PLANT RESEARCH INTERNATIONAL

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Effects of two herbicides and one fungicide on field margins

Continuation of a study with the EPOP-model

M.M. Riemens, A. Uffing, C. Kempenaar & T. Dueck

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Front cover photographs: Model vegetations in experiments in greenhouse (M. Riemens, Plant Research International) and spraying of herbicides in a potatoe-field in practice (R. Groeneveld, Plant Research International).

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Samenvatting

In de afgelopen jaren is er steeds meer belangstelling gekomen voor zoomvegetaties rondom akkers. Dit groene 'netwerk' van zoomvegetaties maakt deel uit van de Ecologische HoofdStructuur (EHS). Veranderingen van de vegetatie in deze ecologische corridors kunnen de hele EHS raken. Om deze reden wordt er veel aandacht besteed aan de effecten van pesticiden op zoomvegetatie in deze ecologische corridors. Doel van deze studie is het leveren van een bijdrage aan de ontwikkeling van een geschikte methode om neveneffecten van pesticiden op niet-doel vegetatie te bepalen. Deze studie maakt deel uit van het LNV-onderzoeksprogramma 416, 'Gewasbescherming en milieu'.

Doelstellingen van het in dit rapport beschreven onderdeel van deze studie, zijn: 1) het modelleren van effecten van een aantal herbiciden met een verschillend werkingsmechanisme op een zogenaamde model vegetatie als gevolg van spuitdrift en 2) het vaststellen en, indien mogelijk, modelleren van een eventueel effect van fungicide drift op een niet-doel zoomvegetatie.

Om de effecten van herbiciden met een verschillend werkingsmechanisme op de biomassa van een zoomvegetatie te kunnen bepalen, werden zogenaamde model vegetaties met sublethale doseringen van Finale en Aramo bespoten. Modelvegetaties bestonden uit acht plantensoorten, waarvan 4 dicotylen en 4 monocotylen. De dosis effect relaties werden vervolgens geanalyseerd met regressie analyse. Na bespuiting met Finale konden na vier weken effecten op de biomassa van zowel de dicotylen als de monocotylen gemeten worden. Het effect op de biomassa van de dicotylen was groter dan het effect op de biomassa van de monocotylen. De ratio biomassa monocotylen/biomassa dicotylen nam bij toenemende doseringen finale toe. Na bespuiting met Aramo konden na vier weken effecten op de biomassa van de monocotylen gemeten worden. De biomassa van de dicotylen bleef onveranderd. De ratio biomassa monocotylen/biomassa dicotylen nam bij toenemende doseringen Aramo af. Het effect van competitie tussen de planten en eventuele verschillen in de mate waarmee de herbiciden het competitieve vermogen van de verschillende plantensoorten beïnvloeden kan niet uit de gemeten effecten gefilterd worden.

In deze studie is voor de modellering een nieuwe versie van EPOP gebruikt om de effecten van Finale en Aramo op zoomvegetaties te modelleren. De verkregen dosis effect relaties zijn als input voor EPOP gebruikt. EPOP gaf vervolgens de biomassa van de modelvegetatie op verschillende afstanden tot de rand van een bespoten perceel weer. Volgens dit model zal de biomassa van de modelvegetatie binnen een afstand van 12.5 m met 5% of meer afnemen na bespuiting van het veld met Finale. De biomassa van de monocotylen en dicotylen zal met 5% of meer afnemen tot op een afstand van respectievelijk 10.5 en 13 m. van de rand van het veld.
Voor Aramo liggen deze afstanden op 11.5 m voor de totale vegetatie en 12.5 m voor de monocotylen (biomassa van de dicotylen werd niet beïnvloed).

Bij hoge, sublethale Finale doseringen was de relatieve biomassareductie van de dicotylen groter dan die van de monocotylen. Bij hoge, sublethale Aramo doseringen was de relatieve biomassareductie van de monocotylen groter dan die van de dicotylen. Op basis van deze resultaten kan verwacht worden dat veranderingen in de samenstelling van een zoomvegetatie na veld bespuitingen met zowel Finale als ook Aramo kunnen optreden binnen respectievelijk 13 en 12.5 m afstand tot de rand van een perceel.

Het optreden van eventuele neveneffecten op zoomvegetaties als gevolg van fungicidendrift werd experimenteel bepaald met behulp van directe bespuitingen op *Stellaria media* met Mancozeb. Er konden geen visuele effecten of effecten op de biomassa van de planten worden vastgesteld. De gebruikte doseringen waren gelijk aan de maximum toegelaten doseringen in de praktijk. Neveneffecten op de zoomvegetatie als gevolg van fungicide drift lijken daarmee niet waarschijnlijk. Om in algemene zin te kunnen stellen dat fungicide drift geen neveneffecten met zich meebrengt, is het nodig om aanvullende experimenten te doen met verschillende plantensoorten en fungiciden met verschillende werkingsmechanismen.

Eindconclusie: Met het EPOP model en gebruik van de modelvegetatie is het mogelijk om, na bespuiting van een naastgelegen veld met herbiciden, voorspellingen te doen over veranderingen in de samenstelling van zoomvegetaties op verschillende afstanden tot de rand van het bespoten perceel.

Summary

In the past years, the interest for areas surrounding arable fields has increased significantly. These so- called field margins are part of the National Ecological Network (NEN). As a consequence, concern regarding effects of pesticides on the vegetation in these ecological corridors and thereby the whole network is articulated.
Aim of the present study is to contribute to the development of a methodology suitable for determination of pesticide side-effects on non-target vegetation. This study is part of the LNV-research programme 416, 'Gewasbeschermingsmiddelen en milieu'.

Specific goals of the present study were: 1) to model the effects of spray drift of a number of herbicides with a different mode of action on a so-called model or surrogate vegetation and 2) to model the potential effect of fungicide spray drift on non-target field boundary vegetation.

The effects of sub-lethal concentrations of two herbicides, Finale (glufosinate-ammonium) and Aramo (tepraloxydim), on the biomass of a model vegetation were studied in order to assess direct injury and recovery. Model vegetations were grown in pots and consisted of eight weed species; *Poa annua, Echinochloa crus- galli , Elymus repens, Panicum milliaceum* (four monocotyledons) and *Solanum nigrum, Stellaria media, Chenopodium album* and *Centaurea cyanus* (four dicotyledons). Dose-effect relationships were analysed with regression analysis.
Effects of Finale on the biomass of both monocotyledons as well as dicotyledons could be measured four weeks after treatment. The biomass of dicotyledons was more affected than the biomass of monocotyledons. At increasing glufosinate ammonium dosages the relative amount of biomass of the dicotyledons decreased, whereas the relative amount of biomass of the monocotyledons increased.
Effects of Aramo on the biomass of monocotyledons could be measured four weeks after treatment. Dicotyledons remained unaffected. At increasing tepraloxydim dosages the relative amount of biomass of the monocotyledons decreased, whereas the relative amount of biomass of the dicotyledons increased.
The possible effects of competition between plant species on the measured effects and different responses in competitive ability of the species as a result of herbicide spraying are discussed. As a result recommendations on future research set-ups are made.

An updated version of EPOP was used to model the effects of spray drift of Finale and Aramo on the model vegetations. The dose-effect relationships were used as input data for EPOP and modelled effects were represented as amount of vegetation biomass at several distances from the (sprayed) field edge. It was modelled that the total model vegetation biomass was reduced by 5% or more within 12.5 m from the field edge after spraying with Finale. These distances were 13 m for dicotyledons and 10.5 m for monoctyledons in the model vegetations.
For Aramo these distances were 11.5 m and 12.5 m for total vegetation and monocotyledon biomass respectively. (Biomass of dicotyledons was uneffected by Aramo).

It was concluded that shifts in vegetation composition can be expected in the field boundary after spraying a field with either Finale or Aramo. At high (sub-lethal) dosages of Finale the relative dicotyledon biomass was reduced more than the relative amount of monocotyledon biomass and, as a result, a shift in vegetation composition from dicotyledons to monocotyledons can be expected. According to EPOP this shift will occur within 13 m from the field edge. At high (sub-lethal) dosages of Aramo the relative monocotyledon biomass was reduced more than the relative amount of dicotyledon biomass and, as a result, a shift in vegetation composition from monocotyledons to dicotyledons can be expected. According to EPOP this shift will occur within 12.5 m from the field edge.

The potential effects of fungicide spray drift on non-target field boundary vegetation was estimated with results of an experiment in which individual *Stellaria media* plants were sprayed with mancozeb. No visual effects or effects on the biomass (fresh or dry weight) of Mancozeb treatments on *S. media* plants were found. Applied dosages ranged from 1250 to 5000 g ai/ha. These dosages are equal to the maximum allowed dosages in apple and flowers, respectively. It is therefore not likely that sprayed dosages of fungicides are able to affect plants. However, more studies with different plant species and fungicides with different mode of actions are necessary to be able to exclude possible effects.

With the EPOP model and the model vegetation approach it is possible to predict alterations in the vegetation composition at different distances from the field boundary.

1. Introduction

In the past years, interest for areas surrounding arable fields has increased significantly. These so- called field margins are part of the National Ecological Network (NEN). This NEN forms ecological corridors connecting nature reserves in the Netherlands.
As a consequence, concern regarding the effects of pesticides on the vegetation in these ecological corridors and thereby the whole network is articulated. Although several studies (Luken, Beiting *et al.*, 1993; Marrs, Frost *et al.*, 1993; Seefeldt, Jensen *et al.*, 1995; Fletcher, Pfleeger *et al.*, 1996; Pywell, Nowakowski *et al.*, 1996; De Jong & Udo de Haas, 2001; Franzaring, Kempenaar *et al.*, 2001; De Snoo, Tamis *et al.*, 2003; Follak & Hurle 2004) were aimed at effects on non-target plants, these effects are at this moment not well documented. For a large part information on these effects and methodologies to determine these effects are lacking.

Aim of the present study is to contribute to the development of a methodology suitable for determination of pesticide side-effects on non-target vegetation. This study is part of the LNV-research programme 416, 'Gewasbeschermingsmiddelen en milieu'.

In the first phase of this study (Riemens, Davies *et al.*, 2004) the EPOP-model (Effects of Pesticides On Plants) was presented. The model links dose-response relationships to information on spray drift. To date the single plant approach was used; dose response relationships of three herbicides were determined by means of available data (from literature and unpublished data from PRI). Plant species used for determination of the dose-effect relationship differed for the herbicides. These dose response relationships were used to model the effect of those herbicides on these plants at several distances from the sprayed field. Information on spray drift was obtained from the IDEFICS-model (Van de Zande, Holterman *et al.*, 1995; Holterman, Van de Zande *et al.*, 1997).
It was shown that plants were affected by modelled herbicide concentrations deposited in field edges after spraying directly.
Individuals may however react differently in a vegetation. Different plant species may differ in sensitivity to the herbicides and thereby the competitive ability of one species may be influenced more then that of another during a certain period of time (Follak & Hurle, 2004).
Besides, individual plant species in a vegetation may be exposed to pesticides differently as single plants in a pot.

The main aim of the present study was to simulate a vegetation and model the influence of a number of herbicides with a different mode of action on this vegetation. Model vegetations were grown in pots and exposed to sub-lethal concentrations of two herbicides in order to assess injury and recovery. Effects in turn were related to the simulated pesticide doses at increasing distances to the field boundary. With these results the potential effects of herbicide spray drift on recovery and competitive ability of non-target field boundary vegetation was estimated.

Besides, the potential effects of fungicide spray drift on non-target field boundary vegetation was estimated with results of a similar experiment in which individual *Stellaria media* plants were sprayed with mancozeb.

2. Materials and methods

The effects of two herbicides on model vegetations and the effects of a fungicide on a dicotyledon were determined. The approach is described in this chapter.

2.1 Plants

2.1.1 Vegetations

Model vegetations were grown in 5 L. pots, each filled with 8 different plant species. Each vegetation consisted of four monocotyledons and four dicotyledons which are described in Table 1. Pots were filled with a peat : sand mixture (2:1). All plant species, except *Elymus repens*, were seeded directly into the 5 L. pots. Since *E. repens* reproduces vegetatively, small pieces of the root systems were placed in the pots. *Stellaria media* seeds were seeded four days after the other seeds, so that emergence of all species would coincide. Monocotyledons and dicotyledons were placed alternately in the pots. A number of seedlings was removed after emergence, untill eight plants of each species remained in the pots. Vegetations were grown in a greenhouse with a day-night temperature of 18 - 12 °C and a light-dark period of 16-8 h untill spraying. Experiments were performed during May and June.

Table 1. Monocotyledons and dicotyledons used to simulate a vegetation.

	English	Latin	Abbreviation	Family
Monocotyledons	Annual bluegrass	*Poa annua*	poaan	Graminae
	Barnyard grass	*Echinochloa crus- galli*	ech-cg	
	Couch grass	*Elymus repens,* also called *Agropyron repens* or *Elytrigia repens*)	elyre	
	European Millet, also called Broomcorn Millet, Common Millet, Hog Millet, Wild-proso Millet	*Panicum milliaceum*	panmi	
Dicotyledons	Black nightshade	*Solanum nigrum*	solni	Solanacea
	Chickweed	*Stellaria media*	steme	Caryophyllaceae
	Common lambsquarters or Fat hen	*Chenopodium album*	cheal	Chenopodiacae
	Cornflower	*Centaurea cyanus*	cency	Compositae

2.1.2 Stellaria media

S. media plants were grown in 0,5 l pots. Plants were grown on a peat : sand mixture (2:1) in a greenhouse with a day-night temperature of 18 - 12 °C and a light-dark period of 16-8 h untill spraying. Experiments were performed in February and March.

2.2 Treatments

2.2.1 Herbicides

One month old plants were sprayed with two herbicides, either glufosinate ammonium (Finale) or tepraloxydim (Aramo). Glufosinate-ammonium is used as a herbicide to control dicotyledons as well as monocotyledons, whereas tepraloxydim is specifically used to control grasses. The herbicides were sprayed in an experimental spray chamber with Birchmeier nozzles (1.2 mm) with sub-lethal dosages (Table 2) and a spray volume of 400 l/ha. Two days after treatment the first visual symptoms such as colouration of the leafs were described.

Table 2. Applied dosages (l/ha) of Aramo and Finale on model vegetations.

Aramo (50 g active ingredient/l) n=4	Finale (150 g active ingredient/l) n=4
0	0
0.02	0.004
0.1	0.2
0.2	0.4
1	2
2	4

Four weeks after treatment the fresh and dry weight of the above ground plant parts was determined. For each pot, the total weight of the eight plants belonging to one species was determined. Subsequently the average weight of one species was determined for each dose (n=4) and analysed with regression analysis (Genstat 7th edition).

The dose response curves were used to relate the effect of simulated pesticide dosages at increasing distances to the field boundary to the weight reduction of the plants. This was done as described in Riemens, Davies *et al.*, 2004 using the EPOP-model.

To be able to show changes in the composition of the vegetations caused by the herbicides, the ratio between the fresh weight of the monocotyledons and the fresh weight of the dicotyledons was plotted against the log dose.

2.2.2 Fungicide

To get an impression of the possible effects of a fungicide on non-target organisms such as vegetation surrounding a field, *S. media* plants (n=5) were sprayed with a fungicide, Mancozeb (Dithane M45), three weeks after sowing. *S. media* is a dicotyledon belonging to the caryophyllaceae. Mancozeb contains dithiocarbomates and is used as a fungicide in orchards (apple and pear), onion, asperges, potatoe, flower bulbs and cut flowers. The fungicide was sprayed in an experimental spray chamber with Birchmeier nozzles (1.2 mm) that delivered 400 l/ha. The maximum allowed dosages range from 1286 g a.i./ha in apple to 2475 g a.i./ha in flowers. Dosages in this experiment were 0, 1250, 2500, 3750 en 5000 g a.i./ha.
Two weeks after treatment the fresh and dry weight of the aboveground plant parts was determined. The fresh and dry weight was plotted against the dosages and analysed with regression analysis (Genstat 7th edition).

2.3 Selection of effect parameter

End points suitable for determining effects on vegetation composition are the biomass and seedproduction of the species in the vegetation. Since the aim was to model the effect of sub-lethal dosages, mortality of the plants will not be noticed. The amount of visible damage will not give any information on recovery of the plants or other factors such as competitive ability and thereby no information on the development of a vegetation. Photosynthesis can only be measured (by means of PPM) within a short range of time after application and is therefore not suitable for determining shifts in vegetation composition.
Since the methodology should eventually be suitable for determining herbicide side-effects on non-target vegetation by means of a relatively quick greenhouse experiment, the biomass was chosen as an endpoint.

There is no literature available on a possible difference between the suitablilities of the parameters fresh and dry weight to determine the long term effect of herbicides.
In the experiments, both the dry and fresh weight of the shoots were measured to determine which parameter is most suitable for application. Differences in observed responses between fresh weight and dry weight measurements were however very small.

It was decided to choose the fresh weight as the effect parameter that will be discussed and analysed. It is less time consuming to measure this parameter in future research.

The fresh weight of the shoots was also used in a study by (De Jong & Udo de Haas, 2001) to determine the effect of different herbicides on *Brassica napus* and *Poa annua*, three weeks after treatment.

3. Up-date of EPOP

New insights on spray drift led to the adjustment of the IDEFICS model. Since EPOP (Riemens, Davies *et al.*, 2004) is based on the IDEFICS model, changes in IDEFICS have to be incorporated into a new EPOP version.
The reference situation for IDEFICS used to determine the new parameters a and b for EPOP version 2 is described in Table 3.

Table 3. Reference situation to determine parameters from IDEFICS.

IDEFICS, 2004, scenario SC495, IDEFICS version: v 3.1	
Crop height (m)	0.5
Boom height (m)	0.5 above crop
Nozzle type	Teejet XR11004 (class Medium spray quality) frequently used in the Netherlands (pers. comm. Holterman)
Spray pressure (kPa)	300
Liquid consumption (l/ha)	300
Distance outer nozzle from crop edge (m)	0.5
Windspeed (m/s)	3
Relative humidity	60
Temperature	15
Atmospheric stability	neutral

The deposition results (Figure 1) from IDEFICS for this reference situation were analysed with regression analysis (Genstat 7th edition) and parameters for EPOP version 2 were determined as a=21.923 and b=-0.35172. This new EPOP version is used for data analysis in this report.

