Fosamine - a new brush control agent

J.G. Campion
Du Pont (Australia) Ltd.
P.O. Box 930, North Sydney 2060, New South Wales

SUMMARY

Fosamine - ammonium ethyl carbamoylphosphonate - is a new growth regulator, which has introduced a new concept for control of many undesirable brushwood species in the Northern Hemisphere and shows considerable promise for long-term control of problem woody weeds in Australia, including blackberry (*Rubus fruticosus* agg.), lantana (*Lantana camara*) sweet briar (*Rosa rubiginosa*) and other species.

Application prior to leaf senescence in susceptible deciduous species, e.g. *Malus* spp., *Prunus* spp., *Quercus* spp.) causes little if any visible effect on the foliage. Normal leaf drop occurs during autumn but bud and shoot development the following spring is either severely limited or is prevented.

A series of blackberry and sweet briar trials conducted in south-eastern Australia over four seasons has shown that applications of fosamine made in late summer to early autumn caused variable degrees of defoliation prior to the dormant winter period, while refoliation and growth in spring was limited, and was stunted and distorted. The die-back of original growth was noticeably faster in treated blackberry than in treated sweet briar, where distorted unthrifty leaf buds could still be observed 2 years after application. However, fosamine treated bushes did not appear to recover from the initial application. Regrowth, from crown buds of both blackberry and sweet briar has, in many cases, been effectively suppressed by a single application.

Good control was achieved with fosamine applied as a dilute spray, however treatment of blackberry, in particular, using a mist blower produced a much faster and more complete defoliation, a greater suppression of crown regrowth and, in overall terms, more reliable control.

Treatment of lantana in coastal and sub-coastal New South Wales during the late summer/autumn period using either a dilute spray or a mist blower application has often resulted in complete defoliation within 6 months and effective control of the bushes within 9 to 12 months of treatment.

INTRODUCTION

Fosamine is a new plant growth regulator developed by E.I. Du Pont de Nemours and first introduced to Australia in 1973. It is completely soluble in water and is available as a 48% w/v miscible liquid. Fosamine is non-flammable, non-volatile and only slightly corrosive to metals such as copper or brass if they are in continuous contact with the chemical e.g. spray equipment components. Being non-volatile the compound can be used in areas adjacent to sensitive crops without posing an undue vapour drift hazard. The compound has a very low acute and chronic oral toxicity, i.e. is not an eye irritant, a skin irritant, nor a skin sensitizer.

Fosamine has an acute oral LD_{50} (rat) of 10,200 mg/kg. A very favourable subacute oral toxicity is indicated by the fact that when groups of male and female rats were fed diets at rates up to 10,000 ppm for 90 days, no clinical and pathological changes attributable to the compound were detected and no adverse effect on the birth of offspring was noted.

The LD_{50} acute dermal (rabbit) is $>$1683 mg/kg, while wildlife toxicity data are as follows:-

bobwhite quail	- oral LD_{50}	$>$4200 mg/kg
mallard duck	- oral LD_{50}	$>$4200 mg/kg
rainbow trout	- TL_{50} (96 hrs)	$>$420 mg/ℓ
fathead minnow	- TL_{50} (96 hrs)	$>$420 mg/ℓ

In addition to low toxicity on aquatic fauna fosamine breaks down rapidly in water.

Fosamine is readily adsorbed by soil organic colloids having a Freundlich K equilibrium constant on Keyport silt loams of greater than 20. It is rapidly decomposed by soil micro-organisms and has a soil half-life of 1 to 3 weeks. Therefore this material is not likely to run-off into surface waters or leach into subterranean aquifers.

The product has been extensively tested in Europe and in the U.S.A. and has proven effective against a wide range of undesirable brush species (Neihuss and Roediger, 1974). Many of the species considered undesirable in the Northern Hemisphere and susceptible to fosamine have a pronounced deciduous habit, which contrasts with Australia where evergreen hardwoods dominate the tree flora and where some of the major woody weed species such as blackberry (*Rubus fruticosus* agg.) exhibit a semi-deciduous habit because of the absence of an adequate dormant period prior to bud break.

Patterns of absorption of the chemical by buds, foliage and stems and of its translocation within the plant have not been clearly defined. However, Richardson, (personal communication) working with C^{14} labelled fosamine, has found that the compound is quite systemic within the blackberry plant, moving rapidly from a fully expanded treated leaf into untreated leaf buds. On the other hand it is less rapidly translocated into the root system and plant crown.

In this paper the activity of fosamine on blackberry (*Rubus procerus* - also known as *Rubus discolor* and *R. ulmifolius* hybrids), lantana (*Lantana camara*) and sweet briar (*Rosa rubiginosa*) is reviewed.

METHODS AND MATERIALS

In 1973/74 exploratory screening trials on blackberry were conducted in Tasmania, New South Wales, Victoria and South Australia while sweet briar testing was initiated in Tasmania, New South Wales and Victoria. Hand gun equipment which applied between 2500 and 3000 ℓ total spray volume per ha at a pressure of approximately 1000 kPa was used in these experiments. Rates of fosamine tested varied between 0.25% w/v and 3.6% w/v of active ingredient. Plots were generally replicated four times and consisted of discreet thickets of well developed bushes. In this series of trials time of application varied from December through to July.

