin (105 to 140g ha^{-1}) pre-emergence.

Weed	Comment
Hordeum histrix) *Vulpia myuros*) *Vulpia bromoides)*) *Bromus mollis*)	1981 Pre-sowing: weeds just emerging - two weeks after germinating rain. Sencor T 525g ha^{-1}.
Amsinckia calycina) *Chenopodium album*) *Arctotheca calendula*) *Sisymbrium orientale*) *Juncus bufonius*) *Crassula sp.*)	Various seasons. Post-sow pre-emergence Sencor T 700g ha^{-1} metribuzin 140g ha^{-1}.
Fumaria bastardii) *Polygonum aviculare*) *Emex australis*)	Weeds reached cotyledon stage then died.
Raphanus raphanistrum	Approx. 3 to 4 weeks effect.
Phalaris minor	80 to 90% reduction 1983.
Barrel medic cv Borung *(Medicago truncatula)*	67% survival 1983
Trifolium spp	Variable - less than 100% survival.
Conringia orientalis	40% survival (but good early post-emergence control) 1983.

Pre-requisite: soil moist to the surface when metribuzin products applied.

Whereas it may be desirable for weed control to be obtained with a single pass for both pasture knockdown and in-crop germinations, this may not always be possible - or there may be some undesirable effect. There will consequently be situations and occasions when post-sowing weed control is necessary in direct drilled crops. Annihilation of legumes and rye grass may be neither desirable nor necessary for optimum crop and subsequent production, whereas complete removal of other weeds, e.g. toad rush and cape weed (*Arctotheca calendula*) may. Removal of some or most weeds may lead to an explosion in the density of the remainder. This has been seen on occasions following use of Methabenzthiazuron where removal of capeweed has resulted in strong growth of sub-clover and annual rye grass in crops. Toad rush thrives when other weeds are killed.

CONCLUSION

Sencor T and metribuzin offer practical control of weeds in conventional and conservation tillage systems in southern N.S.W., Victoria and South Australia (in the absence of sour sob (*Oxalis pes-caprae*)). Application (by air if ground is too wet) as soon as the first haze of germinating weeds is seen offers immediate control through leaf uptake and a period of about three weeks' control of weeds yet to emerge. Alternatively, crops may be sprayed while soil is moist to the surface following the first useful rain after sowing whether this occurs after one or five to six weeks. Follow-on legume crops or pastures are not affected. The risk of head distortion in cereals by phenoxy herbicide additives is avoided. Time of application of metribuzin products is sufficiently flexible for them to be of great practical and economic value in cereal (and other) crops.

LITERATURE CITED

Black, I.D. 1984. Aust. Weeds 3(2): 74-77.