PRIMERJAVA MED KONVENCIONALNIM, INTEGRIRANIM IN EKOLOŠKIM GOJENJEM PORA (*Allium porrum* L.)

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IZVLEČEK

Cilj naše raziskave je bil primerjati vplive konvencionalnega, integriranega in ekološkega gojenja pora ter vpliv endomikorize na nekatere morfološke lastnosti in na pridelek pora. V letih 2003 in 2004 je bil poskus s porom v treh ponovitvah postavljen v Otočcu (Hrvaška). Uporabljena je bila split-plot poskusna zasnova. Preučevana sta bila dva dejavnika: način gojenja na treh ravneh (konvencionalni, ekološki in integrirani) in vpliv mikorize na dveh ravneh (sadike pora, inokulirane z endomikorizno glivo *Glomus mossae*, in sadike brez inokuluma). Prejšnji posevek na parcelicah z ekološkim načinom gojenja je bil grahor (*Vicia sativa* L.), ki se je pokošen uporabil kot zastirka. Druge parcelice so bile prekrite s črno-belo folijo. Pridelava je temeljila na priporočenih metodah za vsakega od načinov gojenja pora. V letu 2004 je bila statistično značilno najmanjša gostota rastlin dosežena pri integriranem gojenju (9,76 rastline m^{-2}; načrtovano 10,67 rastline m^{-2}). V istem letu so imele rastline v ekološki pridelavi daljše lažno steblo (za 36 oziroma 44 %) v primerjavi z integriranim oziroma konvencionalnim gojenjem. V obeh letih so rastline, gojene integrirano in konvencionalno dosegle od 17 do 34 % večji premer lažnega stebla od ekološko gojenih rastlin. Prav tako je bila v obeh letih teža rastlin v integrirani in konvencionalni proizvodnji za 45 do 70 % večja od rastlin, ki so bile gojene ekološko. Zato je bil v obeh letih tudi tržni pridelek v integrirani in konvencionalni proizvodnji večji kot v ekološki, in sicer za 60 do 71 %. Med dejavnikoma način gojenja in vpliv mikorize ni prišlo do interakcije.

Ključne besede: konvencionalna pridelava, integrirana pridelava, ekološka pridelava, endomikoriza, por, *Allium porrum* L.

A COMPARISON OF CONVENTIONAL, INTEGRATED AND ORGANIC LEEK (*Allium porrum* L.) MANAGEMENT

ABSTRACT

In spite of producers preferences for conventional horticulture, newer research results pointed out possibilities of growing vegetables in alternative ways, which are environment friendly, but still obtain satisfactory economic results. The goal of this research was to determine influences of alternative crop management systems (organic and integrated) and measure effects of endomycorrhiza on vegetative growth and leek yield. During 2003 and 2004 a two-factor trial with three repetitions and split-plot field research design was set up in Otočac (Croatia). The main factor "crop management" had three levels (organic, integrated and conventional) while the sub factor "mycorrhiza" had two levels (leek seedlings inoculated with endomicorrhizal fungus *Glomus mossae* and non-inoculated seedlings). On plots

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assigned for organic crop management, common vetch plants (*Vicia sativa* L.) were grown on plots, then mowed down and used as mulch. Other plots were mulched with black polyethylene film. Leek seedlings were planted with root ball; fertilization and cultivation measures were performed according to basic principles of organic, integrated and conventional crop management system. In 2004, field results showed lowest densities of plants in integrated production management – 9.76 plant/m^2 (planned 10.67 plant/m^2) and were statistically significant. Plants in organic production had longer blanched stem in the same year (for 36 or 44%) in comparison with integrated and conventional crop management system. In both years, plants cultivated in integrated and conventional systems achieved 17 to 34% larger diameters of blanched stem than plants in organic management. Likewise in both years plants weight in integrated and conventional production were between 45 and 70% higher then in organic production system. Consecutive, in both years the marketability for integrated and conventional production was higher relating to organic production - between 60 and 71%. No significant interaction of crop management and endomycorrhiza was indicated in the morphological features and leek yield.

Key words: conventional crop management, integrated crop management, organic crop management, endomycorrhiza, leek (*Allium porrum* L.)

1. INTRODUCTION

Profitable conventional vegetable production is characterized by a high degree of chemization, highly specialized farms, high production with high input of means and materials in order to increase the yield and decrease the costs per unit area (Abdul-Baki, 1998). Such production inevitably requires procedures which pose a risk to the environment and human health, and leads to soil degradation (Bašić, 1996). Recent research (Novak, 1997; Gaskel *et al.*, 2000; Ban, 2001; Bulluck *et al.*, 2002; Elliot and Mumford, 2002; Ban *et al.*, 2003) suggests possible alternative systems in vegetable production, which are less risky for the environment but with satisfactory economic effects. The objective of this research was to determine effects of alternative production systems (organic and integrated) and endomycorrhiza on vegetative growth and yield of leek (*Allium porrum* L.) in comparison with the conventional system.

