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A FURTHER STUDY OF THE EFFECT OF SIX CEREAL HERBICIDE TREATMENTS ON A RANGE OF BROAD-LEAVED FIELD MARGIN PLANTS

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NOTE

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A FURTHER STUDY OF THE EFFECT OF SIX CEREAL HERBICIDE TREATMENTS ON A RANGE OF BROAD-LEAVED FIELD MARGIN PLANTS.

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SUMMARY

Six herbicide treatments; mecoprop, ioxynil+bromoxynil, isoproturon, clopyralid, diclofop-methyl and chlorsulfuron were applied to a range of broad-leaved plants common to field margins.

Results were obtained at two dates, five and fifteen weeks after treatment. Many species which were significantly reduced in comparison to the untreated control after five weeks recovered by the end of the assessment period.

With the exception of *Lamium album* (white dead nettle) mecoprop affected all species, causing severe stunting in some cases, at five weeks after treatment. *Anthriscus sylvestris* (cow parsley) recovered from all but one of the herbicide treatments, chlorsulfuron, indicating that under field conditions some perennial species may survive a single application of certain herbicides.

INTRODUCTION

Ideally a cereal field margin would consist of a strip of land, adjacent to the field boundary, 1-2 metres wide containing a permanent ground cover of a range of non-invasive perennial plants typical of uncropped habitats. It would not only be pleasing to look at but serve as a sanctuary and feeding ground for other farmland wildlife. The effect of the strip would be to act as a barrier in which the habitat available to potentially troublesome annual species, e.g. sterile brome, is restricted. It would also offer some protection to hedgebottom species from accidental drift of herbicides and fertiliser.

It is generally accepted that the field edge flora of arable fields may be influenced by agricultural inputs within the crop. In particular herbicide and possibly fertiliser applications.

A research project to investigate the susceptibility of field margin plants to agrochemicals, funded by the Perry Foundation, is being done at the Weed Research Division. This report describes further evaluation of a range of broad-leaved field edge species to commonly applied arable herbicides. It is hoped that the information generated by this project will provide a basis for further study aimed at achieving the 'ideal' field edge and in the short term inform the users of agrochemicals of the potential damage that can be inflicted on non-target plant species inhabiting farmland.

METHOD

Details of the species investigated are given in Table 1. Those species raised from seed were germinated on peatblocks in an unheated glasshouse. The seedlings were subsequently transplanted into a sandy loam soil and moved outdoors (Birnie,1984).

Plant material was collected from field edges throughout the spring at both Begbroke Hill farm and Boxworth E.H.F. near Cambridge. All species were transplanted into 18 cm diameter pots on the 9 May 1984, at a density of one plant/pot using the same soil mixture as described previously (Birnie,1984).

Difficulty in obtaining sufficient numbers of each species meant that not all of the herbicide treatments were applied to all species. Treatment details are given in Table 2. Table 3. describes the growth stage of each species at the time of herbicide application.

Table 1. Species list and origin of plant material.

Common name	Latin name	Source Seed	Source Field
Broad-leaved dock	Rumex obtusifolius L.	*	
Cow parsley	Anthriscus sylvestris(L.)Hoffm		*
Creeping buttercup	Ranunculus repens L.		*
Creeping thistle	Cirsium arvense(L.)Scop.		*
Field bindweed	Convolvulus arvensis L.	*	
Hemlock	Conium maculatum L.		*
Perforate St Johns Wort	Hypericum perforatum L.	*	
Red-veined dock	Rumex sanguineus L.		*
Small flowered cranesbill	Geranium pusillum L.		*
Smooth tare	Vicia tetrasperma(L.)Schreber	*	
Stinging nettle	Urtica dioica L.		*
Welted thistle	Carduus acanthoides L.		*
White campion	Silene alba (Miller)	*	
Wild white clover	Trifolium repens L.	*	
White dead nettle	Lamium album L.		*
Yarrow	Achillea millefolium L.		*

Table 2. Treatment details
* indicates herbicide treatment applied

Herbicide treatments	mecoprop	ioxynil + bromoxynil	isoproturon	clopyralid	diclofop - methyl	chlorsulfuron
Dose rate kg a.i./ha (kg a.e./ha)	2.40	0.76	1.88	(0.20)	1.14	0.02
Species						
A.millefolium	*	*	*	*	*	*
A.sylvestris	*	*	*	*	*	*
C.acanthiodes	*	*				
C.maculatum	*	*	*	*	*	*
C.arvense	*	*	*	*	*	*
C.arvensis	*					
G.pusillum	*	*	*	*	*	*
H.perforatum	*	*	*	*	*	*
L.album	*	*		*		
R.repens	*	*	*	*	*	*
R.obtusifolius	*	*		*		
R.sanguineus	*	*	*	*	*	
S.alba	*	*	*	*	*	
T.repens	*	*		*		
V.tetrasperma	*	*	*	*		
U.dioica	*	*	*	*	*	*

Table 3. Growth stage of plant species at time of treatment.

Species	Growth stage
Achillea millefolium	mature rosette
Anthriscus sylvestris	8 leaves
Carduus acanthiodes	mature rosette
Conium maculatum	6 leaves
Cirsium arvense	10cm (height)
Convolvulus arvensis	pre-flowering
Geranium pusillum	flowering
Hypericum perforatum	3 branches
Lamium album	flowering
Ranunculus repens	flowering
Rumex obtusifolius	13 leaves
Rumex sanguineus	20cm (height)
Silene alba	flowering
Trifolium repens	pre-flowering
Vicia tetrasperma	4 branches
Urtica dioica	22cm (height)

Treatments were applied on the 5 June 1984 using a laboratory pot sprayer fitted with a single Spraying Systems 8004 tee-jet nozzle at a pressure of 210 kPa, delivering a measured volume rate of 212 l/ha at 30 cm above ground level. The volume rate was measured using the method described by Taylor and Richardson (1972).

Relative humidity at the time of treatment was 77%; the maximum and minimum temperatures were 19.4 and 8.7 ^{o}C respectively

A simple scoring system on a 0-9 scale (Birnie,1984), was used to monitor herbicide damage. Assessments were made at weekly intervals for a period of eight weeks and thereafter at two weekly intervals up to fifteen weeks after treatment.

At six weeks after treatment, two species, creeping buttercup and small flowered cranesbill, became senescent. They are not, therefore, included in the results obtained at fifteen weeks after spraying.

RESULTS AND DISCUSSION

The assessment data were subjected to analyses of variance. The data obtained at five weeks and fifteen weeks after treatment are presented in Table 5 and 6 respectively.

The effect of individual herbicide treatments on each plant species is described in the appendix at the back of the report.

Mecoprop:

($\pm$)-2-(4-chloro-2-methylphenoxy) propionic acid.

Mecoprop is a systemic hormone-type herbicide (Pesticide Manual, 1983) which is used for the control of broad-leaved weeds in a variety of crops.

In the first trial mecoprop damaged a wide range of plants (Birnie, 1984). In this experiment all species with the exception of white dead nettle were significantly reduced in vigor in comparison with the unsprayed control.

Only three species made a significant recovery over the assessment period; perforate St John's wort, broad-leaved dock and white clover. Hemlock, welted thistle and white campion were killed. Of the other species cow parsley made a slight recovery.

Ioxynil + bromoxynil:

4-hydroxy-3,5-di-iodobenzonitrile + 3,5-dibromo-4-hydroxybenzonitrile

Ioxynil + bromoxynil are both contact herbicides which inhibit photosynthesis (Pesticide Manual, 1983). This mixture is widely used to control seedling broad-leaved weeds.

Both white clover and broad-leaved dock were completely unaffected by this treatment. It is not recommended for use in white clover, which is usually sensitive (MAFF, 1983). However, the plants treated in this experiment were well established, which may account for the absence of herbicide damage.

Welted thistle was highly sensitive and died within five weeks of treatment. Other species which deteriorated over the assessment period were; hemlock, white deadnettle, smooth tare and perforate St Johns wort. By fifteen weeks after treatment eight species; yarrow, cow parsley, creeping thistle, red veined dock, broad-leaved dock, white campion, white clover and stinging nettle had recovered.

Isoproturon:

(N) -(4-isopropylphenyl)-N,N-dimethylurea

Isoproturon is used to control both annual grasses and some broad-leaved weeds in winter barley, rye and wheat either pre or post-emergence of the crop (MAFF, 1985).

With the exception of smooth tare and small flowered cranesbill all species were significantly damaged compared to the unsprayed control five weeks after treatment.

Though perforate St John's wort and red-veined dock made some recovery over the assessment period they were still more damaged than cow parsley and smooth tare at fifteen weeks after treatment. Two of the species most severely damaged ,yarrow and creeping thistle, are members of the Compositae; it is interesting to note that the only broad-leaved species which was significantly reduced in vigour in the previous experiment (Birnie, 1984), was ox-eye daisy, also a composite. This sensitivity may be a result of lack of a well developed root/rhizome system at the time of treatment.

Clopyralid:

3,6-dicloropyradine-2-carboxylic acid.

This chemical is selective in graminaceous crops affecting compositae, leguminosae and umbelliferae (Pesticide Manual, 1983).

The species which were most severely affected were; the compositae (yarrow, welted thistle and creeping thistle) and the leguminosae (white clover and smooth tare). Though cow parsley and hemlock, umbelliferae, were significantly reduced in vigour compared to the unsprayed control at five weeks, cow parsley made a marked recovery over the following weeks.

Stinging nettle and red veined dock made some recovery during the assessment period whereas broad-leaved dock, white campion and perforate St Johns Wort deteriorated slightly. White dead nettle was not affected by this chemical.

Five weeks after treatment creeping buttercup was only slightly reduced in vigor, though significantly in comparison to the unsprayed control, small flowered cranesbill was not significantly damaged.

Diclofop-methyl:

methyl 2-[4-(2,4-diclorophenoxy) phenoxy] propionate.

This grass specific herbicide, absorbed by both roots and shoots, can be used in a variety of crops including wheat, oilseed rape, beans and peas (Hoechst; 1984).

None of the species treated in this experiment were severely damaged. Hemlock, perforate St John's wort, white campion and cow parsley were, however, reduced in vigour compared to the untreated control. At fifteen weeks after treatment, although there was no statistically significant damage between any of the species or between treated and untreated, the treated white campion died back much more quickly than the untreated control.