In the following seasons, 1975 and 1976, dosages in the range of 0.06% w/v to 0.48% w/v of active ingredient were compared as late summer to autumn treatments for blackberry control in an extensive series of replicated and demonstration trials throughout New South Wales, Victoria, Tasmania and South Australia.

Treatments were again applied as a drenching spray using low pressure (1000 kPa) hand gun equipment. In 1977 the same dosage range was tested both as a low pressure and high pressure (3500 to 4000 kPa) drenching spray and compared with concentrations of 4.8% w/v and 2.4% w/v of active ingredient applied through a "SOLO" mist blower. It should be emphasized that the majority of blackberry trials (and over 50 such trials have been carried out since 1973) have evaluated fosamine on *Rubus ulmifolius* hybrids, which are generally regarded as being harder to kill than *R. procerus* with commercially available brush-killers.

Lantana trials commenced in 1976. The dosage range has generally been higher i.e. 0.24% w/v to 0.96% w/v of active ingredient, than that tested in blackberry and sweet briar trials. Mist blower application at concentrations of 4.8% w/v and 2.4% w/v of active ingredient were tested during 1977.

Results were recorded at regular intervals during the first 12 months after application and, where appropriate, evaluation was continued into the second year. Assessments have been made on the basis of percentage effect on original growth using foliage reduction and cane or stem die back as parameters. In the case of regrowth, presence or absence was recorded and if present a qualitative description of regrowth was applied. Standard herbicides used at recommended rates included 2,4,5-T butyl ester and amitrole in the case of blackberry, amitrole and 2,4-D amine in lantana trials and picloram in sweet briar evaluations.

RESULTS AND DISCUSSION

A rate of 0.48% w/v of fosamine applied as a drenching spray through conventional hand gun equipment has provided reliable control of blackberry, lantana and sweet briar over a range of test sites throughout south-eastern Australia (Tables 1 and 2). Lower rates i.e. 0.24% w/v have provided only partial defoliation and have permitted unacceptable levels of regrowth from original stems or canes and in general have not provided any better suppression of crown or rhizome shoot initiation than the reference herbicides such as 2,4,5-T, amitrole, 2,4-D amine and picloram. However, under ideal growth conditions and optimum spray timing, a 0.24% w/v doage has given slow but acceptable control of lantana within a 12 month period. Applications of fosamine at 2.4% w/v and 4.8% w/v of active ingredient using mist blower equipment have provided a more rapid and complete defoliation of blackberry and lantana than have the conventional methods. Again the higher concentration, namely 4.8% w/v. has provided a more reliable defoliation over the range of trial situations.

In Australia the results and trends with fosamine application have in general been consistent with the findings overseas in as much as the chemical has been effective on certain deciduous/semi-deciduous species. In the case of blackberry the best control has been achieved by applying after the main berry set but before leaf senescence. In most regions this has normally coincided with the February-March period. It is suggested that application made during the period when there is maximum downward translocation of phytosynthates to the auxiliary leaf buds on the canes and to the crown and roots of the blackberry plant, is the preferred timing, as this would also tend to concentrate active ingredient in these organs. It would appear therefore that in February-March prevailing climatic conditions are normally more conducive for a better translocation of fosamine to the various sites of action.

The timing of application for lantana appears to be less critical than that for blackberry and plants treated from March through to May have been effectively controlled (see Table 2). It must, however, be pointed out that best results for a given rate of fosamine have coincided with the main autumn flowering period.

The field trials in Australia have shown that optimum results with fosamine are obtained if the chemical is applied under conditions of relatively high temperatures and humidity and good soil moisture. Under such conditions leaf and bud absorption appear to be maximized. Conversely, low temperatures and dry conditions do not seem to allow sufficient fosamine to penetrate plant tissue to provide satisfactory results.

In this respect target species growing in shaded sites have shown a better response to fosamine in our trials than those growing in exposed sites, presumably due to a more rapid foliar absorption under such conditions. Again, treatments applied to wet foliage or on days when rain has occurred soon after application have been noticeably ineffective even at higher rates. It must be assumed in these instances that either rainfall or run-off has prevented adequate absorption of the fosamine into the plant tissue. There are insufficient basic data available to recommend a precise rain-free post spray period but as a guide based on our experience fosamine should not be applied when rainfall is expected within 24 hours.

With blackberries, lantana and sweet briar defoliation and stem or cane bie-back have occurred more quickly in areas where good growing conditions have prevailed i.e. an evenly distributed rainfall, adequate soil fertility and a relatively warm and humid growing season. It would appear that the activity of fosamine increases with increasing plant vigour, both in terms of foliar effect and suppression of regrowth. On the other hand where plant growth is slow and 'hardened' due to moisture stress, poor soil fertility or a combination of factors, fosamine generally gives a poorer control. It has also been observed that partial defoliation by animals or man after application can adversely effect results, presumably by disrupting the translocation of the compound within the plant.

