

Herbigation* in a Vineyard: Persistence of Four Pre-emergence Herbicides in a Sandy Loam Soil**

J.C. Fourie

Nietvoorbij Institute for Viticulture and Oenology (Nietvoorbij), Private Bag X5026, 7599 Stellenbosch, Republic of South Africa

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The persistence of simazine, oxadiazon, napropamide and oryzalin in a sandy loam soil was monitored over a period of 60 days by means of a bio-assay. *Avena sativa* L. (oat) [oxadiazon and oryzalin] and *Hordeum vulgare* L. (barley) [simazine and napropamide] were used in the bio-assay. Sixty days after application 12%, 16%, 38% and 76% of simazine, oxadiazon, oryzalin and napropamide, respectively, initially present, were detected in the 0-300 mm soil layer, the latter herbicide being the most persistent. Migration, to a greater or lesser extent, could be detected in the case of simazine, oxadiazon and napropamide. Oryzalin was seemingly resistant to leaching. A 20 mm herbigation seemed optimal for oryzalin and napropamide. In the case of oxadiazon and simazine, however, it is suggested that the herbigation volume should be reduced to 15 mm. It was confirmed that the use of wettable powders for herbigation should be avoided and solutions should rather be used. The criteria established for herbigation on a sandy loam soil could be used as a guideline for medium-textured soils.

Various researchers have achieved effective weed control with simazine [2-chloro-4,6-di(ethylamino)-1,3,5-triazine], oryzalin (3,5-dinitro-N⁴,N⁴-dipropylsulfanilamide), napropamide [2-(*n*-naphthoxy)-N,N-diethylpropionamide] and oxadiazon [2-tert-butyl-4-(2,4-dichloro-5-iso-propoxyphenyl)-1,3,4-oxadiazoline-5-one], or mixtures of any two of these herbicides, applied through an irrigation system (Lange *et al.*, 1974; Fischer *et al.*, 1985; Fourie, 1988). The efficacy of a pre-emergence herbicide is strongly influenced by the extent of its movement in a soil and depends upon its ability to stay in the 0-100 mm soil layer, the area in which most of the weed seeds germinate. During the application of a pre-emergence herbicide, a slight downward movement of the chemical is therefore necessary to ensure adsorption in the 0-100 mm soil layer and to restrict volatilization and photodecomposition at the soil surface. The distance a herbicide moves vertically in the soil is crucial as far as its potential for crop damage and environmental pollution is concerned. Beside leaching, microbial and chemical breakdown are some of the more important factors that cause a herbicide to become non-phytotoxic or disappear from soil. To date the dissipation of pre-emergence herbicides in the vineyard soils of South Africa has not been studied. To ensure optimal herbigation (the application of a herbicide through an irrigation system) with pre-emergence herbicides in South African vineyards, their efficacy should be evaluated in relation to their persistence in the soil.

The purpose of this study was to determine the persistence of the abovementioned herbicides in the 0-300 mm layer of a sandy loam soil, common to the viticultural area of Stellenbosch, and to correlate persistence with efficacy.

MATERIALS AND METHODS

The investigation was done on a dystrophic sandy loam soil at Nietvoorbij in Stellenbosch. The soil was classified as a Clovelly and the analyses are given in Table 1. The microjet irrigation system used was the same as described by Fourie (1988). Treatments were replicated four times in a randomised block design (108 m² per replicate). Four pre-emergence herbicides (Table 2) were injected into the irrigation line by means of a diaphragm pump during the first 20 minutes of a 20 mm irrigation during the second week of November 1988. The pressure in the system was 200 kPa. For the duration of the trial 25 mm of irrigation water was applied weekly. Rainfall over the 60-day period was 26 mm.

