

Végéphy – 24^e CONFÉRENCE DU COLUMA
JOURNÉES INTERNATIONALES SUR LA LUTTE CONTRE LES MAUVAISES HERBES
ORLÉANS – 3,4, ET 5 DÉCEMBRE 2019

**GF-3885 : A NEW POST-EMERGENCE HERBICIDE FOR EFFECTIVE WEED CONTROL IN EUROPEAN
SUNFLOWER CROPS.**

F. MONTAGNE, M. SALAS ⁽¹⁾

(1) CORTEVA AGRISCIENCE (France), 1 bis Avenue de 8 Mai 1945,
78280 Guyancourt
France

RÉSUMÉ

La préparation GF-3885 est un herbicide sélectif de post-levée des adventices dicotylédones en culture de tournesol qui peut s'utiliser sur toutes les variétés, conventionnelles et tolérantes aux herbicides. L'herbicide GF-3885 contient de l'halauxifène-méthyle (Arylex[™] actif), une nouvelle substance active découverte pour la première fois par Dow AgroSciences en 2005, et en cours de développement sur diverses cultures de plein champ, avec pour objectif de fournir aux agriculteurs des solutions uniques de désherbage en foliaire. GF-3885 apporte une nouvelle solution aux agriculteurs contre *Ambrosia artemisiifolia* en culture de tournesol ainsi que d'autres adventices difficiles à contrôler, comme *Chenopodium album*, *Xanthium strumarium* et *Abutilon theophrasti*. GF-3885 peut s'utiliser sur toutes les variétés de tournesol à une dose de 3 g ae / ha. Une série d'essais sur le terrain a été menée pour étudier les performances biologiques de GF-3885 en cultures de tournesol et a démontré une maîtrise des adventices dicotylédones, des stades plantule-jeune plante (BBCH 12) aux stades plus développés (jusqu'à 20-30 cm). De même, la série d'essais mis en place pour étudier la tolérance du tournesol à GF-3885 a démontré sa parfaite sélectivité, quelles que soit les variétés, conventionnelles ou tolérantes aux herbicides Clearfield®, Clearfield® Plus, and ExpressSun®.

Mots-clés: halauxifène-méthyl, ambrosie, dicotylédones, sélectivité, tournesol.

ABSTRACT

GF-3885 is a selective post-emergence herbicide for use on all conventional and herbicide tolerant varieties of sunflower for control of key competitive broad-leaved weeds. GF-3885 contains halauxyfen methyl, Arylex[™] active, a novel herbicide first discovered by Dow AgroSciences in 2005 and currently being under development for use in various field crops to provide farmers unique foliar weed control solutions.

A new unique solution for farmers against *Ambrosia artemisiifolia* in sunflower production as well as against many other difficult to control weeds, including *Chenopodium album*, *Xanthium strumarium*, and *Abutilon theophrasti*. GF-3885 can be used in all registered sunflower hybrids at a dose rate of 3 g ae/ha.

A series of field trials have been carried out in many European countries in order to investigate the biological performance of GF-3885 in sunflower and have demonstrated effective control of broadleaf weeds at growth stages ranging from small plants at 2 leaves growth stage (BBCH 12) up to large plants (up to 20-30 cm high). At the same time adequate crop tolerance was demonstrated from GF-3885 on sunflower crops, including conventional, Clearfield®, Clearfield® Plus, and ExpressSun® tolerant hybrids.

Keywords: halauxyfen-methyl, ambrosia, dicotyledons weeds, crop safety, sunflower.