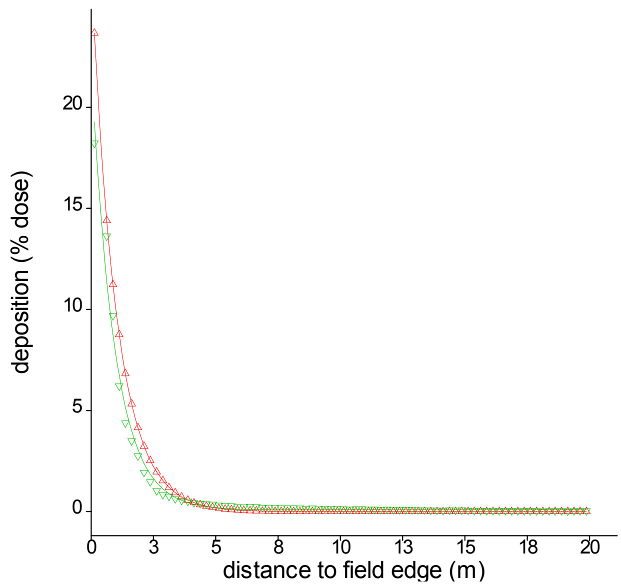

Figure 1. IDEFICS deposition results for the reference situation used in EPOP version 1: a=26.8, b=0.37 (red) and the situation used in EPOP version 2 (this report): a=21.9, b=-0.35 (green).

4. Results

4.1 Dose effect relationships

4.1.1 Glufosinate-ammonium (Finale)

One month old vegetations were sprayed with 6 different dosages of Finale. Two days after treatment the first visual symptoms such as colouration of the leaves were observed (Table 4).

Table 4. Visual symptoms, observed two days after treatment with glufosinate-ammonium (Phytotox). Dosages in l/ha.

Finale (150 g active ingredient/l) n=4	Visual symptoms
0	None
0.004	None
0.2	Poaan: none
	Elyre, Cheal, Solni, Steme: yellow spots
	Panmi, Ech-cg: yellow leaftips
	Cency: yellow spots and wilting
0.4	All species yellow spots and wilting
2	All species yellow spotsand wilted
4	All species yellow/brown spots and wilted

Four weeks after treatment the fresh and dry weights of the aboveground plant parts were determined (Appendix I, Tables 1 and 2). The fresh weight is used as the effect parameter and is shown in this chapter (see also paragraph 2.3), results of the dry weight are shown in Appendix I (Figures 1-8, 17 and 19-21).

The fresh weight was analysed with regression analysis (Genstat 7th edition). After four weeks the weight of all the individual plant species in the vegetation was still affected by the glufosinate-ammonium (Appendix I, Figures 9-16). The fresh weight (Figures 2-4) of the total vegetation, of the dicotyledons and the monocotyledons was plotted against the log dose.

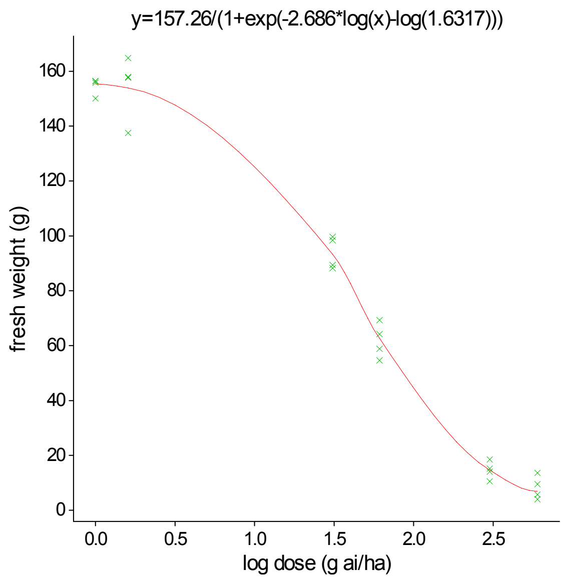

Figure 2. Dose-effect relationship of total vegetation sprayed with Finale. Fresh weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

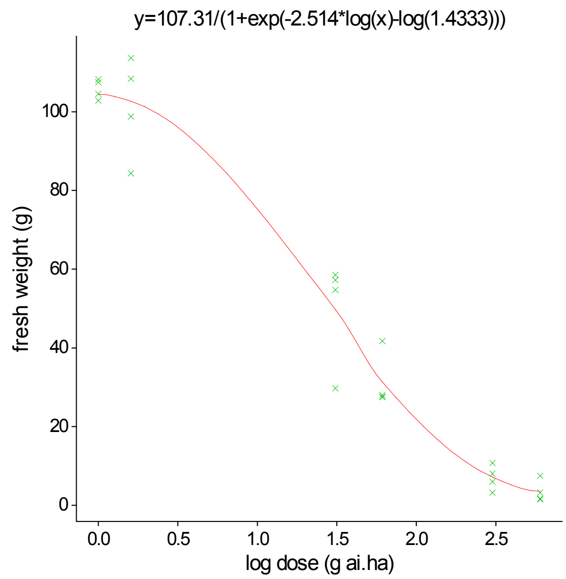

Figure 3. Dose-effect relationship of dicotyledons sprayed with Finale. Fresh weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

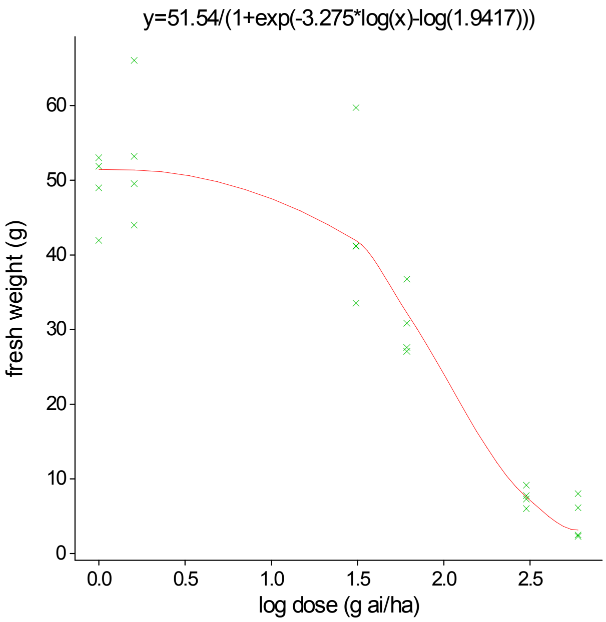

Figure 4. Dose-effect relationship of monocotyledons sprayed with Finale. Fresh weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

To be able to show expected changes in the composition of the vegetation caused by the herbicides, the ratio between the fresh weight of the monocotyledons and the dicotyledons was plotted against the log dose (Figure 5).

This graph shows that although both the monocotyledons as well as the dicotyledons were affected by the glufosinate ammonium (Figures 3 and 4), they were not effected or did not recover to the same extent. Different species in the model vegetations were influenced at different concentrations. It is likely that the competitive ability of some species will be affected by the herbicides to another extent than the ability of others (Follak & Hurle, 2004).

Therefore, the most sensitive species will be affected at greater distances from the field edge, and are likely to be outcompeted by less-sensitive species. In the unsprayed vegetation the ratio (fresh weight monocotyledons)/(fresh weight dicotyledons) was smaller then one, or in other words a larger part of the vegetation biomass consisted of dicotyledons. This ratio changes with increasing glufosinate ammonium dose. So, if dosages of glufosinate ammonium are high enough, the biomass composition of a vegetation can be changed as a result of herbicide application. This result is consistent with the trends found in a field study in which the amount of dicotyledons and total vegetation coverage decreased with increasing glufosinate ammonium dosage and the amount of monocotyledons increased. Effects, although not significant, in that study were measured in spring, in the year after summer herbicide applications (Snoo, Tamis *et al.*, 2003).

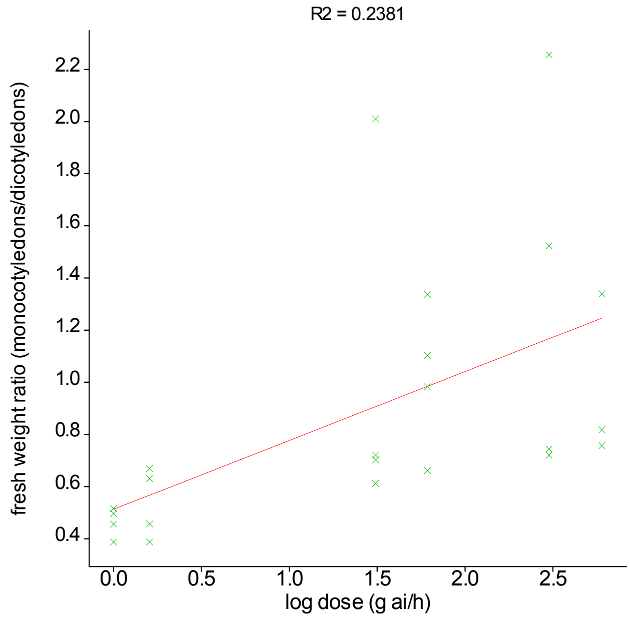

Figure 5. *The ratio between the fresh weight of the monocotyledons and dicotyledons, plotted against the log dose for glufosinate-ammonium.*

4.1.2 Tepraloxydim (Aramo)

One month old vegetations were sprayed with 6 different dosages of Aramo. Two days after treatment the first visual symptoms such as colouration of the leafs were described (Table 5).

Table 5. *Visual symptoms, observed two days after treatment with tepraloxydim.*

Aramo (50 g active ingredient/l) n=4	Visual symptoms
0	None
0.02	None
0.1	None
0.2	Panmi yellow spots
1	Panmi yellow spots
2	Panmi yellow spots

Four weeks after treatment the fresh and dry weights of the aboveground plant parts were determined (Appendix II, Tables 1 and 2). The fresh weight is used as the effect parameter and shown in this chapter (see also paragraph 2.3), results of the dry weight are shown in Appendix II (Figures 1-4, 10 and 11-13).

The fresh weight was analysed with regression analysis (Genstat 7th edition). After four weeks the weight of all the individual monocotyledons in the vegetation was still affected by the tepraloxydim (Appendix II, Figures 5-8).
The fresh weight (Figures 6-8) of the total vegetation, of the dicotyledons and the monocotyledons was plotted against the log dose.

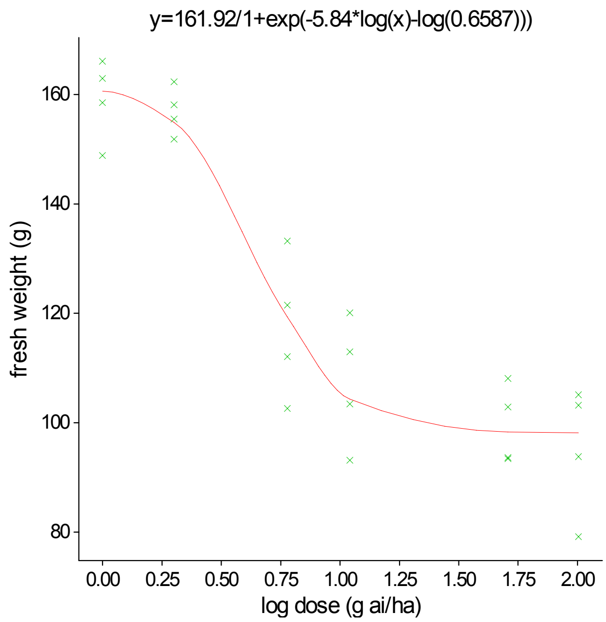

Figure 6. Dose-effect relationship of total vegetation sprayed with aramo. Fresh weight (g per plant) was plotted against tepraloxydim dose (g ai/ha). x= observed value. Fpr<0.001

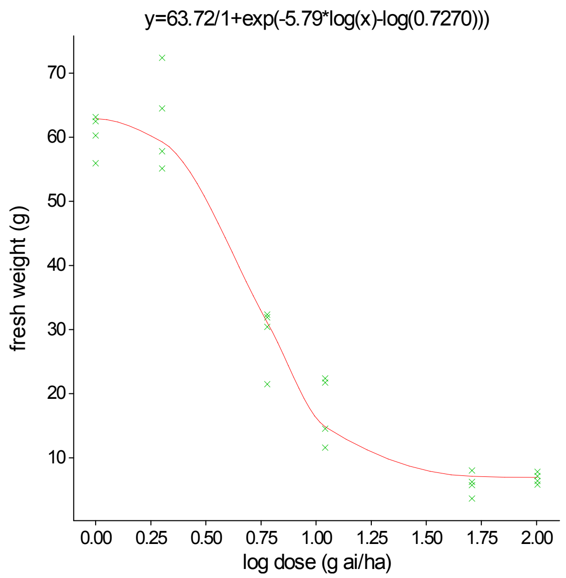

Figure 7. Dose-effect relationship of monocotyledons sprayed with aramo. Fresh weight (g per plant) was plotted against tepraloxydim dose (g ai/ha). x= observed value. Fpr<0.001.

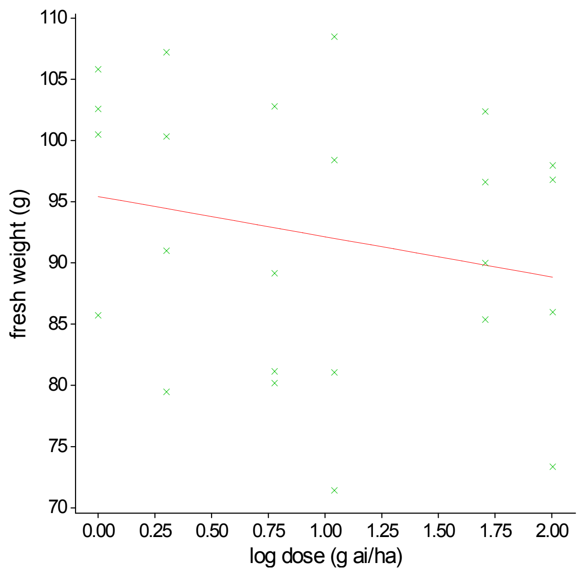

Figure 8. Dose-effect relationship of dicotyledons sprayed with aramo. Fresh weight (g per plant) was plotted against tepraloxydim dose (g ai/ha). x= observed value. Fpr=0.642.

The fresh weight of the monocotyledons was reduced by the tepraloxydim concentrations. No effects were found for the dicotyledons.

To be able to show expected changes in the composition of the vegetation caused by Aramo, the ratio between the fresh weight of the monocotyledons and the dicotyledons was plotted against the log dose (Figure 9).

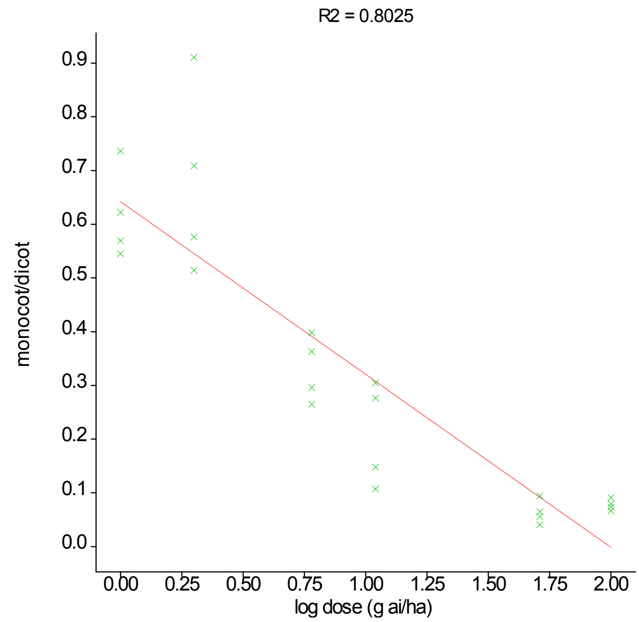

Figure 9. The ratio between the fresh weight of the monocotyledons and dicotyledons, plotted against the log dose.

This figure shows that although only the monocotyledons were effected by the tepraloxydim and the biomass of the dicotyledons remained constant, the composition of the vegetation changes with increasing dose.

4.2 Effect on vegetation in field boundaries (EPOP)

4.2.1 Glufosinate-ammonium (Finale)

EPOP was used to determine the deposition of glufosinate ammonium per m^2 at different distances from the field edge for the recommended dosage in potatoes; 3 l/ha (Crijns, Galema *et al.*, 2001) (Figure 10).

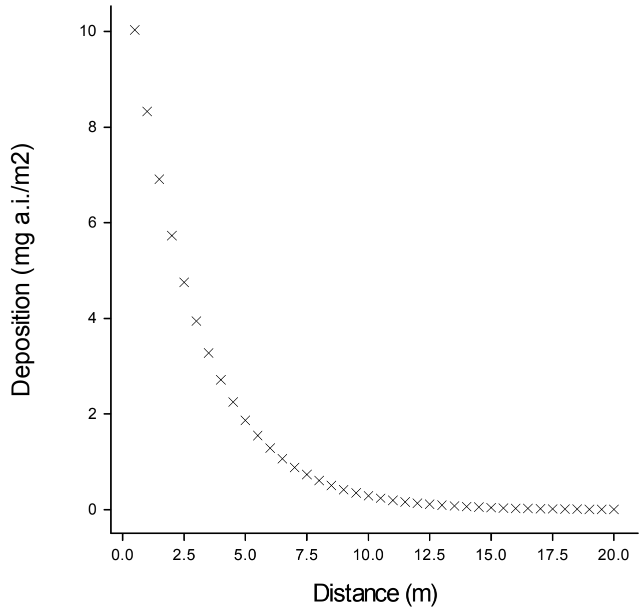

Figure 10. *Deposition of Glufosinate ammonium at different distances from the field edge, calculated by EPOP at the field dosage of 3 l/ha, 150 g a.i./l.*

Information on the deposited glufosinate ammonium (Figure 10) and the dose-effect relationships (Figures 2-4) were used to model herbicide concentrations in field edges and corresponding fresh weight four weeks after treatment. The results for the individual plant species are shown in Appendix I, Figure 18. The results for the total vegetation, the dicotyledon and the monocotyledon weight are shown in Figure 11.