Soil samples were taken from the 0-50 mm, 50-100 mm, 100-150 mm and 150-300 mm soil layers one day, 30 days, and 60 days after herbicide application. Each soil sample consisted of three subsamples selected randomly in a plot. The presence of the different pre-emergence herbicides was determined by means of a bio-assay adapted from a procedure described by Burnside & Behrens (1961). In the case of oxadiazon and oryzalin *Avena sativa* L. (oat) was employed as the bio-assay plant, whereas in the case of simazine and napropamide *Hordeum vulgare* L. (barley) was used. The bio-assay was executed as follows: a plastic pot with the holes in the bottom covered with four layers of paper towel was filled with 500 grams of oven-dried soil. Ten seeds were planted per pot \pm 10 mm below the soil surface. Each pot received 0,1 g of Chemicult (6,5% N; 2,7% P; 1,3% K; 7% Ca; 2,2% Mg; 7,8% S; 0,024% B; 0,002% Cu; 0,15% Fe; 0,024% Mn; 0,001% Mo and 0,005% Zn) dissolved in 50 ml of distilled H₂O after the

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TABLE 1

Analyses of the 0-300 mm soil layer of a sandy loam soil used for a herbigation experiment at Nietvoorbij Experimental Farm in Stellenbosch.

pH in 1 M KCl	Organic matter (%)	Electrical conductivity (mS.m ⁻¹)	Clay (%)	Silt (%)	Sand (%)	Bulk density (kg.m ⁻³)	Exchangeable Cations (me/100 g)		
							K	Ca	Mg
5,1	0,80	35	18	12,2	69,8	1620	0,49	0,92	0,55

TABLE 2

The amount of pre-emergence herbicide injected into the microjet irrigation system during the first 20 minutes of a 20 mm irrigation (November 1988).

Herbicide	Formulation ¹	Active ingredient per hectare (g)
Simazine	WP	3000
Oxadiazon	SOL	1440
Napropamide	WP	2700
Oryzalin	WP	2300

¹WP = wettable powder.

SOL = solution.

seeds had been planted and every third day thereafter to ensure optimal plant growth. The pots were watered by subirrigation to keep the soil at field capacity. The plants were grown in a glasshouse with a 16-hour day and 8-hour night cycle, a maximum day temperature of 31°C (± 1,5), a minimum night temperature of 25°C (± 0,5), and a relative humidity of 55% (± 10). After a growth period of 24 days the above-ground parts were harvested and the fresh mass per pot determined. The amount of herbicide present in the soil sample was determined from a standard curve drawn for each herbicide, (e.g. Figs. 1 & 2). The presence of toxic metabolites would influence the accuracy of the bio-assay. As far as the herbicides used in this study are concerned, however, perusal of the available literature did not substantiate the occurrence of toxic metabolites in the soil. Where the efficacy of a pre-emergence herbicide is evaluated in relation to its persistence, the bio-assay gives the best indication of its potential to control weeds at a given time.

RESULTS AND DISCUSSION

Application efficiency: The percentages of simazine, napropamide, oxadiazon and oryzalin that reached the soil are shown in Tables 3 to 6. The poor application efficiency achieved with simazine, napropamide and oryzalin, in comparison to the excellent results obtained with oxadiazon, can be attributed mainly to the fact that oxadiazon was applied as a solution whereas the other herbicides were applied as wettable powders. The drastic loss of simazine, napropamide and oryzalin could have been

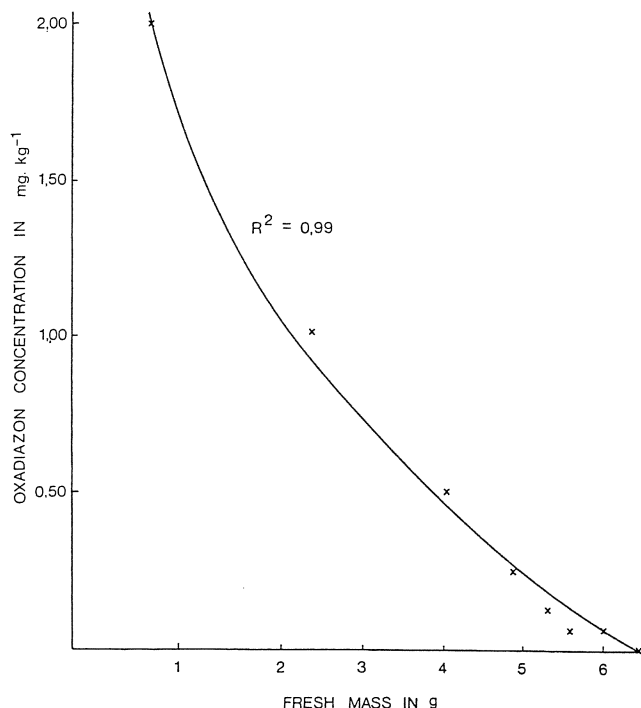


FIGURE 1

A calibration curve showing the influence of different concentrations of oxadiazon applied to the Clovelly soil on the fresh mass of the above-ground parts of the bio-assay plant *Avena sativa* L., measured after a growth period of 24 days in a glasshouse.