INTRODUCTION

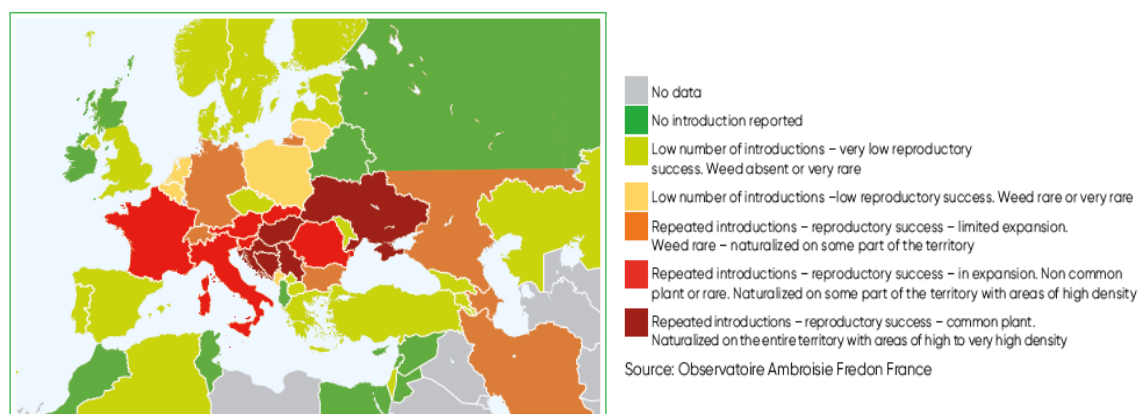
Halauxyfen-methyl (GF-3885) is a new active substance that belongs to the synthetic auxin chemical family, and is classified as group O under the HRAC (Herbicide Resistance Committee) mode of action classification. This new synthetic auxin, will be commercialized with the name of Viballa™, is an innovative herbicide with certain characteristics not very common in this chemical family, including efficacy independent of low temperature at the time of product application and a significantly lower dose rate in grams of active (3 g a.e./ha).

GF-3885 is a very effective and flexible post-emergence herbicide with unique efficacy against key important economic weeds in sunflower crops like *Ambrosia artemisiifolia*, *Chenopodium album*, *Xanthium strumarium*, *Abutilon theophrasti* and others. It can be used in sunflower from BBCH14 (4 unfolded leaves) to BBCH30 (beginning of stem elongation) for the South Regulatory Zone countries. GF-3885 can be applied to all sunflower hybrids (conventional and herbicide tolerant).

Sunflower is one of the most important oil crops in Europe and Middle East Africa region with approximately 18 Mio. hectares of harvested area (FAOSTAT, 2014) in key countries. One of the biggest challenges in sunflower production is the post-emergence control of broadleaf weeds. This problem was partially solved with the development of sunflower hybrids tolerant to specific herbicides. Despite this, there are still weed control challenges. One of them is the reliable control of *Ambrosia* sp., a quarantine weed, for which mandatory control is required due to public health concerns in some countries.

A. artemisiifolia (ragweed) belongs to the Asteraceae family, is an annual plant that has been introduced in Europe around XIX century from the North America where it originated (Dessaint *et al.*, 2005). From end of July to November this plant produces a large quantity of pollen that are easily transported by the wind. This pollen is the major cause of allergies which increasingly threatens public health in European countries such as France, Italy, Germany, Austria, Hungary, Czech Republic, Romania, Bulgaria, Ukraine, Russia, and the Balkans.

Figure 1: Presence of *Ambrosia artemisiifolia* by country
Présence de *Ambrosia artemisiifolia* par pays



A. artemisiifolia pollen is intrinsically far more allergenic than grass pollen. Researchers participating in the EU Atopica (<https://www.atopica.eu/>) project indicate that ragweed sensitization will more than double by 2041-2060, increasing from 33 million to 77 million people. Those projections reflect current trends in the spread of this invasive plant species across Europe. *A. artemisiifolia* is listed as an invasive alien plant by the European Plant Protection Organization (EPPO) due to its high potential for spread. The EPPO strongly recommends countries where ragweed has been reported to take measures to prevent further spread or to manage established weed populations. There is no specific European regulation for control of *A. artemisiifolia*, however some countries in Europe have decided to

implement local specific plans for ragweed control (like Hungary and France) that aim to monitor and control the spread of this weed species.

In France, there is «L'arrêté national relatif aux règles de Bonnes Conditions Agricoles et Environnementales (BCAE) » from the July 13, 2010 that targeted *Ambrosia* specifically. Some regions in France have implemented additional methods to manage fields with *Ambrosia*.

Under this condition Corteva Agriscience proposes a new herbicide based on a new active substance halauxifen-methyl (GF-3885) to effectively control *A. artemisiifolia* as well as many other economically important weed species in sunflower. The objective of this paper is to demonstrate the efficacy of GF-3885 against *A. artemisiifolia*, *Chenopodium album*, *Xanthium strumarium*, and *Abutilon theophrasti* that are currently not fully controlled by existing herbicide solutions or biotypes resistant to other modes of action, such as ALS inhibitors and glyphosate (Bohren *et al.*, 2010) , and at developed stages of the plant.

