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Efficiency of some soil herbicides in a raspberry plantation under drip irrigation

Zaria Rankova, Kouman Koumanov

Fruit Growing Institute, Plovdiv, Bulgaria

Abstract: The selectivity and the efficiency of some soil herbicides and their impact on plant growth was studied in a raspberry plantation of the primocane-fruiting cultivar Lewlin, under permanent soil moistening, provided by a drip irrigation system. The experiment was carried out on the territory of Fruit Growing Institute in Plovdiv, on alluvial-meadow soil (Fluvisol) during the period 2002-2003. Drippers were with discharge of 2.4 *l/ha* (10 *l/h/m*) and were set at distance of 30 *cm* along the row. Irrigation was scheduled based on 80 % of the evaporation from a „Class A" evaporation pan. The variants investigated were: 1) Control (non treated); 2) Pendimethalin (Stomp 33 EC) - 4 *l/ha*; 3) Pendimethalin (Stomp 33 EC) - 6 *l/ha*; 4) Metolachlor (Dual Gold 960 EC) - 1 *l/ha*; 5) Metolachlor (Dual Gold 960 EC) - 1.5 *l/ha*; 6) Oxadiargyl (Raft 800 WG) - 0.25 *kg/ha*; 7) Oxadiargyl (Raft 800 WG) - 0.50 *kg/ha*. Subject of investigation was the efficiency of herbicides on 10 weed species constituting the weed association in the row strip. Results were obtained by the quantitative-weight method the samples being collected at intervals of 30 days. At this stage, the best effect, regarding weed control and raspberry-plant tolerance under permanent soil moistening, was found under the following herbicides and doses: Pendimethalin (Stomp 33 EC) - 4 *l/ha*; Metolachlor (Dual Gold 960 EC) - 1 *l/ha*; and Oxadiargyl (Raft 800 WG) - 0.5 *kg/ha*.

Key words: Raspberry, soil herbicides, weeds, drip irrigation.

Introduction

When raspberry is grown under drip irrigation, the maintaining of high soil moisture and the application of fertilizers with irrigation water stimulates development of weeds, which compete with culture plants for water and nutrients. Generally, the activity of soil herbicides depends on the soil moisture. The application of soil herbicides is of special interest for the primocane-fruiting raspberry cultivars. Different soil herbicides affect in a different way the growth and the yield of raspberry plants (Lawson, 1982; Esau et al., 1983; Atanasova and Baeva, 1995; Reynolds and Roden 1996; Funt et al., 1999). This paper presents the results of an investigation on the effi-

