RESEARCHES ON ANNUAL WEED CONTROL BY GOAL 4F HERBICIDE IN STRAWBERRIES

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ABSTRACT

Strawberry crop is very sensitive to weed infestation, especially Stellaria media because this weed prefers cool climate, emerges in autumn and grows during winter reaching a tick vegetal cover in the spring that asphyxiates the strawberry plant that was planted in autumn. This fact is produced because this weed crawls on the soil and its stems forms adventive roots were the stems touch the soil. The Goal 4F herbicide contains 480 g/l oxyfluorfen. This herbicide active ingredient burns the green parts where it falls because it breaks the cellular membrane. Our experiment tried increasing concentrations that have succeeded to destroy annual weeds, including Stellaria media that have recently emerged and did not affected the strawberry plant.

INTRODUCTION

First organic herbicide was accidentally discovered at Jeallot's Hill agricultural station when researchers tried to increase the cereal yield by artificial hormone. When higher concentrations of 2,4 D hormone was applied, cruciferous weeds have been destroyed and wheat plants showed no symptoms. This was the first herbicide, still in use and started a real revolution in plant production.

Nowadays, there are synthetized over 250 herbicide active ingredients from which there are produced over 3.000 comercial herbicide products. In order to synthetize a herbicide active ingredient there are taken in study about 1.000 potentially active ingredients and there are spent between 40-60 million dolars.

Herbicides must be absorbed into plants in order to be effective. Herbicide absorption can occur through leaves, roots or both. The process by which herbicides kill weeds, called mode of action, requires herbicide absorption and may also require herbicide movement or translocation within the plant. Translocation means that the herbicide moves from the site of absorption to some other plant part. Foliar applied herbicides that have the necessary characteristics to move in the phloem will translocate to areas of the plant that are actively growing; however, not all foliar-applied herbicides move from the leaves that intercepted the spray solution. Herbicides that are absorbed but not translocated are called contact herbicides, while herbicides that translocate to shoot or root meristems are called systemic herbicides [5].

The primary barrier to foliar absorption of herbicides (or any pesticide) is the cuticle. The cuticle is not a simple wax layer covering the leaf surface. The cuticle is a complex matrix of materials that vary in water solubility and include waxes, cutin and pectin. The most lipophilic (fat loving) components of the cuticle are the surface epicuticular and cuticular waxes. These layers restrict water movement into and out of the plant and are significant barriers to herbicide absorption. Below the surface epicuticular and cuticular wax layers, a less lipophilic layer of cutin occurs interlaced with strands of pectin and embedded wax. Pectin strands are actually hydrophilic (water loving) and are believed to provide an avenue for the absorption of hydrophilic herbicides like glyphosate (Roundup and many generics). The cuticle ends at the cell wall of the underlying epidermis. Depending on their lipophilic or hydrophilic properties, there are several possible routes that herbicides might follow as they move through the cuticle [5].

Lipophilic herbicides are readily absorbed into cuticular waxes, moving easily through embedded waxes to the cutin and pectin layers. At this point, the cuticle becomes more hydrophilic and movement of lipophilic herbicides slows. Initial absorption into cuticular waxes can be very high as a percentage of the total amount of herbicide intercepted by the leaf. Lipophilic herbicides may have difficulty moving out of the cuticle and into the underlying epidermal cells. A certain amount of these lipophilic herbicides can also be retained in the plasma membrane of epidermal cells. The plasma membrane is the lipid bilayer that separates the cytoplasm from the cell wall [5].

Some characteristics of lipophilic herbicides are illustrated in Table 1. Note that these herbicides have low water solubility and log K_{ow} values greater than 1. Log K_{ow} is defined as the log of the octanol-water partition coefficent. This unitless number is the ratio of the amount of herbicide found in octanol (organic solvent) compared to the amount of herbicide found in water and expressed on a log scale. In general terms, it is a good indicator of the lipophilic or hydrophilic nature of a pesticide. Two herbicides listed in table 1, Fusilade and Goal, are formulated as ethyl or butyl esters. In this form they are rapidly absorbed into the cuticle; however, once inside the plant the ester linkage is cleaved, producing the free acid which is the active form of the herbicide. Formulating herbicides in this way takes advantage of the fact that lipophilic herbicides are rapidly absorbed by plants [5].

Table 1

Examples of lipophilic herbicides and their properties

Trade name	Common chemical name	Water solubility	Log Kow	General use
Fusilade	Fluazifop butyl	1.1 mg/l	1.3	Post emergence control of annual and perennial grasses in broadleaf crops.
Goal	oxyfluorfen	0.1 mg/l	4.5	Broadleaf weed control in onion, and before transplanting of vegetables

Oxyfluorfen herbicide active ingredient belongs to the group of active ingredients that burns the cellular membrane. This action is made because this active ingredient has a log Kow parameter close to 5 which means that it is very lipophylic and remain between cell membrane and breaks it.

