ACTA Acta Sci. Pol., Hortorum Cultus 12(3) 2013, 35-45

THE EFFECT OF INTERCROPS AND PLOUGHING TERM ON THE STRUCTURE OF YIELD AND SOME QUALITIES OF SALSIFY (*Tragopogon porrifolius* L.) ROOTS

Mirosław Konopiński, Tadeusz Kęsik, Marzena Błażewicz-Woźniak
University of Life Sciences in Lublin

Abstract. Due to frequent cultivation procedures and the chemicalization of crops the cultivated layer of soil is often subject to detrimental changes in its physical, chemical and biological characteristics. The aggregate structure of the soil disappears, the content of organic substance is lowered and the biological activity diminished. In order to reproduce the organic substance of the soil and improve its characteristics ploughed intercrops are introduced in the horticulture. The biomass of common vetch, tansy phacelia and oats were used for soil cultivation for the crop cultures of salsify. It was then confirmed, that independently from the intercrop plant used, the ploughed biomass had a significantly positive influence on the yield of salsify roots. The positive influence of the organic substance added to the soil on the percentage of marketable yield of roots and the total amount of crops were both confirmed. Among the investigated intercrops the common vetch had the most beneficial influence on the crops of salsify. The most beneficial method of cultivation of salsify crops proved to be its cultivation on ridged soil, which resulted in the largest crop yield and the largest percentage of marketable yield. The roots from this type of culture were also longer and had higher phosphorus content. Due to the beneficial influence on the root crops and its structure, the best time for ploughing of the biomass of the intercrops was the spring term.

Key words: salsify, soil mulching, pre-winter and spring ploughing, ridges

INTRODUCTION

Numerous cultivation measures and the chemicalization of the plants cultivation are the main causes of deterioration in the quality and productivity of soil. Intensive agriculture and horticulture leads to the destruction of the aggregate structure of the soil, reduction of its organic substance content and biological activity of the soil environment. The

Corresponding author: Mirosław Konopiński, Departament of Cultivation and Fertilization of Horticultural Plants, University of Life Sciences in Lublin, Leszczyńskiego 58, 20-068 Lublin, Poland, e-mail: miroslaw.konopinski@up.lublin.pl

consequences of the above are the dusting of the soil, as well as its proclivity towards densification and formation of crust. The detrimental changes in the soil environment can be limited by constant replenishment of its organic substance content. For that purpose the cultivation of intercrop plants and introduction to the soil of their biomass is justified. The intercrop plants and their protective properties positively influence the physical condition of the soil as well as growth and crop characteristics of the plants. They also improve the quality of crops. The organic substance introduced into the soil restores its aggregate structure and fertility. The type of plant material introduced into the soil, its allelopathic potential and the date of its mixing with the soil, play an important role in its fertilization. The examinations performed up to date, by Borowy et al. [2000], Kęsik et al. [2006], Konopiński [2003, 2008, 2009], Błażewicz-Woźniak et al. [2008], confirm that there is a strong reaction of vegetable plants to the type of organic substance introduced to the soil in the form of intercrop biomass. The type of organic substance, depending on the kind of vegetable plant influenced the quality and quantity of the crops in a substantial way.

The aim of this investigation was to determine the influence of intercrop plants: common vetch, tansy phacelia and oats, the pre-winter and spring ploughing as well as ridged and flat cultures on the structure of salsify root crops, and some of its qualities.

MATERIAL AND METHODS

The field experiments were conducted in the years 2006–2008, at the Experimental Farm of University of Life Sciences in Lublin located in Felin, district of Lublin (22º 56’E, 51º 23’N, Central East of Poland, 200m a.s.l.), on lessive soil developed from medium, dusty loams. Completely randomized blocks method at four replications was used in the experiment. The experimental plant was the salsify (*Tragopogon porrifolius* L.) of the “Mamut” cultivar. Three intercrop plants were taken into account during the experiment: common vetch (*Vicia sativa* L.) Kwarta cv., tansy phacelia (*Phacelia tanacetifolia* Bantham) Stala cv. and oats (*Avena sativa* L.) Kasztan cv.; as well as two kinds of soil cultivation methods: a) complex of pre-sowing culture, the sowing of intercrop plants in the second decade of August and pre-winter ploughing (mixing the green mass with soil), b) complex of pre-sowing practices, the sowing of intercrop plants in the second decade of August and spring ploughing (mixing the plant mass with soil); and two methods of cultivating the plants: in ridges and in flat soil. Total area of field experiment was 400 m^2, and the plot size for harvest was 4 m^2. Mineral fertilization in the quantity of 100 kg of N, 44 kg of P and 166 kg of K was used. Nitrogen in dose 50 $kg \cdot ha^{-1}$ was also applied before intercrops sowing. Doses of nutrients were determined on the base of soil analysis. The nitrogen fertilizer (ammonium nitrate) was applied in two doses: ½ before sowing and ½ as a top dressing, the phosphorus fertilizer (triple superphosphate) and the potassium fertilizer (potassium salt) were both applied before sowing of salsify seeds. The seeds were sowed in the first decade of May, in the quantity of 20 $kg \cdot ha^{-1}$ in rows with 50 cm separation at the depth of 1.5 cm. Plants density was 25 u. per 1 m^2. Three days after sowing, and in order to protect the culture from weeds, Kerb 50WP herbicide (propyzamide) in the dose of 2 $kg \cdot ha^{-1}$ was applied.