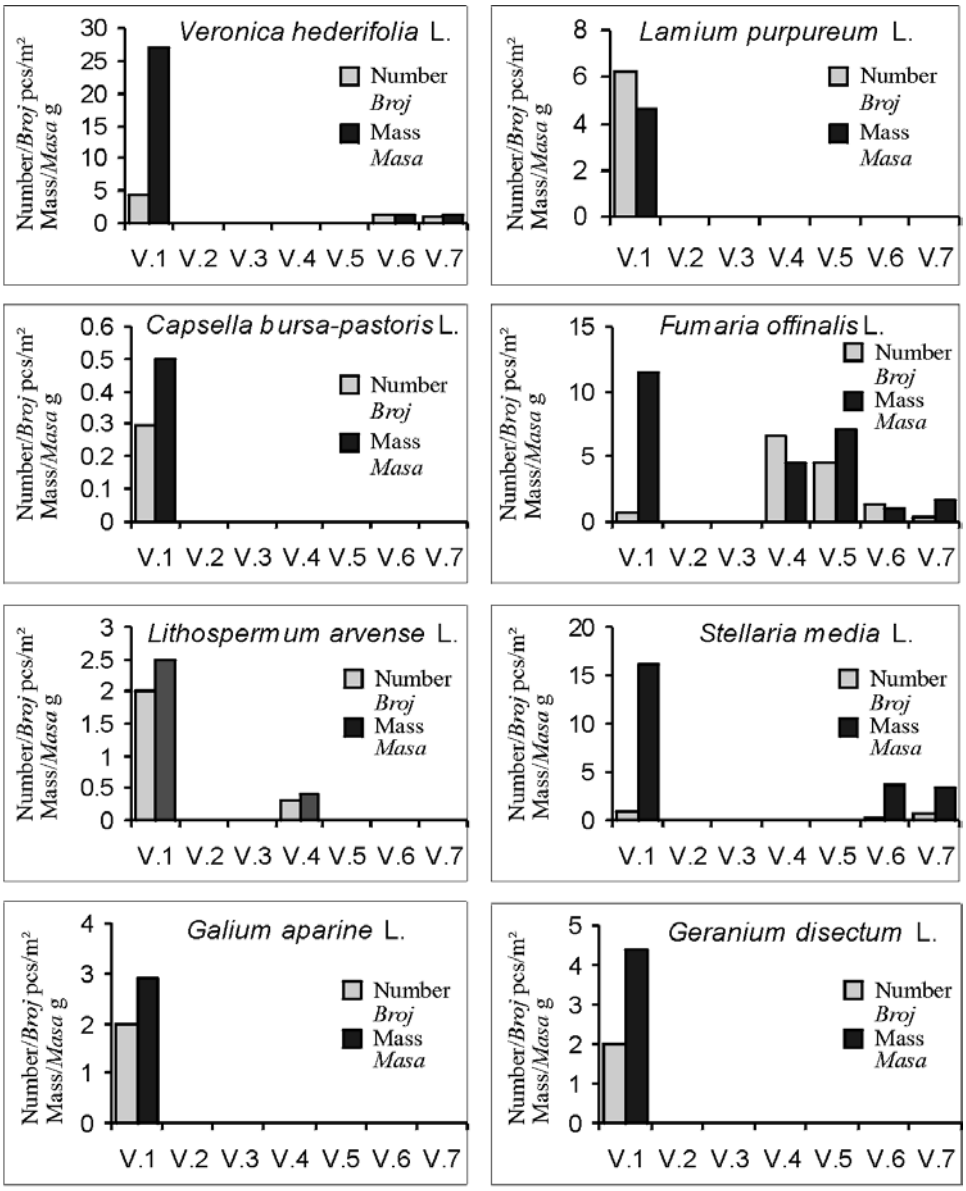
ciency of some soil herbicides and their impact on the growth of raspberry plants of the primocane-fruiting variety Lewlin in conditions of permanent soil moistening.

Material and methods

Experimental work was carried on the territory of Fruit Growing Institute in Plovdiv in the period 2002-2003. The soil is alluvial-meadow (Fluvisol). The raspberry plantation was established in the fall of 1998 with planting distances 0.50 x 2.30 *m*. Herbicide treatments were applied in the middle of March, before the start of raspberry plants vegetation. Seven variants in three replications with area of 1.0 m² were set up according to the method of the long rows: 1) Control variant (non treated); 2) Pendimethalin (Stomp 33 EC) - 4 *l/ha*; 3) Pendimethalin (Stomp 33 EC) - 6 *l/ha*; 4) Metolachlor (Dual Gold 960 EC) - 1 *l/ha*; 5) Metolachlor (Dual Gold 960 EC) - 1.5 *l/ha*; 6) Oxadiargyl (Raft 800 WG) - 0.25 *kg/ha*; 7) Oxadiargyl (Raft 800 WG) - 0.50 *kg/ha*. The system of drip irrigation was constructed in the spring of 2000 with dripper spacing along the rows 0.30 *m* and dripper discharge of 2.4 *l/h* (10 *l/h/m*). Irrigation scheduling was based on 80 % of the evaporation from Class A pan. The efficiency of the herbicides and the herbicide doses was investigated on 10 weed species constituting the weed association in the row strip: *Veronica hederifolia* L., *Lamium purpureum* L., *Capsella bursa-pastoris* L., *Fumaria offinalis* L., *Lithospermum arvense* L., *Stellaria media* L., *Galium aparine* L., *Geranium disectum* L., *Lamium amplexicaule* L., and *Sonchus oleraceus* L. Weeds were collected 30 days and 60 days after the herbicide treatment. Samples were weighed and the plants of each species counted. Raspberry plants were examined for visual symptoms of phytotoxicity. Leaf samples were taken in the middle of June, during the active plant vegetation, for determining the mass of the leaf dry matter and the content of chlorophyll in leaves. Growth parameters as height and diameter of the canes were measured after the vegetation period.

