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EFFECT OF MULCHING ON WEED INFESTATION AND YIELDS OF LEEK (*ALLIUM PORRUM* L.)

Nina GERASIMOVA[1], MilenaYORDANOVA[2]

[1]Institute of Plant Physiology and Genetics, Bulgarian Academy of Sciences, Acad. G. Bonchev Street, Bldg. 21,1113, Sofia, Bulgaria, GSM: +359.889.968.339, Email:gerasimova_n@abv.bg
[2]University of Forestry, Faculty of Agronomy, 10 KlimentOhridski Blvd, 1756, Sofia, Bulgaria, GSM: +359.887.698.775, Email: yordanova_m@yahoo.com

Corresponding author email: yordanova_m@yahoo.com

Abstract

The aim of this field experiment was to study the effect of two mulching materials on weed infestation and yield of leek, cv. 'Bulgarian Giant'. The field experiment was carried out in the period 2010-2012 in the experimental field on University of Forestry – Sofia. The experimental design was the randomized block with four replicates. Two different mulching materials – barley straw mulch (BSM) and mulch from spent mushroom compost (SMCM) were compared with two control variants – non-mulching, but weeding control (WC) and non-mulching and non-weeding control (NWC). The mulching materials were spread manually in a 5 cm thick layer, one week after transplanting the seedlings of leek. On the 30th, 60th and 90th day after mulching were recorded the number of weeds on each plot. It was found out that mulching with BSM and SMCM have a significant depressing effect on weeds, especially on Echinochloa crus-galli L., Setaria glauca (L.) Beauv., Galinsoga parviflora Cav., Polygonum lapathifolium L. and Portulaca oleracea L. The yields were increased from 3.7 to 4 times when the leek was grown with mulches, compared with NWC. Data were subjected to statisticall analysis using dispersion method. Means were separated by application of Duncan's Multiple Range Test at $p \leq 0.05$.

Key words*: barley straw mulch, spent mushroom compost mulch, weed infestation, leek.*

INTRODUCTION

Leeks (*Allium porrum* L.) are members of onion family, closely related to onion, garlic, shallots and chives. (Cholakov, 2009).

Weeds are competitors of most vegetable crops and can reduce their yields significantly. The main annual weeds that occur on arable land under cultivation of species of family Alliaceae are different types of amaranth, fat-hen, thorn-apple, pale persicaria, bristle-grass, cockspur, red finger-grass etc. Also, infestation of arable land with perennial weeds such as Johnson grass, creeping thistle, field bindweed, etc. has been observed (Tonev, 2000). Decrease of weed infestation depend on fact that leek is growing under irrigation and natural fertilizer.

One of alternative method for weed control is use of different kinds of mulch. In the integrated and ecological agriculture systemsmore attention is being paid to the longest possible periodof soil coverage with plant mulches and mulches from straw left aftercereal grain harvest (Szymona, 1993). Organic mulch can block light to the soil surface,reducing the germination and growth of weeds (Anyszka, Dobrzański, 2008).A number of studies have documented that straw mulch isa good means of decreasing weed emergence and growth (Duppong et al., 2004; Grassbaught et al., 2004; Teasdale and Mohler, 2000). Covering or mulching the soil surface canreduceweed problems bypreventing weedseed germination or by suppressing the growth of emerging seedlings (Bond et al., 2003). Mulching decrease the numbers of hand-hoeing and mechanical cultivations for remove of weeds. The key factors that make straw mulchattractive are low cost and easy in availability and application(Ramakrishnaetal., 2006).

According to the data of experiments, straw mulchis best for weed control. In plots with straw mulch weeddensity wasestablished at2.8–6.4 times lower compared with weed density in plots without mulch (Sinkevičienė et al., 2009). According to Radwanand Hussein (2001) broad-leaved weeds were more susceptible than

grassy weed to mulching treatments. Mulching improves plant growth, increases yields their quality (Sharma, Sharma, 2003; Singh et al., 2007).

In studying of effect of different organic mulches on weed infestation was establish that mulching with spent mushroom compost, crushed corn cobs and long wheat straw reduced weed germination and weed growth. They suppressed bettermonocotyledonous than dicotyledonous weeds, except straw mulch (Yordanova, Shaban, 2007).

The aim of thepresentstudy was to evaluate the influence of different organic mulches on weed infestation and yield of leek.

MATERIALS AND METHODS

The studies were conducted in the period 2010-2012 in the experimental field on University of Forestry – Sofia, on the Fluvisol soil type.