Chlorsulfuron:

(N)-(2-chlorobenzenesulphonyl)-N-(4-methoxy-6-methyl-1,3,5-triazin-1-yl) urea

Chlorsulfuron is used in mixture with other chemicals to control broad-leaved weeds in cereals, inhibiting cell division in the roots and shoots of susceptible species (Pesticide Manual, 1983).

All species treated were significantly reduced in vigour compared to the untreated control at five and fifteen weeks after treatment. Though stinging nettle and yarrow had recovered slightly at fifteen weeks they were still significantly damaged.

A wider range of field margin species should be screened against this chemical and its analogue metsulfuron-methyl, both of which are commercially available.

Table 4. Field margin species severely damaged by herbicide treatment at fifteen weeks.

Chemical treatment	Species with a final score of 4 or less
mecoprop	Welted thistle Hemlock White campion Smooth tare Stinging nettle Red Veined dock Creeping buttercup Creeping thistle Field bindweed
ioxynil + bromoxynil	Welted thistle Hemlock
isoproturon	Yarrow Creeping thistle Stinging nettle White campion Hemlock Creeping buttercup Red Veined dock
clopyralid	Yarrow Welted thistle Creeping thistle White clover Smooth tare
diclofop-methyl	-
chlorsulfuron	Cow parsley Creeping thistle Creeping buttercup Small flowered cranesbill Yarrow

CONCLUSION

The survival of both biennial and perennial species after herbicide treatment is dependent on many factors eg. mode of action of the chemical used, species growth stage, growing conditions etc.

In particular the ability of a species to recover from herbicide application appears to be linked to both the possession of an underground storage organ for example tap root or rhizome and the ease with which some chemicals are translocated within the plant.

Under field conditions even deliberate herbicide application may not kill a species. This is borne out by previous work at the Weed Research Organization investigating the control of perennial weeds in amenity plantings, where creeping thistle is particularly difficult to eradicate due to its extensive creeping root systems (Bailey,1980).

In this trial no treatment was safe to all species investigated. Indeed mecoprop damaged all species. Although not all effects were statistically significant, even transient scorch or deformity is unacceptable where visual attractiveness of field edge plants is important. No single species was tolerant to every herbicide treatment, though some, Rumex spp. were generally fairly tolerant to most. This contrasts with the previous trial in which both common couch and sterile brome were unaffected by the same range of herbicide treatments (Birnie,1984).

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TABLE 5. The susceptibility of field margin species to six herbicides at five weeks after treatment. Species in *italics* are significantly reduced in vigor compared to the unsprayed control. Mean score values in parenthesis 9 = control 0 = complete kill.

mecoprop		ioxynil + bromoxynil		isoproturon		clopyralid		diclofop-methyl		chlorsulfuron	
C.acanthoides	(0.0)	*C.acanthioides*	(0.0)	*A.millefolium*	(0.0)	*C.acanthoides*	(0.0)	*C.maculatum*	(8.0)	*G.pusillum*	(1.0)
R.repens	(0.0)	*C.maculatum*	(4.5)	*C.arvense*	(0.0)	*V.tetrasperma*	(0.0)	*H.perforatum*	(8.0)	*A.sylvestris*	(2.0)
S.alba	(0.0)	*L.album*	(5.0)	*R.sanguineus*	(0.0)	*C.arvense*	(1.0)	*S.alba*	(8.0)	*R.repens*	(2.0)
C.maculatum	(1.0)	*R.sanguineus*	(6.0)	*U.dioica*	(0.0)	*T.repens*	(2.0)	*A.sylvestris*	(8.5)	*U.dioica*	(2.5)
V.tetrasperma	(1.0)	*C.arvense*	(7.0)	*R.repens*	(1.5)	*A.millefolium*	(3.0)	A.millefolium	(9.0)	*A.millefolium*	(3.0)
C.arvensis	(1.5)	*R.repens*	(7.0)	*C.maculatum*	(2.5)	*U.dioica*	(3.0)	C.arvense	(9.0)	*C.arvense*	(3.0)
A.sylvestris	(2.5)	*A.sylvestris*	(7.5)	*S.alba*	(2.5)	*A.sylvestris*	(4.5)	G.pusillum	(9.0)		
R.obtusifolius	(3.0)	*A.millefolium*	(8.0)	*H.perforatum*	(3.5)	*C.maculatum*	(5.0)	R.repens	(9.0)		
U.dioica	(3.0)	*S.alba*	(8.0)	*A.sylvestris*	(6.5)	*R.repens*	(5.0)	R.sanguineus	(9.0)		
A.millefolium	*(4.0)*	*U.dioica*	(8.0)	V.tetrasperma	(7.5)	*R.sanguineus*	(5.5)	U.dioica	(9.0)		
C.arvense	(4.0)	G.pusillum	(8.5)	G.pusillum	(8.5)	*H.performatum*	(7.0)				
R.sanguineus	(4.5)	H.perforatum	(9.0)			*S.alba*	(7.0)				
T.repens	(4.5)	R.obtusifolius	(9.0)			R.obtusifolius	(8.0)				
G.pusillum	(5.5)	T.repens	(9.0)			G.pusillum	(8.5)				
H.perforatum	(6.5)	V.tetrasperma	(9.0)			L.album	(9.0)				
L.album	(8.0)										
LSD treated x control	1.23		0.54		1.83		1.03		0.31		2.0
LSD between species	3.69		2.09		4.50		3.97		N.S.		N.S.

N.S. = no significant difference.

TABLE 6. The susceptibility of field margin species to six herbicides at fifteen weeks after treatment. Species in *italics* are significantly reduced in vigor compared to the unsprayed control. Mean score values in parenthesis 9 = control 0 = complete kill.

mecoprop		ioxynil + bromoxynil		isoproturon		clopyralid		diclofop-methyl		chlorsulfuron	
C.acanthoides	(0.0)	*C.acanthoides*	(0.0)	*A.millefolium*	(0.0)	*A.millefolium*	(0.0)	S.alba	(5.5)	*A.sylvestris*	(1.0)
C.maculatum	(0.0)	*C.maculatum*	(1.5)	*C.arvense*	(0.0)	*C.acanthoides*	(0.0)	A.millefolium	(8.5)	*C.arvense*	(2.5)
S.alba	(0.0)	*V.tetrasperma*	(4.5)	*U.dioica*	(0.0)	*C.arvense*	(0.0)	C.maculatum	(8.5)	*A.millefolium*	(4.0)
C.arvense	(1.0)	*L.album*	(6.5)	*S.alba*	(1.5)	*T.repens*	(0.0)	H.perforatum	(8.5)	*U.dioica*	(5.0)
V.tetrasperma	(1.0)	*H.perforatum*	(7.0)	*C.maculatum*	(2.5)	*V.tetrasperma*	(0.0)	A.sylvestris	(9.0)		
U.dioica	(3.0)	A.sylvestris	(8.0)	*R.sanguineus*	(3.0)	*C.maculatum*	(5.0)	C.arvense	(9.0)		
R.sanguineus	(3.5)	A.millefolium	(9.0)	*H.perforatum*	(4.5)	*R.obtusifolius*	(5.5)	R.sanguineus	(9.0)		
C.arvensis	(3.5)	C.arvense	(9.0)	A.sylvestris	(8.5)	*S.alba*	(5.5)	U.dioica	(9.0)		
A.millefolium	(4.5)	R.sanguineus	(9.0)	V.tetrasperma	(8.5)	*U.dioica*	(5.5)				
A.sylvestris	(6.5)	R.obtusifolius	(9.0)			*H.perforatum*	(6.0)				
H.perforatum	(8.5)	S.alba	(9.0)			A.sylvestris	(8.0)				
L.album	(8.5)	T.repens	(9.0)			R.sanguineus	(8.0)				
R.obtusifolius	(9.0)	U.dioica	(9.0)			L.album	(8.0)				
T.repens	(9.0)										
L.S.O. treated x control	1.84		1.42		2.52		1.45		N.S.		3.27
L.S.O. between species	5.16		5.11		4.02		5.24		N.S.		N.S.

N.S. = no significant difference.

APPENDIX

The effect of various herbicide treatments on a range of field margin flora. Effects were scored on a 0 - 9 scale 0 = kill, 9 = as control. Assessments were made over a period of fifteen weeks after treatment.