2. MATERIALS AND METHODS

The research was conducted on a family farm in Švica (Otočac-Croatia) during 2003 and 2004. A two factorial trial was set up in split-plot design with 3 replications. The main factor, "production system", had three levels (organic, integrated and conventional) and the size of the main plot was 45 m^2 (10 m x 4.5 m). The sub factor, "mycorrhiza", had two levels (leek transplants inoculated with endomycorrhizal fungus *Glomus mossae* and non-inoculated transplants) and the size of one split plot was 22.5 m^2 (5 m x 4.5 m).

The soil had neutral reaction (pH 7.36 in MKCl); it contained 4.05% humus, 0.21% N, 2.52 mg P_2O_5/100 g of soil, 11.99 mg K_2O /100 g of soil and 69.2% $CaCO_3$. The soil for all production systems was ploughed in autumn to a depth of 30 cm in both years. On the plots assigned for the organic production system, stable manure (100 m^3/ha) was ploughed in. After additional soil tillage, spring vetch (140 kg/ha) was sown (on April 28, 2003 and April 26, 2004) on plots assigned for organic production and it was cut in mid-June (both years) and left as cover crop (mulch). At the same time the plots for integrated and conventional production systems were prepared as follows: fertilization was performed with a complex mineral fertilizer (1000 kg/ha NPK 7-20-30), herbicide was applied (trifluralin, 2 l/ha), and plots were irrigated by drip irrigation system (in all production systems) and 1.2 m width black PE mulch was installed (in conventional and integrated production systems).

Leek seedlings in the phase of 3 to 4 true leaves (two months old) of the cultivar Lancelot F_1, grown in polystyrene containers with 150 pots were planted on three beds (June 18, 2003 and June 30, 2004). We planted them in a manner four-row strips per bed. The distance between the rows was 25 cm as well as the distance between the plants in the row while the distance between the beds was 50 cm (10.67 plants/m^2). The middle bed was used for all of the measurements. Irrigation was performed using drip irrigation. Fertilization and basic crop cultivation measures during vegetation were conducted depending on the production system (Table 1 and 2).

Table 1: Fertilization regime for leek production system per year

Fertilizer	Production system		
	Organic	Integrated	Conventional
Farmyard manure	100 m^3/ha	-	-
Mineral fertilizer (NPK 7-20-30)	-	1000 kg/ha (70 kg N/ha)	1000 kg/ha (70 kg N/ha)
Soluble mineral fertilizer (NPK 19-6-20)	-	123 kg N/ha in four portions	176 kg N/ha in seven portions
Total kg N/ha	From farmyard manure~150	193	246

Protection from disease and pests in the ecological system was performed with remedies permitted by the "Rulebook on ecological production of plants and in total production of plant's products" (Official Gazette No. 91/2001).

The harvest of leek was done on October 20, 2003 and October 21, 2004 for all production systems. After the harvest, plant distances were determined as well as lengths and diameters of false steam. We weighted average marketable plant mass, yield of marketable plants and percentage of non-marketable leek.

The effects of the main factor, sub factor and their interactions on the observed characteristics were statistically analyzed by variance analysis (F-test), while differences between average values of the main factor and the interactions were tested by the Duncan's Multiple RANGE TEST ($P \leq 0.05$).

Table 2: Pesticide use per leek production system per year

Pesticide name	Production system		
	Organic	Integrated	Conventional
Limacide:			
- Metaldehyde (Limax M)	1 x (30 kg/ha)	1 x (35 kg/ha)	1 x (40 kg/ha)
Insecticides:			
- Chlorpirifos ethyl (Dursban G-7.5)	-	1 x (15 kg/ha)	1 x (20 kg/ha)
- Dimetoat (Rogor 40 EC)	-	3 x (0.10%)	6 x (0.10%)-2003
- Pyrethrum extract (Biotox P)	2 x (~ 600 l/ha)	-	5 x (0.10%)-2004
- Yellow boards	1 200 piece/ha	-	-
			-
Fungicides:			
- Metalaxyl+mancozeb (Ridomyl MZ 72 WP)	-	1 x (0.30%)	2 x (0.30%)
- Vinclozin (Ronilan SC)	-	1 x (0.20 %)	2 x (0.20%)
Herbicides:	2 x weeding	-	-
- Trifluralin (Treflan EC)	-	1 x (2 l/ha)	1 x (2 l/ha)
- Glufosinate-amonium (Basta 15)	-	1 x (6 l/ha)	3 x (6 l/ha)

3. RESULTS AND DISCUSSION

The production system and mycorrhiza as well as their interaction had no effects on leek density reduction in the first year of research. In the second year we spotted least density in the integrated system (Table 3). Leek density was mostly affected by seedling planting success and intensity of leek fly attacks. As we didn't noticed leek flies in the second year, we presume that leek density was affected by planting success.