The leek cultivar "Bulgarian giant" was grown through seedlings which were planted in the second half of June by scheme 60+25+25+25+25/15. The preceding crop was broccoli. The leek was cultivated by drip irrigation. Each trial was laid out in a randomized block-design with four replications (4x40), with protection zones.

The experiment was carried-out with four treatments: 1 - non mulching, but weeding control (WC); 2 - non mulching and non-weeding control (NWC); 3 – mulch from spent mushroom compost (SMCM); 4 – barley straw mulch (BSM). The mulching materials were spread manually in a 5 cm thick layera month after planted of leek.

The occurrence, extent and types of weeds werestudied at 30 and 60 daysafter mulching (DAM) at fixed sites of 1m^{2}for each treatment and replicate. All weeds in eachquadrat were identified, counted and recorded forsubsequent data analysis.

The efficacy of the tested mulching materials was recorded by Abbot's formula:

WG% = (CA-TA/CA) x 100, where:

WG% - the percentage efficacy of the herbicides;

CA - living individuals in the control after treatment;

TA - individuals living in the variant after treatment.

The length and diameter of the false stem were measured on 10 plants and presented the average results. The total yield is established in tones per decare (t/da) in replications and variants.

Data were subjected to statistical analysis using dispersion method. Means were separated by application of Duncan's Multiple Range Test at $p \leq 0.05$.

RESULTS AND DISCUSSION

The level of weed infestation in agrocenoses of leeks recorded on 30th and 60thDAM is given in Table 1 - 3. In this agrocenoses the following weed species were established: cockspur (*Echinochloa crus-galli* L.), red finger-grass (*Digitaria sanguinalis* (L.) Scop.), green foxtail (*Setaria viridis* (L.) Beauv.), yellow foxtail (*Setaria glauca* (L.) Beauv.), galinzoga (*Galinsoga parviflora* Cav.), amaranth (*Amaranthus retroflexus* L.), common lambsquarters (*Chenopodium album* L.), purslane (*Portulaca oleracea* L.), and pale persicaria (*Polygonum lapathifolium* L.). In the variant with barley straw mulch (BSM) was recorded and barley (*Hordeum vulgare* L.).

The unmulched plots showed a greaterdiversity of weed species than the mulched plots in period 2010-2012. At 30DAM mulching from spent mushroom compost (SMCM) showed lower weed infestation than barley straw mulch (BSM) (table 1). In this variant weed species *Amaranthus retroflexus* had average number per square meter 10.5. The other weeds in agrocenoses of leek were with single numbers which didn't affect on leek. At 60DAM was establishing low increase of weed infestation in V3. *Amaranthus retroflexus* again was with the most numbers per square meter - 11.75. In treatment with BSM was established higher weed infestation with annual monocotyledonous weeds than dicotyledonous. Weed scores showedsignificant differences ($p \leq 0.05$) in three experimental years.

Analogous results were obtained in year 2011 (table 2). The most effective weed control was recorded in the plots with mulch from spent mushroom compost (SMCM) except for amaranth (*Amaranthus retroflexus* L.) which average number was 18.75 per 1 m^2. In spite of this a significantdifferencewas observed

between mulching by spent mushroom compost and non-mulching control. Mulching with barley straw (BSM) showed a slightly difference with SMCM, which is in little higher growth of annual monocotyledonous weed species greenfoxtail (*Setaria viridis* (L.) Beauv.). There were established single numbers in particular replications of weed species *Galinsoga parviflora* and *Portulaca oleracea* in which there was delay in its grow up.At 60DAM the applied organic mulches affected in high extent theweed species. The number of *Amaranthus retroflexus* in SMCM was unaffected but in BSM it was increase. In this variant has reported the single plants of barley (*Hordeum vulgare* L.), which is because of the presence of barley seeds in straw mulch. A significant differences in the average number of weeds in $1m^2$was observed between NWC, SMCM and BSM.