FIGURE 1. *Ranunculus repens*

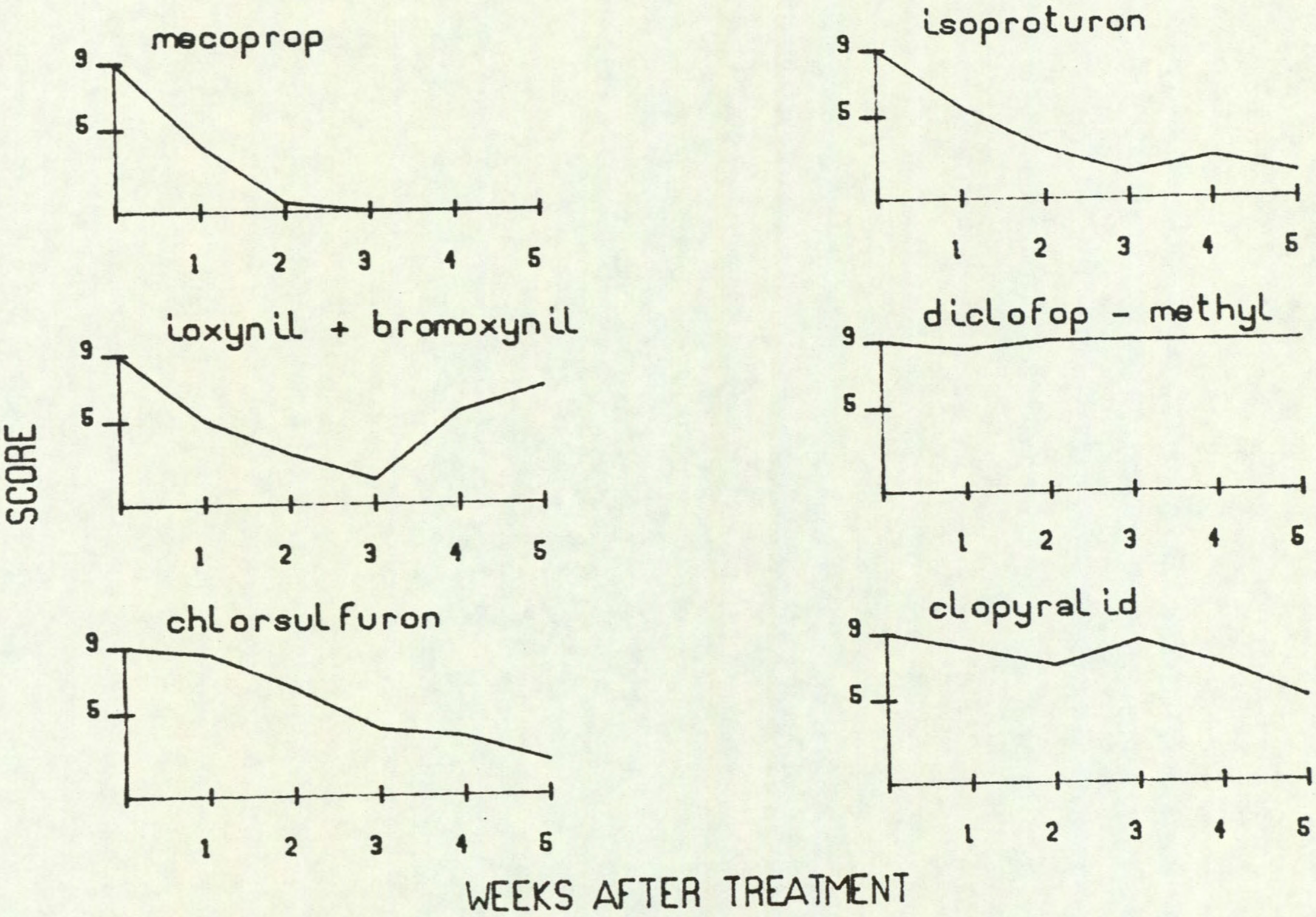


FIGURE 2 *Geranium pusillum*

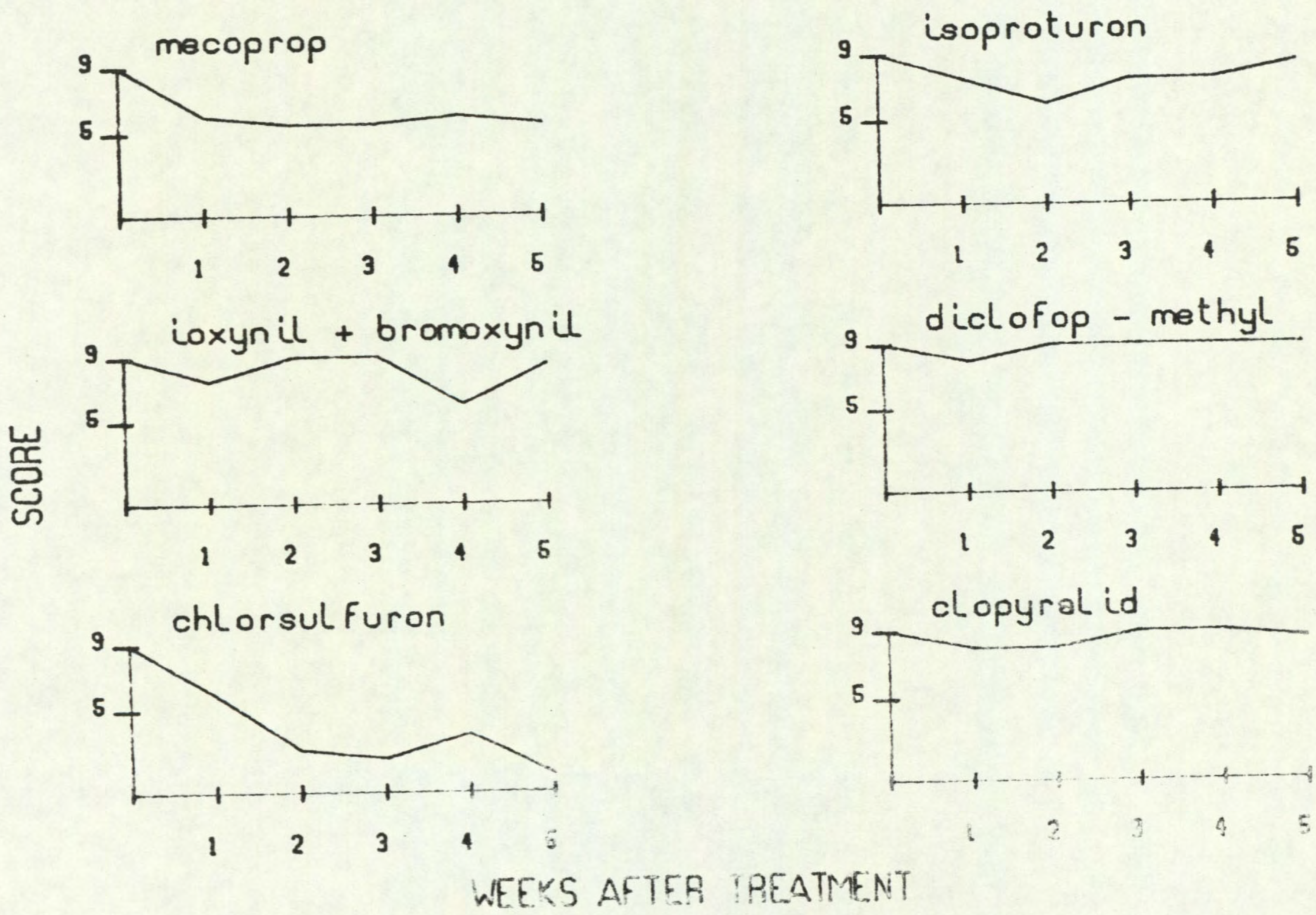


FIGURE 3. Achillea millefolium

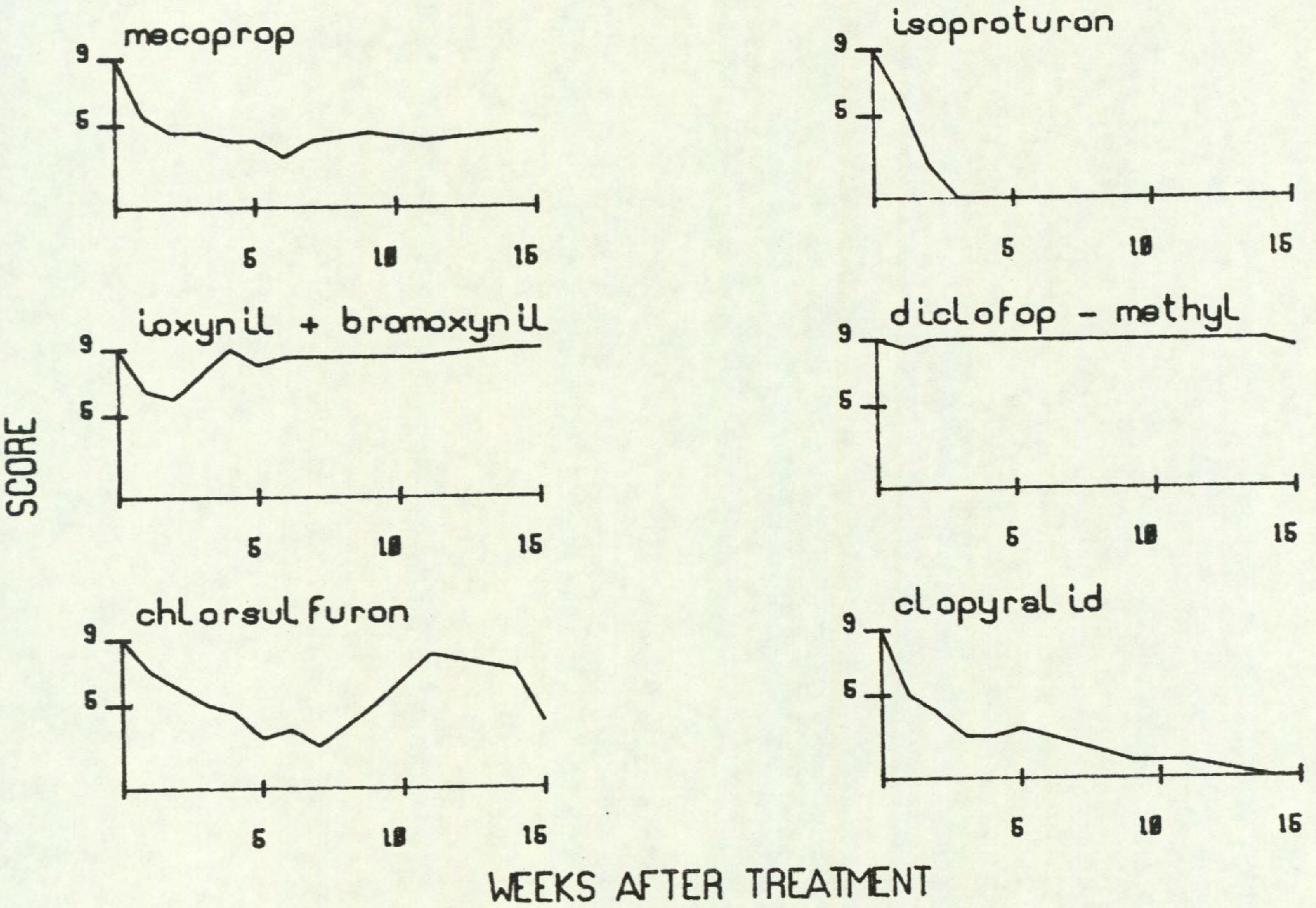


FIGURE 4. Anthriscus sylvestris

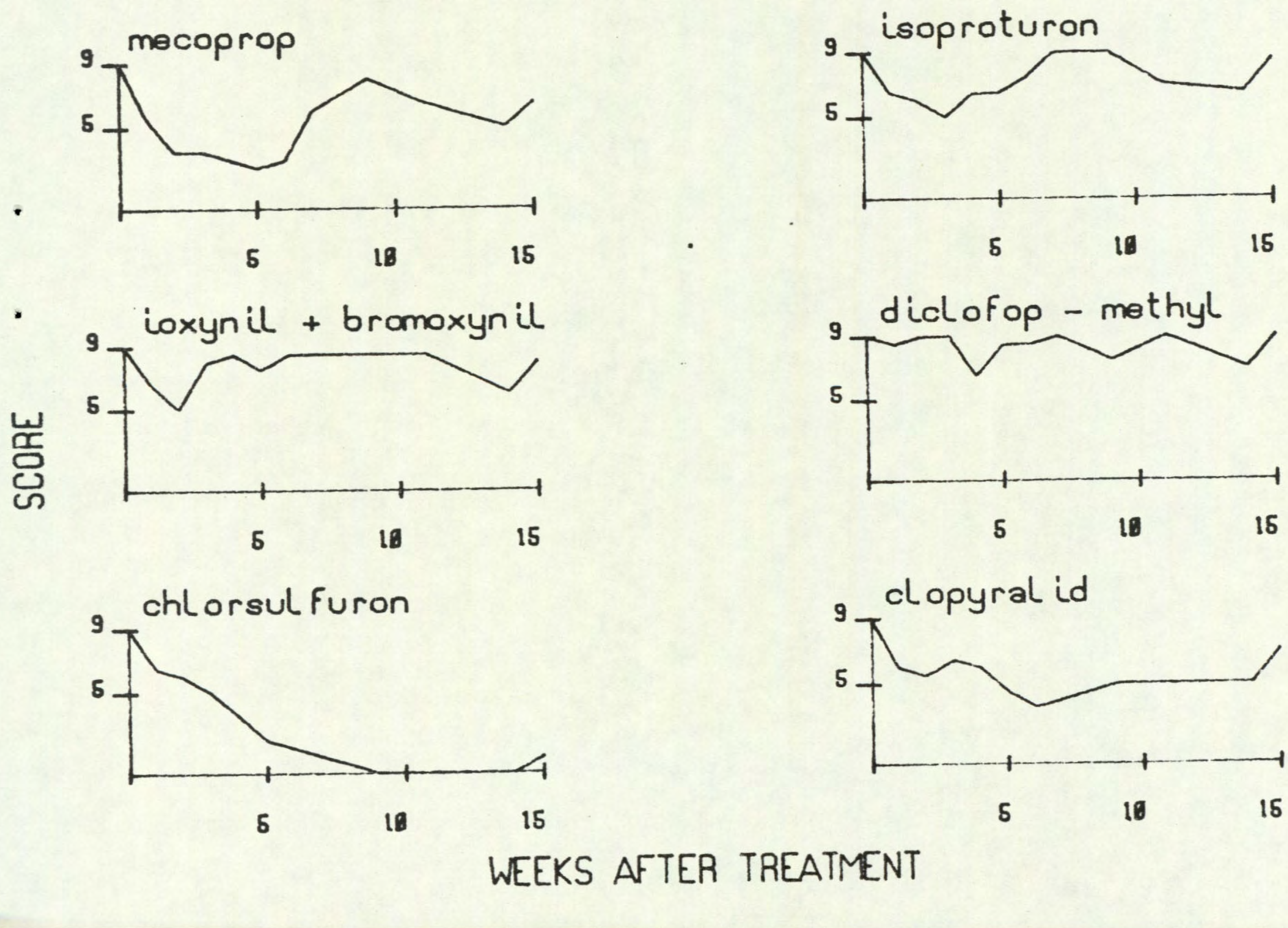


FIGURE 5. Cirsium arvense

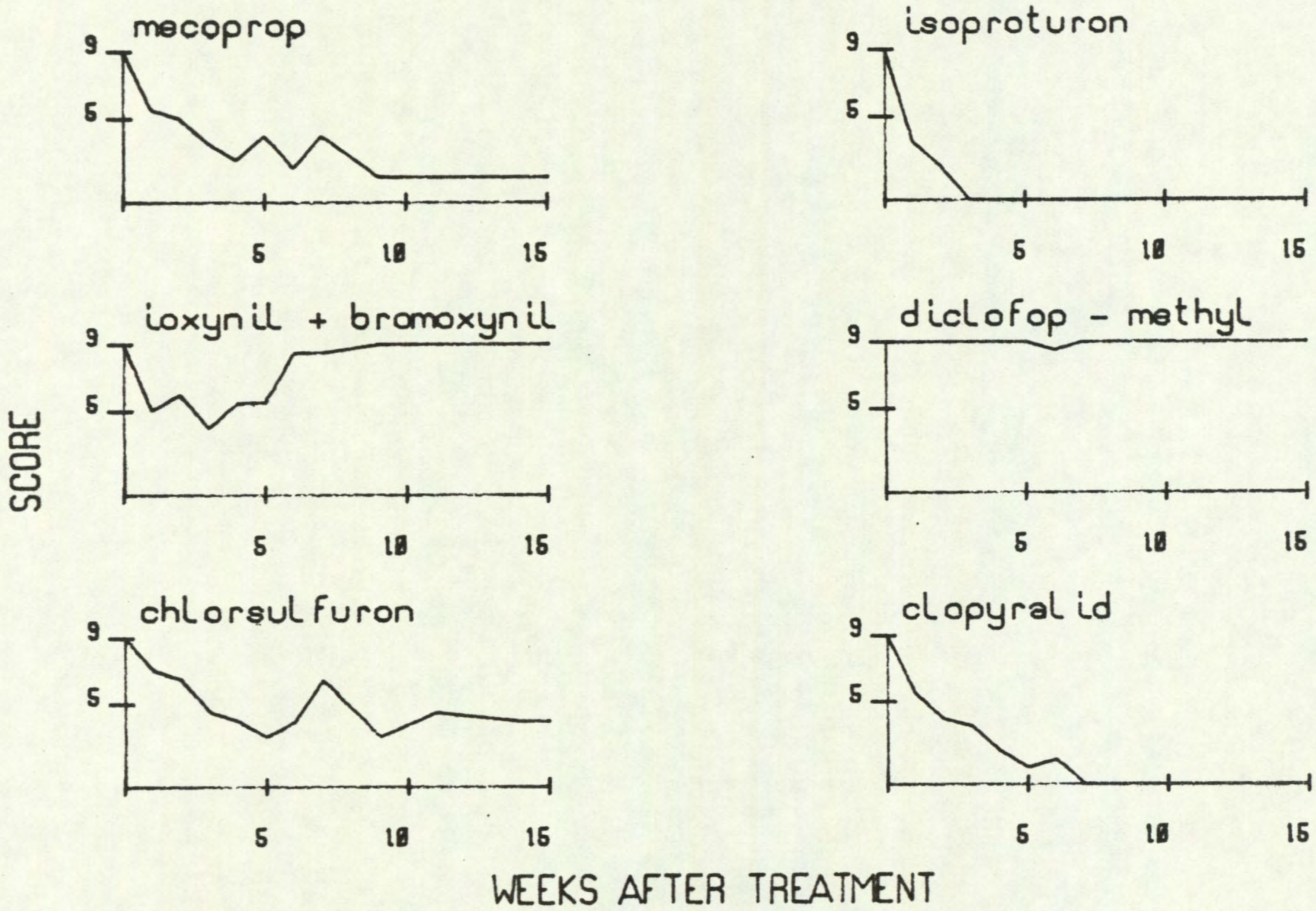


FIGURE 6. Urtica dioica

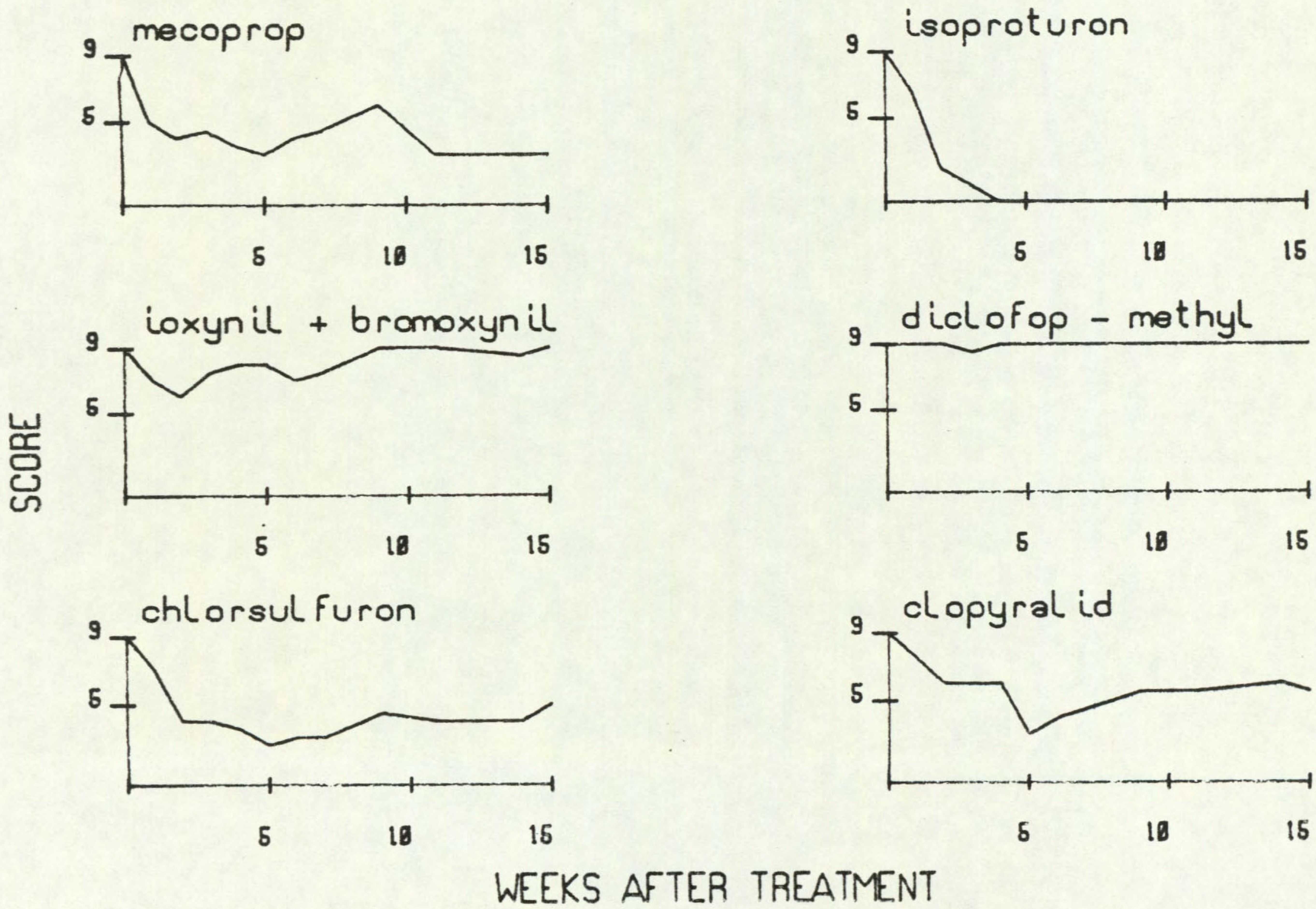


FIGURE 7. Conium maculatum

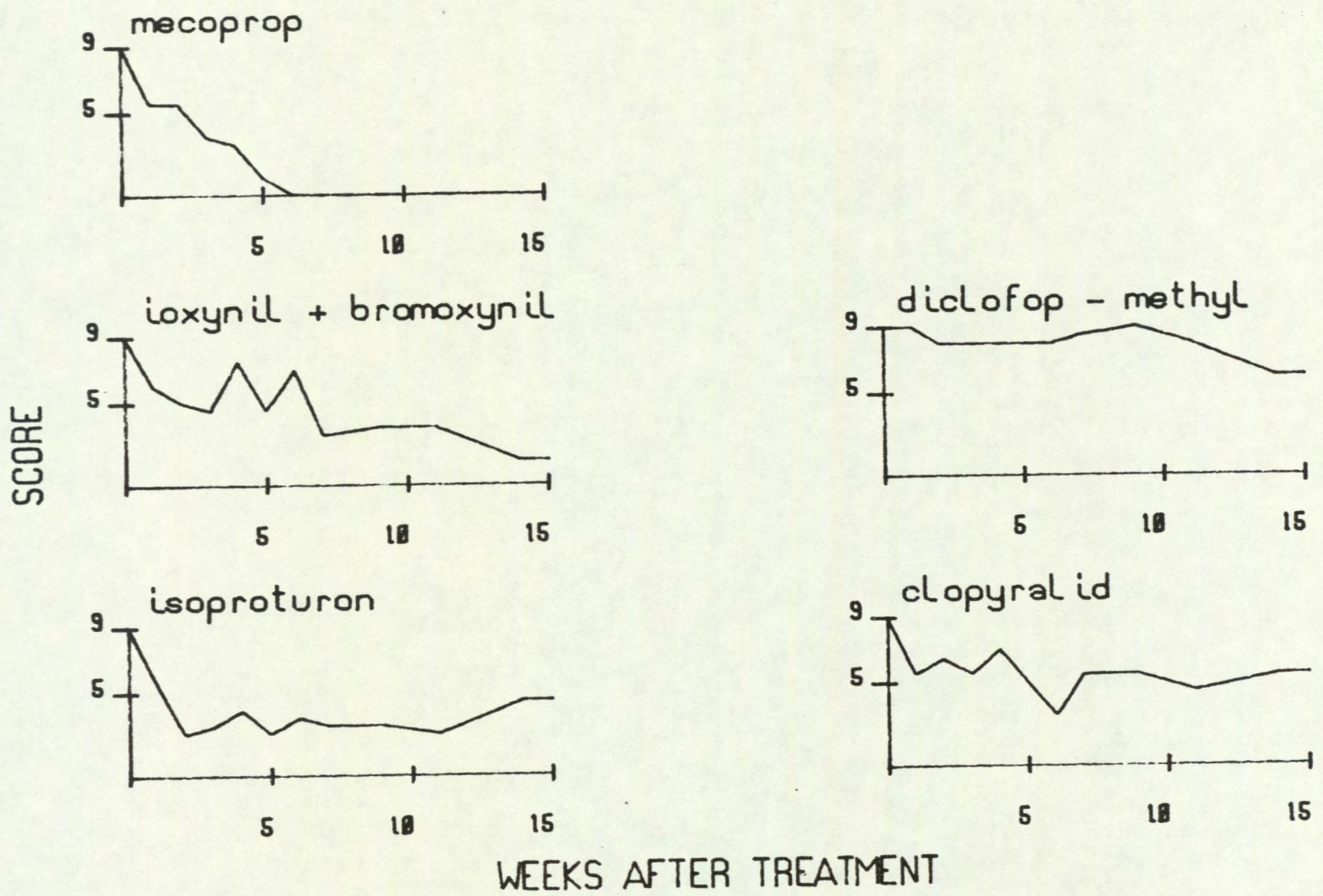


FIGURE 8. Hypericum perforatum

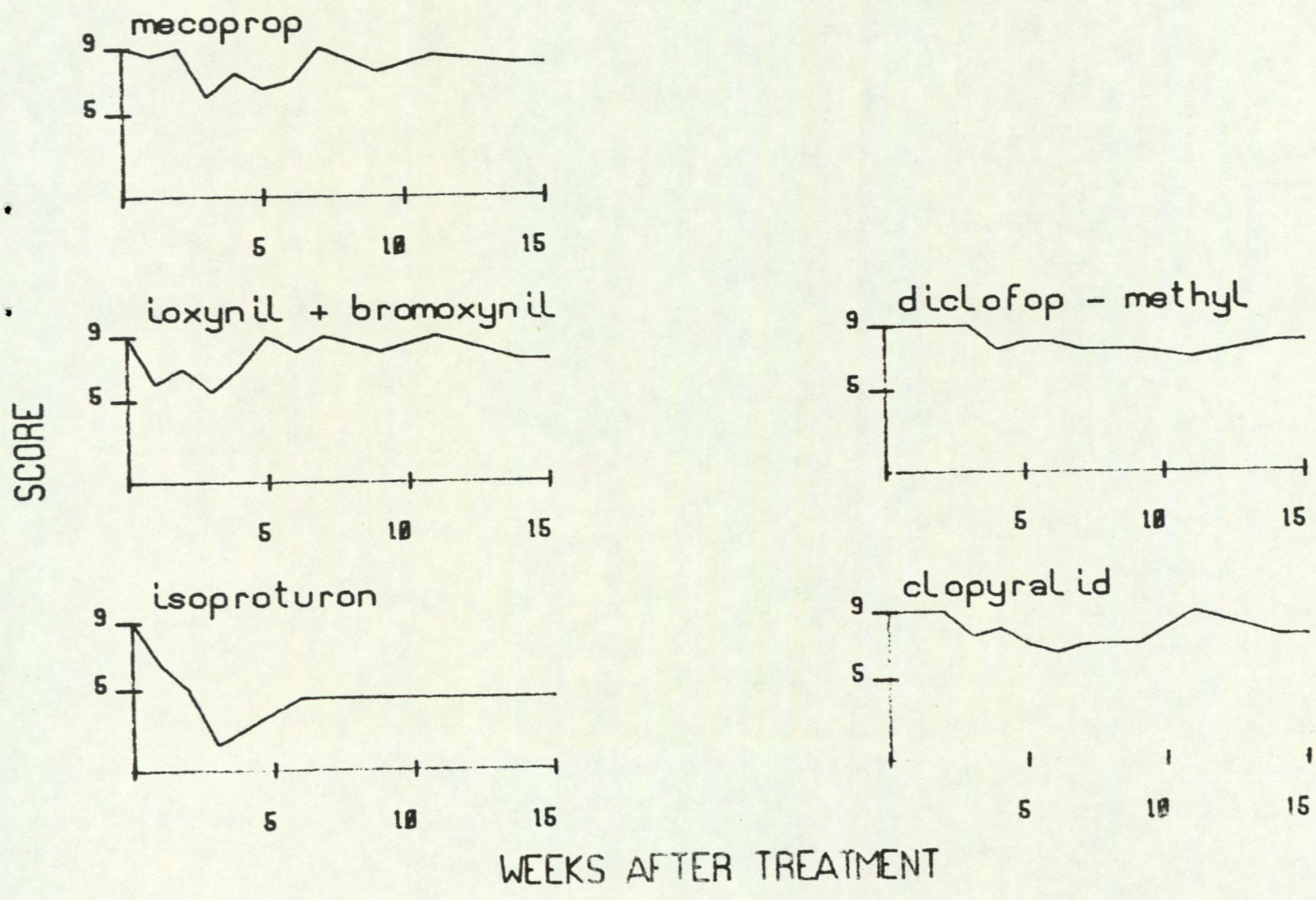


FIGURE 9. Silene alba

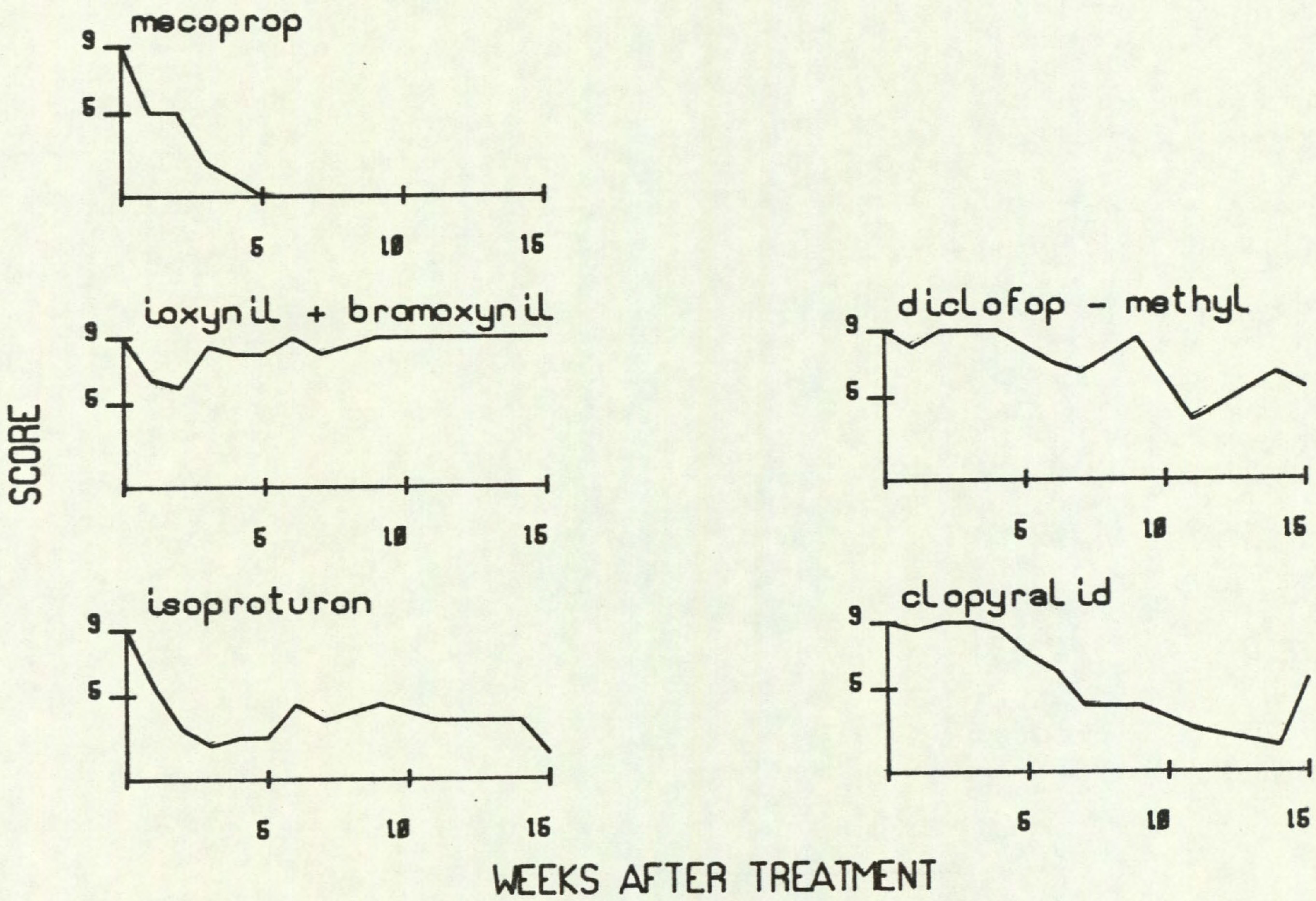


FIGURE 10. Rumex sanguineus