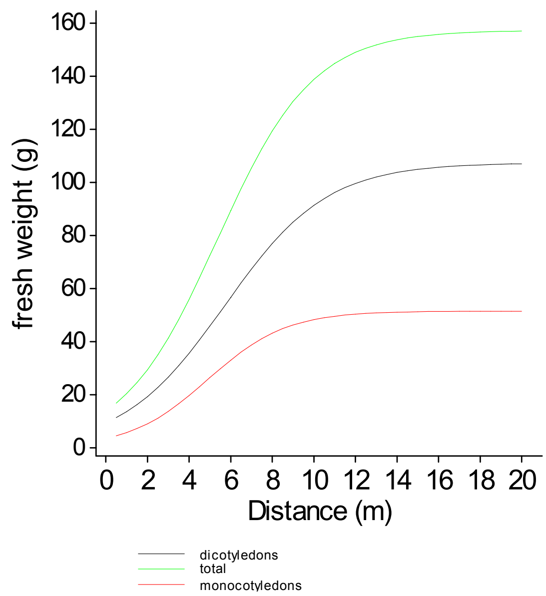

Figure 11. *Fresh weight of above ground total vegetation, dicotyledons and monocotyledons plotted against the distance to the field edge for the recommended dosage (3 l/ha) Finale (150 g glufosinate-ammonium/l).*

The 5% effect dosages (dosage at which max. 5% of the weight was reduced) differed not only between the species but also between the total vegetation, dicotyledons and monocotyledons (Table 5, Appendix I, Table 3). The distance above which the biomass of the total vegetation was reduced by (less than) 5% was 12.5 m. For the dicotyledons the distance is 13 m and for monocotyledons 10.5 m (Table 6).
Or in other words, the different species are influenced at different concentrations, thus at different distances from the field edge. This will likely result in local shifts in speciescomposition.
This is also shown in Figure 5 for the monocotyledons and dicotyledons; at high dosages (thus large distances) the ratio changes in favour of the monocotyledons. In Figure 5 the biomass of the monocotyledons will even exceed the biomass of the dicotyledons if dosages are high enough. The turning point (ratio=1) for this event is according to Figure 5 125 g ai/ha (12,5 mg/m^2). However, the highest deposited dose calculated by EPOP after spraying the recommended dose of 3 l/ha is lower; 10,0336 mg/m^2 (Appendix I, Table I-3) at 0,5 m from the field edge. This means that the dose at which the ratio between monocotyledons and dicotyledons is exceeding one, will not be deposited at the distances plotted in Figure 13. Or in other words, at the recommended dose of 3 l/ha Finale, the vegetation biomass in the field margin will always consist of more dicotyledon biomass than monocotyledon biomass.

Table 6. Maximum deposited dosages (mg a.i./m^2) of Finale and corresponding distances (m) below which the total vegetation, the dicotyledons and the monocotyledons showed 5% or less weight reduction.

	Maximum deposited dosage (mg a.i./m^2) at corresponding distance (m)
	Fresh weight
Total vegetation	0.1139 at 12.5
Dicotyledons	0.0945 at 13
Monocotyledons	0.2403 at 10.5

In 2003, data that described the dose response relationship of individual *Chenopodium album* plants sprayed with glufosinate ammonium (determined four weeks after treatment) was used to model the effect on plants at several distances from the field boundary. The 5% effect dosage (dosage below which weight was reduced by 5% or less) was determined as 0.04957 mg/m^2 at a corresponding distance of 15.5 m. In the present study the 5% effect dosage was determined for all dicotyledons (as well as for *Chenopodium album* plants in the vegetation) as 0.0945 mg/m^2 at a distance of 13 m. The difference of 1.5 m between both studies can be the result of several factors. First of all, in 2003 individual plants were sprayed, whereas in 2004 vegetations were sprayed. Individuals may react differently in a vegetation. Plants may receive less herbicide due to surrounding vegetation. Another factor is the update of EPOP, in which the parameters for the deposition curve were slightly altered (Figure 1).

4.2.2 Tepraloxydim (Aramo)

EPOP was used to determine the deposition of tepraloxydim per m^2 at different distances from the field edge for the recommended dosage in potatoe to control grasses; 2 l/ha (Figure 12).

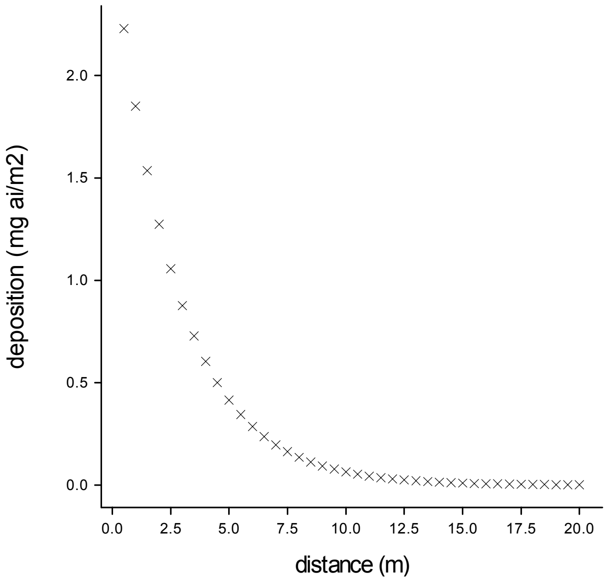

Figure 12. *Deposition of Tepraloxydim at different distances from the field edge, calculated by EPOP at the field dosage of 2 l/ha, 50 g a.i./l.*

Information on the deposited tepraloxydim (Figure 12) and the dose-effect relationships (Figures 6-8) were used to model herbicide concentrations in field edges and corresponding fresh weight four weeks after treatment. The results for the individual plant species are shown in Appendix II, Figure 9. The results for the total vegetation, the dicotyledon and the monocotyledon weight are shown in Figure 13.

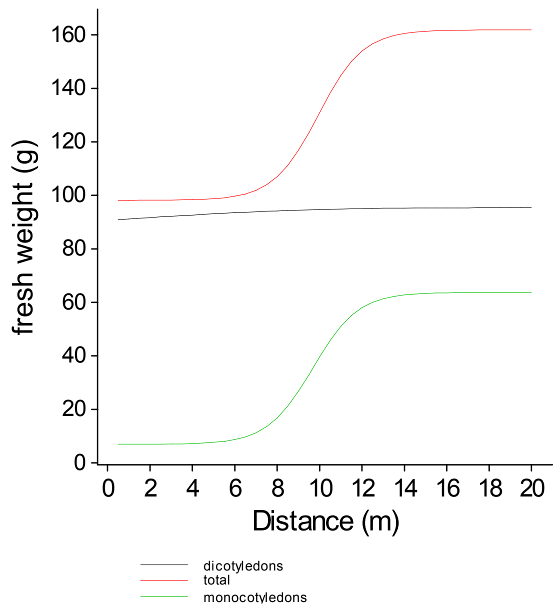

Figure 13. *Fresh weight of above ground total vegetation, dicotyledons and monocotyledons plotted against the distance to the field edge for the recommended dosage (2 l/ha) Aramo (50 g tepraloxydim/l).*

The 5% effect dosages (dosage at which max. 5% of the weight was reduced) differed not only between the species but also between the total vegetation, dicotyledons and monocotyledons (Table 8 and Appendix II, Table 3).
The distance above which the biomass of the total vegetation was reduced by (less than) 5% was 11.5 m and for monocotyledons 12.5m (Table 7).

Table 7. Maximum deposited dosages (mg a.i./m²) Aramo and corresponding distances (m) below which the total vegetation, the dicotyledons and the monocotyledons showed 5% or less weight reduction.

	Maximum deposited dosage (mg a.i./m²) at corresponding distance (m)
	Fresh weight
Total vegetation	0.3675 at 11.5
Dicotyledons	*
Monocotyledons	0.2531 at 12.5

Aramo (tepraloxydim) reduced the weight of the monocotyledons, but the weight of the dicotyledons was not reduced or increased after four weeks. Buffer zones needed to protect 95% of the total biomass present in the vegetation from tepraloxydim should be 11.5 m, buffer zones aimed at the protection of all species in the vegetation for 95% should be 14.5 m (Appendix II, Table 5).

4.3 Fungicide: mancozeb (Dithane M45)

To get an impression of the possible effects of a fungicide on non-target organisms such as vegetation surrounding a field, three weeks after sowing *S. media* plants (n=5) were sprayed with the fungicide, Mancozeb (Dithane M45) in an experimental spray chamber with Birchmeier nozzles (1.2 mm) that delivered 400 l/ha. Dosages were 0, 1250, 2500, 3750 en 5000 g a.i./ha.
Two weeks after treatment the fresh and dry weight of the aboveground plant parts were determined (Appendix III, Table 1).

The fresh and dry weight were plotted against the dosages and analysed with regression analysis (by means of Genstat 7th edition) (Figure 14).

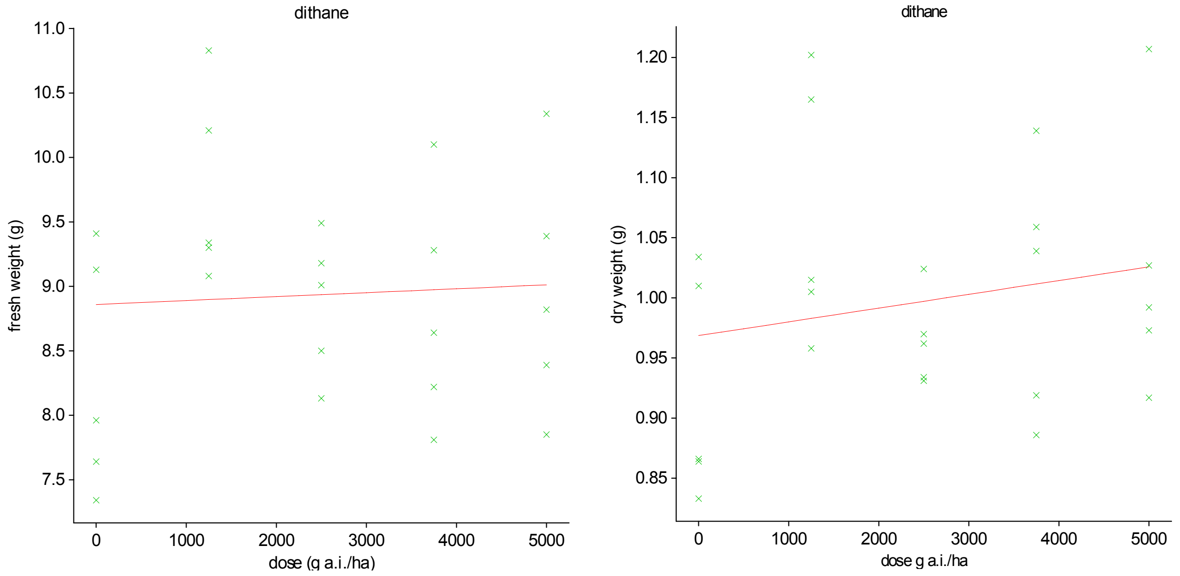

Figure 14. Dose-effect relationship of Stellaria media plants sprayed with Dithane. Fresh (left) and dry (right) weight (g per plant) plotted against mancozeb dose (g ai/ha). x= observed value.

For both the fresh (Fpr=0.770) and dry (Fpr=0.325) weight no significant differences between the dosages existed, indicating that mancozeb did not effect the biomassproduction of the plants. Plants were never visibly effected by the fungicide.

The range of in practice allowed dosages is included in the applied mancozeb dosages in this experiment and even exceeded by a factor 2. Therefore these results suggest that there will be no side-effects of possible drift of this fungicide on *S. media* plants in field boundaries. Furthermore the fact that the deposited amount of fungicide on plants in field boundaries due to drift will be lower than the applied amount in the field as calculated by EPOP (Figure 15), is strengthening this suggestion.

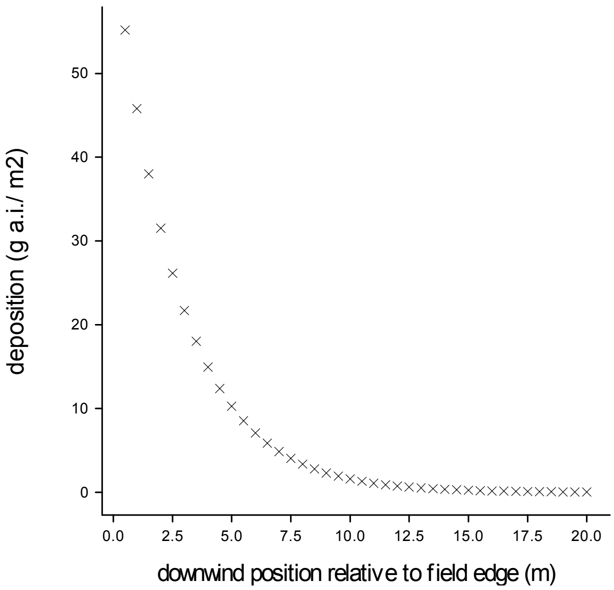

Figure 15. Deposition of Mancozeb at different distances from the field edge, calculated by EPOP. Input data: 2475 g a.i./ha, 500 g a.s./l.

5. Discussion and conclusions

Herbicides

In this study model vegetations were sprayed with two different herbicides; one specifically active on monocotyledons (Aramo) and one active on both dicotyledons and monocotyledons (Finale). Species were chosen from five different families that were easy to handle in the greenhouse. Three of these families, the Caryophyllaceae, Compositeae and Gramineae belong to the 5 most abundant families in Europe (Cole, Canning *et al.*, 1993). Besides the fact that the family is the lowest level of taxonomy that can be taken to be representative of plants in general, in many cases the response of the plants belonging to one family to a chemical is comparable. Four weeks after spraying effects on the biomass of the vegetations were measured.
Since information in literature on the optimum moment for measuring is variable and, if available, based on single plants, the timing of the measurements was based on experience in previous spraying experiments and measurements were done four weeks after treatment. The different species in the vegetations, all have a different relative growth rate. This means that the time at which the optimum effect on the biomass of the plants can be measured will probably vary between species.
According to De Jong and De Haas (2001) the best moment to measure short term effects is one week after the occurrence of the first visual effects at the highest dose. Any effects measured after this week are thought to give information on the long term effects and recovery. In our experiments two days after treatment the first visual symptoms occurred at the highest dosage. According to De Snoo, *et al.* (2003) the best moment for measuring long term effects on the biomass is at the end of the growing season. Together with the fact that some species started flowering after four weeks in some treatments and the control, it was decided to harvest the plants after four weeks.
Although earlier measurements could have given larger effects, long term effects on the biomass could still be measured and four weeks was probably a good moment to score changes in the biomass of the vegetation. Whether these measured effects are not only the result of the effect of the herbicide on the individual species, but also caused by differences in the recovery rate and the competitive ability of plant (species) can not be excluded. Therefore, the effect of the herbicides and competitive ability of the individual species need to be measured in single plant experiments.

Nevertheless, dose-effect relationships from the experiments could be used as input for the EPOP model. With the approach presented in this study, it was possible to show that differences in sensitivity of the plant species present in a vegetation can be used to predict alterations in the vegetation composition at different distances from the field boundary.

The different responses of the dicotyledons and monocotyledons, as well as the individual plant species to the different herbicides, found in this study, show the importance of agreement on the degree to which vegetation should be protected. The EPOP model shows that different criteria lead to different buffer zones.
From these results it becomes clear that the effects of herbicides on non-target vegetation are highly dependent on the species composition of the vegetation and the used herbicides. Variation in sensitivity of monocotyledons, dicotyledons and the individual species in a vegetation makes it very difficult to determine buffer zones for general situations without agreement on the acceptable damage level.
Therefore, it is important to determine standard model vegetations which can be used to determine the response of highly sensitive species within monocotyledons and dicotyledons to herbicides with different mode of actions. It would be very usefull to determine the response of sensitive plant species common in field margins to different dosages for herbicides from different classes (e.g. herbicides may be devided into classes based on their mode of action). Together with criteria describing to what degree a vegetation in the field margins should be protected these dose-effect relationships can be used to model the length of the buffer zones. The vegetation structure, for instance differences in height between the different species, can influence the deposition of the herbicides on the plants and influence the response of the total vegetation. Therefore, dose response relationships should be determined in both single plant as well as vegetation experiments.

Fungicide

Besides the effect of different herbicides on model vegetations, the effect of a fungicide, Dithane M45 (Mancozeb), on individual *Stellaria media* plants was tested. For both the fresh and dry weight no significant differences between the dosages were found, indicating that Mancozeb did not effect the biomassproduction of the plants. Plants were never visibly effected by the fungicide.
Nevertheless it is recommended that more fungicides are tested for their possible effects on vegetation. One study with one fungicide and one plant species (dicotyledon) is not enough to exclude side effects of fungicides on plants in field margins. Although it is not likely that the sprayed dosages of fungicides are able to affect plants, more studies with different plant species and fungicides with different mode of actions are necessary to be able to exclude possible effects.