FIGURE 2

Reduction in the above-ground growth of the bio-assay plant *Hordeum vulgare* L. caused by different oryzalin concentrations applied to a Clovelly soil up to a maximum level of 4 ppm, after a growth period of 24 days in a glasshouse.

caused, *inter alia*, by precipitation of the wettable powders in the irrigation lines during application as the point of injection was situated approximately 100 metres from the nearest treatment plot. This is supported by the views of Callihan (1974), Ogg (1976) and Fourie (unpublished data).

Excessively high air temperatures ($> 30^{\circ}\text{C}$) and low relative humidity ($< 15\%$) greatly increase evaporation (Jensen, 1980 as quoted by Ogg, 1986) and can adversely affect the application efficiency of certain herbicides when applied through sprinklers (Ogg *et al.*, 1983). Crutchfield, Clark & Wiese (1977) found that when atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine] and trifluralin (2,6, dinitro-N,N-dipropyl-4-trifluoromethylaniline) were applied through a sprinkler irrigation system, the evaporation loss of atrazine was 10% and that of trifluralin 85% with the loss of water amounting to 13%. These applications were made at a day temperature of 35°C and a relative humidity of 30%, which corresponds with the climatic conditions that prevailed while the herbicides used in this study were applied (relative humidity 30%, day temperature $36,5^{\circ}\text{C}$). Under normal climatic conditions (temperatures between 20°C and 30°C) volatilization of oryzalin, simazine and napropamide is reported to be minimal (Hilton *et al.*, 1974). However, the poor application efficiency experienced in the present study could be attributed partially to volatilization occurring under the drastic climatic conditions mentioned above.

Simazine: Seventy nine percent of the simazine detected in the soil one day after application was found in the 0-50 mm soil layer (Table 3). The other 21% could be detected mainly in the 50-100 mm soil layer with only a minute amount in the 150-300 mm soil layer. Following an application of $2,24 \text{ kg ha}^{-1}$ of simazine on a soil with an organic matter of 4% and a clay content of 28,6%, Burnside, Schmidt & Behrens (1961) applied 25 mm of water and

found that simazine moved to a depth of 75 mm. When 50 mm of water was applied, simazine leached to a depth of 150 mm with 90% of the chemical being absorbed in the 0-75 mm soil layer. A leaching study by Harris (1966) on a Lakeland sandy loam with a clay content of 18% and an organic matter content of 3,3%, packed in columns with a 75 mm diameter and subirrigated, showed that simazine moved a distance of 150 mm within a period of 3 to 5 days. The herbicide was present in the whole of the 150 mm soil layer. Comparing the data of the present study with those of the abovementioned researchers, it is clear that the positioning of simazine in the soil is determined by soil type and the amount of irrigation water applied directly after application. Although 92% of the herbicide was found in the 0-100 mm soil layer, where most of the weed seeds germinate, the amount of irrigation water applied directly after the application of simazine could be reduced from 20 mm to 15 mm for the soil type used in the present study. The smaller irrigation volume should reduce the chances of the herbicide migrating deeper than the 0-100 mm soil layer.

Thirty days after application the amount of simazine in the 0-300 mm soil layer decreased by 70%. Sixty days after application a further 50% decrease was perceived, with only 15% of the original amount of herbicide detected in the soil still present in the 0-300 mm soil layer. The drastic loss of simazine detected in the soil is not the result of leaching only, but was apparently also caused by microbial or chemical breakdown. Soil temperature in the presence of sufficient soil water has been shown to have a considerable effect on the microbial and chemical breakdown of simazine (Burnside *et al.*, 1961; Talbert & Fletchall, 1964; Nicholls, Briggs & Evans, 1984; Zandvoort, 1987). Thirty four days after the application of 3 kg ha^{-1} simazine on a silty clay loam, with soil temperatures at a depth of 100 mm varying between $0,2^{\circ}\text{C}$ and $11,5^{\circ}\text{C}$, 80% of the simazine

TABLE 3

The occurrence of simazine at different soil depths measured one day, 30 days and 60 days after application by a 20 mm herbigation on a sandy loam soil at the Nietvoorbij Experimental Farm in Stellenbosch.

