

Comparative Study of early growth Stages
and cytological effects of eight herbicides
on plants

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Introduction

The rapid progress in the use of herbicides in agriculture has nowadays attracted the attention of botanists. This study is basically assigned to growth and cytological criteria. Eight different organic herbicides belonging to different groups have been tested on three plants namely; Vicia, Faba, Zea mays and Vicia sativa. The herbicides are :

1. 2,4-D amine : amine salt of chlorophenoxy acetic acid.
2. Dalapon : Sodium salt of 2,2-dichloropionic acid.
3. Eptam : Ethyl N.N-Di-n-propyl thiocarbamate.
4. Linuron : 3- (3,4-dichlorophenyl) - 1-methyl methoxy
-1- methyl urea.
5. Cotoran : N-(3- trifluoromethyl phenyl) -N-N
dimethyl urea.
6. Simazine : 2- Chloro-4-6, bis (ethyl amino) -S-
triazine.

7. Treflan : : ,a,a,a - trifluoro -2,6- dinitro- N,N- dipropyl-P- toluidine.
8. Gramoxone : I-I- dimethyl -4-4- dipyridylum dichlorides.

Material and Methods

The present study was carried out on Vicia faba (var. Giza 1), Zea mays (Shami, hybrid 17) and Vicia sativa (vetch). Concentrations of the herbicides used were 0.1, 1, 10, 100, 500 ppm. for treflan, dalapon, gramoxone, and 2,4-D amine (water soluble). For slightly soluble herbicides, concentrations used were 0.1, 1, 10, 100 and 375 ppm for eptam, 0, 1, 1, 10 and 90 ppm. for cotoran, 0.1, 1, 10 and 75 ppm. for linuron and 0.1, 1, and 5 ppm, for simazine.

For early growth stage studies, 20 seedlings with roots 2 cm. in length were planted in jars containing the herbicide solutions. Tap water was used for controls. Root length was measured every 24 hours. Observations on seedlings with roots immersed in well aerated solutions were continued for 10 days, the fresh weights of the plants were recorded and also mean increase in root length. The results were taken of the mean of 2 replicates.

For mitotic study broad beans (Vicia faba) was chosen as an example. Four days old roots were dipped in the different concentrations of the herbicide solutions for 24 and 72 hours. Tap water was used for control experiments. Counts were made from permanent root tip squash preparations stained with Feulgen.

Results and Discussion

1. Early growth effects :

The effects of different concentrations of the used herbicides on early growth stages of broad beans, maize and vetch have revealed that nearly all concentrations inhibited root growth, (Figs 1-3). However, higher concentrations inhibited lateral root initiation and growth as well. The daily growth rates of the treated plants were usually less than the controls in nearly all herbicides used, (Figs 4-II); the degree of inhibition increased with increase of concentration. Some higher concentrations such as 500 ppm 2,4-D amine, and triflan, 375 ppm optam and 100 ppm gramoxone were toxic. Diminution in the fresh weight of the treated plants occurred in nearly all herbicides used and specially at higher concentrations.

Tolerance of the tested plants could be measured by determining the strength of the herbicide solution which causes 50%

diminution of fresh weight. These concentrations are reported in Table I(a). Tolerances of the tested plants towards various experimental herbicides could be arranged in ascending order as follows :

2,4-D amine, eptam, cotoran and Simazine :

1- Vetch 2- broad beans 3- maize.

Dalapon, and linuron ;

1- Vetch 2- Maize 3- broad beans

Treflan ;

1- Vetch 2- maize and broad beans.

Gramoxone :

1- nearly equal tolerance of the three plants.

Table I (a)

Herbicide concentration causing 50 % diminution
of plant fresh weight

Agent	Tested plants		
	Vetch	Broad beans	Maize
1. 2,4-D amine	0.1 ppm	1 ppm	100 ppm
2. Dalapon	0.1 "	100 "	1 "
3. Eptam	0.1 "	1 "	100 "
4. Cotoran	0.1 "	1 "	90 "
5. Linuron	1 "	-	10 "
6. Simazine	1 "	-	-
7. Treflan	0.1 "	10 "	10 "
8. Gramoxone	1 "	1 "	1 "

Fig (I) shows root failure to elongate normally and club-shaped roots in corn as a results of treatment with treflan.