Conclusions

- Effects of Finale (glufosinate-ammonium) on the biomass of both monocotyledons as well as dicotyledons could be measured four weeks after treatment. The biomass of dicotyledons was more affected than the biomass of monocotyledons. At increasing glufosinate ammonium dosages the relative amount of biomass of the dicotyledons decreased, whereas the relative amount of biomass of the monocotyledons increased. Therefore, a shift in vegetation composition (from dicotyledons to monocotyledons) may be expected at very high dosages.
- Effects of Aramo (tepraloxydim) on the biomass of monocotyledons could be measured four weeks after treatment. Dicotyledons remained unaffected. From the ratio between monocotyledon and dicotyledon biomass it becomes clear that a shift in vegetation composition can be expected. (The dicotyledons will become more dominant and the monocotyledons may disappear).
- It is impossible to exclude the competition between plant species from the measured effects or to distinguish alterations in competitive ability as a result of herbicide application with this set up. Therefore, dose effect relationships for a species should be determined in both single plant experiments as well as in model vegetations. Furthermore, the competitive ability of each species should be determined at several moments after treatment to determine the length of time the competitive ability of a species is altered.
- Fresh weight seems to be a good end point for determining the effect of herbicides on a vegetation.
- With the EPOP model and the model vegetation approach it is possible to predict alterations in the vegetation composition at different distances from the field boundary.
- Variation in sensitivity of monocotyledons, dicotyledons and the individual species in a vegetation makes it very difficult to determine buffer zones for general situations without agreement on the acceptable damage level.
- No visual effects or effects on the biomass (fresh or dry weight) of Mancozeb treatments on *S. media* plants were found. Applied dosages ranged from 1250 to 5000 g ai/ha. These dosages are equal to the maximum allowed dosages in apple and flowers, respectively. It is therefore not likely that sprayed dosages of fungicides are able to affect plants. However, more studies with different plant species and fungicides with different mode of actions are necessary to be able to exclude possible effects.

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Appendix I.
Glufosinate-ammonium

Table I-1. Fresh weight of above-ground plant parts of the eight plant species in the pots four weeks after treatment with glufosinate-ammonium (Finale).

			Fresh weight (g)										
Dose l/ha	Dose (gr.a.l./ha)	Log dose (g ai/ha)	* poaan	steme	ech-cg	solni	panmi	cency	cheal	elyre	monocot	dicot	total
0	0	0	8.19	32.41	24.19	43.07	13.26	13.21	14.12	7.39	53.03	102.81	155.84
0	0	0	9.01	49.75	18.06	30.17	11.58	12.25	15.29	10.33	48.98	107.46	156.44
0	0	0	7.14	51.63	22.23	15.71	3.5	22.31	18.53	9.06	41.93	108.18	150.11
0	0	0	6.38	52.83	15.29	33.93	19.91	10.07	7.68	10.31	51.89	104.51	156.4
0.004	0.6	0.204	6.62	25.34	18.39	33.77	17.74	12.51	12.73	10.46	53.21	84.35	137.56
0.004	0.6	0.204	9.23	46.77	19.58	22.26	5.62	25.33	19.26	9.57	44.00	113.62	157.62
0.004	0.6	0.204	9.59	60.28	11.99	28.7	28.97	4.14	5.63	15.51	66.06	98.75	164.81
0.004	0.6	0.204	5.27	60.38	12.28	15.15	17.74	21.36	11.47	14.26	49.55	108.36	157.91
0.2	30	1.491	7.65	16.41	10.96	29.49	6.57	4.59	8.04	15.97	41.15	58.53	99.68
0.2	30	1.491	1.52	18.31	8.48	22.92	13.75	12.41	1.11	9.76	33.51	54.75	88.26
0.2	30	1.491	8.28	17.15	8.13	5.35	24.94	6.04	1.17	18.37	59.72	29.71	89.43
0.2	30	1.491	2.34	15.92	11.18	31.09	13.8	0.00	10.18	13.91	41.23	57.19	98.42
0.4	60	1.785	6.38	14.81	14.94	10.64	6.12	0.00	2.02	9.3	36.74	27.47	64.21
0.4	60	1.785	3.26	9.67	9.79	11.42	5.26	6.24	0.22	8.76	27.07	27.55	54.62
0.4	60	1.785	2.78	7.28	9.34	26.67	7.86	2.22	5.54	7.62	27.6	41.71	69.31
0.4	60	1.785	4.62	4.57	14.01	19.19	0.92	3.91	0.32	11.31	30.86	27.99	58.85
2	300	2.478	2.93	1.21	1.04	0.97	0.67	0.26	0.8	2.67	7.31	3.24	10.55
2	300	2.478	1.18	1.65	4.11	7.44	0.55	0.54	1.14	1.92	7.76	10.77	18.53
2	300	2.478	4.49	1.66	2.27	1.48	0.34	2.46	0.41	2.06	9.16	6.01	15.17
2	300	2.478	0.92	2.74	1.16	0.98	0.26	3.56	0.78	3.66	6.00	8.06	14.06
4	600	2.778	0.97	1.94	0.28	0.57	0.27	0.36	0.42	0.97	2.49	3.29	5.78
4	600	2.778	5.36	0.36	0.71	0.44	0.39	0.51	0.21	1.57	8.03	1.52	9.55
4	600	2.778	0.21	0.76	0.19	0.54	0.35	0.19	0.22	1.54	2.29	1.71	4.00
4	600	2.778	2.85	6.35	1.28	0.57	0.86	0.27	0.32	1.15	6.14	7.51	13.65

*) *poaan= Poa annua, steme= Stellaria media, ech-cg= Echinogloa crus-galli, solni= Solanum nigrum, panmi= Panicum milliaceum, cency= Centaurea cyanus, cheal= Chenopodium album, elyre= Elymus repens, monocot= monocotyledons, dicot= dicotyledons.*

Table I-2. Dry weight of above-ground plant parts of the eight plant species in the pots four weeks after treatment with glufosinate-ammonium (Finale).

			Dry weight (g)										
Dose l/ha	Dose (gr.a.l./ha)	Log dose (g ai/ha)	* poaan	steme	ech-cg	solni	panmi	cency	cheal	elyre	monocot	dicot	total
0	0	0	1.465	3.529	3.711	8.885	1.964	2.415	3.964	2.091	9.231	18.793	28.024
0	0	0	1.857	5.029	2.572	5.781	1.824	2.485	4.371	2.978	9.231	17.666	26.897
0	0	0	1.712	6.699	3.083	3.195	0.689	5.569	5.214	2.634	8.118	20.677	28.795
0	0	0	1.071	5.173	2.218	6.781	3.089	2.031	2.079	3.042	9.42	16.064	25.484
0.004	0.6	0.204	1.295	2.668	2.446	5.988	2.495	2.287	3.326	2.534	8.77	14.269	23.039
0.004	0.6	0.204	2.104	6.691	2.727	4.401	0.774	5.758	5.124	2.858	8.463	21.974	30.437
0.004	0.6	0.204	1.939	7.717	1.879	5.845	4.16	0.732	1.374	4.105	12.083	15.668	27.751
0.004	0.6	0.204	0.781	6.676	1.646	2.775	2.614	3.542	2.952	3.253	8.294	15.945	24.239
0.2	30	1.491	1.498	2.147	1.529	5.419	0.835	0.469	1.979	4.542	8.404	10.014	18.418
0.2	30	1.491	0.302	2.208	1.283	4.328	2.172	2.742	0.179	2.685	6.442	9.457	15.899
0.2	30	1.491	1.884	1.713	1.187	0.926	3.473	1.248	0.204	4.672	11.216	4.091	15.307
0.2	30	1.491	0.465	2.354	1.526	5.397	2.051	0	2.569	4.171	8.213	10.32	18.533
0.4	60	1.785	1.499	1.738	2.051	1.402	1.269	0	0.423	2.33	7.149	3.563	10.712
0.4	60	1.785	0.743	1.336	1.427	1.193	0.728	0.945	0.101	2.174	5.072	3.575	8.647
0.4	60	1.785	0.612	1.187	1.426	4.436	1.098	0.427	1.359	2.238	5.374	7.409	12.783
0.4	60	1.785	1.003	0.625	2.108	3.173	0.512	0.542	0.104	2.842	6.465	4.444	10.909
2	300	2.478	0.521	0.811	0.511	0.758	0.507	0.161	0.441	0.547	2.086	2.171	4.257
2	300	2.478	0.268	0.988	0.749	1.666	0.214	0.257	0.862	0.598	1.829	3.773	5.602
2	300	2.478	0.862	0.571	0.486	0.548	0.092	0.669	0.26	0.539	1.979	2.048	4.027
2	300	2.478	0.201	0.691	0.421	0.618	0.199	0.511	0.295	1.215	2.036	2.115	4.151
4	600	2.778	0.286	0.768	0.114	0.389	0.123	0.262	0.246	0.462	0.985	1.665	2.65
4	600	2.778	0.827	0.178	0.262	0.368	0.237	0.145	0.153	0.533	1.859	0.844	2.703
4	600	2.778	0.089	0.516	0.051	0.391	0.198	0.144	0.191	0.485	0.823	1.242	2.065
4	600	2.778	0.475	0.839	0.43	0.415	0.252	0.145	0.187	0.412	1.569	1.586	3.155

**) poaan= Poa annua, steme= Stellaria media, ech-cg=Echinogloa crus-galli, solni= Solanum nigrum, panmi= Panicum milliaceum, cency=Centaurea cyanus, cheal= Chenopodium album, elyre= Elymus repens, monocot= monocotyledons, dicot= dicotyledons.*

Table I-3. EPOP-output. Fresh and dry weight of above-ground plant parts of the total vegetation, the dicotyledons and the monocotyledons in the field edge four weeks after treatment with glufosinate-ammonium (Finale) at 3 l/ha (150 g a.i./l).

		Total vegetation		Dicotyledons		Monocotyledons	
Deposition (mg a.i./m^2)	Distance (m)	fresh weight (g)	dry weight (g)	fresh weight (g)	dry weight (g)	fresh weight (g)	dry weight (g)
10.0336	0.5	16.8719	4.5455	11.4527	3.5624	4.5452	1.0380
8.3256	1	20.4415	5.2264	13.7101	3.9837	5.7720	1.2865
6.9084	1.5	24.6337	5.9834	16.3365	4.4417	7.2786	1.5833
5.7324	2	29.5004	6.8171	19.3620	4.9365	9.1004	1.9320
4.7566	2.5	35.0743	7.7262	22.8074	5.4676	11.2621	2.3345
3.9469	3	41.3603	8.7068	26.6798	6.0334	13.7707	2.7892
3.2751	3.5	48.3274	9.7520	30.9688	6.6319	16.6076	3.2909
2.7176	4	55.9020	10.8520	35.6424	7.2597	19.7238	3.8301
2.2550	4.5	63.9666	11.9947	40.6459	7.9128	23.0391	4.3935
1.8711	5	72.3641	13.1652	45.9019	8.5862	26.4484	4.9651
1.5526	5.5	80.9079	14.3477	51.3144	9.2744	29.8340	5.5280
1.2883	6	89.3982	15.5252	56.7750	9.9712	33.0817	6.0663
1.0690	6.5	97.6401	16.6813	62.1716	10.6701	36.0950	6.5668
0.8870	7	105.4610	17.8007	67.3970	11.3646	38.8058	7.0200
0.7360	7.5	112.7239	18.8700	72.3575	12.0484	41.1773	7.4209
0.6108	8	119.3347	19.8785	76.9790	12.7154	43.2021	7.7681
0.5068	8.5	125.2429	20.8179	81.2098	13.3603	44.8951	8.0634
0.4205	9	130.4376	21.6833	85.0214	13.9784	46.2862	8.3106
0.3489	9.5	134.9397	22.4722	88.4059	14.5659	47.4128	8.5149
0.2895	10	138.7930	23.1845	91.3728	15.1199	48.3147	8.6820
0.2403	10.5	142.0561	23.8222	93.9445	15.6386	49.0299	8.8174
0.1994	11	144.7944	24.3886	96.1519	16.1207	49.5929	8.9263
0.1654	11.5	147.0749	24.8883	98.0307	16.5660	50.0335	9.0135
0.1373	12	148.9621	25.3266	99.6185	16.9747	50.3768	9.0829
0.1139	12.5	150.5156	25.7089	100.9522	17.3480	50.6432	9.1380
0.0945	13	151.7890	26.0408	102.0668	17.6870	50.8494	9.1816
0.0784	13.5	152.8290	26.3279	102.9943	17.9936	51.0088	9.2160
0.0651	14	153.6760	26.5753	103.7635	18.2698	51.1316	9.2431
0.0540	14.5	154.3642	26.7878	104.3995	18.5175	51.2262	9.2644
0.0448	15	154.9222	26.9700	104.9240	18.7391	51.2990	9.2812
0.0372	15.5	155.3740	27.1258	105.3558	18.9367	51.3550	9.2943
0.0308	16	155.7394	27.2587	105.7106	19.1123	51.3980	9.3046
0.0256	16.5	156.0345	27.3720	106.0018	19.2682	51.4310	9.3127
0.0212	17	156.2727	27.4684	106.2405	19.4061	51.4564	9.3191
0.0176	17.5	156.4649	27.5504	106.4361	19.5280	51.4759	9.3240
0.0146	18	156.6198	27.6200	106.5961	19.6356	51.4908	9.3279
0.0121	18.5	156.7446	27.6790	106.7269	19.7303	51.5023	9.3310
0.0101	19	156.8451	27.7291	106.8339	19.8136	51.5110	9.3334
0.0084	19.5	156.9261	27.7715	106.9214	19.8869	51.5178	9.3353
0.0069	20	156.9913	27.8074	106.9928	19.9512	51.5230	9.3367

Figures I-1 till I-8; Dosis effect relationships for dry weight of the individual species sprayed with finale (glufosinate ammonium).

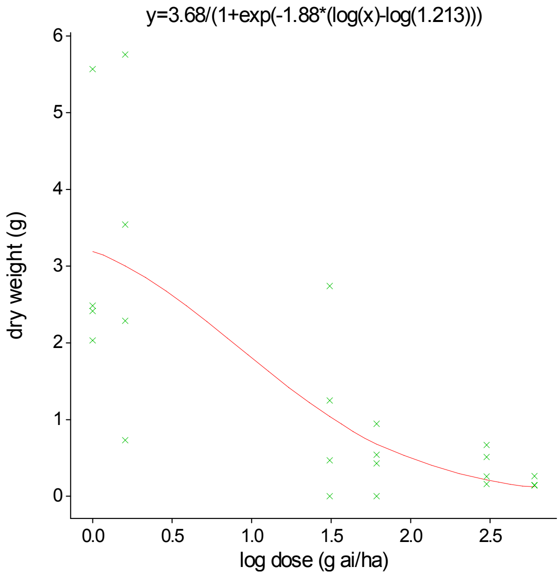

Figure I-1. Dose-effect relationship of Centaurea cyanus sprayed with finale. Dry weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

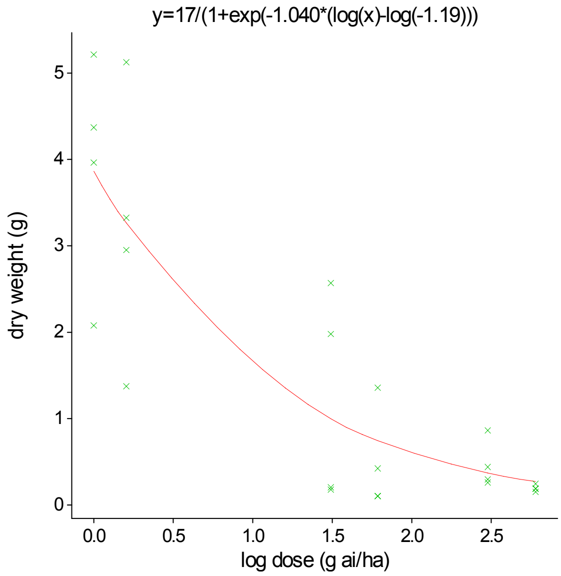

Figure I-2. Dose-effect relationship of Chenopodium album sprayed with finale. Dry weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

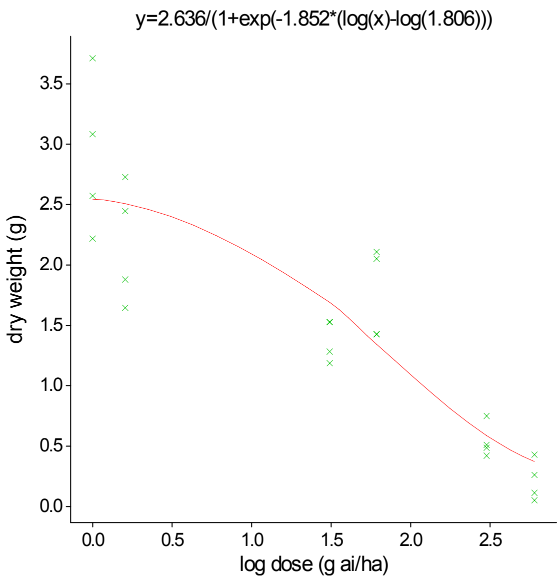

Figure I-3. Dose-effect relationship of Echinogloa crus-galli sprayed with finale. Dry weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

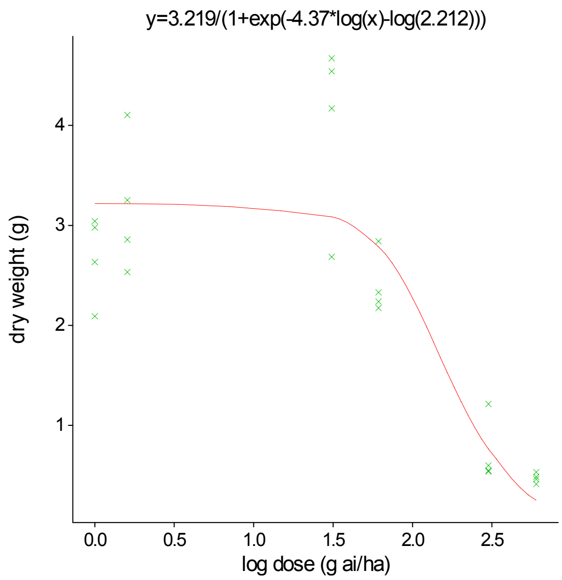

Figure I-4. Dose-effect relationship of Elymus repens sprayed with finale. Dry weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