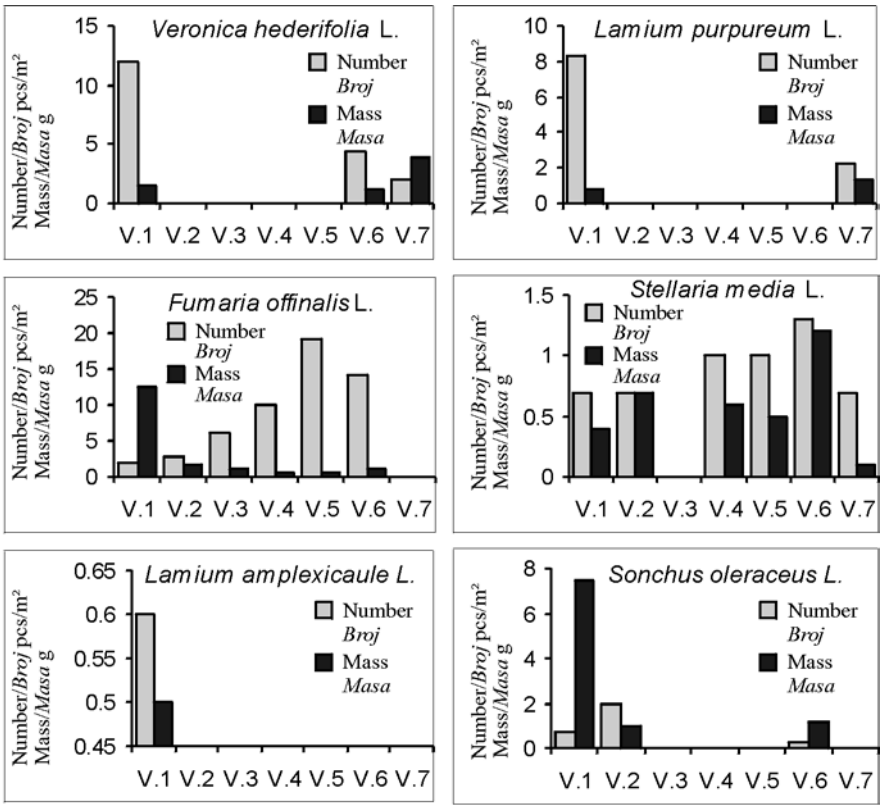
Results and discussion

The number of weed plants per square meter and the mass of weeds are shown by species and by dates of sampling in Graphs 1 and 2. Al treatments applied were proven to be effective concerning the control on the weed association. This eliminated the competition between weeds and culture plants in the early stages of vegetation - emerging and intensive growth of the canes. Both pendimethalin doses realized total control on the developing weed species during the first 30 days after the treatment. Even 60 days after the treatment we counted only six plants per square meter of *Fumaria offinalis* L. under the dose of 6.0 *l/ha*. The density of *Fumaria offinalis* L. was higher in the two variants treated with metolachlor - 10.0 *pcs/m²* and 19.3 *pcs/m²* respectively, versus 2.0 *pcs/m²* in the control variant. We explain this with the compensating reaction of *Fumaria offinalis* L., which is tolerant to metolachlor (Tonev, 2000). Because of the same reasons, we found plants of *Stellaria media* L. in the variants treated with oxadiargyl. *Stellaria media* L. is of moderate tolerance to this herbicide. The species *Capsella bursa-pastoris* L., *Lithospermum arvense* L., *Geranium disectum* L. and *Galium aparine* L. were not found in the experimental plots 60 days