Soil layer (mm)	Days after application ¹					
	1		30		60	
	Active ingredient (g.ha ⁻¹) ²	Applied simazine remaining (%)	Active ingredient (g.ha ⁻¹)	Applied simazine remaining (%)	Active ingredient (g.ha ⁻¹)	Applied simazine remaining (%)
0 – 50	1046	34,9	341	11,3	49	1,6
50 – 100	186	6,2	57	1,9	81	2,7
100 – 150	81	2,7	8	0,3	0	0,0
150 – 300	24	0,8	0	0,0	73	2,4
Total	1337	44,6	406	13,5	203	6,7
D-value ($p \leq 0,05$)	583	–	81	–	40	–

¹ Total amount of water: Day 1 = 20 mm; Day 30 = 125,4 mm; Day 60 = 246,3 mm.

² Active ingredient (g.ha⁻¹) = mg.kg⁻¹ active ingredient measured by bio-assay x bulk density x volume of soil layer.ha⁻¹ x 10⁻³

was still present in the soil (Nicholls *et al.*, 1984). Burnside *et al.* (1961) found that no deactivation of simazine occurred in a frozen or sterile soil, whereas at an incubation temperature of 100°C, approximately 73% of the simazine was deactivated over a period of 30 days. In the present study the soil temperatures measured at a depth of 150 mm varied between 17,4°C and 31°C. These relatively high temperatures are conducive to the rapid breakdown of simazine. It is therefore suggested that chemical and microbial degradation are the main causes for the rapid dissipation of simazine from the 0-300 mm soil layer.

However, the increase in the amount of simazine in the 50-100 mm soil layer, measured 60 days after application, indicates that leaching of the herbicide did occur to some extent. Burnside, Fenster & Wicks (1963) also found that simazine leached from the 0-75 mm soil layer into the 75-150 mm soil layer over a period of three months. The clay content of the soil was 31% and the organic matter content 3%, with rainfall totalling 43 mm. In the case of a soil with a clay content of 19,3% and an organic matter content of 2,2% with the rainfall totalling 14 mm, no leaching occurred. This indicates that despite the heavier texture of the aforementioned soil, the higher rainfall caused some of the simazine to move to the deeper soil layer. In contrast Clay & Stott (1973) found that with simazine applied at a yearly rate of 2,8% kg ha⁻¹ to a soil with a clay content of 16%, no herbicide could be found below a depth of 125 mm 12 months after the last treatment, despite an annual rainfall amounting to 860 mm. According to these authors it could, however, be that small amounts of simazine did leach to the deeper soil levels but broke down rapidly prior to the sampling date under these specific conditions which favoured the dissipation of the chemical. This is supported by the results of Hall & Hartwig (1990) who found that simazine, applied at a rate of 2,2 kg ha⁻¹, could be detected at a depth of 460 mm after a period of 71 days and a total rainfall of 300 mm. These results indicated that the loss of

simazine measured in the 0-300 mm soil layer can be attributed partially to the leaching of the herbicide to the deeper soil layers. Some of the loss could also have been caused by the herbicide being taken up by germinating weeds.

Results obtained by Hall & Hartwig (1990) during 1975, under more or less similar experimental conditions as in the present study, indicated a dissipation rate of 62% and 88,5% after 35 days and 71 days, respectively, which corresponds well with the dissipation rates of 70% and 85% after 30 days and 60 days, respectively, measured in the present study. These dissipation rates are also supported by the results of Pestemer *et al.* (1988).

Oxadiazon: Eighty eight percent of the herbicide was detected in the 0-50 mm soil layer one day after application (Table 4). Being a scorching agent, it is important that the herbicide should be situated as near to the soil surface as possible. A further 9% was adsorbed in the 50-100 mm soil layer and the remaining 3% in the 100-150 mm soil layer. Horowitz & Bucsbaum (1978) found that the herbicidal activity of oxadiazon did not change appreciably when the amount of irrigation water directly after application was increased from 25 mm to 75 mm. However, the present study indicated that reducing the herbigation from 20 mm to 15 mm, may increase the efficacy of the herbicide by concentrating more of the herbicide in the 0-50 mm soil layer. Thirty days after application the concentration of oxadiazon in the 0-300 mm soil layer decreased by 24% and sixty days after application a further decrease of 78% was detected with only 17% of the original amount detected in the soil still present in the 0-300 mm soil layer. The dissipation of oxadiazon in the present study was much faster than the rate reported by Ambrosi, Kearney & Macchia (1977) but much slower than the dissipation rate of 50% in 15-17 days reported by Barrett & Lavy (1984) under more or less similar experimental conditions. According to Hilton *et al.* (1974) and Horowitz & Bucsbaum