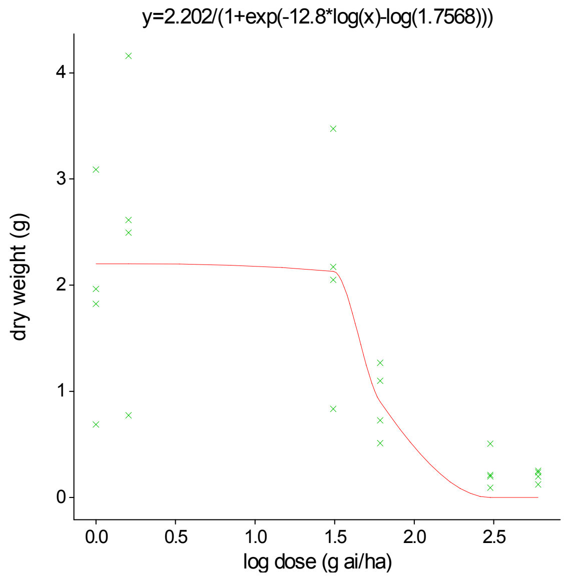

Figure I-5. Dose-effect relationship of Panicum milliaceum sprayed with finale. Dry weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

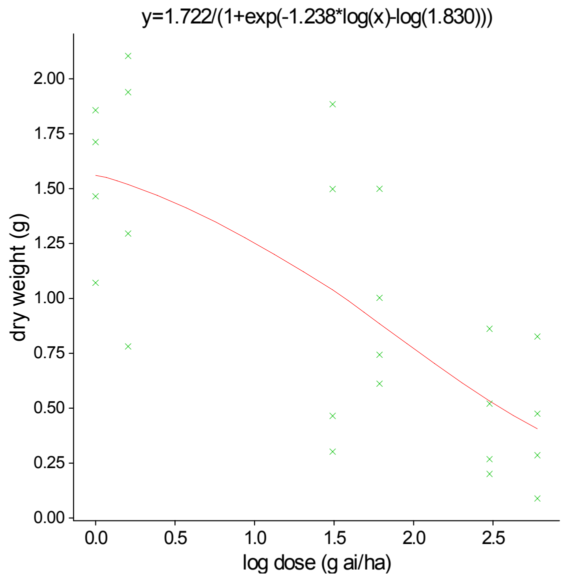

Figure I-6. Dose-effect relationship of Poa annua sprayed with finale. Dry weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

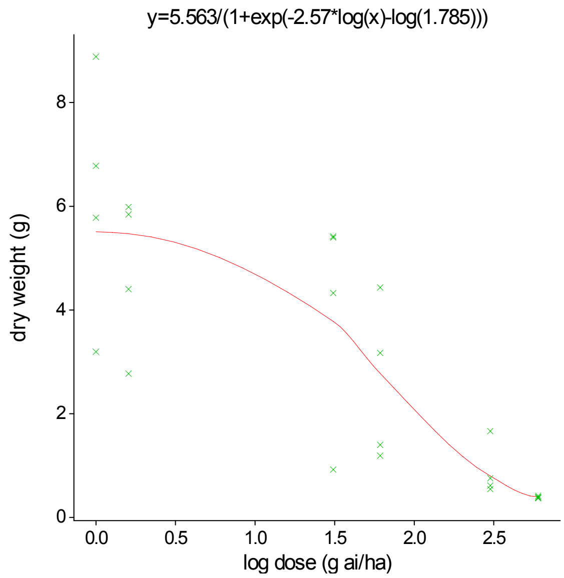

Figure I-7. Dose-effect relationship of Solanum nigrum sprayed with finale. Dry weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

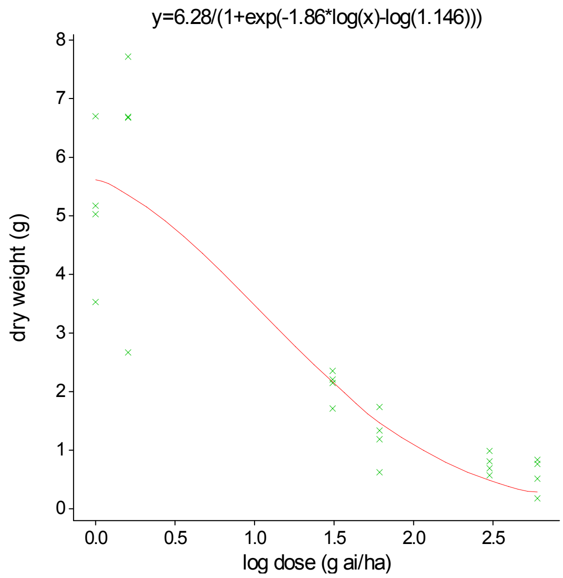

Figure I-8. Dose-effect relationship of Stellaria media sprayed with finale. Dry weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

Figures I-9 till I-16; Dosis effect relationships for the fresh weight of the individual species sprayed with finale (glufosinate ammonium).

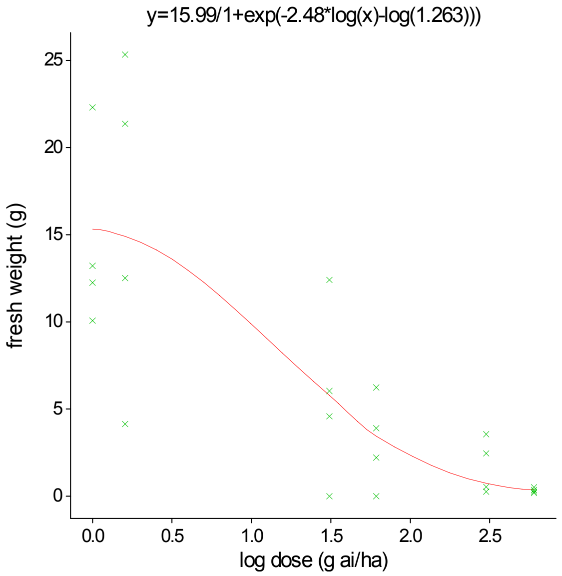

Figure I-9. Dose-effect relationship of Centaurea cyanus sprayed with finale. Fresh weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

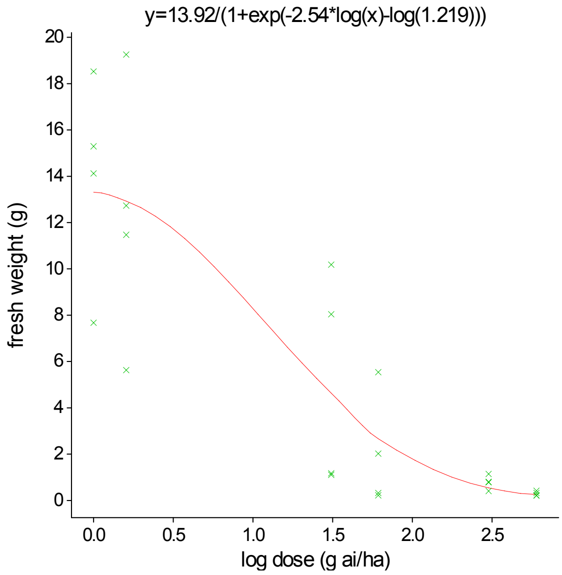

Figure I-10. Dose-effect relationship of Chenopodium album sprayed with finale. Fresh weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

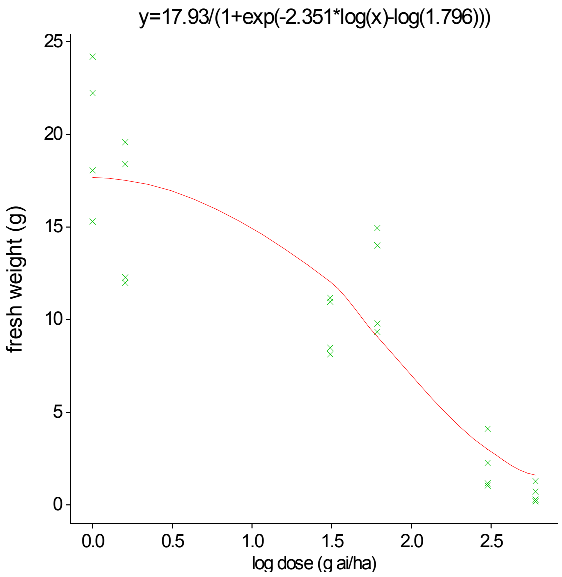

Figure I-11. Dose-effect relationship of Echinogloa crus-galli sprayed with finale. Fresh weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

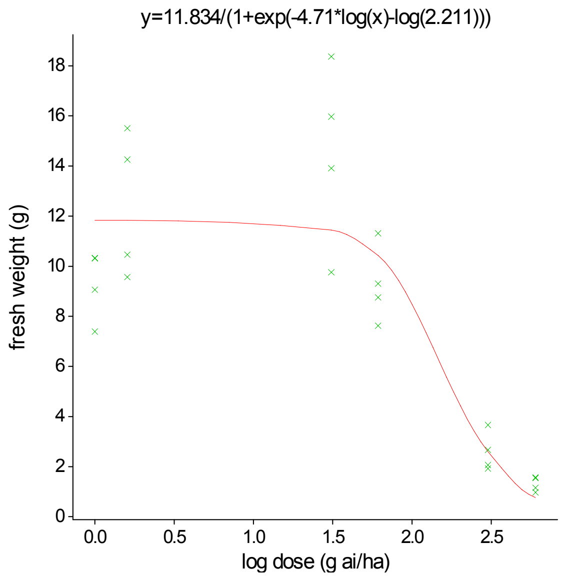

Figure I-12. Dose-effect relationship of Elymus repens sprayed with finale. Fresh weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

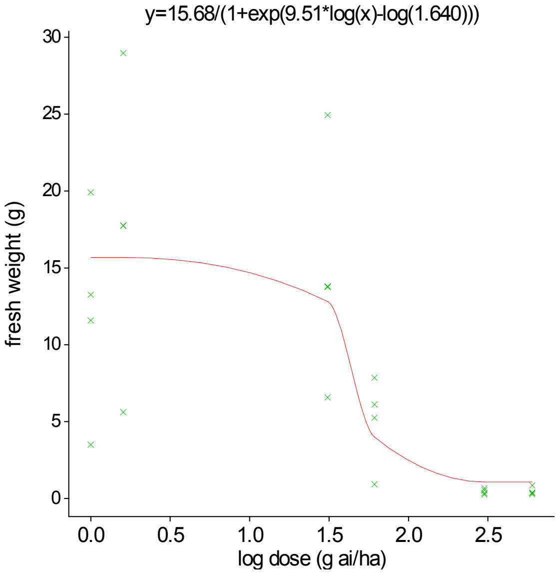

Figure I-13. Dose-effect relationship of Panicum milliaceum sprayed with finale. Fresh weight (g per plant) was plotted against inate ammonium dose (g ai/ha). x= observed value. Fpr=0.003.

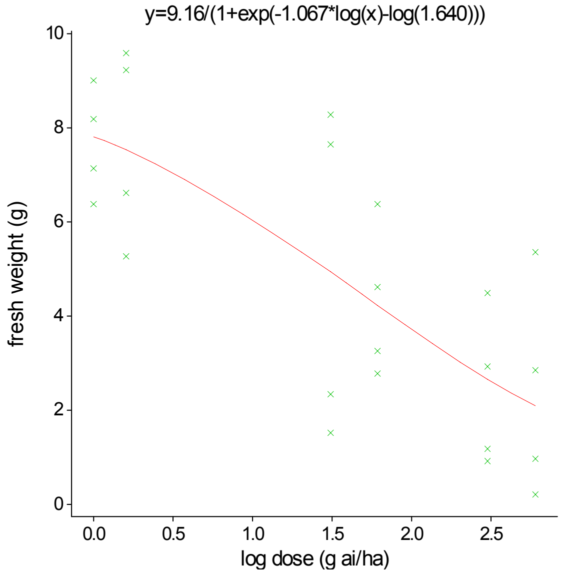

Figure I-14. Dose-effect relationship of Poa annua sprayed with finale. Fresh weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

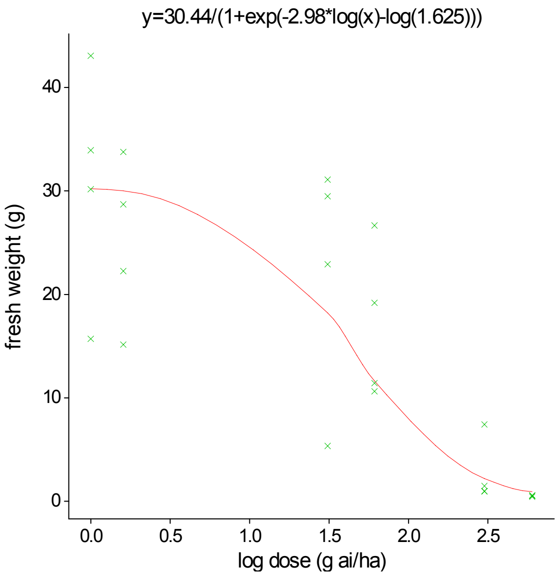

Figure I-15. Dose-effect relationship of Solanum nigrum sprayed with finale. Fresh weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

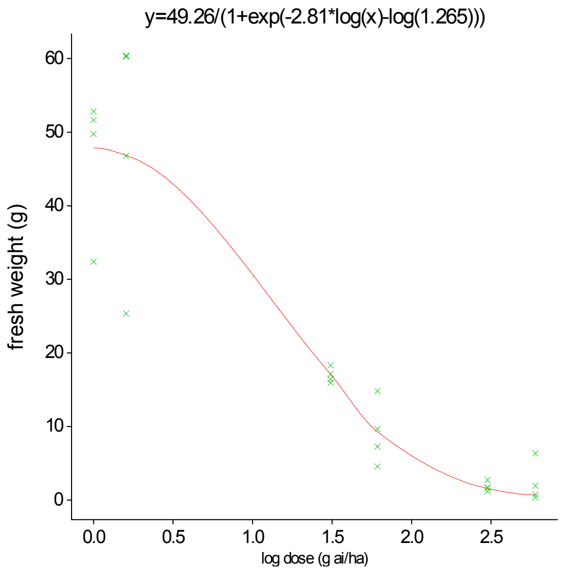

Figure I-16. Dose-effect relationship of Stellaria media sprayed with finale. Fresh weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

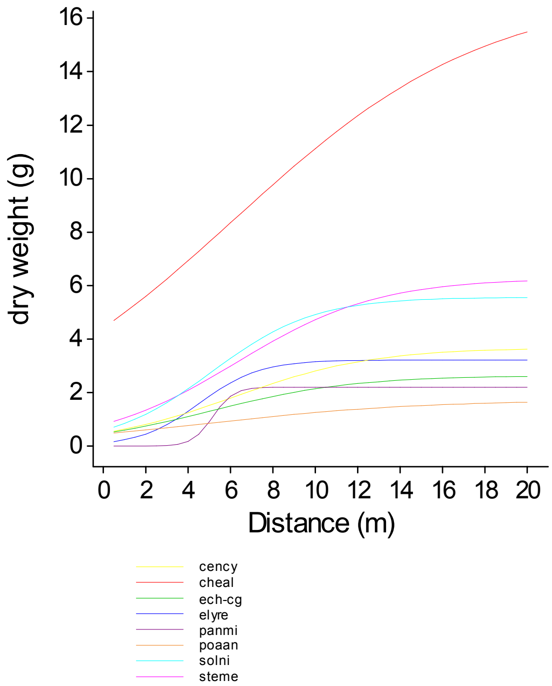

Figure1-17. Dry weight of above ground plant parts of all individual species in the vegetation plotted against the distance to the field edge for the recommended dosage (3 l/ha) Finale (150 g glufosinate-ammonium./l).

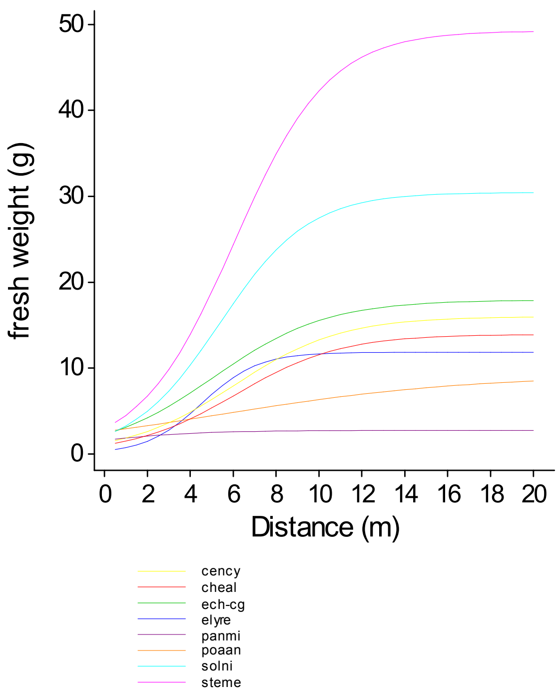

Figure1-18. Fresh weight of above ground plant parts of all individual species in the vegetation plotted against the distance to the field edge for the recommended dosage (3 l/ha) Finale (150 g glufosinate-ammonium./l).