Spray coverage appears to be vital and so thorough leaf wetting is essential for best results. In Australia, little attempt has been made to compare various rates of surfactants or wetting agents but based on overseas experience 0.25% v/v of a recommended surfactant has been added to fosamine treatments. Tween 20[+] and Triton X-100[++] appear to be two of the commercially available surfactants in Australia which are not antagonistic to fosamine and which could be recommended as a wetter additive in this country. Summer spraying oils and foam sprays have been tested as possible alternatives to the conventional surfactant materials but have not improved the bioefficacy of fosamine and in the case of the foam spray have actually reduced the level of brush control obtained.

The Australian field experience suggests that in addition to spray timing, droplet size of the applied spray and coverage of the target species will be vital factors in the successful use of fosamine as a brush control agent in this country. It would appear from these trials at least, that fine and more concentrated droplets of fosamine give better initial effect and more effectively prevent crown regrowth.

CONCLUSION

In Australia, growth patterns of blackberries, lantana and sweet briar vary from area to area and within areas due to climate, rainfall, soil type and other factors. As a result, the control with fosamine has shown some variance from site to site. It is therefore suggested that a thorough understanding of the local conditions in relation to the phasic growth of the target species will be most important if consistent results with fosamine are to be obtained from year to year.

It might be pertinent to mention here that variability in fosamine efficacy on blackberry might be due in some measure to the biotype problem occurring in the *Rubus fruticosus* agg.

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REFERENCES

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++ Rohm and Haas Aust. Pty.Ltd.

Table 1. Fosamine - effect of time of application and method of application on blackberry (*R. ulmifolius hybrid*) control.

7 months post-treatment - Dural, N.S.W., 1977

TREATMENTS	DATE OF APPLIC.	METHOD OF APPLICATION														
		HAND GUN 1000 kPa			HAND GUN 2000 kPa			HAND GUN 3500 kPa			MISTING MACH. FLOW SETTING 2			MISTING MACH. FLOW SETTING 3		
		F.R.	CD	C.R.	F.R.	CD	C.R.	F.R.	CD	C.R.	F.R.	CD	C.R.	F.R.	CD	C.R.
FOSAMINE 0.24% ai	18/3/77	95	63	+	99	63	+									
	13/4/77	88	50	+				88	50	+						
FOSAMINE 0.48% ai	18/3/77	99	63	+	99	63	-									
	13/4/77	97	63	-				96	63	-						
FOSAMINE 2.4% ai	18/3/77													100	88	+
	13/4/77										99	75	+			
FOSAMINE 4.8% ai	18/3/77													100	88	-
	13/4/77										98	63	+			
2,4,5-T BUTYL ESTER 0.1%	18/3/77	100	75	++	100	75	+									
	13/4/77	100	88	-				100	88	++						
2,4,5-T BUTYL ESTER 1.0%	18/3/77													100	88	++
	13/4/77										100	88	++			
UNTREATED CONTROL	18/3/77	38	25	+	38	25	+	38	25	+	38	25	+	38	25	+
	13/4/77	25	13	+	25	12	+	25	13	+	25	13	+	25	13	+

F.R. = FOLIAR REDUCTION %
CD = CANE DIEBACK %
C.R. = CROWN REGROWTH

\- = ABSENT
\+ = RARE
++ = COMMON
+++ = FREQUENT

Non-ionic agricultural surfactant at 0.125% v/v added to all herbicide treatments

Table 2. Fosamine - effect of application rate and time of application on lantana (*Lantana camara*) control in New South Wales

LOCATION / TIME OF APPLICATION / ELAPSED TIME	TREATMENTS +											
	FOSAMINE 0.24% ai		FOSAMINE 0.48% ai		FOSAMINE 0.96% ai		AMITROLE 0.227% ai		2,4-D AMINE (See below)		UNTREATED CONTROL	
	F.R.	SD	F.R.	SD	F.R.	SD	F.R.	SD	F.R.	SD	F.R.	SD
DEE WHY, NSW 22/3/76 13½ MONTHS	100	88	100	100	100	75	0	13	-	-	0	0
SEAFORTH, NSW 23/3/76 17½ MONTHS	50	25	80	50	95	63	45	13	-	-	0	0
CASTLE HILL, NSW * 14/4/76 11 MONTHS	80	13	99	63	100	88	70	13	-	-	0	0
ERARING, NSW 26/4/76 7 MONTHS	91	13	100	63	100	88	50	13	-	-	0	13
PATERSON, NSW ** 27/4/76 12 MONTHS	5	13	15	13	36	25	5	13	-	-	10	13
GRAFTON, NSW 5/5/76 11 MONTHS	54	25	99	50	100	88	-	-	+1.25% ai 95	88	4	0
COFFS HARBOUR, NSW 6/5/76 11 MONTHS	80		99		100		-	-	0.31% ai 70	88	5	0

F.R. = FOLIAR REDUCTION
S.D. = STEM DIEBACK

* Lantana in flower and fruiting at time of application
** Small bushes, heavily grazed by cattle

+ Non-ionic agricultural surfactant at 0.125% v/v added to all herbicide treatments