TABLE 4

The occurrence of oxadiazon at different soil depths measured one day, 30 days and 60 days after application by a 20 mm herbigation on a sandy loam soil at the Nietvoorbij Experimental Farm in Stellenbosch.

Soil layer (mm)	Days after application ¹					
	1		30		60	
	Active ingredient (g.ha ⁻¹) ²	Applied oxadiazon remaining (%)	Active ingredient (g.ha ⁻¹)	Applied oxadiazon remaining (%)	Active ingredient (g.ha ⁻¹)	Applied oxadiazon remaining (%)
0 – 50	1230	85,4	769	53,4	227	15,8
50 – 100	129	9,0	105	7,3	8	0,5
100 – 150	40	2,8	186	12,9	0	0,0
150 – 300	0	0,0	0	0,0	0	0,0
Total	1399	97,2	1060	73,6	235	16,3
D-value (p ≤ 0,05)	130	–	154	–	130	–

¹ Total amount of water: Day 1 = 20 mm; Day 30 = 125,4 mm; Day 60 = 246,3 mm.

² Active ingredient (g.ha⁻¹) = mg.kg⁻¹ active ingredient measured by bio-assay x bulk density x volume of soil layer.ha⁻¹ x 10⁻³.

(1978), oxadiazon is strongly adsorbed by soil colloids and very little migration or leaching occurs. In contrast to these results, movement of oxadiazon from the 50-100 mm soil layer to the 100-150 mm soil layer was detected 30 days after application in this study.

Napropamide: All the herbicide was distributed in the 0-100 mm soil layer with 69% being situated in the top 50 mm of the soil (Table 5). This is a clear indication that the 20 mm of irrigation water, applied directly after application of the herbicide, is the correct amount to be used. The dissipation rate of 24% measured over a period of 60 days is less than half of the rate of 50% in approximately 70 days (Hilton *et al.*, 1974 and Gerstl & Yaron, 1983a). The laboratory study by Gerstl & Yaron (1983a) was executed at a soil temperature of 35°C, which is 4°C higher than the maximum soil temperature in this study. The half life of napropamide was 617 days at 5°C (Gerstl & Yaron, 1983a). It seems, therefore, that soil temperature has a major effect on the degradation rate of napropamide in soils.

Thirty days and sixty days after application leaching of napropamide could be detected from the 50-100 mm soil layer to the 100-150 mm soil layer and from the 0-50 mm soil layer to the 50-100 mm soil layer, respectively. Various researchers also found that napropamide migrates in the soil to a greater or lesser extent (Wu *et al.*, 1975; Gerstl & Yaron, 1983b; Jury, Elabd & Resketo, 1986). For instance, in a laboratory study employing columns, Wu *et al.* (1975) found that most of the napropamide did not move deeper than 80 mm into a sandy loam soil, even after application of 230 mm of water. However, a small concentration moved with the water front. This is supported by Jury *et al.* (1986) who detected 73% of the herbicide in the upper 100 mm of soil after the application of 230 mm of water over a period of two weeks, but found trace concentrations as deep as 1,8 metres. Therefore, although the bulk of napropamide in the soil seems immobile, move-

ment of small amounts of the herbicide to deeper soil layers can be expected.

Oryzalin: Ninety nine percent of the herbicide detected in the soil one day after application was found in the 0-100 mm soil layer, with 66% situated in the top 0,50 mm soil layer (Table 6). As in the case of napropamide, it seems that the amount of irrigation water (20 mm) applied directly after the application of oryzalin is optimal for the specific soil type. The minute amount of oryzalin found in the 100-150 mm soil layer, approximately 1% of the total adsorbed to the 0-150 mm soil layer, is negligible as far as the efficacy of the agent is concerned.