Weather conditions in years 2006–2008 encouraged cultivation of salsify. Average temperature in the period from April to October amounted to 14.5ºC and was higher by 1.2ºC than the average long-term. Similarly, the total rainfall during this period amounted to 429.7 mm and was higher by 24.9 mm than the average rainfall of long-term.

The roots were harvested in the second decade of October. The roots were sorted in two classes: marketable roots (length of roots minimum 15 cm, diameter 2 cm) and a small and shapeless. The marketable yield of roots, percentage of the total yield and its structure, mass of one salsify root in marketable yield, the length of the root and its thickness (in head part) were determined. The contents of nitrogen, phosphorus and potassium in roots were specified. The nitrogen content was determined with the use of Kjeldahl's method, the phosphorus content colorimetrically with ammonium vanado-molybdate, potassium with the using of the ASA method (Perkin-Elmer Analyst 300), [Ostrowska et al. 1991].

The results of these tests were subject to statistical analysis of their variance. The statistical significance was tested with the use of the Tukey test, at the significance level of $\alpha = 0.05$.

RESULTS

The marketable yield of roots. Irrespectively from the factors of the experiment the average yield of the salsify roots amounted to 11.13 $t \cdot ha^{-1}$ (tab. 1). The experimental factors had a significant influence on salsify's yielding. Pre-winter ploughing caused significant decrease of root yield in comparison with spring ploughing. The cultivation of salsify in the ridges had a significant influence on the marketable yield of roots. Higher yield of roots (by 1.11 $t \cdot ha^{-1}$) were collected in cultivation in the ridges, than in the cultivation in flat soil. Similarly, applying of intercrop plants caused significant increase of root yield as compared to cultivation without intercrop plants. The largest root yield was found in the object with common vetch, on average by 6.41 $t \cdot ha^{-1}$ higher than the one achieved in the objects without intercrop plant.

Table 1. Marketable yield of salsify roots, mean from years 2006–2008 ($t \cdot ha^{-1}$)

Soil tillage	Cultivation of salsify	Intercrop plants				Mean
		control	vetch	phacelia	oats	
Pre-winter ploughing	on ridges	7.66	12.13	10.60	9.65	10.01
	on flat soil	5.83	14.12	10.23	11.70	10.47
	mean	6.75	13.13	10.42	10.68	10.24
Spring ploughing	on ridges	8.47	13.67	15.87	15.45	13.36
	on flat soil	6.00	13.70	11.32	11.73	10.69
	mean	7.23	13.68	13.59	13.59	12.02
Mean	on ridges	8.06	12.90	13.23	12.55	11.69
	on flat soil	5.91	13.91	10.78	11.72	10.58
	mean	6.99	13.40	12.00	12.13	11.13
$LSD_{(0.05)}$ for:	soil tillage					0.94
	cultivation of salsify					0.94
	intercrop plants					1.89

The biomass of intercrop plants used beneficially influenced the structure of the salsify roots yield, especially the percentage share of marketable roots in the total roots yield. The largest share of the roots was recorded in the yield harvested from objects with common vetch (51.3%), the smallest in case of objects without intercrops, average just 39.8% (tab. 2). The term of ploughing the intercrop plant biomass had no larger influence on the percentage share of marketable roots in the total roots yield, but a slightly higher (by 0.7%) was found in the objects ploughed in spring. Independently from the type of intercrop plants and the term of ploughing the ridged cultures achieved (by 1.5%) higher share of marketable roots in the total yield of roots.