MATERIAL AND METHODS : EFFICACY TRIALS

1) European Efficacy trials of GF-3885 on sunflower crops

In 2018, a total of 53 trials were carried out in several countries in Europe: France (7), Hungary (12), Italy (11), Romania (9), and Bulgaria (14) - covering the South-east and mediterranean EPPO zones. In France during 2017 and 2018 a total 12 trials were conducted. All these efficacy trials were undertaken either internally by employees of Corteva Agriscience or by Private Cooperator and Government, all of which had Official Recognition status for undertaking efficacy trials in accordance with the principles of Good Experimental Practice (GEP). All testing facilities employed have been notified to the relevant competent Authorities under Directive 93/71/EEC.

Table I. Products and rates applied in the efficacy trials
Produits et doses appliqués dans les essais

Product	Active substance	Concentration	Dose	Application time (sunflower growth stage)
GF-3885	Halauxyfen methyl	3 g ae/l	1 l/ha	BBCH14-30
ALS inhib. Reference 1	Tribenuron methyl	50 g/kg	22.5-30 g/ha	BBCH14-16
ALS inhib. Reference 2	Imazamox	40 g/kg	1.25 l/ha	BBCH14-16

Sites were selected on the basis of known weed infestation and trials were carried out in commercially grown sunflower fields. The trials were subject to normal agricultural inputs. The crop was well established with good uniformity and vigour prior to the application of the herbicide treatments. All trials were set up under a randomized complete block design with four replicates and a minimum plot size of 18 m². Treatments were applied to all trials using a compressed air backpack sprayer, calibrated to apply a spray volume of 200-300 l/ha using conventional nozzles.

In all trials, one evaluation was performed at 8 weeks after application (WAA) – at 51-56 days after application (DAA). The application timings for GF-3885 at the dose rate of 1 l/ha (3 g ae/ha) was done at crop growth stage from BBCH14 to BBCH30, and compared with the most important commercial reference products available in the market, and applied at their respective recommended dose rates and application timings. Only trials with significant weed infestation (>5 plants/m²) were considered and included in this analysis.

Each weed species was counting on the untreated plots before the application of the treatments by shooting a 1m² squared 3 times on each plot and replication.

Assessments were carried out according to the EPPO guidelines PP 1/63 “weeds in sunflower” and assessments were presented as the % visual control of the weeds per plot.

These 53 trials are summarised to present the weed spectrum of GF-3885 across the main European sunflower countries, from those trials, 28 were used to conduct a comparative analysis on several weeds comparing small weed to larger weeds.

Table II. Proposed efficacy scale for herbicides according to SANCO/10055/2013 Rev.4
Niveau de sensibilité des adventices sur l'échelle SANCO/10055/2013 Rev.4

Weed species susceptibility	Proposed EU scale for weed control
Highly Susceptible (HS)	95 - 100%
Susceptible (S)	85 - 94.9%
Moderately Susceptible (MS)	70 - 84.9%
Partially Susceptible (PS)	50 - 69.9%
Not Susceptible (NS)	0 - 49.9%

2) Selectivity trials of GF-3885 on sunflower crops

During 2017 and 2018 six selectivity trials have been carried out in France as part of the South regulatory zones. The objective of these selectivity trials was to evaluate the impact of GF-3885 on the quantitative (yield) and quality (oil content) parameters in sunflower crop. French selectivity trials were carried out free of weeds and on conventional and herbicide tolerant (imazamox and tribenuron methyl) hybrids. These selectivity trials were undertaken either internally by employees of Corteva Agriscience or by Private Cooperator and Government, all of which had Official Recognition status for undertaking efficacy trials in accordance with the principles of Good Experimental Practice (GEP). Assessments were done on a regular bases some weeks after the application of the treatments, and at key growth stage of the crop such as beginning and end of flowering. Plot size ranged from 24 to 30 m², and 4 replications. The 6 French selectivity trials were harvested and yield, and oil content were recorded.

GF-3885 has been compared to current market standard products. Table III shows the tested and reference products

Table III : Products and rates applied in the trials
Produits et doses appliqués dans les essais

Products	active substances (formulation)	Concentration g/l or g/kg	Doses l or kg/ha	Growth stage of Sunflower to product application
GF-3885	Halauxifen-methyl (EC)	3 g	1 l	4-8 leaves
		6 g	2 l	
Inhib. of ALS Ref. 1	Tribenuron-methyl (SG)	22.5 and 30 g	0.045 and 0.06 kg	
		45 and 60 g	0.090 and 0.120 kg	

RESULTS EFFICACY

1) Efficacy of GF-3885 on sunflower crops from France & European trials

Figure 3, figure 4 shows the efficacy of GF-3885 at the the dose rate of 1 l/ha in comparison to the standards, which were grouped as a mean of ALS inhibitor herbicides.