A similar observation was reported by Hacskaylo and Amato (1968).

Kuratle (1969) found that linuron decreased cell activity, root length, dry weight and increased root width in cucumber.

Table I (b)

Herbicide causing 50 % diminution in fresh weight of broad beans in 10 days arranged in descending order effect.

- 1- 2,4-D amine, gramoxone, eptan, cotoran.
- 2- Simazine, treflan, linuron.
- 3- Dalapon.

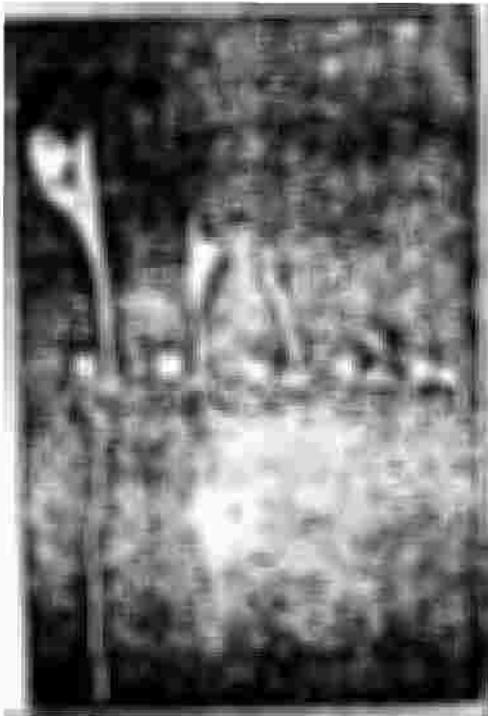


Fig (I)

Control maize plant (16 days old).

2,3,4,5 Treated maize plants with 0.1, 1, 10, 100 ppm
treflan.

Note swelling of the root tips.

Z=9

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(7)

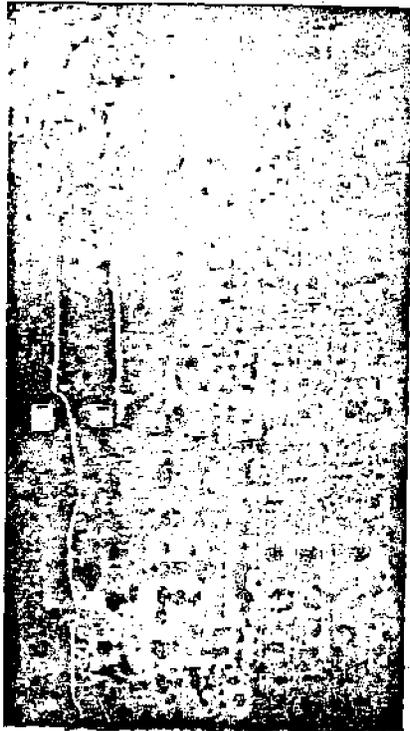


Fig (2)

I Control Vetch plants (14 days old)

2,3,4,5 Treated Vetch plants with 0.1, 1, 10, 100 ppm.

2,4-D amine.



Fig (3)

- I. Control Vicia plant (14 days old.)
2,3,4,5 Treated Vicia plants with 0.1, 1, 10, 90 ppm. cotoran.