Graph 1. Number of weed plants per square meter and average fresh mass of weeds by species and by dates of sampling 30 days after the herbicide treatment

Graf. 1. Broj korova po m² i prosečna masa korova po vrstama i datumima prikupljanja 30 dana nakon tretiranja herbicidom



Graph 2. Number of weed plants per square meter and average fresh mass of weeds by species and by dates of sampling 60 days after the herbicide treatment
Graf. 2. Broj korova po m² i prosečna sveža masa korova po vrstama i datumima prikupljana 60 dana nakon tretiranja herbicidom

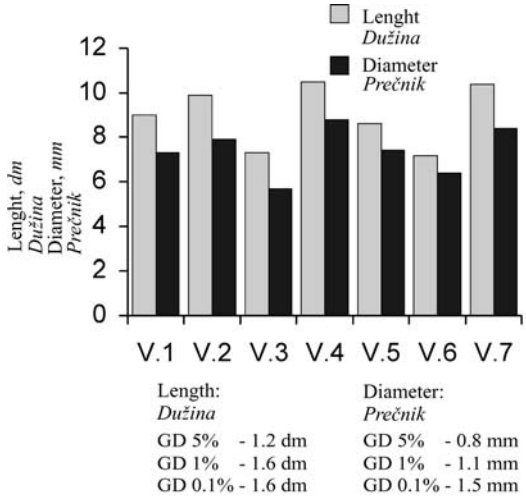
after the herbicide treatment because of the early ending of their vegetation. Because of the same reason, they were not found in the control variant, too. Taking in account the good herbicide effect on the other weed species, we assume that the applied herbicides and doses proved to be effective for a 60-day period after the treatment in conditions of permanent soil moistening. This is seen also from the data for the average number of weed plants per square meter (Tab. 1). Thirty days after the treatment with oxadiargyl in dose of 0.5 *kg/ha*, the weed density was 2.0 *pcs/m²* and the weed mass was 6.2 *g* versus 18.6 *pcs/m²* and 74.2 *g* in the control variant. Sixty days after the treatment, the results are similar.

Raspberry plants did not show symptoms of phytotoxicity due to the herbicide treatments. Slide anthocianic coloration of the leaves was observed under oxadiargyl treatment in dose of 0.5 *kg/ha* during the first month after the cane emerging, but plants overcame this soon afterwards. Probably, this effect was due to dual action of the oxadiargyl - as total and as contact herbicide. Herbicides did not affect the leaf dry matter and the chlorophyll content, too.

Tab. 1. Total number and average fresh mass of weed plants by variants and by dates of sampling; absolute values and percentage versus the control variant
Ukupni broj i prosečna sveža masa korova po varijantama i datumima prikupljanja; apsolutne vrednosti i procenat u odnosu na kontrolnu varijantu

Variants *Varijante*	30 days after treatment *30 dana nakon tretiranja*				60 days after treatment *60 dana nakon tretiranja*			
	Number/*Broj*		Mass/*Masa*		Number/*Broj*		Mass/*Masa*	
	pcs/m²	*%*	*g*	*%*	*pcs/m²*	*%*	*g*	*%*
V.1(c)	18.6	100	74.2	100	24.3	100	23.2	100
V.2	0	0	0	0	5.4	22.2	3.5	15.1
V.3	0	0	0	0	6.0	24.7	1.2	5.2
V.4	6.8	36.6	4.9	6.6	11.0	45.3	1.2	5.2
V.5	5.6	30.1	8.2	11.1	20.3	83.5	1.0	4.3
V.6	3.0	16.1	6.1	8.2	20.2	83.1	3.5	15.1
V.7	2.0	10.8	6.2	8.4	5.0	20.6	5.2	22.4