Table 2. Percentage of salsify marketable roots in the total yield, mean from years 2006–2008 (%)

Soil tillage	Cultivation of salsify	Intercrop plants				Mean
		control	vetch	phacelia	oats	
Pre-winter ploughing	on ridges	41.6	49.1	43.4	48.1	45.6
	on flat soil	37.9	54.6	50.5	46.3	47.3
	mean	39.8	51.9	47.0	47.2	46.4
Spring ploughing	on ridges	42.6	48.8	51.8	54.2	49.4
	on flat soil	37.1	52.7	44.1	45.1	44.8
	mean	39.9	50.8	48.0	49.7	47.1
Mean	on ridges	42.1	49.0	47.6	51.2	47.5
	on flat soil	37.5	53.7	47.3	45.7	46.0
	mean	39.8	51.3	47.5	48.4	46.7

The objects with common vetch have also shown the smallest percentage share of small and shapeless roots (48.7%) (tab. 3). The most of small and shapeless roots, 60.2% on average, were found in the unmulched objects. A slight (by 0.6%) reduction of the share of small and shapeless roots was found in objects with ploughing in spring. Independently from other factors of the experiment the cultivation of salsify in ridges had a visible (1.4%) influence on the reduction of the percentage share of small and shapeless roots.

Table 3. Percentage of small and shapeless salsify roots in the total yield, mean from years 2006–2008 (%)

Soil tillage	Cultivation of salsify	Intercrop plants				Mean
		control	vetch	phacelia	oats	
Pre-winter ploughing	on ridges	58.4	50.9	56.6	51.9	54.5
	on flat soil	62.1	45.4	49.5	53.7	52.7
	mean	60.3	48.2	53.1	52.8	53.6
Spring ploughing	on ridges	57.4	51.2	48.2	45.8	50.7
	on flat soil	62.9	47.3	55.9	54.9	55.3
	mean	60.2	49.3	52.1	50.4	53.0
Mean	on ridges	57.9	51.1	52.4	48.9	52.6
	on flat soil	62.5	46.4	52.7	54.3	54.0
	mean	60.2	48.7	52.6	51.6	53.3

No significant influence of the intercrop plants on the root mass of salsify, which irrespective of examined factors amounted to 64.8 g on average (tab. 4) was noticed. Only a slight positive tendency of pre-winter ploughing and flat-soil cultivation was found in the experiment. The most beneficial intercrop plant in this aspect was tansy phacelia.

The root mass, independently from the term of the ploughing and method of plant cultivation in objects with tansy phacelia was 66.4 g on average, with common vetch 63.3 g, and the unmulched objects gave an average of 64.5 g. Larger mass (by 3.7 g on average) was found in the case of roots of plants cultivated in flat soil.

Table 4. Mass of one salsify root, mean from years 2006–2008 (g)

Soil tillage	Cultivation of salsify	Intercrop plants				Mean
		control	vetch	phacelia	oats	
Pre-winter ploughing	on ridges	63.3	65.8	61.9	69.9	65.2
	on flat soil	67.0	64.5	72.2	64.0	66.9
	mean	65.2	65.2	67.1	67.0	66.1
Spring ploughing	on ridges	54.6	61.7	65.1	61.2	60.7
	on flat soil	73.0	61.3	66.4	64.4	66.3
	mean	63.8	61.5	65.8	62.8	63.5
Mean	on ridges	59.0	63.8	63.5	65.6	62.9
	on flat soil	70.0	62.9	69.3	64.2	66.6
	mean	64.5	63.3	66.4	64.9	64.8
$LSD_{(0.05)}$ for:	soil tillage					n.s.*
	cultivation of salsify					n.s.
	intercrops					n.s.

n.s.* – differences not significant

Table 5. Length of salsify root, mean from years 2006–2008 (mm)

Soil tillage	Cultivation of salsify	Intercrop plants				Mean
		control	vetch	phacelia	oats	
Pre-winter ploughing	on ridges	230	232	220	234	229
	on flat soil	217	245	206	226	224
	mean	224	239	213	230	226
Spring ploughing	on ridges	232	247	243	238	240
	on flat soil	222	224	226	223	224
	mean	227	236	235	231	232
Mean	on ridges	231	240	232	236	235
	on flat soil	220	235	216	225	224
	mean	225	237	224	230	229
$LSD_{(0.05)}$ for:	soil tillage					n.s *
	cultivation of salsify					6.91
	intercrops					n.s.

n.s.* – differences not significant

The intercrop plants used in the experiment, as well as the ploughing term, did not significantly influence the length of salsify roots. But it was established, that the common vetch had the most beneficial influence on the length of the roots. Independently from other factors of the experiment the average length of the root in this case was 237 mm, while in the objects with tansy phacelia was only 224 mm (tab. 5).

The ridged cultivation was found to be a factor largely stimulating the length of the salsify roots. The roots harvested from these cultures were, on average 11 mm longer, than the ones gathered from the flat-soil cultures. This feature was also positively influenced by spring ploughing, with plant roots from such objects being, on average, 6 mm longer than the roots from objects ploughed before winter.