Note: chlorosis of 10 ppm treated plants

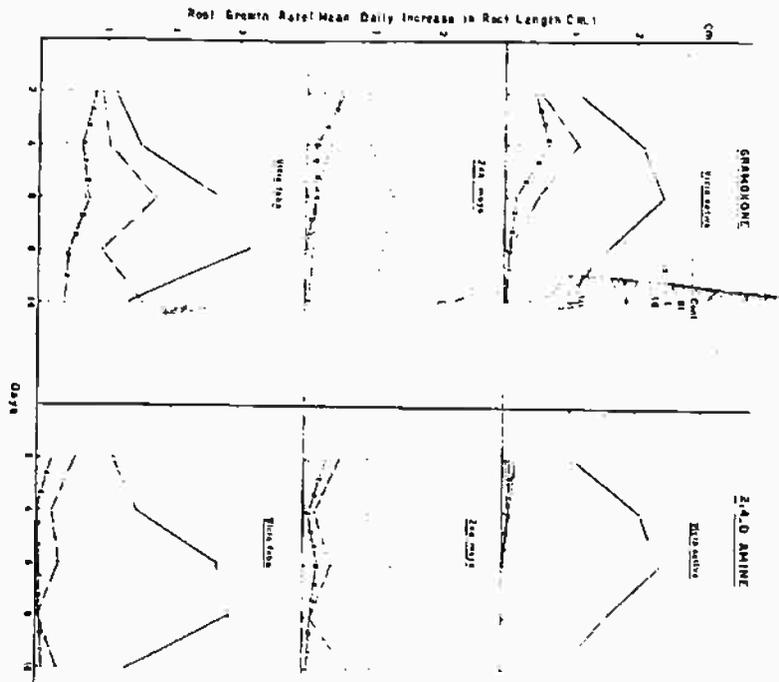


FIG (4) : Fresh weight/plant and root growth (length) of beans, maize and vetch as affected by 2,4-D amine and Gramoxone.

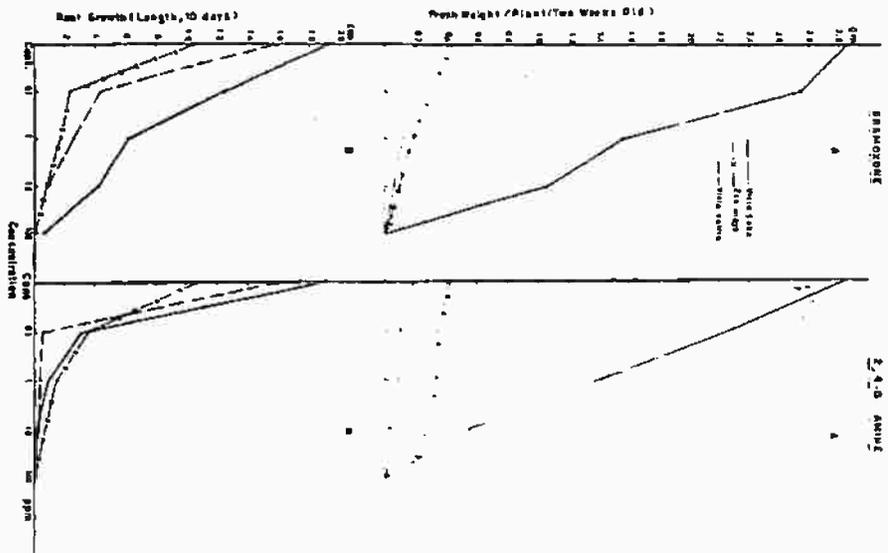


FIG (5) : Root Growth rate of beans, maize and vetch as affected by 2,4-D amine

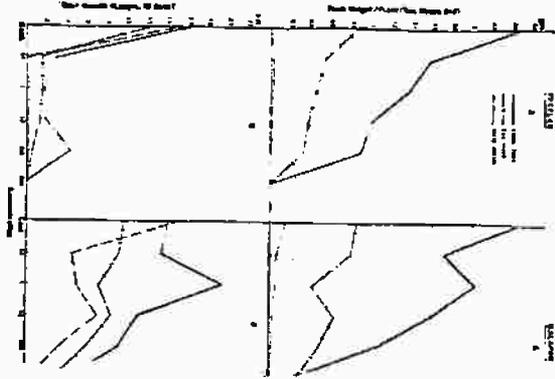


Fig (6) : Fresh weight/plant and root growth (length) of beans, maize and vetch as affected by trellis and delpon.

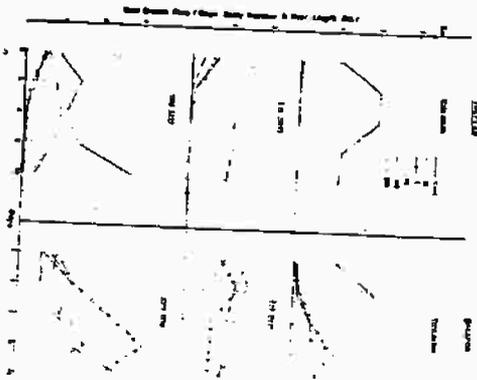


Fig (7) : Root growth rate of beans, maize and vetch as affected by trellis and delpon.