Table 1. Average number of weeds in 1 m^2 after mulching (2010)

Weed species	NWC		SMCM		BSM	
	30 DAM	60 DAM	30 DAM	60 DAM	30 DAM	60 DAM
Echinochloa crus-galli	17.75 [a]	51.5 [a]	1.5 [b]	1.75 [b]	2.50 [b]	2.75 [b]
Digitaria sanguinalis	9.75 [a]	11.5 [a]	0 [b]	0.75 [b]	1.50 [b]	2.00 [b]
Setaria viridis	11.25 [a]	17.5 [a]	0 [b]	0 [b]	9.50 [a]	9.50 [a]
Setaria glauca	3.50 [a]	6 [a]	0 [b]	0 [b]	0 [b]	0 [b]
Hordeum vulgare	0	0 [b]	0	0 [b]	0	7.00 [a]
Galinsoga parviflora	11.00[a]	19.5 [a]	0 [b]	0.75[b]	1.25 [b]	2.25[b]
Amaranthus retroflexus	43.50 [a]	52.5 [a]	10.5 [b]	11.75 [b]	2.75 [c]	7.50 [c]
Chenopodium album	2.25 [a]	3.25 [a]	0 [b]	0 [b]	0 [b]	0 [b]
Portulaca oleracea	18.75 [a]	21.5 [a]	0.5[b]	0.50[b]	0[b]	0[b]
Polygonum lapathifolium	1.75[a]	3.5[a]	0[b]	0[b]	0[b]	0[b]

Values with the same letter within years are not significantly different (Duncan's Multiple Range Test at $p \leq 0.05$)

Table 2.Average number of weeds in 1 m^2 after mulching (2011)

Weed species	NWC		SMCM		BSM	
	30 DAM	60 DAM	30 DAM	60 DAM	30 DAM	60 DAM
Echinochloa crus-galli	27.75 [a]	45.75 [a]	1.25 [b]	1.25 [b]	1.25 [b]	1.50 [b]
Digitaria sanguinalis	10.25 [a]	21.50 [a]	0 [b]	0.25 [b]	1.50 [b]	1.50 [b]
Setaria viridis	9.75 [a]	9.75 [a]	0 [b]	0 [b]	9.50 [a]	9.50 [a]
Setaria glauca	0.75 [a]	2.00 [a]	0 [b]	0 [b]	0 [b]	0 [b]
Hordeum vulgare	0	0 [b]	0	0 [b]	0	9.00 [a]
Galinsoga parviflora	8.00 [a]	15.50 [a]	0.50 [b]	1.00[b]	1.25 [b]	2.25[b]
Amaranthu sretroflexus	24.50 [a]	32.50 [a]	18.75 [b]	18.75 [b]	1.75 [c]	6.00 [c]
Chenopodium album	0.25 [a]	0.25 [a]	0 [b]	0 [b]	0 [b]	0 [b]
Portulaca oleracea	4.25 [a]	4.25 [a]	1.00[b]	1.25[b]	0[b]	0[b]
Polygonum lapathifolium	0.25[a]	0.25[a]	0[b]	0[b]	0[b]	0[b]

Values with the same letter within years are not significantly different (Duncan's Multiple Range Test at $p \leq 0.05$)

Table 3.Average number of weeds in 1 m^2 after mulching (2012)

Weed species	NWC		SMCM		BSM	
	30 DAM	60 DAM	30 DAM	60 DAM	30 DAM	60 DAM
Echinochloa crus-galli	10.50 [a]	32.75 [a]	0.75 [b]	1.75 [b]	1.25 [b]	2.50 [b]
Digitaria sanguinalis	3.75 [a]	6.50 [a]	0 [b]	0. 50 [b]	0.75 [b]	1.75[b]
Setaria viridis	7.50 [a]	13.50 [a]	0 [b]	0 [b]	4.75 [a]	5.00 [a]
Hordeum vulgare	0	0 [b]	0	0 [b]	0	6.50 [a]
Galinsoga parviflora	7.50[a]	12.25[a]	0 [b]	0.50[b]	0.25 [b]	0.75[b]
Amaranthu sretroflexus	22.75 [a]	24.25 [a]	0.50 [b]	0.75 [b]	0 [b]	0.50 [b]
Chenopodium album	1.50 [a]	3.50 [a]	0 [b]	0 [b]	0 [b]	0 [b]
Portulaca oleracea	9.75 [a]	10.50 [a]	0[b]	0.50[b]	0[b]	0[b]
Polygonum lapathifolium	1.50[a]	2.75[a]	0[b]	0[b]	0[b]	0[b]

Values with the same letter within years are not significantly different (Duncan's Multiple Range Test at $p \leq 0.05$)

In year 2012 was established lower weed infestation than previous experimental years (Table 3). In SMCM treatmentwere monitored single plants in particular replications at 30 and 60 DAM of *Echinochloa crus-galli, Digitaria sanguinalis, Galinsoga parviflora, Amaranthus retroflexus* and *Portulaca oleracea*. In BSM treatment again was established higher growth of monocotyledonous weed species than dicotyledonous. Straw mulch's favourable effect on the limiting ofweeds infestation was also confirmed in the study by Ramakrishna et al. (2006).

