height of the coleoptile was most susceptible to chemicals produced by decaying residues of sunflower, root length was most susceptible to chemicals liberated by dried residues. Whether these phenomena are the result of differing concentrations of the same chemical or to different chemicals remains to be determined. Comparisons with the compounds present in Experiments 1 and 2 have also to be made.

Since sunflower and wheat may occur as summer and winter crop combinations in Australian agriculture, and as the latter may germinate in proximity to residues of the former, allelopathy may be a significant factor in successful establishment of a wheat crop.

LITERATURE CITED

ANDERSON, R.C., KATZ, A.J. and ANDERSON, M.R. 1978. Allelopathy as a factor in the success of *Helianthus mollis. Journal of Chemical Ecology* 4, 9 — 16.

COOPER, W.S. and STOESZ, A.D. 1931. The subterranean organs of *Helianthus scaberrimus. Bulletin of the Torrey Botanical Club* 58, 67 — 72.

CURTIS, J.T. and COTTAM, G. 1950. Antibiotic and autotoxic effects in prairie sunflower. *Bulletin of the Torrey Botanical Club* 77, 187 — 191.

HALL, A.B. and BLUM, U. 1977. The effects of varying nutrient and density levels on allelopathy of *Helianthus annuus* cultivar Russian Mammoth, Asteraceae, on *Amaranthus retroflexus,* Amaranthaceae. *Association of South-east Biologists Bulletin* 24.

HARPER, J.L. 1977. *Population Biology of Plants.* Academic Press.

KOEPPE, D.E., SOUTHWICK, L.M. and BITTELL, J.E. 1976. The relationship of tissue chlorogenic acid concentrations and leaching of phenolics from sunflowers grown under varying phosphate nutrient conditions. *Canadian Journal of Botany* 54, 593 — 599.

LEATHER, G.R. and FORRENCE, L.E. 1979. Allelopathic potential of thirteen varieties of sunflower *(Helianthus annuus).* Abstracts of 1979 Meeting of the Weed Science Society of America, pp. 79 — 80.

LOVETT, J.V. 1982. The effects of allelochemicals on crop growth and development. In *"Chemical Manipulation of Crop Growth and Development",* Proceedings of the 33rd Nottingham Easter School in Agricultural Science, Butterworths, London (In press).

RICE, E.L. 1974. *Allelopathy.* Academic Press.

SCHILDKNECHT, S. 1981. Irritant and defence substances of higher plants — a chemical herbarium. Angewandte Chemie (International Edition in English) 20, 164 — 184.

TANG, C.S. and YOUNG, C.C. 1979. Allelopathic inhibition of legumes by grasses. II. Collection of allelopathic inhibitors from root systems by continuous trapping on an XAD-4 resin column. *Plant Physiology* 63 (Supplement), 105.

TUKEY, H.B. 1969. Implications of allelopathy in agricultural plant science. *The Botanical Review* 35, 1 — 16.

WILSON, R.E. and RICE, E.L. 1968. Allelopathy as expressed by *Helianthus annuus* and its role in old-field succession. *Bulletin of the Torrey Botanical Club* 95, 432 — 448.

POST-EMERGENCE WEED CONTROL IN SUNFLOWER.

YVES REGNAULT
C.E.T.I.O.M., 174 Avenue Victor Hugo 75116-Paris, France.

ABSTRACT

There are many occasions when pre-emergent herbicides can be used for weed control and if properly used they are quite satisfactory. After crop emergence, we have not been able to use any herbicides to control dicotyledons in our trials, but certain anti-graminae herbicides could be used. These were alloxydime-Na, fluazifop-butyl or dic-lofop methyl. It seems that these herbicides are only economical if used quite early in crop growth.

INTRODUCTION

Although sunflower is widely grown in our country — we expect some 200,000 ha to be grown in 1982 — little research has been conducted into herbicide requirement for this crop. As a matter of fact, none of the products generally used on sunflower were developed for that crop first. Now we have shown, and there is general agreement among crop specialists, that weed control in sunflowers is quite profitable.

Some 10 products are used for weed control in sunflower crops in France (Table 1). These are normally applied after sowing and are therefore dependent on rainfall to be effective. Moreover, farmers may find some weed species which they did not know occurred in their field. Lastly, except in the case of trifluralin which has a wide action, it is not possible to increase the dosage of most products to improve efficacy.