Table 3: Effects of production systems and mycorrhiza on achieved leek density (number of plants/ m^2) at harvest time, Švica, October 20, 2003 and October 21, 2004.

Production system	Mycorrhiza	Without mycorrhiza	Production system average
2003			
Organic	9.69 N.S.[1]	9.33 N.S.	**9.51 N.S.**[2]
Integrated	9.96 N.S.	10.36 N.S.	**10.16 N.S.**
Conventional	10.13 N.S.	9.95 N.S.	**10.04 N.S.**
Average "mycorrhiza"	**9.93 N.S.**[3]	**9.88 N.S.**	
2004			
Organic	10.36 N.S.[1]	10.49 N.S.	**10.42 A**[2]
Integrated	9.78 N.S.	9.73 N.S.	**9.76 B**
Conventional	10.00 N.S.	10.36 N.S.	**10.18 AB**
Average "mycorrhiza"	**10.05 N.S.**[3]	**10.19 N.S.**	

[1,2]Duncan`s Multiple Range test ($P \leq 0.05$) for interaction "production system" x "mycorrhiza" and for factor "production system", [3]justifiable F-test ($P \leq 0.05$) for sub factor "mycorrhiza"

In the first year of research, we didn't notice any influences of mycorrhiza, either not in correlation with production management systems on false stem height. In the second year false stems in ecological production were significantly higher than in other two systems (Table 4). Leek from ecological system had 36% respectively 49% higher stems relating to integrated and conventional production. In the second year, longer stems in ecological production were a consequence of overgrown weeds. Stem heights and weed effects in the ecological system affected diminishment of stem diameters relating to integrated and conventional systems (Table 5). In both years plants grown in integrated and ecological systems had 17-34% larger plant stem diameters than plants in ecological system. Mycorrhiza had no significant influence on stem diameter; either there were no significant effects of mycorrhiza along with production system.

Table 4: Effects of leek production systems and mycorrhiza on the length of false stem (cm) in harvest time, Švica, October 20, 2003 and October 21, 2004.

Production system	Mycorrhiza	Without mycorrhiza	Production system average
2003			
Organic	12.22 N.S.[1]	12.59 N.S.	**12.41 N.S.**[2]
Integrated	11.86 N.S.	12.18 N.S.	**12.02 N.S.**
Conventional	11.97 N.S.	12.09 N.S.	**12.03 N.S.**
Average "mycorrhiza"	**12.02 N.S.**[3]	**12.29 N.S.**	
2004			
Organic	15.97 N.S.[1]	16.12 N.S.	**16.05 A**[2]
Integrated	12.76 N.S.	12.06 N.S.	**12.41 B**
Conventional	12.04 N.S.	11.38 N.S.	**11.71 B**
Average "mycorrhiza"	**13.59 N.S.**[3]	**13.19 N.S.**	

[1,2]Duncan`s Multiple Range test ($P \leq 0.05$) for interaction "production system" x "mycorrhiza" and for factor "production system", [3]justifiable F-test ($P \leq 0.05$) for sub factor "mycorrhiza"

Table 5: Effect of leek production system and mycorrhiza on the diameter of false stem (cm) in the time of harvest, Švica, October 20, 2003 and October 21, 2004.

Production system	Mycorrhiza	Without mycorrhiza	Production system average
2003			
Organic	3.45 N.S.[1]	3.18 N.S.	**3.32 B**[2]
Integrated	3.96 N.S.	3.83 N.S.	**3.90 A**
Conventional	3.86 N.S.	3.88 N.S.	**3.87 A**
Average "mycorrhiza"	**3.75 N.S.**[3]	**3.63 N.S.**	
2004			
Organic	2.60 N.S.[1]	2.74 N.S.	**2.67 B**[2]
Integrated	3.64 N.S.	3.54 N.S.	**3.59 A**
Conventional	3.52 N.S.	3.38 N.S.	**3.45 A**
Average "mycorrhiza"	**3.25 N.S.**[3]	**3.22 N.S.**	

[1,2]Duncan`s Multiple Range test ($P \leq 0.5$) for interaction "production system" x "mycorrhiza" and for factor "production system", [3]justifiable F-test ($P \leq 0.05$) for sub factor "mycorrhiza"

Leek plants grown in conventional and integrated production systems had more plant mass than plants in ecological system (table 6). Mycorrhiza and production systems interaction had no significant influence on this attribute. Higher plant mass (45-70%) in integrated and conventional production systems was achieved through better nutrition and better weeds control.