Figure 2 Efficacy (% visual) of GF-3885 on the main weed species present in sunflower crops – means of 53 trials carried out in Europe in 2018
Efficacité (% visuelle) de la préparation GF-3885 sur 53 essais en Europe

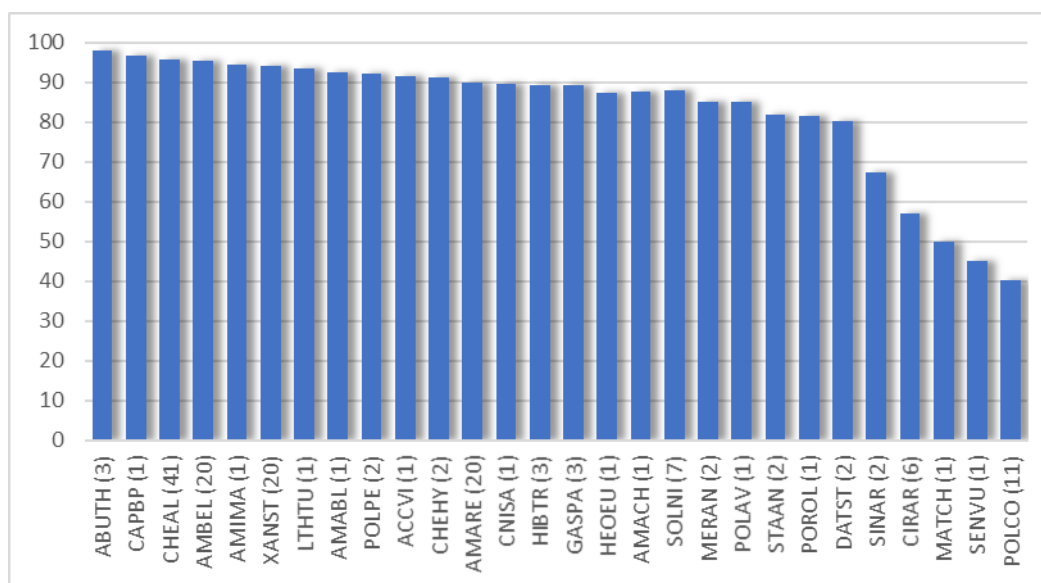


Table IV : Efficacy of GF-3885 applied at 1 l/ha at 4 - 8 leaves of the crop in France
Efficacité de la préparation GF-3885 appliquée à 1 l/ha au stade 4 - 8 feuilles du tournesol en France

Weeds	Density /m ²	Weed stage (BBCH)	GF-3885 1 l/ha applied at 4 - 8 leaves of sunflower		
			Nr.of trials	% efficacy	sensitivity
<i>Ambrosia artemisiifolia</i>	10–528	10-33	9	95.2	TS
<i>Chenopodium album</i>	14–48	12-31	4	94.5	S
<i>Xanthium strumarium</i>	17–67	10-18	2	95.8	TS
<i>Amaranthus hybridus</i>	11	10-36	1	86.8	S
<i>Solanum nigrum</i>	28	10-26	1	92.5	S

Results from the European trials (Fig.2) and also from the trials conducted in France (Table IV) demonstrate excellent efficacy of GF-3885 on key major broadleaf weeds on sunflower crops. Efficacy on weeds like *A. theophrasti*, *C. album*, *A. artemisiifolia*, *Xanthium strumarium* and *Ammi majus* were equal to 95% or superior, which is critical to successfully controlling those important and difficult weeds, and eliminating weed competition.

Figure 3 shown the performance of GF-3885 compared to the ALS inhibitors herbicides. On weeds such as *A. artemisiifolia*, *C. album*, *Cannabis sativa*, efficacy of GF-3885 was superior to 95%, also an efficacy near to 90% and again superior to the ALS inhibitors standards herbicides was observed on *Mercurialis annua*, and *Polygonum aviculare*. For many other weeds species efficacy of GF-3885 and standards was

equivalent. That was the case for *Amaranthus retroflexus*, *Chenopodium hybridum*, *Hibiscus trionum* and *Xanthium* species.