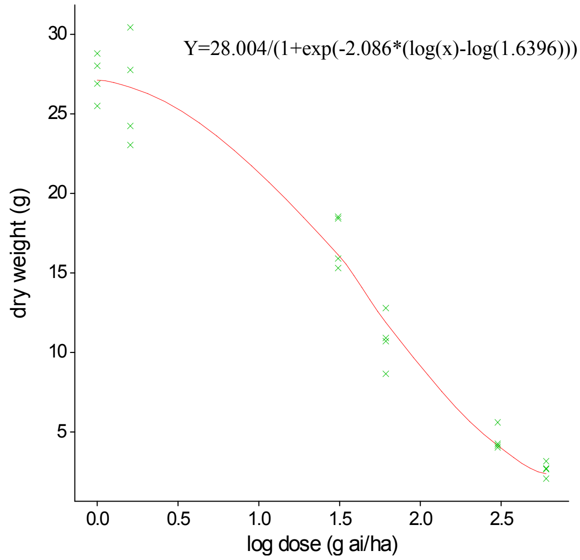

Figure I-19. Dose-effect relationship of total vegetation sprayed with finale. Dry weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

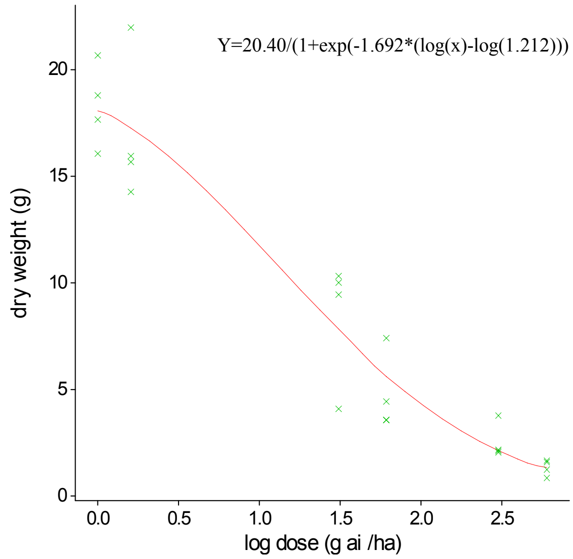

Figure I-20. Dose-effect relationship of dicotyledons sprayed with finale. Dry weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

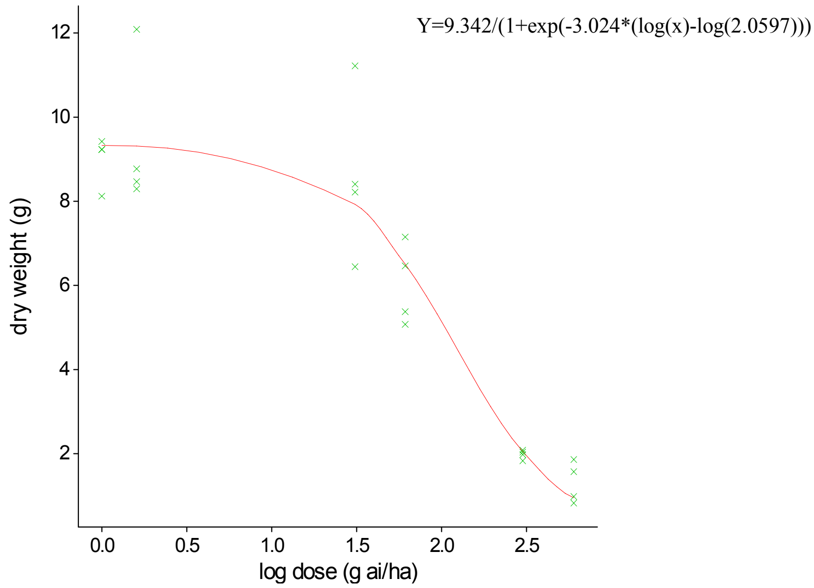

Figure I-21. Dose-effect relationship of monocotyledons sprayed with finale. Dry weight (g per plant) was plotted against glufosinate ammonium dose (g ai/ha). x= observed value. Fpr<0.001.

Table I-4. EPOP-output. Fresh weight of above-ground plant parts of the individual plant species in the field edge four weeks after treatment with glufosinate-ammonium (Finale) at 3 l/ha (150 g a.i./l).

Deposition (mg ai/m^2)	Distance (m)	Solni	Steme	Cency	Cheal	Ech-cg	Elyre	Panmi	Poaan
10.0336	0.5	2.6358	3.6439	1.5495	1.2396	2.6397	0.5131	1.7243	2.7634
8.32564	1	3.2782	4.4908	1.8544	1.4926	3.0980	0.7368	1.8498	2.9330
6.908413	1.5	4.0544	5.5107	2.2101	1.7898	3.6171	1.0489	1.9665	3.1081
5.732432	2	4.9807	6.7275	2.6214	2.1361	4.1985	1.4756	2.0732	3.2880
4.756632	2.5	6.0699	8.1629	3.0921	2.5354	4.8417	2.0430	2.1693	3.4724
3.946937	3	7.3288	9.8337	3.6244	2.9904	5.5437	2.7702	2.2547	3.6607
3.275072	3.5	8.7549	11.7487	4.2183	3.5020	6.2985	3.6595	2.3296	3.8523
2.717575	4	10.3344	13.9052	4.8712	4.0684	7.0972	4.6868	2.3946	4.0465
2.254977	4.5	12.0407	16.2855	5.5773	4.6853	7.9281	5.7978	2.4506	4.2427
1.871125	5	13.8348	18.8561	6.3275	5.3450	8.7775	6.9174	2.4985	4.4401
1.552614	5.5	15.6687	21.5670	7.1098	6.0368	9.6303	7.9677	2.5392	4.6381
1.288321	6	17.4895	24.3555	7.9095	6.7477	10.4711	8.8892	2.5735	4.8359
1.069017	6.5	19.2463	27.1510	8.7110	7.4631	11.2855	9.6512	2.6024	5.0327
0.887045	7	20.8948	29.8824	9.4983	8.1680	12.0608	10.2512	2.6266	5.2278
0.736048	7.5	22.4020	32.4848	10.2564	8.8482	12.7869	10.7055	2.6469	5.4205
0.610755	8	23.7473	34.9056	10.9727	9.4915	13.4565	11.0395	2.6638	5.6103
0.506789	8.5	24.9230	37.1077	11.6376	10.0886	14.0653	11.2798	2.6779	5.7963
0.420521	9	25.9313	39.0707	12.2444	10.6331	14.6116	11.4500	2.6896	5.9782
0.348938	9.5	26.7824	40.7889	12.7899	11.1217	15.0963	11.5691	2.6993	6.1553
0.289541	10	27.4912	42.2692	13.2735	11.5538	15.5219	11.6518	2.7074	6.3272
0.240254	10.5	28.0747	43.5272	13.6972	11.9311	15.8921	11.7090	2.7141	6.4936
0.199357	11	28.5506	44.5839	14.0644	12.2569	16.2118	11.7484	2.7196	6.6540
0.165421	11.5	28.9360	45.4628	14.3797	12.5355	16.4858	11.7754	2.7242	6.8083
0.137263	12	29.2460	46.1879	14.6483	12.7718	16.7194	11.7939	2.7280	6.9562
0.113897	12.5	29.4942	46.7821	14.8755	12.9709	16.9176	11.8066	2.7311	7.0977
0.094509	13	29.6921	47.2663	15.0667	13.1375	17.0849	11.8153	2.7337	7.2326
0.078421	13.5	29.8495	47.6591	15.2268	13.2764	17.2258	11.8212	2.7359	7.3609
0.065072	14	29.9742	47.9766	15.3603	13.3915	17.3439	11.8253	2.7377	7.4826
0.053995	14.5	30.0730	48.2326	15.4712	13.4868	17.4428	11.8280	2.7392	7.5979
0.044804	15	30.1510	48.4383	15.5631	13.5653	17.5254	11.8299	2.7404	7.7067
0.037177	15.5	30.2125	48.6034	15.6392	13.6299	17.5943	11.8312	2.7414	7.8094
0.030849	16	30.2610	48.7357	15.7019	13.6830	17.6516	11.8321	2.7422	7.9059
0.025598	16.5	30.2993	48.8416	15.7536	13.7265	17.6993	11.8327	2.7429	7.9966
0.02124	17	30.3293	48.9262	15.7961	13.7621	17.7389	11.8331	2.7435	8.0816
0.017625	17.5	30.3530	48.9938	15.8310	13.7912	17.7718	11.8334	2.7439	8.1612
0.014624	18	30.3716	49.0478	15.8597	13.8150	17.7990	11.8336	2.7443	8.2356
0.012135	18.5	30.3863	49.0909	15.8833	13.8344	17.8216	11.8337	2.7447	8.3050
0.010069	19	30.3978	49.1252	15.9026	13.8502	17.8403	11.8338	2.7449	8.3698
0.008355	19.5	30.4068	49.1526	15.9185	13.8632	17.8558	11.8339	2.7451	8.4300
0.006933	20	30.4139	49.1744	15.9314	13.8737	17.8686	11.8339	2.7453	8.4860

Table I-5. EPOP-output. Dry weight of above-ground plant parts of the individual plant species in the field edge four weeks after treatment with glufosinate-ammonium (Finale) at 3 l/ha (150 g a.i./l).

Deposition (mg ai/m^2)	Distance (m)	Solni	Steme	Cency	Cheal	Ech-cg	Elyre	Panmi	Poaan
10.03360483	0.5	0.7069	0.9277	0.5565	4.6969	0.5302	0.1728	0.0001	0.4925
8.325640268	1	0.8457	1.0533	0.6323	4.9887	0.5966	0.2407	0.0004	0.5285
6.908412984	1.5	1.0062	1.1921	0.7161	5.2909	0.6687	0.3324	0.0011	0.5660
5.732432392	2	1.1893	1.3445	0.8081	5.6028	0.7463	0.4538	0.0031	0.6047
4.756632415	2.5	1.3956	1.5106	0.9083	5.9238	0.8292	0.6101	0.0086	0.6446
3.946937422	3	1.6244	1.6902	1.0165	6.2531	0.9167	0.8045	0.0242	0.6856
3.275072289	3.5	1.8738	1.8828	1.1323	6.5898	1.0084	1.0364	0.0669	0.7274
2.717575009	4	2.1408	2.0873	1.2551	6.9330	1.1033	1.2991	0.1790	0.7698
2.25497738	4.5	2.4207	2.3023	1.3839	7.2815	1.2006	1.5801	0.4399	0.8127
1.871125164	5	2.7084	2.5262	1.5178	7.6342	1.2992	1.8630	0.9100	0.8559
1.552613969	5.5	2.9976	2.7568	1.6552	7.9900	1.3980	2.1306	1.4649	0.8990
1.288321157	6	3.2821	2.9916	1.7948	8.3476	1.4959	2.3696	1.8688	0.9420
1.069017435	6.5	3.5563	3.2282	1.9348	8.7058	1.5919	2.5720	2.0711	0.9846
0.887044563	7	3.8150	3.4637	2.0738	9.0632	1.6849	2.7360	2.1538	1.0265
0.736047917	7.5	4.0546	3.6956	2.2101	9.4186	1.7741	2.8641	2.1847	1.0677
0.610754587	8	4.2724	3.9214	2.3423	9.7708	1.8588	2.9615	2.1958	1.1079
0.506789242	8.5	4.4672	4.1389	2.4692	10.1186	1.9385	3.0339	2.1998	1.1469
0.420521337	9	4.6390	4.3462	2.5896	10.4608	2.0127	3.0868	2.2012	1.1847
0.348938337	9.5	4.7886	4.5419	2.7028	10.7965	2.0813	3.1251	2.2017	1.2211
0.289540511	10	4.9173	4.7249	2.8081	11.1246	2.1442	3.1525	2.2019	1.2559
0.240253645	10.5	5.0270	4.8945	2.9054	11.4443	2.2014	3.1721	2.2020	1.2892
0.199356608	11	5.1197	5.0504	2.9945	11.7548	2.2532	3.1859	2.2020	1.3209
0.165421245	11.5	5.1976	5.1927	3.0754	12.0555	2.2997	3.1957	2.2020	1.3510
0.13726251	12	5.2626	5.3216	3.1485	12.3457	2.3414	3.2026	2.2020	1.3793
0.113897079	12.5	5.3166	5.4377	3.2141	12.6251	2.3784	3.2075	2.2020	1.4060
0.094509014	13	5.3612	5.5417	3.2727	12.8933	2.4112	3.2109	2.2020	1.4311
0.078421272	13.5	5.3980	5.6344	3.3247	13.1500	2.4402	3.2133	2.2020	1.4546
0.065072057	14	5.4283	5.7166	3.3707	13.3952	2.4658	3.2150	2.2020	1.4765
0.053995204	14.5	5.4531	5.7893	3.4112	13.6288	2.4882	3.2162	2.2020	1.4968
0.044803901	15	5.4734	5.8533	3.4468	13.8508	2.5078	3.2170	2.2020	1.5158
0.037177183	15.5	5.4901	5.9095	3.4779	14.0614	2.5249	3.2176	2.2020	1.5333
0.030848719	16	5.5036	5.9587	3.5051	14.2606	2.5398	3.2180	2.2020	1.5495
0.025597514	16.5	5.5147	6.0016	3.5288	14.4488	2.5528	3.2183	2.2020	1.5645
0.021240192	17	5.5237	6.0391	3.5494	14.6262	2.5641	3.2185	2.2020	1.5782
0.017624592	17.5	5.5311	6.0717	3.5673	14.7932	2.5739	3.2187	2.2020	1.5909
0.014624456	18	5.5370	6.1000	3.5828	14.9500	2.5823	3.2188	2.2020	1.6026
0.012135017	18.5	5.5419	6.1246	3.5962	15.0972	2.5897	3.2188	2.2020	1.6132
0.010069341	19	5.5459	6.1458	3.6078	15.2350	2.5960	3.2189	2.2020	1.6230
0.008355293	19.5	5.5491	6.1643	3.6179	15.3639	2.6015	3.2189	2.2020	1.6320
0.006933018	20	5.5517	6.1802	3.6265	15.4844	2.6063	3.2189	2.2020	1.6402

Appendix II.
Tepraloxydim (Aramo)

Table II-1. *Fresh weight of above-ground plant parts of the eight individual species and the monocotyledons, dicotyledons and total vegetation, four weeks after treatment with tepraloxydim (aramo).*

Dose (l/ha)	Dose (g.a.i./ha)	Log dose (g ai/ha)	Fresh weight (g) * poaan	steme	ech-cg	solni	panmi	cency	cheal	elyre	monocot	dicot	total
0	0	0.00	4.02	34.71	32.70	28.28	16.42	12.68	10.05	9.99	63.13	85.72	148.85
0	0	0.00	3.56	35.07	20.52	38.17	21.33	17.86	11.48	10.52	55.93	102.58	158.51
0	0	0.00	2.99	40.24	22.06	44.76	26.54	18.22	2.59	8.69	60.28	105.81	166.09
0	0	0.00	3.86	40.25	16.94	38.62	30.56	13.63	7.98	11.12	62.48	100.48	162.96
0	1	0.30	1.69	51.76	26.39	28.10	12.32	10.44	10.02	17.41	57.81	100.32	158.13
0	1	0.30	4.76	35.99	33.07	35.83	22.17	4.86	2.79	12.38	72.38	79.47	151.85
0	1	0.30	5.03	47.52	28.69	38.61	15.57	7.66	13.41	5.84	55.13	107.20	162.33
0	1	0.30	7.26	49.43	23.58	29.14	15.58	2.67	9.76	18.08	64.50	91.00	155.50
0	5	0.78	8.61	36.47	13.72	24.68	2.86	9.52	18.48	7.15	32.34	89.15	121.49
0	5	0.78	7.45	41.40	9.16	14.52	2.69	12.64	11.62	12.63	31.93	80.18	112.11
0	5	0.78	3.09	37.48	5.05	14.22	3.83	11.61	17.83	9.51	21.48	81.14	102.62
0	5	0.78	4.41	38.24	13.73	29.07	6.04	24.87	10.61	6.25	30.43	102.79	133.22
0	10	1.04	7.97	46.14	4.74	24.76	1.22	7.92	2.23	8.45	22.38	81.05	103.43
0	10	1.04	3.71	23.82	6.99	21.86	6.01	10.11	15.63	5.03	21.74	71.42	93.16
0	10	1.04	4.14	43.51	5.60	31.50	0.69	11.92	11.47	4.11	14.54	98.40	112.94
0	10	1.04	5.24	43.51	1.59	40.38	1.50	15.55	9.04	3.29	11.62	108.48	120.10
1	50	1.71	0.91	35.20	0.80	34.52	0.61	22.38	10.26	3.43	5.75	102.36	108.11
1	50	1.71	1.71	29.20	1.57	34.27	0.71	14.04	7.86	4.05	8.04	85.37	93.41
1	50	1.71	0.98	38.05	0.60	19.56	1.84	11.23	27.76	2.83	6.25	96.60	102.85
1	50	1.71	0.99	39.27	0.84	20.06	0.77	17.78	12.88	1.06	3.66	89.99	93.65
2	100	2.00	1.91	54.53	1.42	25.01	0.81	8.56	9.86	3.01	7.15	97.96	105.11
2	100	2.00	1.78	17.01	1.01	33.56	1.13	7.06	15.72	1.90	5.82	73.35	79.17
2	100	2.00	1.93	41.08	1.11	23.53	1.09	15.34	16.84	2.29	6.42	96.79	103.21
2	100	2.00	1.46	34.58	2.20	24.23	1.80	11.81	15.36	2.37	7.83	85.98	93.81

*) *poaan= Poa annua, steme= Stellaria media, ech-cg=Echinogloa crus-galli, solni= Solanum nigrum, panmi= Panicum milliaceum, cency=Centaurea cyanus, cheal= Chenopodium album, elyre= Elymus repens, monocot= monocotyledons, dicot= dicotyledons.*

Table II-2. Dry weight of above-ground plant parts of the eight individual species and the monocotyledons, dicotyledons and total vegetation, four weeks after treatment with tepraloxydim (aramo).