Thirty days after application the dissipation of oryzalin from the 0-150 mm soil layer was less than 5%, but 60 days after application the dissipation rate increased drastically, with only 38% of the original amount of herbicide detected in the soil still present in the 0-150 mm soil layer. No explanation for this initial resistance to degradation was apparent. Gingerich & Zimdahl (1976) found that oryzalin dissipated to 50% of the initial field application after 1,5 to 2 months (in a loam soil with a clay content of 22% and an organic matter content of 1,45% incubated under aerobic conditions). According to these researchers oryzalin has a half life of 1,4 months at 30°C and 4,35 months at 15°C. The dissipation rates reported by these researchers are relatively slow in comparison to the rate determined in this study of between 30 days and 60 days after application, but compare well with the dissipation rate of 62% over the whole period.

It seems that oryzalin adsorbs strongly to the clay colloids and organic matter in the soil as no leaching could be detected up to 60 days after the herbicide was applied.

Efficacy in relation to persistence: The efficacy of the four pre-emergence herbicides used in the trial is shown in Table 7. (Data compiled from Fourie, 1988). In the case of simazine the weeds were controlled efficiently by a con-

TABLE 5

The occurrence of napropamide at different soil depths measured one day, 30 days and 60 days after application by a 20 mm herbigation on a sandy loam soil at the Nietvoorbij Experimental Farm in Stellenbosch.

Soil layer (mm)	Days after application ¹					
	1		30		60	
	Active ingredient (g.ha ⁻¹) ²	Applied napropamide remaining (%)	Active ingredient (g.ha ⁻¹)	Applied napropamide remaining (%)	Active ingredient (g.ha ⁻¹)	Applied napropamide remaining (%)
0 – 50	641	23,7	624	23,1	608	22,5
50 – 100	292	10,8	73	2,7	97	3,6
100 – 150	0	0,0	32	1,2	0	0,0
150 – 300	0	0,0	0	0,0	0	0,0
Total	933	34,5	729	27,0	705	26,1
D-value (p ≤ 0,05)	154	–	162	–	194	–

¹ Total amount of water: Day 1 = 20 mm; Day 30 = 125,4 mm; Day 60 = 246,3 mm.

² Active ingredient (g.ha⁻¹) = mg.kg⁻¹ active ingredient measured by bio-assay x bulk density x volume of soil layer.ha⁻¹ x 10⁻³.

TABLE 6

The occurrence of oryzalin at different soil depths measured one day, 30 days and 60 days after application by a 20 mm herbigation on a sandy loam soil at the Nietvoorbij Experimental Farm in Stellenbosch.

Soil layer (mm)	Days after application ¹					
	1		30		60	
	Active ingredient (g.ha ⁻¹) ²	Applied oryzalin remaining (%)	Active ingredient (g.ha ⁻¹)	Applied oryzalin remaining (%)	Active ingredient (g.ha ⁻¹)	Applied oryzalin remaining (%)
0 – 50	502	21,8	567	24,7	202	8,8
50 – 100	251	10,9	162	7,0	89	3,9
100 – 150	8	0,3	0	0,0	0	0,0
150 – 300	0	0,0	0	0,0	0	0,0
Total	761	33,0	729	31,7	291	12,7
D-value (p ≤ 0,05)	105	–	154	–	40	–

¹ Total amount of water: Day 1 = 20 mm; Day 30 = 125,4 mm; Day 60 = 246,3 mm.

² Active ingredient (g.ha⁻¹) = mg.kg⁻¹ active ingredient measured by bio-assay x bulk density x volume of soil layer.ha⁻¹ x 10⁻³.

centration of 341 g ha⁻¹ present in the 0-50 mm soil layer, which amounts to only 11,4% of the dosage normally applied to a soil. However, after a period of 60 days and at a concentration of 49 g ha⁻¹ and 81 g l⁻¹ in the 0-50 mm and 50-100 mm soil layers, respectively (Table 3), the weeds were breaking through (Table 7). It seemed possible, therefore, that the amount of simazine registered for use in vineyards (3 kg of active ingredient per hectare), if applied more frequently but in smaller quantities, could enhance the control of the weed species identified by Fourie (1988). At a dissipation rate of 70%, two applications of 1,5 kg of simazine per hectare should keep the vineyard free of these weeds for a period of 60 days instead of 30 days (Table 7) under these unfavourable conditions, conducive to breakdown as well as leaching of the herbicide.