Taking these facts into account, we decided to examine postemergence weed control.

Table 1. Herbicides used in cropping.

Active Matter Name	dose/ha	Application time	Observations
diallate	1600 g	p.s.i.	only against graminae — immediate incorporation.
trifluralin	1 200 g	p.s.i.	mixed spectrum — the most selective.
e.p.t.c. + phyto-protector	2 932 g	p.s.i.	mixed spectrum — immediate incorporation.
linuron	500 g	p.e.	only to complement trifluralin.
linuron + monolinuron	250 g +250 g	p.e.	only to complement e.p.t.c.
terbutryn	2 000 g	p.e.	application as soon as sowing. The most used in this category. May follow diallate.
butralin + linuron	2 444 +600	p.e.	industrial formulation. Wide spectrum.
carbetamid + oxadiazon	2 100 g +750 g	p.e.	to be mixed at application-time. wide spectrum.

MATERIALS AND METHODS

Each year since 1973 we have conducted herbicide product screening trials in the field. During these trials, observations were made on the selectivity of these products as well as efficacy. The methods used were similar to those of the "Commission des Essais biologiques francaise" and acknowledged by the European Network of Scientific Co-operation on Sunflower sponsored by F.A.O. As there is no comparison of results, it is unnecessary to use a statistical system, but a systematic approach is more efficient in simplifying comparisons on the behaviour of plants at different doses of product (zero dose included).

The products which show promise in the initial field trials are retested to confirm their selectivity and efficacy at the initial dose used and at double that dose. Lastly, yield data enabled us to estimate the economics of using the various products and techniques.

The selection of product in these experiments was essential and difficult. Although few problems were encountered with anti-graminae herbicides and we just tested efficacy and their effect on yield, we had difficulty in obtaining suitable herbicides with activity against dicotyledons (Tables 2 and 3). We knew that certain herbicides — triazines, ureas, hormons and dinitroanilines — could not be used in sunflower. In short, the number of products in this class was extremely limited and hence research into new herbicides effective against dicotyledons should be extremely useful.

Table 2. Antigraminae herbicides used in post-emergence treatments (C = sorting trials of products; R = confirmation trials).

Active Matter Name	Doses (g/ha)	Years	Experiments Number & Type	Observations
barban	375 — 750	73	3 C	
benzoylprop-ethyl	1 000 — 2 000	74 — 75 — 77	7 R	always after terbutryn.
dalapon	2 850 — 5 700	75	3 C	
diclofop methyl	1 080 — 2 160	77 — 78 — 79 — 80	7 C — 21 R	always after terbutryn.
L-flamprop isopropyl	600 — 800 — 1 600	78 — 79	7 C — 7 R	always after terbutryn.
alloxydime-sodium	750 — 1 125 — 2 250	77 — 78 — 79 — 80	7 C — 21 R	after terbutryn. 3 1/ha of oil to be added.
fluazifop butyl	500 — 1 000 g	80	4 R	after terbutryn. Oil or wetting agent to be added.

Table 3. Antigraminae herbicides trialed in post-emergence treatments. (C = sorting trials of products).

Active Matter Name	Doses (g/ha)	Years	Trials Number and Type
aminotriazole + thiocyanate	1 680 + 1 505	73	3 C
lenacil	320 — 640	75	3 C
phenmediphame	1 000 — 2 000	75	3 C
ethofumesate + phenmediphame	1 200 — 2 400 + 835 + 1 770	76	6 C
chlorprophame + phemediphame	1 000 — 1 600 — 2 400 + 835 + 835 + 1 770	76	6 C
MCPA Na and K-salts	400 — 800 — 1 200	80	3 C
mecoprop	575 — 1 150 — 2 300	80	3 C
bromophenoxim	250 — 500 — 1 000	80	3 C
monalid	1 000 — 2 000 — 5 000	80	3 C
nitrofen	960 — 1 920 — 2 400	80	3 C

RESULTS

We can see from the tables that no herbicide, with efficacy against dicotyledons, survived the first screening trial. As a matter of fact, nitrofen is the only product which can be considered as sufficiently selective to use in sunflower, even though it can burn leaves at a high dose rate of 1920g. Efficacy of this product at lower doses is poor.