			Dry weight (g)										
Dose (l/ha)	Dose (gr.a.l./ha)	Log dose (g ai/ha)	* poaan	steme	ech-cg	solni	panmi	cency	cheal	elyre	monocot	dicot	total
0	0	0.00	0.68	4.14	4.97	5.84	2.66	3.10	2.67	2.50	10.81	15.74	26.55
0	0	0.00	0.80	3.70	2.98	7.42	3.41	3.69	3.28	3.34	10.53	18.09	28.62
0	0	0.00	0.73	6.00	3.43	8.65	4.51	4.73	0.75	2.47	11.13	20.13	31.26
0	0	0.00	0.69	3.71	2.49	7.93	4.45	3.04	2.03	3.09	10.71	16.72	27.42
0.02	1	0.30	0.23	4.67	3.51	5.11	1.40	1.56	2.70	4.22	9.35	14.03	23.39
0.02	1	0.30	0.98	5.20	4.90	6.04	3.33	0.80	0.69	3.19	12.40	12.73	25.13
0.02	1	0.30	1.19	6.06	4.03	7.60	2.68	1.79	3.58	1.71	9.62	19.04	28.65
0.02	1	0.30	1.39	4.41	2.50	5.69	1.98	0.41	2.49	4.70	10.56	13.00	23.56
0.1	5	0.78	1.52	5.42	2.24	4.49	0.56	2.00	5.42	1.56	5.88	17.33	23.21
0.1	5	0.78	1.25	4.92	1.65	2.67	0.54	2.85	2.81	3.09	6.52	13.24	19.76
0.1	5	0.78	0.52	4.53	0.80	2.76	0.97	2.65	4.76	2.17	4.46	14.70	19.16
0.1	5	0.78	0.99	5.24	2.11	5.56	1.08	6.42	2.96	1.63	5.81	20.19	26.00
0.2	10	1.04	1.33	5.79	1.57	5.19	0.50	1.30	0.56	2.39	5.78	12.84	18.62
0.2	10	1.04	0.57	2.95	2.33	4.17	1.49	2.20	4.03	1.49	5.88	13.36	19.23
0.2	10	1.04	0.79	4.93	1.38	6.18	0.55	2.92	3.12	1.33	4.05	17.15	21.20
0.2	10	1.04	1.08	4.93	1.19	8.18	0.76	3.59	2.31	1.16	4.18	19.01	23.19
1	50	1.71	0.20	4.40	0.64	6.62	0.42	5.36	2.73	1.69	2.95	19.12	22.07
1	50	1.71	0.43	4.00	1.30	6.13	0.62	3.27	2.04	1.57	3.92	15.44	19.36
1	50	1.71	0.26	4.52	0.47	3.82	0.69	2.08	7.62	1.46	2.87	18.03	20.90
1	50	1.71	0.26	4.53	0.43	3.52	0.55	3.14	3.31	0.72	1.95	14.50	16.45
2	100	2.00	0.43	8.72	1.22	4.94	0.68	2.27	2.77	1.67	4.00	18.70	22.70
2	100	2.00	0.35	2.14	0.75	6.54	0.85	1.66	3.89	1.08	3.02	14.22	17.25
2	100	2.00	0.46	6.05	0.81	4.52	0.90	3.10	4.59	1.13	3.31	18.25	21.55
2	100	2.00	0.36	5.36	1.67	4.49	1.21	2.95	4.26	1.22	4.47	17.05	21.51

**) poaan= Poa annua, steme= Stellaria media, ech-cg=Echinogloa crus-galli, solni= Solanum nigrum, panmi= Panicum milliaceum, cency=Centaurea cyanus, cheal= Chenopodium album, elyre= Elymus repens, monocot= monocotyledons, dicot= dicotyledons.*

Table II-3. EPOP-output. Fresh and dry weight of above-ground plant parts of the total vegetation, the dicotyledons and the monocotyledons in the field edge four weeks after treatment with tepraloxydim (Aramo) at 2 l/ha (50 g ai./ha).

		Total vegetation		Dicotyledons		Monocotyledons	
Deposition (mg a.i./m^2)	Distance (m)	fresh weight (g)	dry weight (g)	fresh weight (g)	dry weight (g)	fresh weight (g)	dry weight (g)
22.2969	0.5	98.1684	20.1489	90.9339	16.4631	6.9304	3.4373
18.5014	1	98.1735	20.1527	91.1877	16.4427	6.9366	3.4389
15.3520	1.5	98.1817	20.1577	91.4391	16.4225	6.9465	3.4414
12.7387	2	98.1948	20.1641	91.6876	16.4025	6.9624	3.4452
10.5703	2.5	98.2158	20.1725	91.9327	16.3828	6.9877	3.4509
8.7710	3	98.2496	20.1833	92.1740	16.3634	7.0281	3.4594
7.2779	3.5	98.3037	20.1974	92.4106	16.3444	7.0927	3.4722
6.0391	4	98.3903	20.2156	92.6420	16.3258	7.1956	3.4914
5.0111	4.5	98.5289	20.2391	92.8673	16.3077	7.3593	3.5202
4.1581	5	98.7502	20.2695	93.0857	16.2902	7.6191	3.5632
3.4503	5.5	99.1021	20.3088	93.2963	16.2732	8.0295	3.6271
2.8629	6	99.6588	20.3595	93.4983	16.2570	8.6733	3.7214
2.3756	6.5	100.5322	20.4247	93.6908	16.2415	9.6723	3.8592
1.9712	7	101.8841	20.5084	93.8729	16.2269	11.1961	4.0576
1.6357	7.5	103.9340	20.6154	94.0439	16.2132	13.4616	4.3375
1.3572	8	106.9470	20.7517	94.2032	16.2004	16.7036	4.7206
1.1262	8.5	111.1793	20.9244	94.3505	16.1885	21.0992	5.2245
0.9345	9	116.7603	21.1418	94.4853	16.1777	26.6412	5.8532
0.7754	9.5	123.5372	21.4128	94.6078	16.1678	33.0228	6.5883
0.6434	10	130.9884	21.7474	94.7180	16.1590	39.6467	7.3849
0.5339	10.5	138.3372	22.1549	94.8165	16.1511	45.8214	8.1804
0.4430	11	144.8481	22.6434	94.9036	16.1441	51.0266	8.9124
0.3676	11.5	150.0906	23.2178	94.9802	16.1379	55.0552	9.5370
0.3050	12	153.9965	23.8781	95.0471	16.1325	57.9718	10.0366
0.2531	12.5	156.7413	24.6179	95.1050	16.1279	59.9829	10.4158
0.2100	13	158.5920	25.4230	95.1549	16.1239	61.3234	10.6925
0.1743	13.5	159.8051	26.2721	95.1977	16.1204	62.1969	10.8885
0.1446	14	160.5858	27.1384	95.2343	16.1175	62.7577	11.0245
0.1200	14.5	161.0823	27.9928	95.2653	16.1150	63.1142	11.1176
0.0996	15	161.3955	28.8080	95.2915	16.1129	63.3396	11.1806
0.0826	15.5	161.5923	29.5613	95.3137	16.1111	63.4814	11.2230
0.0686	16	161.7154	30.2372	95.3324	16.1096	63.5706	11.2514
0.0569	16.5	161.7924	30.8278	95.3480	16.1083	63.6264	11.2703
0.0472	17	161.8405	31.3321	95.3612	16.1073	63.6614	11.2830
0.0392	17.5	161.8704	31.7542	95.3722	16.1064	63.6834	11.2914
0.0325	18	161.8891	32.1017	95.3814	16.1057	63.6971	11.2970
0.0270	18.5	161.9008	32.3839	95.3890	16.1051	63.7057	11.3007
0.0224	19	161.9080	32.6106	95.3954	16.1045	63.7110	11.3031
0.0186	19.5	161.9125	32.7910	95.4007	16.1041	63.7144	11.3048
0.0154	20	161.9153	32.9335	95.4052	16.1038	63.7165	11.3059

Figures II-1 till II-4; Dosis effect relationships for dry weight of the individual plant sprayed with aramo (tepraloxydim).

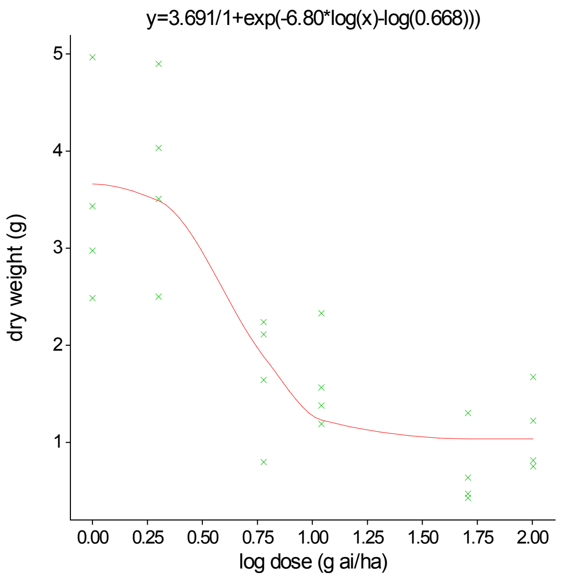

Figure II-1. Dose-effect relationship of Echinogloa crus-galli sprayed with aramo. Dry weight (g per plant) was plotted against tepraloxydim dose (g ai/ha). x= observed value. Fpr<0.001.

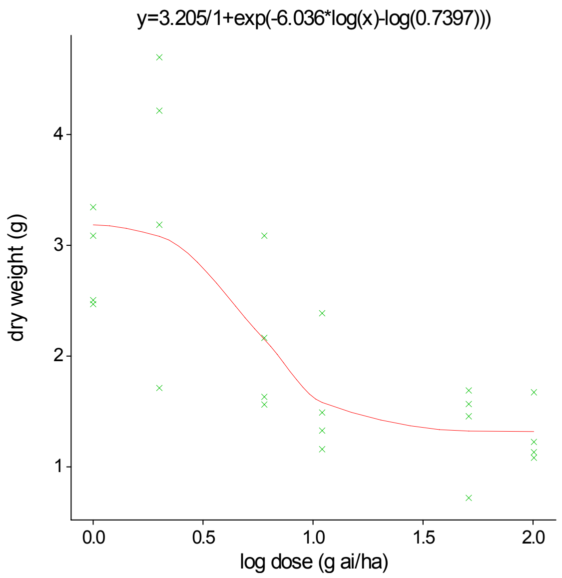

Figure II-2. Dose-effect relationship of Elymus repens sprayed with aramo. Dry weight (g per plant) was plotted against tepraloxydim dose (g ai/ha). x= observed value. Fpr<0.001.

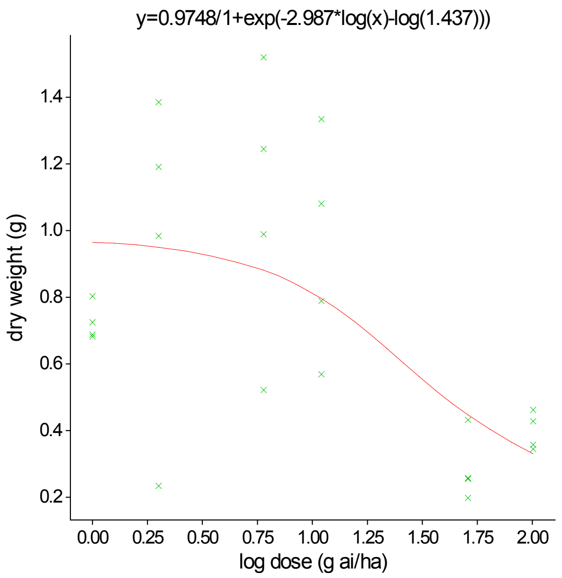

Figure II-3. Dose-effect relationship of Panicum milliaceum sprayed with aramo. Dry weight (g per plant) was plotted against tepraloxydim dose (g ai/ha). x= observed value. Fpr<0.001.

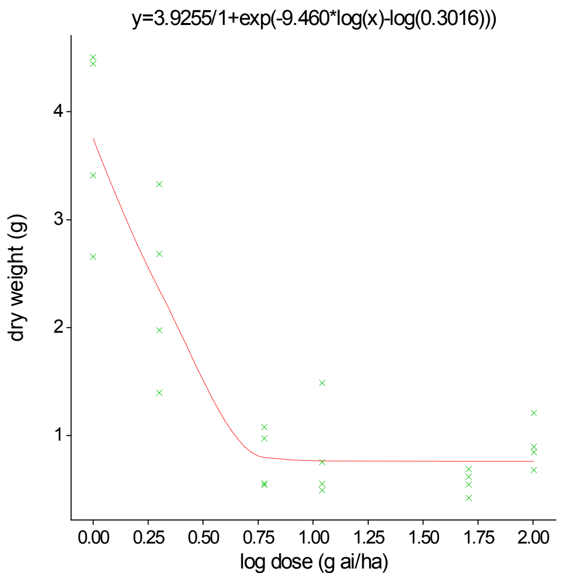

Figure II-4. Dose-effect relationship of Poa annua sprayed with aramo. Dry weight (g per plant) was plotted against tepraloxydim dose (g ai/ha). x= observed value. Fpr=0.017.

Figures II-5 till II-8; Dosis effect relationships for fresh weight of the individual monocotyledons sprayed with aramo (tepraloxydim).

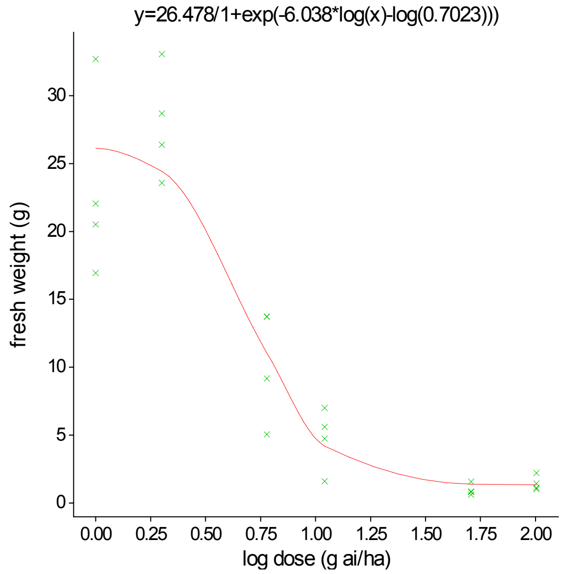

Figure II-5. Dose-effect relationship of Echinogloa crus-galli sprayed with aramo. Fresh weight (g per plant) was plotted against tepraloxydim dose (g ai/ha). x= observed value. Fpr<0.001.

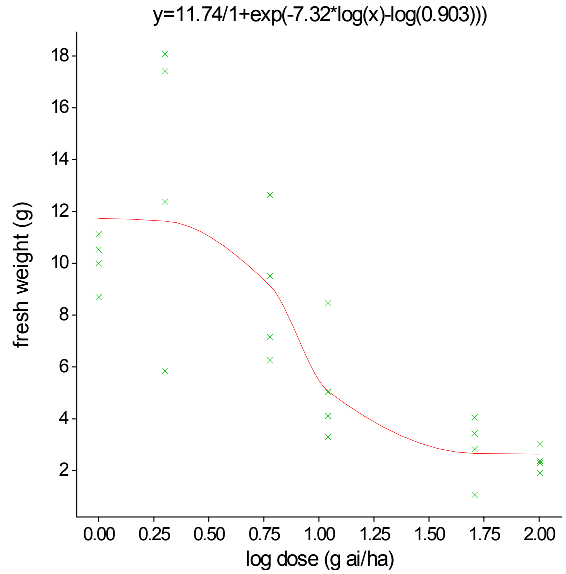

Figure II-6. Dose-effect relationship of Elymus repens sprayed with aramo. Fresh weight (g per plant) was plotted against tepraloxydim dose (g ai/ha). x= observed value. Fpr<0.001.

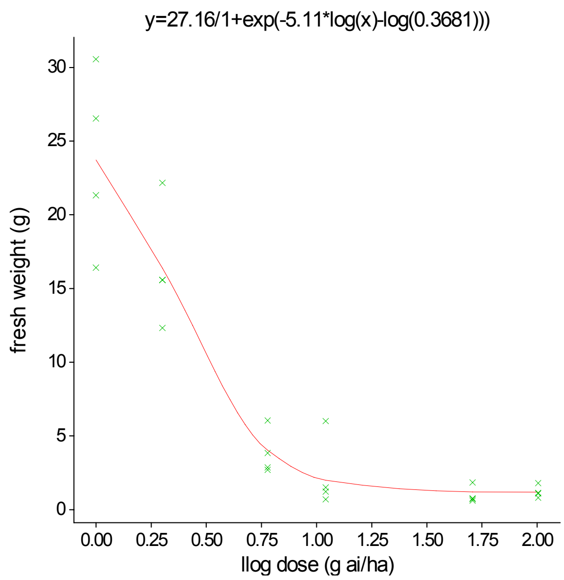

Figure II-7. Dose-effect relationship of Panicum milliaeum sprayed with aramo. Fresh weight (g per plant) was plotted against tepraloxydim dose (g ai/ha). x= observed value. Fpr<0.001.

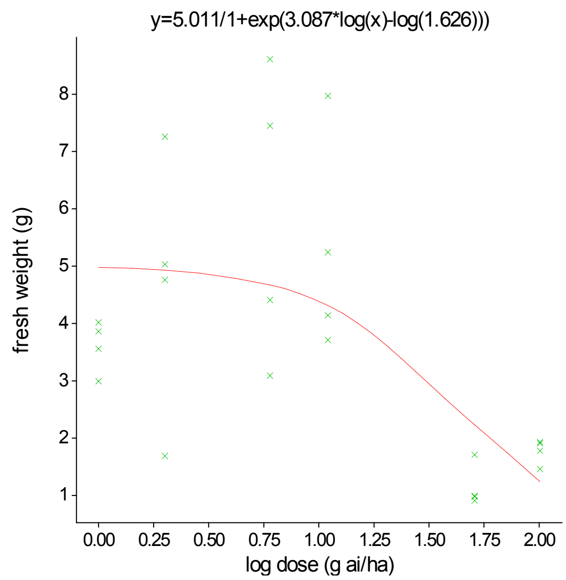

Figure II-8. Dose-effect relationship of Poa annua sprayed with aramo. Fresh weight (g per plant) was plotted against tepraloxydim dose (g ai/ha). x= observed value. Fpr<0.011.