Figure 3: Efficacy (% visual) of GF-3885 on the main weed species present in sunflower crops compare to the standard reference presented as a mean of ALS inhibitor herbicides, ref 1 & 2 – means of 53 trials carried out in Europe on 2018
Efficacité (% visuelle) de la préparation GF-3885 sur les plus importantes mauvaises herbes présentes en tournesol en comparaison aux produits de référence présentés comme moyenne des références 1 12 à base d'inhibiteurs d'ALS– 53 essais européens

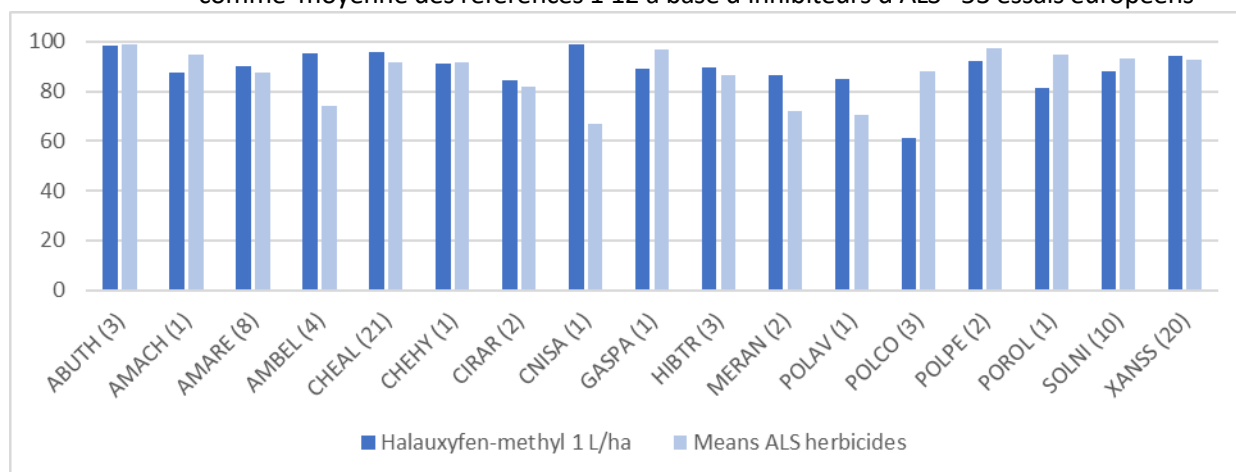
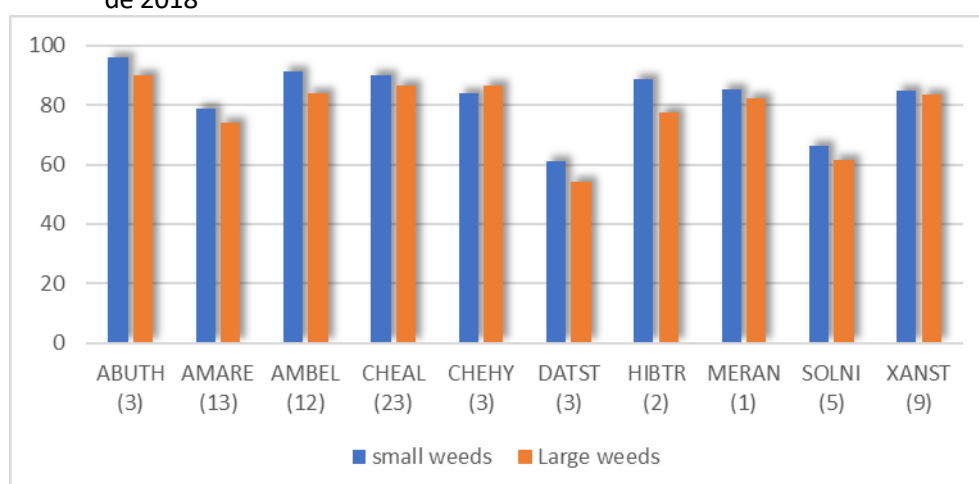


Figure 4: Efficacy (% visual) of GF-3885 on main weed species present in sunflower crops comparing small weeds (BBCH12) with more developed weeds (20-30 cm) - means of 23 trials carried out in Europe in 2018
Efficacité (% visuelle) de la préparation GF-3885 sur les plus importantes mauvaises herbes présentes en tournesol à différents stades développement – du stade précoce (BBCH12) au stade plus développé (20-30 cm) – moyenne des 23 essais européens de 2018



The application window of GF-3885 in the countries from the South regulatory zone is from 4 unfolded leaves of the crop to BBCH30 (beginning of stem elongation), this large window of application brings

flexibility to the farmer by allowing them to better manage their time without compromising weed control. The results from figure 4 show the consistent and satisfactory control of large weeds by GF-3885.