The lowest weed infestation was recorded in mulching variants. This show the effectiveness of this method in the suppressing weed germination. The spend mushroom compost has a strong depressing effect on the development of annual monocotyledonous weeds, which has been found by other authors (Yordanova, Shaban, 2007). Lowerinfestation on the covered plots was due to the fast rateof crop plant growth and higher possibilities to competewith weeds compared to plants with non-mulching and non-weeding control.The results showed that two types of mulch caused a decreasein weed infestation, compared to the control plot. This was confirmedin the study by Kosterna (2014).

The efficacy of applied soil mulches on weeds is shown in Figure1-2. In year 2010 at 30 DAM mulching from spent mushroom compost (SMCM) showed higher efficacy than barley straw mulch (BSM). It range from 75,9% against *Amaranthusretroflexus* to 100% against *Digitaria sanguinalis, Setaria viridis, Setaria glauca, Galinsoga parviflora, Chenopodium album* and *Polygonum lapathifolium*. The lowest efficacy in BSM was recorded against *Setaria viridis* – 15.6% (fig. 1). In year 2011 the lowest efficacy to *Amaranthus retroflexus* - 23.5% at 30 DAM and 42.3% at 60 DAM and to *Portulaca oleracea*– 76.5% at 30 DAM and 70.6% at 60 DAM was established in SMCM.The toxicity of mulch from spent mushroom compost on the other weeds of agrocenoses that interfere with leek production was above 93%. In BSM treatment the efficacy to monocotyledonous weeds were from 2.6% to *Setaria viridis* at 30 DAM to 96.7% to *Echinochloa crus-galli* at 60 DAM. Barley straw mulch shows lower efficacy for *Amaranthus retroflexus* than mulch from spent mushroom compost (92.9% at 30 DAM and 81.5% at 60 DAM). In year 2012 at 30 DAM was established higher efficacy of mulching from spent mushroom compost than barley straw mulch. There were only single numbers of weed species *Echinochloa crus-galli*and *Amaranthus retroflexus* in SMCM.

At 60 DAM the efficiency of mulching materials retained high (Figure 2). Mulching variants were characterized by low growth rate of existing weed species as they did not competed with the growth of leek plants. The used mulching materials showed good efficacy at 60 DAM against weed species in leek agrocenosis.

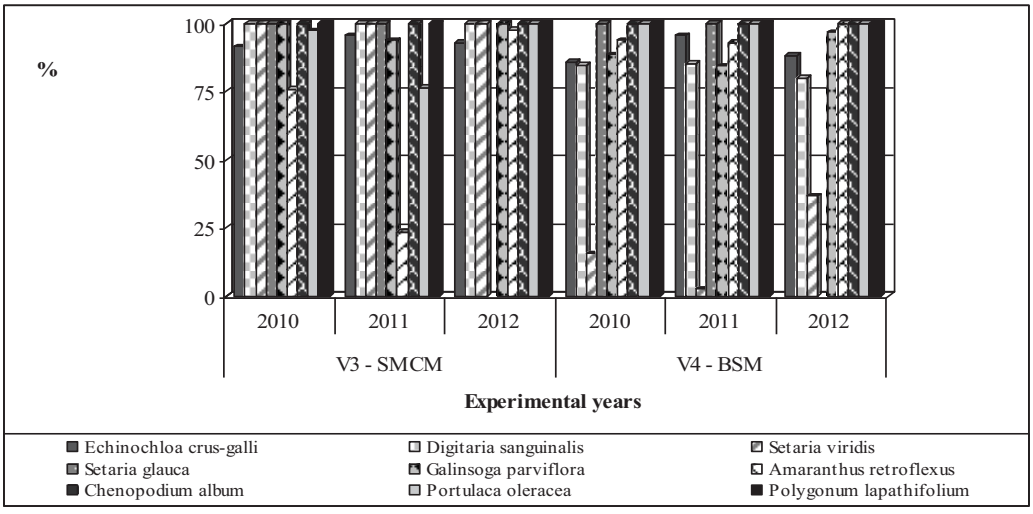


Figure 1. Efficiency of soil mulches compared to the control at 30 DAM (2010-2012)