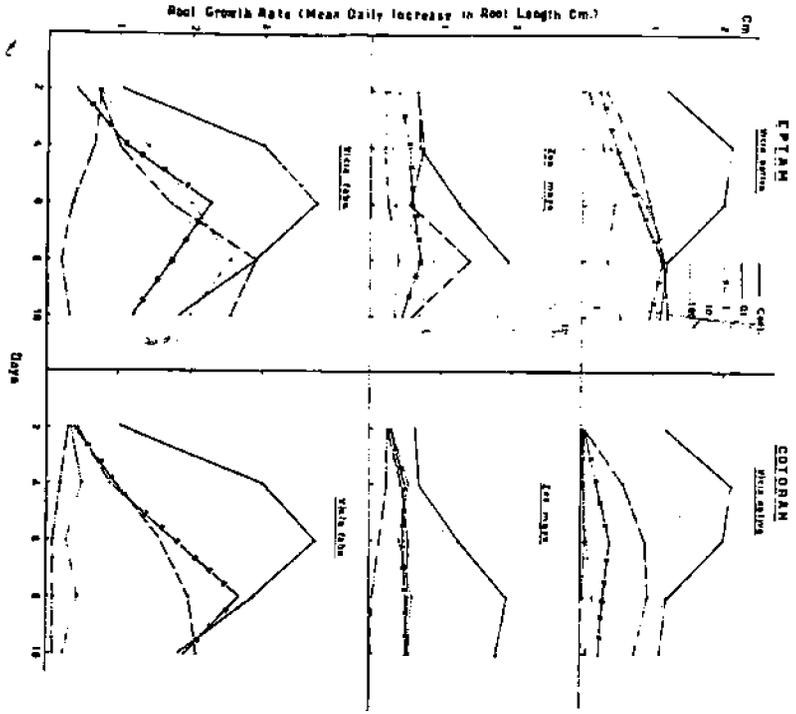


FIG (8) : Fresh weight/plant and root growth (length) of beans, maize and vetch as affected by eptam and Cotoran.

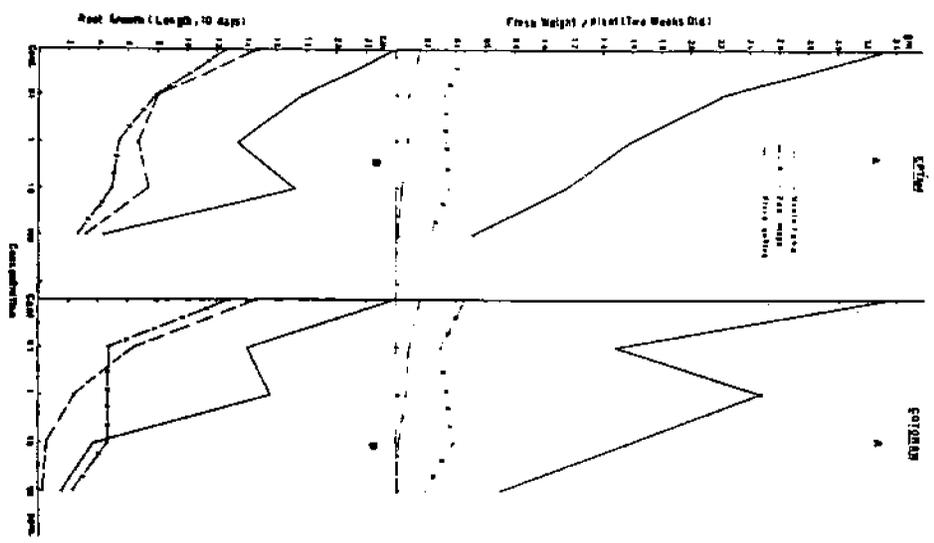


FIG (9) : Root growth rate of beans, maize and vetch as affected by eptam and Cotoran.