As far as oxadiazon is concerned, the level of control achieved did not change up to 60 days after application (Table 7), even though as little as 227 g.ha⁻¹ could be detected in the 0-50 mm soil layer at this time (Table 4). This shows that an acceptable level of weed control, with the dissipation rate of the herbicide not exceeding 78%, could be achieved with 1068 g of oxadiazon per hectare applied at monthly intervals. Although a split dosage will not lengthen the period of weed control, it reduces the concentration of the herbicide in the soil directly after application, thus lessening the impact it might have on the environment.

Although napropamide was persistent in the soil (Table 5), the efficacy of the herbicide seems to deteriorate with time. This can clearly be deduced from the fact that broad-leaf weeds were not controlled sufficiently (Fourie, 1988). The grass species, however, were controlled up to 90 days after application (Fourie, 1988), indicating that the herbicide could control the susceptible species for the duration of the season. It may, therefore, be possible to control grass species in the trial with as little as 0,9 kg of napropa-

mid per hectare, which is one third of the chemical used in the trial.

It is clear that 502 g.ha⁻¹ of oryzalin is necessary to control the grass species mentioned by Fourie (1988). This means that at a dissipation rate of approximately 60%, as measured in the 30 to 60 day period, these species can be controlled by a monthly application of 1,26 kg ha⁻¹.

TABLE 7

Pre-emergence weed control on a sandy loam soil 30 days and 60 days after application, measured as the number of weeds per m²*.

Treatment	Active ingredient (g.ha ⁻¹)	Days after application	
		30	60
		Weeds per m ²	Weeds per m ²
Control (C)	–	134	499
Oryzalin	2300	22	38
Napropamide	2700	3	18
Oxadiazon	1440	4	5
Simazine	3000	0	6
D-value (p ≤ 0,05)		4	129

* Data compiled from Fourie (1988).

CONCLUSIONS

It is suggested that microbial or chemical breakdown was mainly responsible for causing the loss of simazine from the sandy loam soil under the edaphic conditions prevalent in the trial, with leaching contributing towards the dissipation of the herbicide as well. With only 15% of the herbicide left in the 0-300 mm soil layer 60 days after application, the probability of a build-up in the soil is low. There is a strong indication that the efficacy of simazine on a sandy loam or even heavier soils under irrigation can be improved. This could be achieved by applying a split dosage at monthly intervals as opposed to the present situation in practice where a split dosage applied at a two- to three-month interval is advocated.

Oxadiazon dissipated rapidly from the sandy loam soil with microbial or chemical breakdown probably causing the loss of herbicide from the 0-300 mm soil layer. As in the case of simazine, a build up of oxadiazon in the soil is unlikely as only 17% of the herbicide could be detected in the 0-300 mm soil layer 60 days after application. Although leaching of oxadiazon did occur between soil layers, it could not be verified whether some of the chemical did migrate from the 0-300 mm zone. A monthly dosage of approximately 1 kg of active ingredient per hectare should ensure efficient weed control under circumstances similar to those of the trial.

Napropamide is much more persistent than simazine and oxadiazon in an irrigated sandy loam soil. Downward movement of napropamide occurred, but (as in the case of oxadiazon) it seems that no herbicide moved out of the 0-300 mm soil layer.

Oryzalin seems to be immobile in a sandy loam soil but, as in the case of oxadiazon and simazine, dissipated rapidly from the soil. Therefore, a build up of oryzalin in vineyard soils over time seems improbable.

As far as the irrigation directly after the application of the herbicide is concerned, the correct amount of water was used for napropamide and oryzalin. However, a reduction from 20 mm to 15 mm in the irrigation following the application of oxadiazon and simazine should improve the efficacy of these two herbicides. This amount of irrigation should serve as a guideline for medium-textured soils.

The use of the correct formulation of a specific herbicide is very important. The study confirmed that the use of wettable powders for herbigation is not desirable. This fact is underlined by the high application efficiency achieved with the oxadiazon solution.

The dissipation rate of simazine, napropamide, oxadiazon and oryzalin in an irrigated sandy or heavy clay soil, as well as the application of these herbicides by means of herbigation on the same soils, should be researched to supply guidelines for the practical use of this application technique in these vineyard soils. The application efficiency of simazine, napropamide and oryzalin applied as suspension concentrates through a microjet irrigation system should be evaluated as well.

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