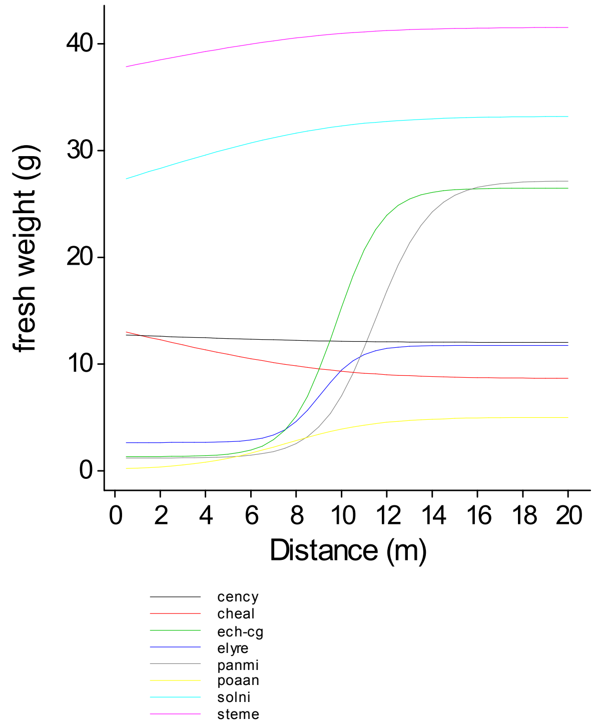

Figure II-9. *Fresh weight of above ground plant parts of the individual species in the vegetation plotted against the distance to the field edge for the recommended dosage (2 l/ha) Aramo (50 g tepraloxydim/l).*

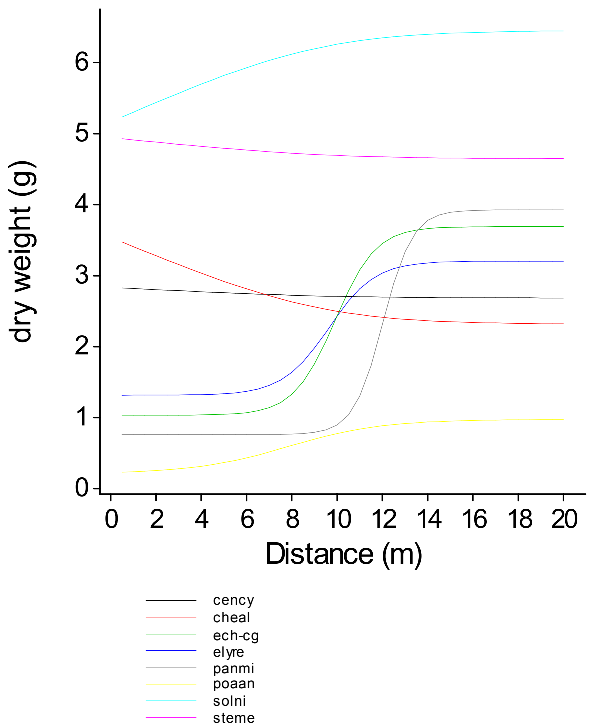

Figure II-10. *Dry weight of above ground plant parts of the individual monocotyledons in the vegetation plotted against the distance to the field edge for the recommended dosage (2 l/ha) Aramo (50 g tepraloxydim/l).*

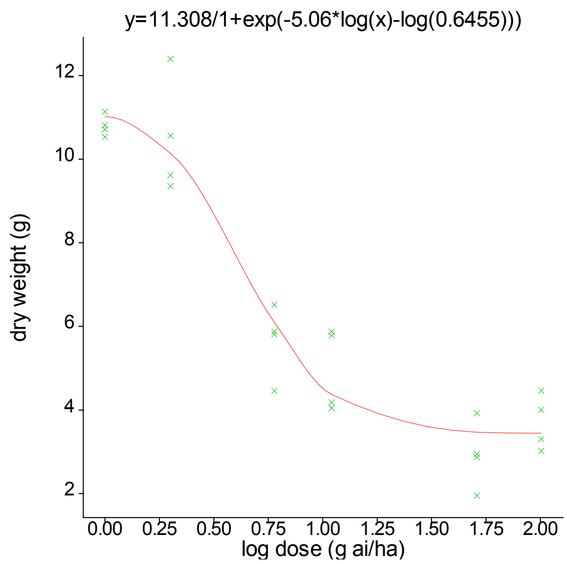

Figure II-11. Dose-effect relationship of monocotyledons sprayed with Aramo. Dry weight (g per plant) was plotted against tepraloxydim dose (g ai/ha). x= observed value. Fpr<0.001.

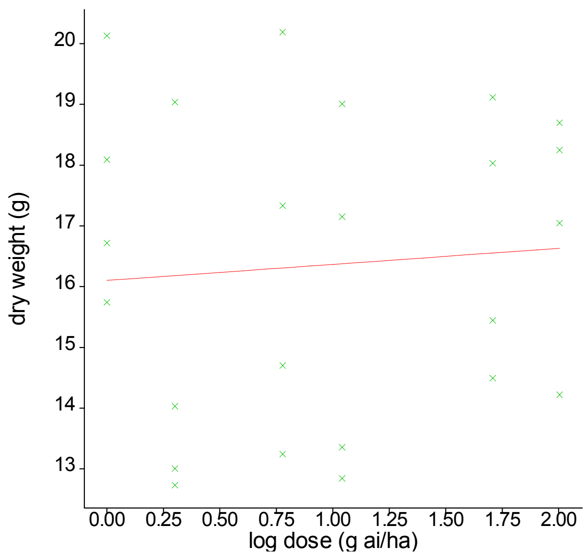

Figure II-12. Dose-effect relationship of dicotyledons sprayed with Aramo. Dry weight (g per plant) was plotted against tepraloxydim dose (g ai/ha). x= observed value. Fpr<0.717.

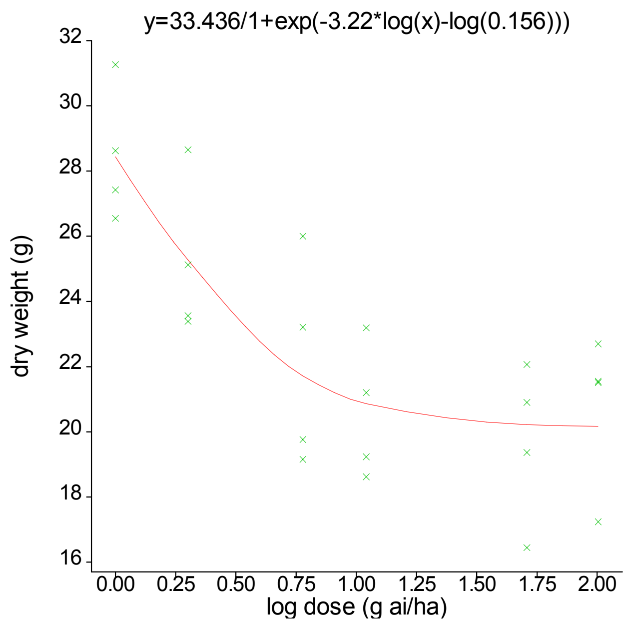

Figure II-13. Dose-effect relationship of total vegetation sprayed with Aramo. Dry weight (g per plant) was plotted against tepraloxydim dose (g ai/ha). x= observed value. Fpr<0.001.

Table II-4. EPOP-output. Fresh weight of above-ground plant parts of the individual plant species in the field edge four weeks after treatment with tepraloxydim (Aramo) at 2 l/ha (50 g ai/l).

Deposition (mg ai/m^2)	Distance (m)	Solni	Steme	Cency	Cheal	Ech-cg	Elyre	Panmi	Poaan
22.2969	0.5	27.3545	37.8736	12.7160	12.9904	1.32090	2.64034	1.18287	0.20853
18.50142	1	27.6862	38.0813	12.6767	12.7442	1.32273	2.64061	1.18435	0.24782
15.35203	1.5	28.0147	38.2869	12.6377	12.5003	1.32572	2.64111	1.18659	0.29735
12.73874	2	28.3395	38.4903	12.5991	12.2592	1.33059	2.64201	1.18997	0.35946
10.57029	2.5	28.6599	38.6909	12.5611	12.0213	1.33853	2.64365	1.19508	0.43687
8.770972	3	28.9752	38.8883	12.5237	11.7873	1.35147	2.64660	1.20281	0.53257
7.277938	3.5	29.2845	39.0819	12.4870	11.5577	1.37256	2.65194	1.21450	0.64977
6.039056	4	29.5869	39.2712	12.4511	11.3333	1.40688	2.66159	1.23216	0.79156
5.011061	4.5	29.8814	39.4556	12.4161	11.1147	1.46265	2.67901	1.25884	0.96069
4.158056	5	30.1669	39.6343	12.3822	10.9028	1.55311	2.71036	1.29910	1.15897
3.450253	5.5	30.4422	39.8066	12.3495	10.6984	1.69926	2.76654	1.35979	1.38682
2.862936	6	30.7062	39.9719	12.3182	10.5025	1.93403	2.86646	1.45106	1.64269
2.375594	6.5	30.9577	40.1294	12.2884	10.3157	2.30757	3.04176	1.58795	1.92270
1.97121	7	31.1958	40.2784	12.2601	10.1391	2.89309	3.34200	1.79230	2.22060
1.635662	7.5	31.4193	40.4183	12.2336	9.9731	3.78962	3.83577	2.09536	2.52817
1.357232	8	31.6275	40.5487	12.2089	9.8186	5.11431	4.59596	2.54038	2.83605
1.126198	8.5	31.8199	40.6691	12.1860	9.6757	6.97205	5.65508	3.18444	3.13483
0.934492	9	31.9962	40.7795	12.1651	9.5449	9.39517	6.94231	4.09730	3.41619
0.775419	9.5	32.1563	40.8797	12.1461	9.4261	12.2735	8.27059	5.35353	3.67374
0.643423	10	32.3004	40.9699	12.1290	9.3191	15.3358	9.42868	7.01386	3.90343
0.533897	10.5	32.4290	41.0504	12.1137	9.2236	18.2347	10.2991	9.09496	4.10359
0.443015	11	32.5429	41.1218	12.1002	9.1391	20.6908	10.8831	11.5368	4.27452
0.367603	11.5	32.6431	41.1844	12.0883	9.0648	22.5835	11.2457	14.1894	4.41798
0.305028	12	32.7304	41.2391	12.0779	8.9999	23.9384	11.4600	16.8405	4.53665
0.253105	12.5	32.8061	41.2865	12.0690	8.9437	24.8578	11.5831	19.2780	4.63363
0.21002	13	32.8714	41.3274	12.0612	8.8953	25.4593	11.6526	21.3532	4.71210
0.174269	13.5	32.9273	41.3624	12.0546	8.8537	25.8436	11.6915	23.0074	4.77510
0.144605	14	32.9751	41.3923	12.0489	8.8183	26.0852	11.7131	24.2581	4.82535
0.119989	14.5	33.0156	41.4177	12.0441	8.7882	26.2357	11.7251	25.1666	4.86523
0.099564	15	33.0500	41.4392	12.0400	8.7627	26.3289	11.7317	25.8073	4.89675
0.082616	15.5	33.0789	41.4573	12.0366	8.7412	26.3864	11.7354	26.2499	4.92158
0.068553	16	33.1033	41.4726	12.0337	8.7231	26.4217	11.7374	26.5512	4.94109
0.056883	16.5	33.1238	41.4854	12.0312	8.7079	26.4435	11.7386	26.7544	4.95639
0.0472	17	33.1410	41.4961	12.0292	8.6952	26.4568	11.7392	26.8905	4.96837
0.039166	17.5	33.1553	41.5051	12.0275	8.6845	26.4650	11.7395	26.9812	4.97774
0.032499	18	33.1673	41.5127	12.0261	8.6756	26.4700	11.7397	27.0416	4.98506
0.026967	18.5	33.1774	41.5189	12.0249	8.6681	26.4731	11.7398	27.0816	4.99078
0.022376	19	33.1857	41.5242	12.0239	8.6619	26.4750	11.7399	27.1081	4.99524
0.018567	19.5	33.1927	41.5285	12.0231	8.6568	26.4761	11.7399	27.1257	4.99872
0.015407	20	33.1985	41.5321	12.0224	8.6525	26.4768	11.7399	27.1373	5.00143

Table II-5. EPOP-output. Dry weight of above-ground plant parts of the individual plant species in the field edge four weeks after treatment with tepraloxydim (Aramo) at 2 l/ha (50 g ai/l).

Deposition (mg ai/m²)	Distance (m)	Solni	Steme	Cency	Cheal	Ech-cg	Elyre	Panmi	Poaan
22.2969	0.5	5.2330	4.9270	2.8273	3.4753	1.0351	1.3173	0.7625	0.2330
18.5014	1	5.3018	4.9113	2.8193	3.4098	1.0351	1.3174	0.7625	0.2386
15.3520	1.5	5.3700	4.8958	2.8114	3.3450	1.0353	1.3177	0.7625	0.2456
12.7387	2	5.4373	4.8804	2.8036	3.2808	1.0354	1.3181	0.7625	0.2543
10.5703	2.5	5.5038	4.8652	2.7959	3.2175	1.0358	1.3188	0.7625	0.2651
8.7710	3	5.5692	4.8503	2.7884	3.1553	1.0363	1.3199	0.7625	0.2784
7.2779	3.5	5.6333	4.8356	2.7809	3.0942	1.0373	1.3217	0.7625	0.2947
6.0391	4	5.6960	4.8213	2.7737	3.0345	1.0390	1.3247	0.7625	0.3144
5.0111	4.5	5.7571	4.8073	2.7666	2.9763	1.0419	1.3294	0.7625	0.3378
4.1581	5	5.8163	4.7938	2.7597	2.9199	1.0469	1.3372	0.7626	0.3654
3.4503	5.5	5.8734	4.7807	2.7531	2.8656	1.0557	1.3498	0.7626	0.3972
2.8629	6	5.9282	4.7682	2.7468	2.8134	1.0706	1.3698	0.7628	0.4333
2.3756	6.5	5.9803	4.7563	2.7407	2.7637	1.0962	1.4017	0.7632	0.4731
1.9712	7	6.0297	4.7450	2.7350	2.7167	1.1395	1.4513	0.7639	0.5162
1.6357	7.5	6.0761	4.7345	2.7296	2.6726	1.2111	1.5266	0.7655	0.5613
1.3572	8	6.1193	4.7246	2.7246	2.6315	1.3264	1.6365	0.7690	0.6074
1.1262	8.5	6.1592	4.7155	2.7200	2.5935	1.5029	1.7878	0.7765	0.6531
0.9345	9	6.1957	4.7071	2.7158	2.5587	1.7538	1.9805	0.7926	0.6971
0.7754	9.5	6.2289	4.6995	2.7119	2.5271	2.0752	2.2027	0.8265	0.7383
0.6434	10	6.2588	4.6927	2.7085	2.4986	2.4364	2.4316	0.8972	0.7759
0.5339	10.5	6.2855	4.6866	2.7054	2.4732	2.7871	2.6415	1.0388	0.8094
0.4430	11	6.3091	4.6812	2.7026	2.4507	3.0822	2.8144	1.3029	0.8386
0.3676	11.5	6.3299	4.6765	2.7002	2.4309	3.3024	2.9447	1.7343	0.8636
0.3050	12	6.3480	4.6723	2.6981	2.4137	3.4523	3.0364	2.3073	0.8847
0.2531	12.5	6.3637	4.6687	2.6963	2.3987	3.5480	3.0979	2.8901	0.9022
0.2100	13	6.3772	4.6656	2.6947	2.3858	3.6066	3.1379	3.3423	0.9166
0.1743	13.5	6.3889	4.6630	2.6934	2.3748	3.6417	3.1633	3.6249	0.9284
0.1446	14	6.3987	4.6607	2.6923	2.3654	3.6624	3.1792	3.7783	0.9379
0.1200	14.5	6.4072	4.6588	2.6913	2.3573	3.6744	3.1891	3.8554	0.9455
0.0996	15	6.4143	4.6572	2.6905	2.3506	3.6814	3.1952	3.8925	0.9516
0.0826	15.5	6.4203	4.6558	2.6898	2.3448	3.6855	3.1990	3.9101	0.9565
0.0686	16	6.4253	4.6547	2.6892	2.3400	3.6878	3.2013	3.9183	0.9603
0.0569	16.5	6.4296	4.6537	2.6887	2.3360	3.6892	3.2027	3.9222	0.9634
0.0472	17	6.4332	4.6529	2.6883	2.3326	3.6899	3.2036	3.9239	0.9658
0.0392	17.5	6.4361	4.6522	2.6879	2.3298	3.6904	3.2041	3.9248	0.9677
0.0325	18	6.4386	4.6516	2.6876	2.3274	3.6906	3.2045	3.9252	0.9692
0.0270	18.5	6.4407	4.6512	2.6874	2.3254	3.6908	3.2047	3.9253	0.9704
0.0224	19	6.4424	4.6508	2.6872	2.3238	3.6909	3.2048	3.9254	0.9714
0.0186	19.5	6.4439	4.6504	2.6870	2.3224	3.6909	3.2049	3.9255	0.9721
0.0154	20	6.4451	4.6502	2.6869	2.3212	3.6910	3.2049	3.9255	0.9727

Appendix III.
Mancozeb (Dithane M45)

Table III-1. Dry and fresh weight of above-ground plant parts of chickweed (Stellaria media) two weeks after treatment with mancozeb (Dithane M45).

Dose (g a.i./ha)	Dry weight (g)	Fresh weight (g)
0	0.833	7.34
0	0.866	7.64
0	0.864	7.96
0	1.01	9.13
0	1.034	9.41
1250	0.958	9.08
1250	1.005	9.3
1250	1.015	9.34
1250	1.202	10.83
1250	1.165	10.21
2500	0.931	8.13
2500	0.934	8.5
2500	0.962	9.01
2500	0.97	9.18
2500	1.024	9.49
3750	0.886	7.81
3750	1.039	8.64
3750	1.059	9.28
3750	1.139	10.1
3750	0.919	8.22
5000	0.992	8.82
5000	1.027	9.39
5000	0.973	8.39
5000	1.207	10.34
5000	0.917	7.85

Table III-2. EPOP output; deposition (g a.i./m²), distance to field edge (m) for a dose of 2475 g a.i./ha.

Dose: 2475 g ai/ha *	
Distance (m)	Deposition (g a.i./m^2)
0.5	55.18483
1	45.79102
1.5	37.99627
2	31.52838
2.5	26.16148
3	21.70816
3.5	18.0129
4	14.94666
4.5	12.40238
5	10.29119
5.5	8.539377
6	7.085766
6.5	5.879596
7	4.878745
7.5	4.048264
8	3.35915
8.5	2.787341
9	2.312867
9.5	1.919161
10	1.592473
10.5	1.321395
11	1.096461
11.5	0.909817
12	0.754944
12.5	0.626434
13	0.5198
13.5	0.431317
14	0.357896
14.5	0.296974
15	0.246421
15.5	0.204475
16	0.169668
16.5	0.140786
17	0.116821
17.5	0.096935
18	0.080435
18.5	0.066743
19	0.055381
19.5	0.045954
20	0.038132

* *2475 g a.i./ha corresponds to an application of 4.95 l/ha and a weight content of 0.5 kg/l.*