2) Crop selectivity of GF-3885 on sunflower crops from France

GF-3885 did not show any crop phytotoxic symptoms (chlorosis, necrosis, growth reduction, growth delay or missing plants). The only observed symptoms were slight leaf deformation, more or less important depending of the sunflower hybrids, and some chlorosis. All these symptoms were transient . No impact on yield or in oil content were observed.

Results from yield and oil content have demonstrated that GF-3885 does not have any negative impact on the quantity and quality parameters of sunflower

Table V : Yield results (% of untreated) of the different sunflower biotypes in Southern Zone
Résultats des essais de rendement (% sur le témoin) sur les différents types de variétés de tournesol dans la zone sud

	Number of trials	GF-3885 (N) 1 l/ha		GF-3885 (2N) 2 l/ha		Ref.1 (N) 0.045-0.060 kg/ha		Ref.1 (2N) 0.090-0.120 kg/ha		Untreated
		t/ha	% yield	t/ha	% yield	t/ha	% yield	t/ha	% yield	t/ha
Mean	3	3.38	98.8	3.38	98.8	3.26	99.7	3.27	95.6	3.42
						Ref.2 (N) 1.2-2 l/ha		Ref.2 (2N) 2.4-4 l/ha		Untreated
						t/ha	% yield	t/ha	% yield	t/ha
Mean	4	4.26	98.4	4.27	98.6	4.57	105.5	4.15	95.8	4.33
						Ref.3 (N) 0.08 kg pr/ha		Ref.3 (2N) 0.16 kg pr/ha		Untreated
						t/ha	% yield	t/ha	% yield	t/ha
Mean	8	3.58	88.2	3.63	89.4	3.56	87.7	3.60	88.7	4.06

Tableau VI : Oil content results in Southern Zone
Résultats des essais de rendement sur la teneur en huile du tournesol en zone sud

Oil % content						
	Nr. of trials	GF-3885 (N) 1 l/ha	GF-3885 (2N) 2 l/ha	Ref.1 (N) 0.045-0.060 kg/ha	Ref.1 (2N) 0.090-0.120 kg/ha	Untreated
Mean	3	47.4	47.6	49.2	47.3	47.8
				Ref.2 (N) 1.2-2 l/ha	Ref.2 (2N) 2.4-4 l/ha	Untreated
				48.1	48.1	48.4
				Ref.3 (N) 0.08 kg/ha	Ref.3 (2N) 0.16 kg/ha	Untreated
				-	46.4	46.0

DISCUSSION & CONCLUSION

The analysis of the trials carried in the South regulatory Zone have shown that GF-3885 applied post-emergence in the sunflower crop is effective in controlling key and most frequent broadleaf weeds such as *A. artemisiifolia*, *X. strumarium*, *Ch. album*, *A. theophrasti* and a good level of efficacy on *Amaranthus*, *Hibiscus*, *Mercurialis*, *Solanum*. This lead to optimize the yield and the quality of oil content in sunflower crops, by allowing a targeted application, a limited environmental pressure of pesticides and being more compliant with Ambrosia regulation to reduce pollen allergen. GF-3885 can be safely applied on all sunflower hybrids, herbicide tolerant or conventional, from 4 fully developed leaves thus offering growers the possibility to choose the best sunflower hybrid for their farm, and for conventional farmers a new and unique solution for the control of weeds post-emergence of the crop.

BIBLIOGRAPHIE

Sites internet consultés :

FAOSTAT, 2014

EU Atopica (<https://www.atopica.eu/>)

Articles :

Bohren C., Delabays N. & Waldispuhl, S. (2010). Contrôle de l'ambrosie, l'agriculture n'est pas seule concernée. *Recherche agronomique Suisse*, numéro 7-8, juillet-août 2010, 260-266

"®™ Trademarks of Dow AgroSciences, DuPont, and Pioneer

"Clearfield, Cleafield Plus is a trademark of BASF"