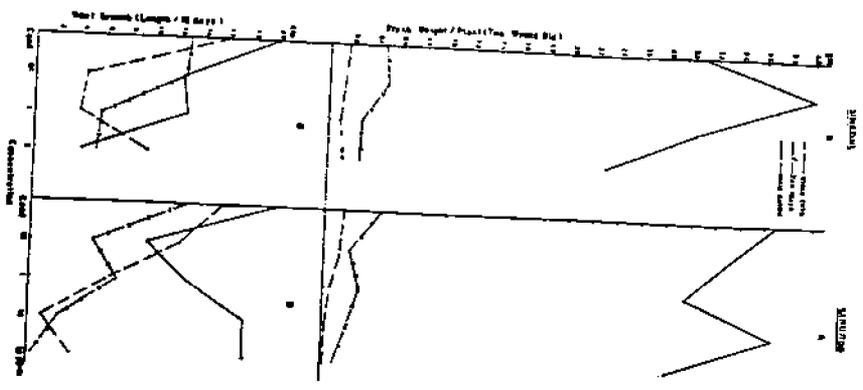


FIG (10) : Fresh weight/plant and root growth (length) of beans, maize and vetch as affected by Simazine and Ilnuron.

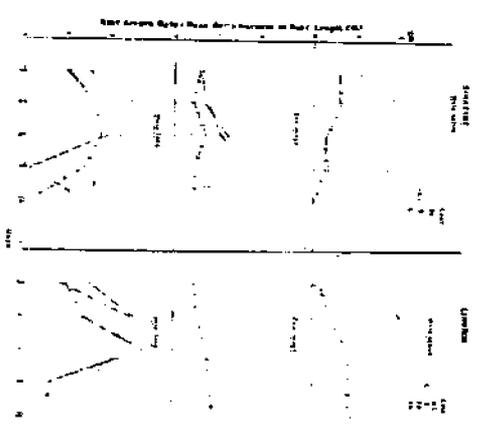


FIG (11) : Root growth rate of beans, maize and vetch as affected by Simazine and Ilnuron.

Cytological effects :

Comparing the effects of herbicides on mitotic index; it is observed that simazine, eptam, linuron, dalapon and cotoran have slight inhibiting action on mitotic index in 24 hours treatment, the degree of inhibition rises with increase of concentration and time of treatment (Table 2). Gramoxone, treflan, 2,4-D and eptam caused either toxic effect in higher concentration, or increase in rate of inhibition of mitosis.

Thus most of the herbicides used in this study can be considered as mitotic poisons, though at different degrees. This is apparent from the obtained figures of root growth rates and their simulates in mitotic indices. Nearly 50 % inhibition of mitosis was induced by 0.1 ppm and 1 ppm 2,4-D amine for 24 and 72 hours treatment, 5 ppm simazine and 10 ppm linuron for 72 hours treatment (Table 3). It is noticed that a concentration of 0.1 ppm 2,4-D amine was effective in causing 50% diminution in mitotic index as compared with 500 ppm for dalapon. Reference to Table 1 (b) shows concordance of results with 2,4-D as the strongest root growth inhibitor and dalapon as the weakest.

Table 2

(24)

Mitotic index of *Vicia faba* as affected by the used herbicides

Experimental agent	Mitotic index after treatment for		Experimental agent	Mitotic index after treatment for	
	24 h.	72 h.		24 h.	72 h.
<u>2,4-D amine</u>			<u>Cotoren</u>		
Cont	82 ± 5.3	79 ± 5.1	Cont	82 ± 5.3	79 ± 5.1
0.1 ppm	50 ± 8.4	38 ± 12.5	0.1 ppm	72 ± 6.3	66 ± 14.1
I "	40 ± 11.2	28 ± 4.9	I ppm	64 ± 4.0	67 ± 8.4
10 "	35 ± 13.4	27 ± 13.2	10 ppm	65 ± 8.1	61 ± 3.1
100 "	32 ± 8.4	17 ± 9.2	90 "	56 ± 7.8	52 ± 2.6
500 "	30 ± 11.1	toxic			
<u>Dalapon</u>			<u>Sinazine</u>		
Cont.	82 ± 5.3	79 ± 5.1	Cont	82 ± 5.3	79 ± 5.1
0.1 ppm	76 ± 9.3	68 ± 4.0	0.1 ppm	72 ± 5.3	56 ± 15.7
I "	76 ± 13.2	67 ± 6.7	I "	70 ± 3.4	53 ± 16.2
10 "	77 ± 4.4	64 ± 4.4	5 "	66 ± 4.4	40 ± 6.2
100 "	59 ± 8.4	57 ± 11.2			
500 "	58 ± 13.2	53 ± 13.6	<u>triflan</u>		
<u>Eptam</u>			Cont		
Cont.	82 ± 5.3	79 ± 5.1	0.1 ppm	82 ± 5.3	79 ± 5.1
0.1 ppm	71 ± 7.6	63 ± 9.6	I "	84 ± 12.0	64 ± 11.2
I "	72 ± 6.7	55 ± 11.5	I "	84 ± 9.4	65 ± 4.9
10 "	72 ± 11.8	62 ± 12.2	10 "	66 ± 4.8	61 ± 15.2
100 "	71 ± 12.4	58 ± 4.0	100 "	63 ± 13.2	54 ± 15.3
375 "	toxic		500 "	48 ± 9.0	toxic
<u>Linuron</u>			<u>Gromoxone</u>		
Cont.	82 ± 5.3	79 ± 5.1	Cont	82 ± 5.3	79 ± 5.1
0.1 ppm	76 ± 6.7	51 ± 14.2	0.1 ppm	72 ± 8.0	63 ± 14.1
I "	77 ± 9.3	50 ± 12.8	I "	66 ± 13.7	62 ± 14.9
10 "	71 ± 8.4	42 ± 14.7	10 "	57 ± 14.2	55 ± 4.0
75 "	69 ± 12.2	46 ± 9.4	100 "	toxic	toxic