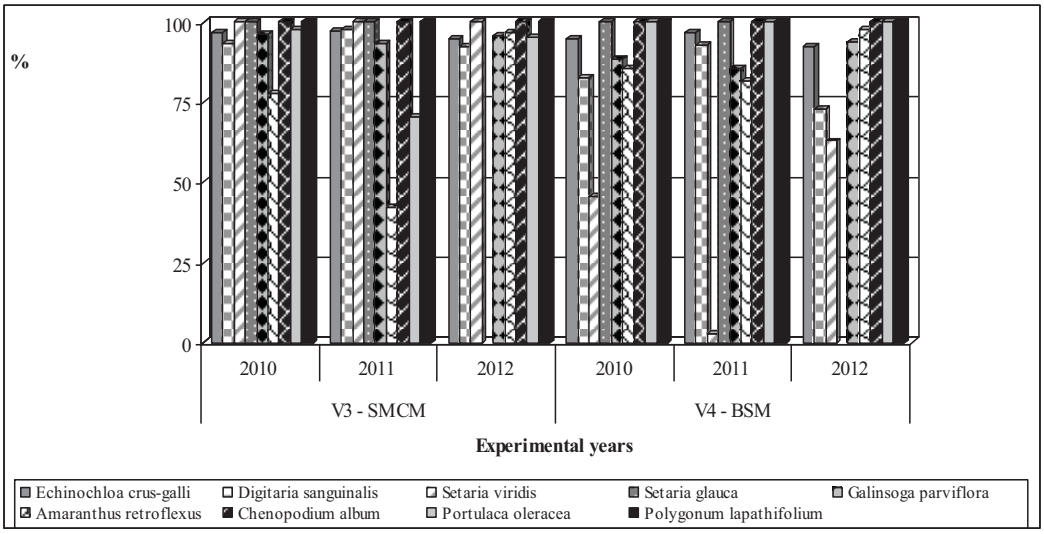
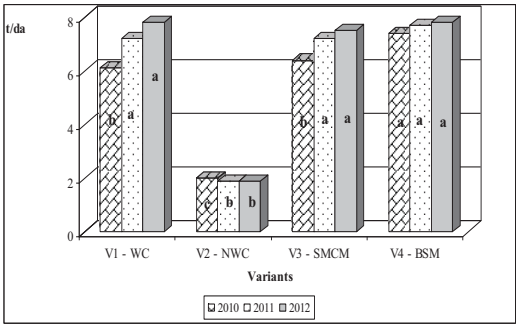


Figure 2. Efficiency of soil mulches compared to the control at 60 DAM (2010-2012)

The results obtained after gathering crop show that the yield of leek is lowest at the variant 2 – non-mulching and non-weeding control (NWC) (Figure 3). The yield obtained by the other variants is highest in year 2012 when the weed infestation was poorly developed compared to the other experimental years. During the three years of the field experiment the highest average yield was obtained in plots, mulched with barley straw mulch – 7.4 t/dain 2010, 7.7 t/da in 2011 and 7.8 t/da in 2012. In the variants mulching with spent mushroom compost the average yields were 6.4 t/da in 2010, 7.2 t/da in 2011 and 7.5 t/da in 2012. The lowest yield was obtained in plots from the second control, which is with non weeding plots (NWC).

The higher yield of mulching plots, compared with both controls – weeding control and non weeding control proves the efficiency of the mulches against weeds, but also in increasing the yields. These results were observed in studies made by other authors (Sharma & Sharma, 2003; Singh et al., 2007).



Values with the same letter within years are not significantly different (Duncan's Multiple Range Test at $p \leq 0.05$)

Figure 3Average yield (t/da) of leek

Differences between non weeding control (NWC) and other variants were very well statistically proven in the three years of field experiment.Weed infestation of non weeding plots decreased significantly the yield – from 3.7 to 4 times lower yield compared with mulching plots.

After the statistical analysis of data we can make the conclusion that yields obtained at mulching by spent mushroom and barley straw mulches differ statistically from the control.

CONCLUSIONS

It was found that growing leek by mulching with barley straw or spent mushroom compost reduces weed infestation.

It is proved that mulching leading to increased yields by 3.7 to 4 times in comparison with plots with weeds.The yields obtained in mulching plots with these studied mulches are similar or higher than those of the weeding plots. This indicates that the mulching is suitable for growing leek through reduced tillage.

The applied mulches can be used easily during the growing stage of leeks and they control efficiently the widespread monocotyledonous and dicotyledonous weed species.

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