Graph 3 shows the impact of herbicide treatments on cane length and cane diameter, presented as variant averages. The highest values of growth parameters were measured in the variants with metolachlor in dose 1.0 *l/ha*, oxadiargyl in dose 0.5 *kg/ha* and pendimethalin in dose 4.0 *l/ha*. Lower values were measured in the variants with the higher herbicide doses: pendimethalin in dose 6.0 *l/ha* and metolachlor in dose 1,5 *l/ha*, which is probably due to increased activity of herbicides under the permanent soil moistening, resulting from drip irrigation.



Graph 3. Impact of herbicide treatments on cane length and cane diameter, presented as variant averages
Graf. 3. Uticaj tretmana herbicidima na dužinu i prečnik izdanka, dat kao prosečna vrednost po varijanti

Conclusions

Based on both the efficiency of soil herbicides and the growth parameters data we recommend the lower doses of the studied system soil herbicides for weed control in drip-irrigated raspberry plantations of primocane fruiting varieties, respectively 4.0 *l/ha* pendimethalin and 1.0 *l/ha* metolachlor. For the total contact soil herbicide oxadiargyl we recommend the higher investigated dose of 0.5 *kg/ha*.

Drip irrigation was found to meet the requirements for integrated fruit production increasing the herbicide application efficiency and decreasing the risks for the environment.

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EFIKASNOST NEKIH ZEMLJIŠNIH HERBICIDA U ZASADU MALINE UZ NAVODNJAVANJE KAP PO KAP

Zaria Rankova, Kouman Koumanov

Institut za voćarstvo, Plovdiv, Bugarska

Summary

Proučavana je selektivnost i efikasnost nekih zemljišnih herbicida i njihov uticaj na rast biljke u zasadu maline jednorodne sorte Lewlin uz konstantno vlaženje zemljišta navodnjavanjem kap po kap. Eksperimentalni zasad je podignut na imanju Instituta za voćarstvo u Plovdivu, na aluvijalno livadskom zemljištu (Fluvisol) tokom 2002-2003. Kapacitet kapaljki je iznosio 2,4 *l/h* (10 *l/h/m*). Rastojanje kapaljki u redu je bilo 30 *cm*. Navodnjavanje je zasnovano na 80% isparenja uređaja klase A. Proučavane su sledeće varijante:1) kontrola (bez tretmana); 2) Pendimethalin (Stomp 33 EC) - 4 *l/ha*; 3) Pendimethalin (Stomp 33 EC) - 6 *l/ha*; 4) Metolachlor (Dual Gold 960 EC) - 1 *l/ha*; 5) Metolachlor (Dual Gold 960 EC) - 1,5 *l/ha*; 6) Oxadiargyl (Raft 800 WG) - 0,25 *kg/ha*; 7) Oxadiargyl (Raft 800 WG) - 0,50 *kg/ha*. Cilj rada je bilo proučavanje efikasnosti herbicida na 10 korovskih vrsta koje su sačinjavale korovsku grupu u formi trake. Rezultati su dobijeni kvanitativnim merenjem uzoraka koji su prikupljani na 30 dana. U pogledu suzbijanja korova i tolerantnosti maline u uslovima konstantnog vlaženja zemljišta, najbolji rezultati su uočeni kod sledećih herbicida i doza: Pendimethalin (Stomp 33 EC) - 4 *l/ha*; Metolachlor (Dual Gold 960 EC) - 1 *l/ha*; i Oxadiargyl (Raft 800 WG) - 0,50 *kg/ha*.

Author' address:
Dr Zaria Rankova
Fruit Growing Institute
12 Ostromila
4004 Plovdiv
Bulgaria