(15)

Table (3) : The concentration of herbicide causing about 50 % diminution in M.I in broad beans for 72 h. soak treatment in descending order :

Agent	Concentration	Agent	Concentration
1. 2,4-D acine	0.1 ppm	5. Eptan	100 ppm
2. Simazine	5 "	6. Treflan	100 "
3. Linuron	10 "	7. Cotoran	100 "
4. Gramoxone	10 "	8. Dalapon	500 "

Some other workers noticed similar results. Talbert (1965) and Bayer et. al. (1967) reported that treflan was a mitotic poison in treated plants. Hacsraylo and Amato (1968) found that cell division was markedly inhibited in treflan treated plants.

Schultz et al. (1958) found as a result of treatment of maize roots with treflan solution, radial enlargement of cortical cells and multinucleate cells in the meristematic regions; synthesis of DNA and RNA and protein was suppressed.

Chkanikov et al (1968) reported that the main reason for the resistance of graminaceous species to 2,4-D is that most of the chemical was found bound to subcellular structures and cytoplasmic protein. In dicotyledonous species, on the other hand most 2,4-D was found as free acid in both tolerant and sensitive species. All plants contained a non protein 2,4-D

derivative which released 2,4-D on acid hydrolysis, no correlation was found between quantity of this substance and the degrees of plant resistance to 2,4-D.

Summary

The present study aimed to compare the effect of eight herbicides, namely : 2,4-D amine, dalapon, eptam, cotoran, linuron, simazine, triflan and gramoxone on early growth stages of three plants, namely; Vicia faba, Zea mays and Vicia sativa. For mitotic studies Vicia faba was chosen as an example.

The daily growth rates of treated plants decreased than that of controls. Tolerance of tested species was measured by the strength of herbicide solution causing 50 % diminution of fresh weight. Vicia faba was the most tolerant plant, followed by Zea mays.

Inhibition of root growth was accompanied by decrease in mitotic index. Inhibition of mitosis increased with increase of concentration and time of treatment.

References

1. Bayer, D.E., Foy, C.L., McIlroy, T.E. and Cutter, E.G. (1967).
Morphological and histological effects of
trifluralin on root development.
Amer. J. Bot. 54, 945.
2. Chkenikov, D.I., Makeev, A.M. and Pavlova, N.N. (1968).
The selectivity of the herbicidal action of
2,4-D.
Khimiya sel'khoz 6, 1. 41
Weed abst. 18, 1, 57, 1969
3. Hacskeylo, J. and Amato, V.A. 1968. Effect of trifluralin
on roots of corn and cotton.
Weed sci. 16, 4.
4. Kuratle, K. 1969. The mode of action and basis for
selectivity of linuron herbicides.
Weed abst. 18, 6.
5. Schultz, D.P., Funderburk, E.H., and Negi, N.S. (1968).
Effect of trifluralin on growth, morphology
and nucleic acid synthesis.
plant physiol. 43, 2, 265.
Weed abst. 17, 6, 458, 1968.
6. Talbert, R.E. 1965. Effects of trifluralin on soybean
root development.
Weed abst. 15, 3, 172, 1966.