MATERIAL AND METHOD

The experiment was located at the Botanic Garden of University of Craiova in 2017 year and comprised five treatments of oxyfluorfen concentrations which applied at after strawberry plantation and annual weed emergence. The treatments were:

V1: 10 ml Goal 4F herbicide in 16 l water = 4,8 ml oxyfluorfen in 16000 ml water = 0.030%; V2: 20 ml Goal 4F herbicide in 16 l water = 9.6 ml oxyfluorfen in 16000 ml water = 0.060%; V3: 30 ml Goal 4F herbicide in 16 l water = 14.4 ml oxyfluorfen in 16000 ml water = 0.090%; V4: 35 ml Goal 4F herbicide in 16 l water = 16.8 ml oxyfluorfen in 16000 ml water = 0.105%; V5: control.

The treatments have been made at an interval of seven days. The first treatment was done one week after crop planting, when the first wave of weeds emerged. The crop was planted at 23 September 2017.

There have been done determination of the number of weeds per square meter for every identified species for every treatment as well for the control treatment.

RESULTS AND DISCUSSIONS

One week after crop planting the annual winter weed emerged. They were counted per square meter at control treatment, were no herbicide was applied. The results are presented in the table below.

Table 1

The weeding degree at the control treatment in strawberries

Weed species	B. c.	Phase/ Height (cm)	Determinations					M	P%	K%
			I	II	III	IV	V			
Chaerophyllum procumbens	d.a.	A/1	3000	-	4500	-	5000	2500	87	60
Hordeum murinum	m.a.	A/1	150	300	500	600	80	326	11	100
Stellaria media	d.a.	A/1	70	50	-	80	-	40	2	60
Total number of weeds/square meter								2866		

These results show a very high number of Chaerophyllum procumbens weed per square meter. Also, there can be noticed that this weed is not present on the entire surface of the experiment. Another observation is that the Hordeum murinum weed is present on all surface. Stellaria media is present on 60% of determinations in a lower number but it has the highest damage potential for strawberry and it was the main weed species to control [1].

The effect of each treatment consisted in burning spots on green parts of the weeds. Due to the fact that oxyflurfen was applied in several increasing concentrations the effect was more intense with the case of higher concentrations. This way, the first tried concentration, 10 ml Goal 4F in 16 l water (0.03%) did not killed the annual weeds present in the experimental field. The second, third and fourth concentrations, of 20, 30 and 35 ml of herbicide in 16 l of water, respectively, 0.060%, 0.09% and 0.105% have had a radical effect on all three annual weeds. The strawberry plant has recorded small burning points on the youngest leaf that grows from the center of the plant.

The appreciation of the effect of herbicide concentrations was made after the scale elaborated by the European Weed Research Society (EWRS). This scale refers both to the efficacy against weeds and the crops phytotoxicity. In both cases the highest accepted mark is 2 which mean good control against weeds and almost no phytotoxicity to the crop [3,4]. The results on herbicide concentrations against weeds and the phytotoxicity to the crop are presented in the table two.

Table 2

The effect of Goal 4F herbicide against annual weeds and its phytotoxicity to the strawberry crop in 2017 appreciated by EWRS marks

Treatment	Weed			Phytotoxicity
	Chaerophyllum procumbens	Hordeum murinum	Stellaria media	
V1: 10 ml Goal 4F herbicide in 16 l water	8	8	8	1
V2: 20 ml Goal 4F herbicide in 16 l water	4	2	2	1
V3: 30 ml Goal 4F herbicide in 16 l water	2	1	1	1
V4: 35 ml Goal 4F herbicide in 16 l water	1	1	1	1

From these data we can observe that Chaerophyllum procumbens weed was not killed by first two concentrations. This fact is explained by a very high density of this weed which made the herbicide to not reach on each leaf of the weed. This is the reason why this weed resisted to the second concentration.

Regarding the plant phytotoxicity, it received mark 1 for all treatments which means no serious harmful effect. In fact, the central, youngest leaf is burned in smal spots but it recovers during its growth.

CONCLUSIONS

1. Goal 4F herbicide which contains 480 g/l oxyfluorfen can be used to the strawberry crop in a concentration of maximum 0.105% (35 ml herbicide in 16 l water) without phytotoxicity problems. Only the youngest central leaf undergo spots of burning that are not harmful for the plant growth.
2. The lowest concentration that was tried, of 0.03% did not nor the weeds or the strawberry crop.
3. The concentrations of 0.06, 0.09 and 0.105 killed freshly emerged annual wedds: Chaerophyllum procumbens, Hordeum murinum and Stellaria media.
4. At a very high weed density (5.000 per square meter), the weed leaves are protected by covering each other. The herbicide does not reach the leaves and does not kill them.

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