Table 6: Influence of leek production systems and mycorrhiza on the average marketable plant mass during harvest time (g), Švica, October 20, 2003 and October 21, 2004.

Production system	Mycorrhiza	Without mycorrhiza	Production system average
2003			
Organic	160 N.S.[1]	170 N.S.	**165 B**[2]
Integrated	247 N.S.	230 N.S.	**238 A**
Conventional	263 N.S.	240 N.S.	**252 A**
Average "mycorrhiza"	**223 N.S.**[3]	**213 N.S.**	
2004			
Organic	153 N.S.[1]	140 N.S.	**147 B**[2]
Integrated	257 N.S.	243 N.S.	**250 A**
Conventional	253 N.S.	237 N.S.	**245 A**
Average "mycorrhiza"	**221 N.S.**[3]	**207 N.S.**	

[1,2]Duncan`s Multiple Range test ($P \leq 0.05$) for interaction "production system" x "mycorrhiza" and for factor "production system", [3]justifiable F-test ($P \leq 0.05$) for sub factor "mycorrhiza"

Plant mass in average was higher in conventional and integrated production systems, comparing to ecological production, finally resulting with higher yields in these two systems (Table 7). As for other leek attributes, mycorrhiza and production system as well their interaction had no significant influence on yields. Higher yields of 60-70% in conventional and integrated production comparing to ecological were a consequence of better nutrition and better disease, pest and weed control. Production systems and mycorrhiza as well as their interaction had no effect on the share of marketable leek (Table 8). Although plants grown in ecological production system had less weight, the majority were marketable, what proves that leek is a very tolerant and adaptable culture.

Table 7: Influence of leek production system and mycorrhiza on the yield of marketable plants (t/ha), Švica, October 20, 2003 and October 21, 2004.

Production system	Mycorrhiza	Without mycorrhiza	Production system average
2003			
Organic	14.55 N.S.[1]	14.68 N.S.	**14.62 B**[2]
Integrated	23.51 N.S.	23.35 N.S.	**23.43 A**
Conventional	25.71 N.S.	23.01 N.S.	**24.36 A**
Average "mycorrhiza"	**21.26 N.S.**[3]	**20.35 N.S.**	
2004			
Organic	14.32 N.S.[1]	13.67 N.S.	**14.00 B**[2]
Integrated	24.10 N.S.	23.42 N.S.	**23.76 A**
Conventional	24.37 N.S.	23.51 N.S.	**23.94 A**
Average "mycorrhiza"	**20.93 N.S.**[3]	**20.20 N.S.**	

[1,2]Duncan`s Multiple Range test (P≤0.05) for interaction "production system" x "mycorrhiza" and for factor "production system", [3]justifiable F-test (P≤0.05) for sub factor "mycorrhiza"

Table 8: Influence of leek production system and mycorrhiza on the mass portion of unmarketable plants (%), Švica, October 20, 2003 and October 21, 2004.

Production system	Mycorrhiza	Without mycorrhiza	Production system average
2003			
Organic	2.40 N.S.[1]	1.72 N.S.	**2.06 N.S.**[2]
Integrated	1.10 N.S.	0.50 N.S.	**0.80 N.S.**
Conventional	1.87 N.S.	2.22 N.S.	**2.04 N.S.**
Average "mycorrhiza"	**1.79 N.S.**[3]	**1.48 N.S.**	
2004			
Organic	2.13 N.S.[1]	3.12 N.S.	**2.62 N.S.**[2]
Integrated	0.75 N.S.	0.38 N.S.	**0.57 N.S.**
Conventional	1.18 N.S.	0.91 N.S.	**1.04 N.S.**
Average "mycorrhiza"	**1.35 N.S.**[3]	**1.47 N.S.**	

[1,2]Duncan`s Multiple Range test (P≤0.05) for interaction "production system" x "mycorrhiza" and for factor "production system", [3]justifiable F-test (P≤0.05) for sub factor "mycorrhiza"

4. CONCLUSIONS

This research alternative found out alternatives for conventional leek production; integrated production system with fewer investments in pest control and mineral fertilizers achieves equal yields as conventional production. Leek could be produced also in the ecological system with higher inputs of human labour but with lower yields comparing to conventional and integrated production. Mycorrhiza had no significant influence on leek production therefore we do not reconcile its usage. The main reason is high additional costs of micellium.

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