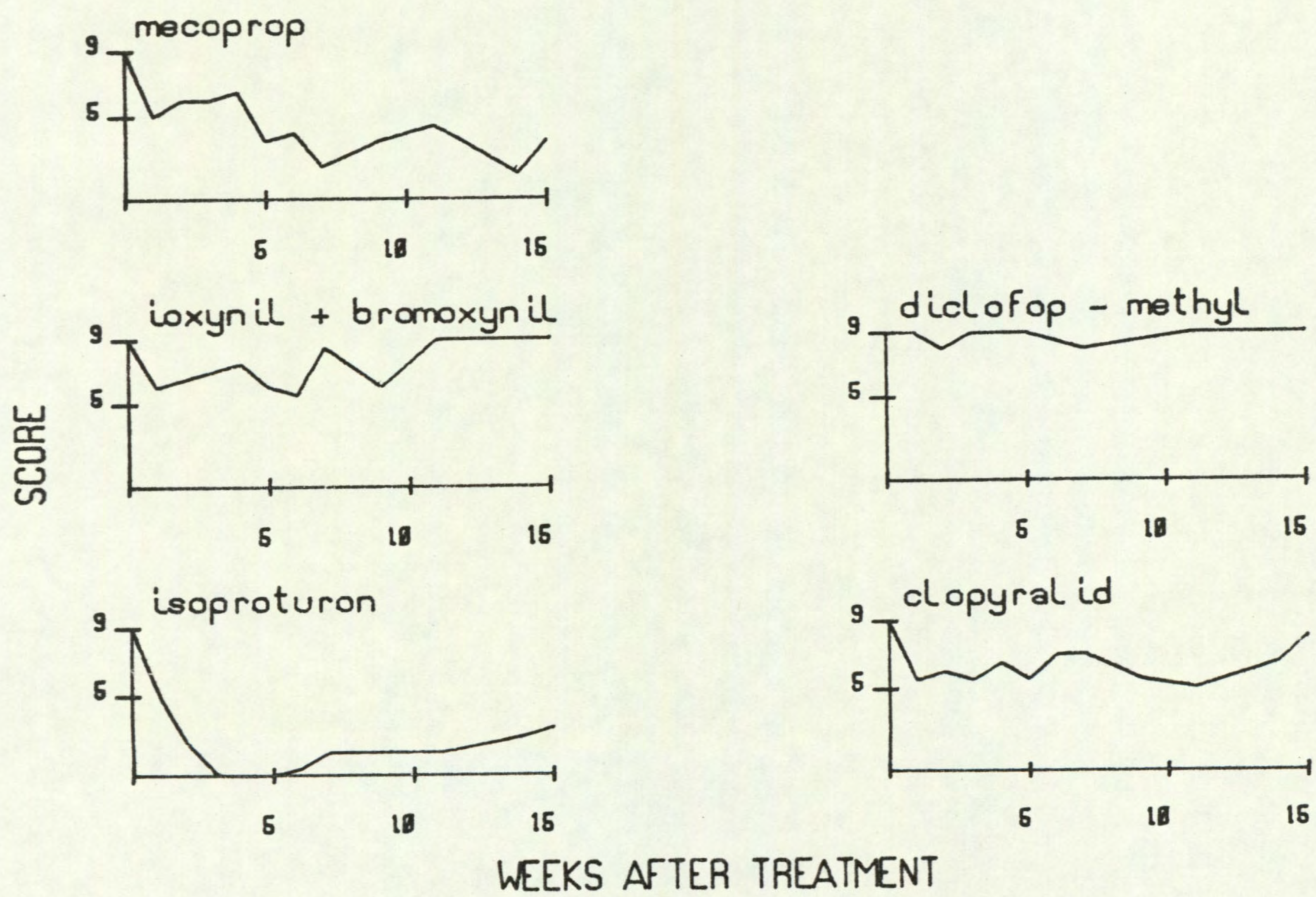


FIGURE 11. Carduus acanthiodes

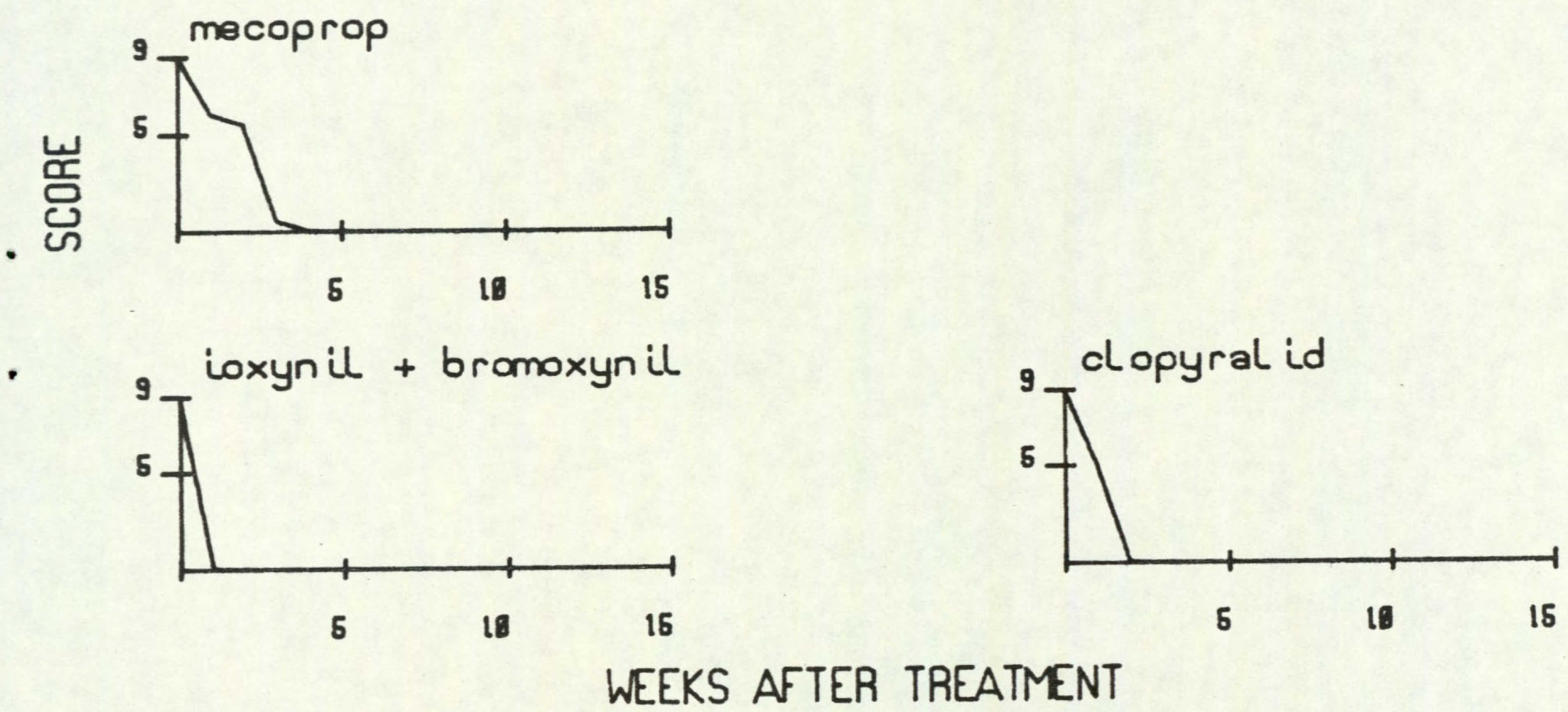


FIGURE 12. Lamium album

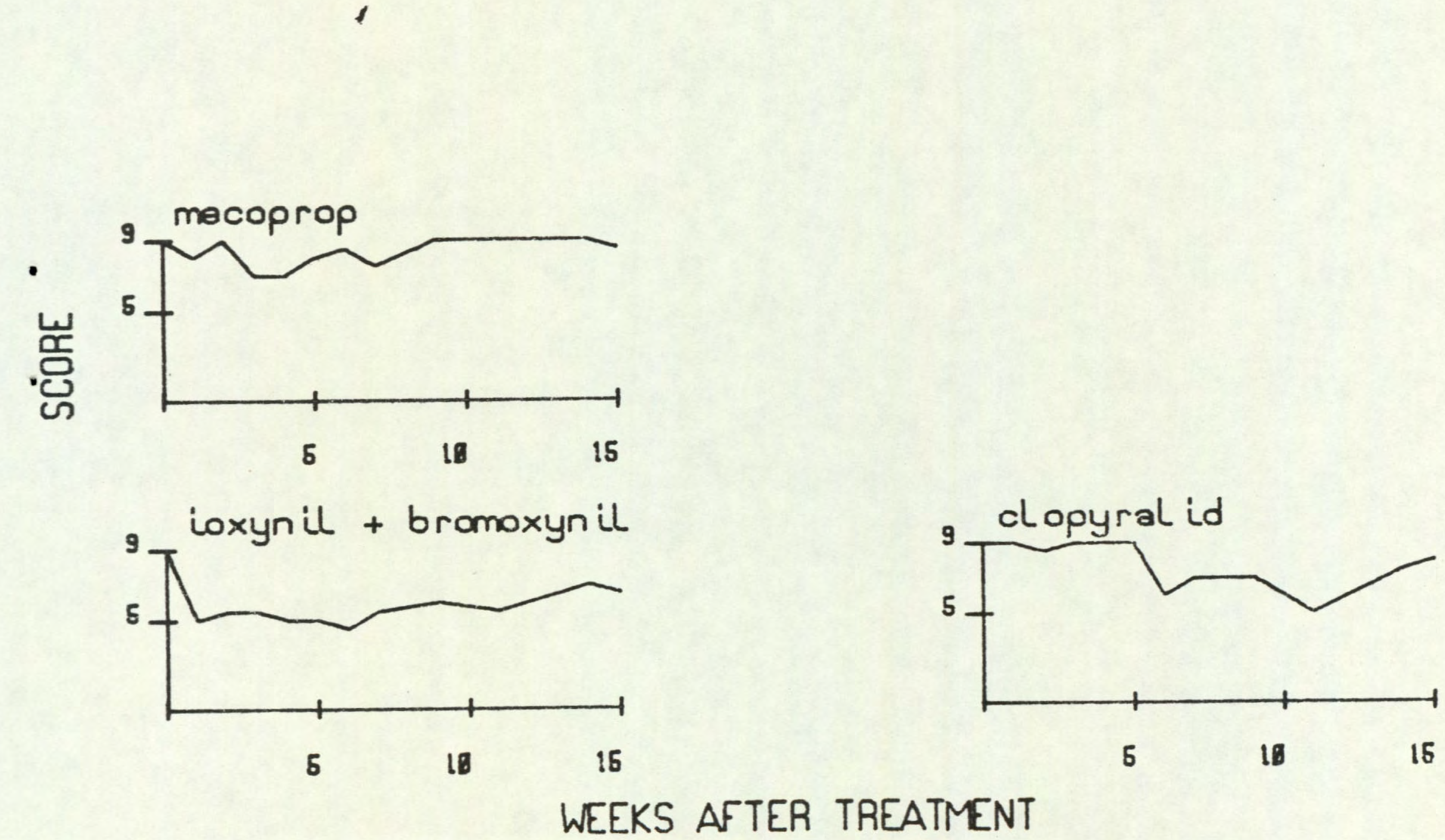


FIGURE 13. *Rumex obtusifolius*

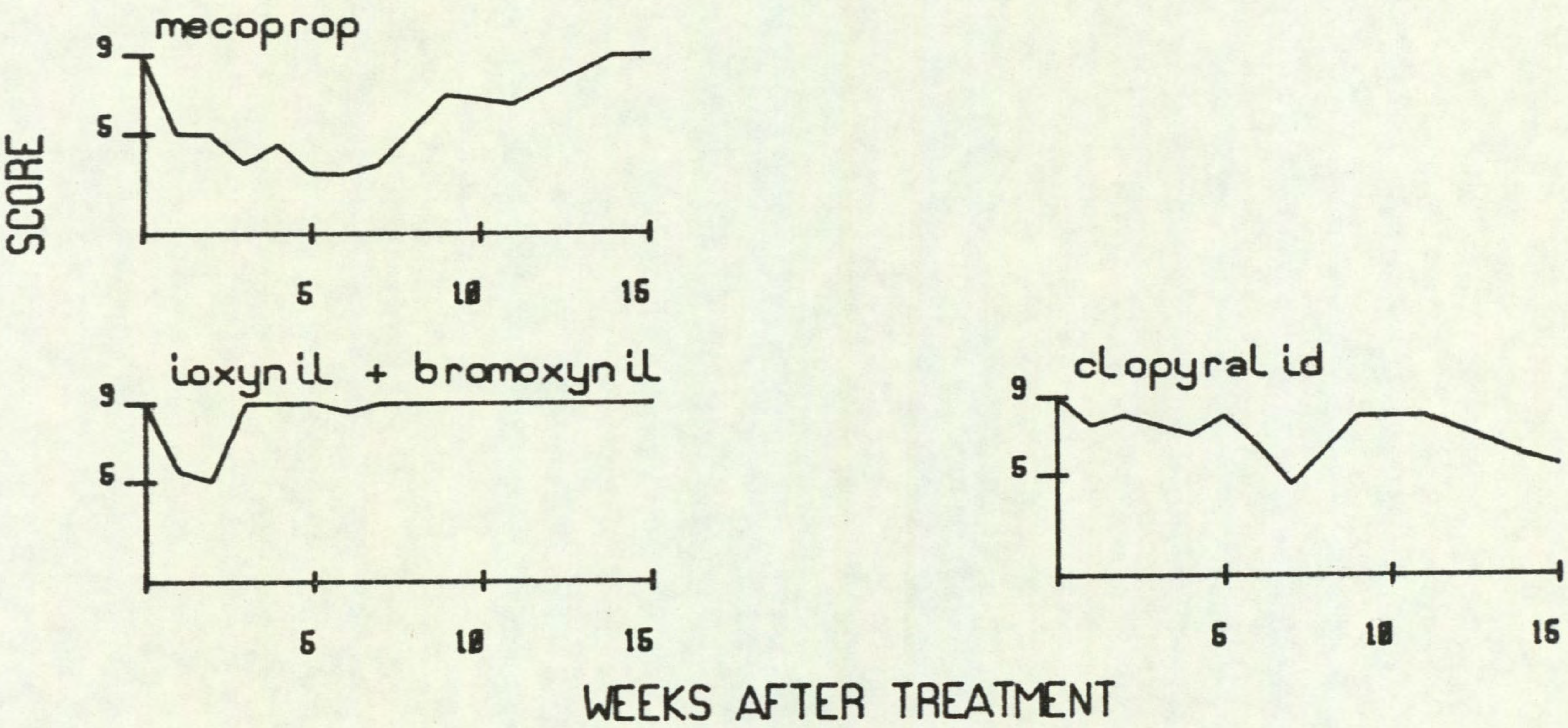


FIGURE 14. *Trifolium repens*

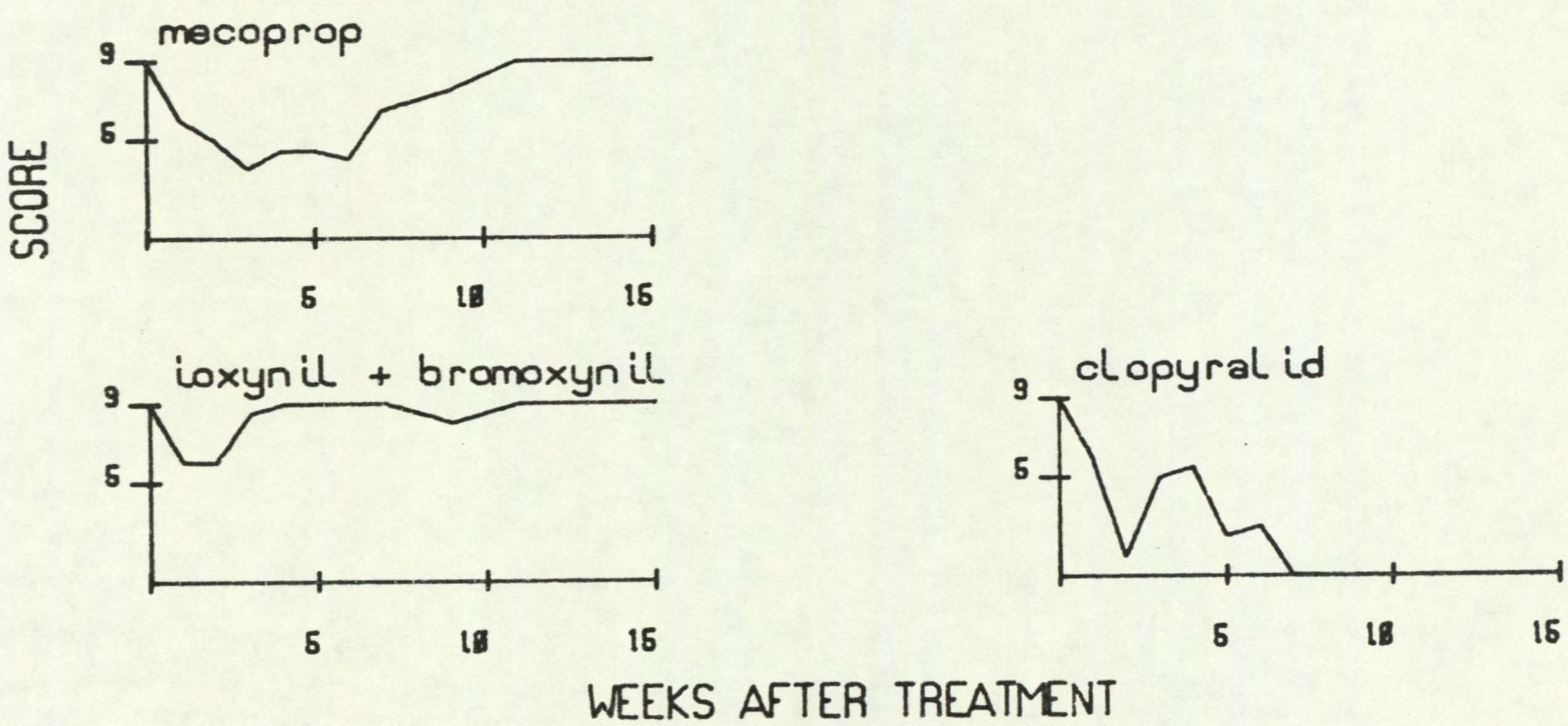


FIGURE 15. Vicia tetrasperma

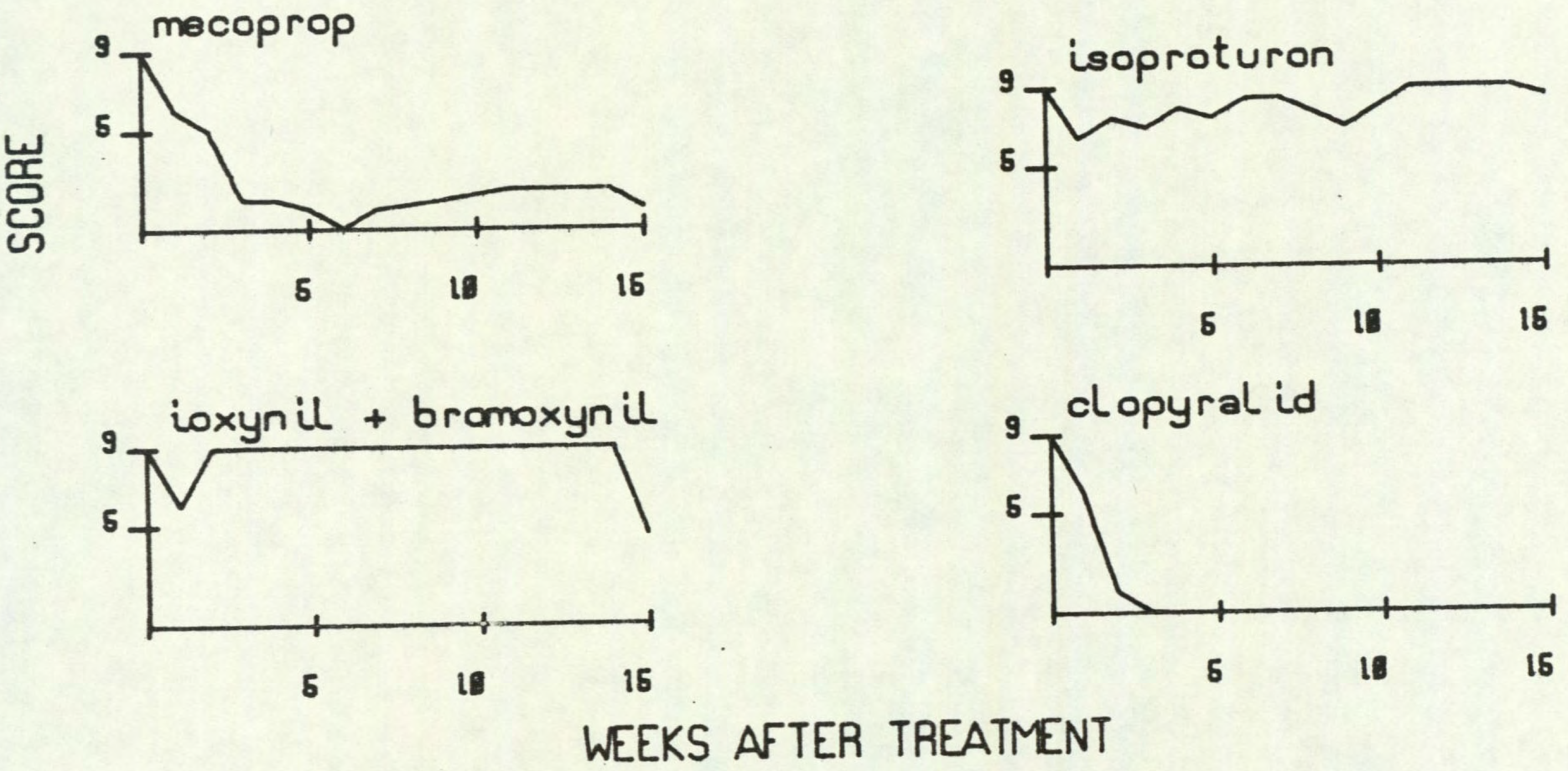
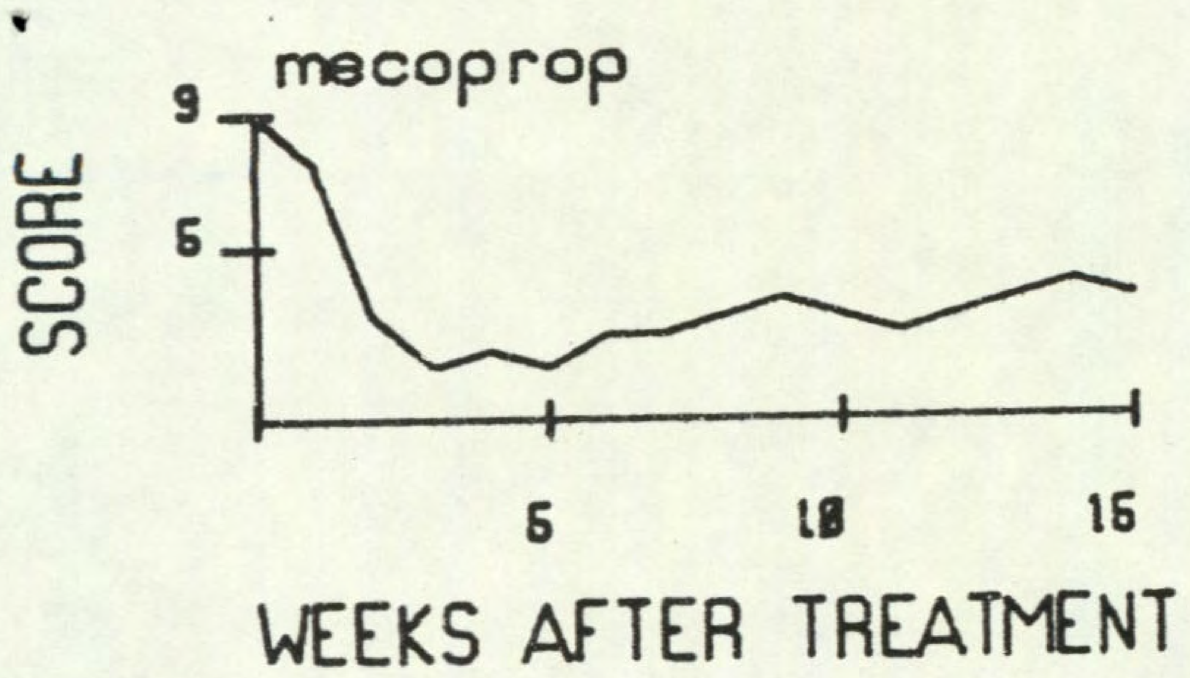


FIGURE 16. Convolvulus arvensis



ABBREVIATIONS

ångström	Å
Abstract	Abs.
acid equivalent*	a.e.
acre	ac
active ingredient*	a.i.
approximately equal to*	$\simeq$
aqueous concentrate	a.c.
bibliography	bibl.
boiling point	b.p.
bushel	bu