Results for herbicides with activity against grasses were better. The products alloxydime sodium and fluazifop-butyl

Table 4. Yield-analysis for some antigraminae-trials.

Trials	1977		1979		
Treatments	A	B	A	B	C
non treated control	100 = 14.89	100 = 14.10	—	—	—
terbutryn 2 000 g	99	120.1	100 = 24.25	100 = 24.57	100 = 20.32
terbutryn + benzoylprop-ethyl 2 000 g + 1 000 g	117.5	191.5	—	—	—
2 000 g + 2 000 g	116.4	176.9	—	—	—
terbutryn + alloxydim sodium 2 000 g + 750 g	—	—	110.6	99.2	120.6
terbutryn + diclofop-methyl 2 000 g + 1 080 g	—	—	111.9	104.6	112.3
terbutryn + L. flampropisopropyl 2 000 g + 600 g	—	—	103.3	95.4	112.4
LSD 0.05	6.2	35.7	11.25	NS	NS
sowing-treatment time	52 days	46 days	42 days	57 days	42 days
stage at treatment-time	4 — 5 leaves	3 — 4 leaves	3 leaves	4 leaves	5 leaves
present weeds/m²	Setaria 51 Panicum 21 Sorghum 9 Dicotyledons 60	Avena fatua 147	Avena fatua 13	Avena fatua 24	Avena fatua 35

must be considered effective against all grasses, perennials included. The others have specific action against species of *Avena* and occasionally some efficacy against *Panicum setaria* and *Digitaria*.

Our results show that production can be increased by herbicide application to control grass weeds — particularly terbutryn. It appears that the most appropriate time for application of these herbicides is when the sunflower plants are at the 3 — 4 leaf stage.

DISCUSSION

One must bear in mind that the results mentioned above only deal with herbicide application on the whole crop area. More or less risky solutions, particularly for dicotyledon weed control, can be obtained with controlled spraying.

As far as grass weeds are concerned, we found that it was necessary to apply the herbicide when the plants were at the 3 — 4 leaf stage, so that weed control would increase yield. Very few of the post-emergence applications showed yield improvement when compared with untreated controls or with pre-emergence application treatments. In fact, only in 3 out of 14 experiments, and it was in these three experiments, that herbicides were applied early. These results are in agreement with observations made by other workers who observed that competition became marked between four, and six weeks after, emergence. In our case, we prefer to define the growth stage of the plant (3 — 4 leaf) which gives some idea of weed development as well.

We must emphasize that yield increases obtained following post-emergence herbicide application were not greater than those obtained with pre-emergence application. As a matter of fact the highest yield increase (204% over controls) was obtained with pre-emergence application of diallate followed by terbutryn.

Hence with the current availability of herbicides, post-emergent use may have limited application at a particular growth stage and even then may not be of economical benefit.

LITERATURE CITED

C.E.T.I.O.M. Rapport d'activite annees 1973 — 74, — 75, — 76, — 77, — 78, — 79, — 80, 174 Avenue Victor Hugo 75116-Paris, France.

JOHNSON, B.J. 1971. Effect on Weed Competition on Sunflower — *Weed Science* 19, 378 — 380.

SARPE, N and TOMOROGA P. 1974. Efficiency of Herbicides applied alone or combined in the Weed Control of Irrigated or Non-Irrigated Sunflower Crops. *Proceedings of the 6th International Sunflower Conference,* Bucharest, Romania.

INFORMATION CONCERNING THE EFFECT OF CULTIVATION AS A COMPLEMENT FOR WEED CONTROL.

A. POUZET and Y. REGNAULT
C.E.T.I.O.M., 174 Avenue Victor Hugo, 75116-Paris, France.

ABSTRACT

The effect of cultivation as a complement for weed control was less marked in 1980 and 1979 than in 1977 (2%, 6% and 14% respectively in yield-increases after cultivation of the chemically controlled plots). The experiments which were carried out in 1981 allowed us to emphasize the influence of two factors: the date of cultivation, and the nature of the herbicides associated to this method.

Complete paper not received at time of printing.