centigrade	C
centimetre*	cm
concentrated	concd
concentration	concn
concentration x time product	ct
concentration required to kill 50% test animals	LC50
cubic centimetre*	cm^3
cubic foot*	ft^3
cubic inch*	in^3
cubic metre*	m^3
cubic yard*	yd^3
cultivar(s)	cv.
curie*	Ci
degree Celsius*	^{o}C
degree centigrade	^{o}C
degree Fahrenheit*	^{o}F
diameter	diam.
diameter at breast height	d.b.h.
divided by*	÷ or /
dry matter	d.m.
emulsifiable concentrate	e.c.
equal to*	=
fluid	fl.
foot	ft
freezing point	f.p.
from summary	F.s.
gallon	gal
gallons per hour	gal/h
gallons per acre	gal/ac
gas liquid chromatography	GLC
gramme	g
hectare	ha
hectokilogram	hkg
high volume	HV
horse power	hp
hour	h
hundredweight*	cwt
hydrogen ion concentration*	pH
inch	in.
infra red	i.r.
kilogramme	kg
kilo (x10^3)	k
less than	$<$
litre	l.
low volume	LV
maximum	max.
median lethal dose	LD50
medium volume	MV
melting point	m.p.
metre	m
micro (x10^{-6})	μ
microgramme*	μg
micromicro (pico: x10^{-12})*	μμ
micrometre (micron)*	μm (or μ)
micron (micrometre)*†	μm (or μ)
miles per hour*	mile/h
milli (x10^{-3})	m
milliequivalent*	m.equiv.
milligramme	mg
millilitre	ml

† The name micrometre is preferred to micron and μm is preferred to μ.

millimetre*	mm
millimicro* (nano: x10^{-9})	n or mµ
minimum	min.
minus	-
minute	min
molar concentration*	M (small cap)
molecule, molecular	mol.
more than	$>$
multiplied by*	x
normal concentration*	N (small cap)
not dated	n.d.
oil miscible concentrate	o.m.c. (tables only)
organic matter	o.m.
ounce	oz
ounces per gallon	oz/gal
page	p.
pages	pp.
parts per million	ppm
parts per million by volume	ppmv
parts per million by weight	ppmw
percent(age)	%
pico (micromicro: x10^{-12})	p or µµ
pint	pint
pints per acre	pints/ac
plus or minus*	$\pm$
post-emergence	post-em
pound	lb
pound per acre*	lb/ac
pounds per minute	lb/min
pound per square inch*	lb/in^2
powder for dry application	p. (tables only)
power take off	p.t.o.
precipitate (noun)	ppt.

pre-emergence	pre-em.
quart	quart
relative humidity	r.h.
revolution per minute*	rev/min
second	s
soluble concentrate	s.c.
soluble powder	s.p.
solution	soln
species (singular)	sp.
species (plural)	spp.
specific gravity	sp. gr.
square foot*	ft^2
square inch	in^2
square metre*	m^2
square root of*	$\sqrt{\ }$
sub-species*	ssp.
summary	s.
temperature	temp.
ton	ton
tonne	t
ultra-low volume	ULV
ultra violet	u.v.
vapour density	v.d.
vapour pressure	v.p.
varietas	var.
volt	V
volume	vol.
volume per volume	v/v
water soluble powder	w.s.p. (tables only)
watt	W
weight	wt
weight per volume*	w/v
weight per weight*	w/w
wettable powder	w.p.
yard	yd
yards per minute	yd/min

* Those marked * should normally be used in the text as well as in tables etc.

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