The thickness of the salsify root head was 27 mm on average (tab. 6). The pre-winter and spring ploughing cultures, as well as the intercrops used had no significant influence on the thickness of salsify root head. The cultivation of the plant in ridges proved to be a significant factor. The roots harvested from this cultivation were (by 2 mm on average) thinner than the ones obtained from flat-soil cultures.

Table 6. Thickness of salsify root, mean from years 2006–2008 (mm)

Soil tillage	Cultivation of salsify	Intercrop plants				Mean
		control	vetch	phacelia	oats	
Pre-winter ploughing	on ridges	25	26	25	27	26
	on flat soil	26	27	29	27	27
	mean	26	27	27	27	27
Spring ploughing	on ridges	25	25	26	25	25
	on flat soil	28	26	28	28	28
	mean	27	26	27	27	26
Mean	on ridges	25	26	26	26	26
	on flat soil	27	27	29	28	28
	mean	26	27	27	27	27
LSD $_{(0.05)}$ for:	soil tillage					n.s.*
	cultivation of salsify					0.98
	intercrops					n.s.

n.s.* – differences not significant

Table 7. Nitrogen content in salsify root, mean from years 2006–2008 (%)

Soil tillage	Cultivation of salsify	Intercrop plants				Mean
		control	vetch	phacelia	oats	
Pre-winter ploughing	on ridges	2.56	2.63	2.55	2.94	2.67
	on flat soil	2.62	2.81	2.65	2.72	2.70
	mean	2.59	2.72	2.60	2.83	2.69
Spring ploughing	on ridges	2.52	2.56	2.60	2.54	2.56
	on flat soil	2.79	2.71	2.57	2.86	2.73
	mean	2.66	2.64	2.59	2.70	2.64
Mean	on ridges	2.54	2.60	2.58	2.74	2.61
	on flat soil	2.71	2.76	2.61	2.79	2.72
	mean	2.62	2.68	2.59	2.77	2.66
LSD $_{(0.05)}$ for:	soil tillage					n.s.*
	cultivation of salsify					n.s.
	intercrops					n.s..

n.s.* – differences not significant

The examined factors of the experiment had no significant influence on nitrogen and phosphorus content in salsify roots. The content of nitrogen was 2.66% of dry mass on average (tab. 7). Slightly higher amounts of this element were only found in roots of plants cultivated in flat soil ploughed before winter. The oats mulch had the most influence on the content of nitrogen in roots of salsify (2.77%) in comparison with other intercrops.

The content of phosphorus in the roots of salsify, independently from all the factors of the experiment was 0.24% of dry mass on average (tab. 8). The term of ploughing and the method of plants cultivation, as well as the plant mulches used, had no significant influence on the content of this element in the plant. The content of phosphorus in the roots from different combination of salsify cultivation was always within the range 0.20–0.27% of dry mass.

Table 8. Phosphorus content in salsify root, mean from years 2006–2008 (%)

Soil tillage	Cultivation of salsify	Intercrop plants				Mean
		control	vetch	phacelia	oats	
Pre-winter ploughing	on ridges	0.24	0.20	0.24	0.24	0.23
	on flat soil	0.25	0.22	0.25	0.21	0.23
	mean	0.25	0.21	0.25	0.23	0.23
Spring ploughing	on ridges	0.27	0.21	0.23	0.22	0.23
	on flat soil	0.24	0.21	0.23	0.27	0.24
	mean	0.25	0.21	0.23	0.25	0.24
Mean	on ridges	0.26	0.21	0.24	0.23	0.23
	on flat soil	0.25	0.22	0.24	0.24	0.24
	mean	0.25	0.21	0.24	0.24	0.24
LSD $_{(0.05)}$ for:	soil tillage					n.s.*
	cultivation of salsify					n.s.
	intercrops					n.s.

n.s * – differences not significant

Table 9. Potassium content in salsify root, mean from years 2006–2008 (%)

Soil tillage	Cultivation of salsify	Intercrop plants				Mean
		control	vetch	phacelia	oats	
Pre-winter ploughing	on ridges	0.97	0.63	0.82	0.75	0.79
	on flat soil	1.04	0.74	0.86	0.84	0.87
	mean	1.01	0.69	0.84	0.80	0.83
Spring ploughing	on ridges	1.06	0.68	1.06	0.78	0.90
	on flat soil	0.82	0.63	0.75	0.67	0.72
	mean	0.94	0.66	0.91	0.73	0.81
Mean	on ridges	1.02	0.66	0.94	0.77	0.84
	on flat soil	0.93	0.69	0.81	0.76	0.79
	mean	0.97	0.67	0.87	0.77	0.82
LSD $_{(0.05)}$ for:	soil tillage					n.s.*
	cultivation of salsify					0.03
	intercrops					0.06

n.s.* – differences not significant

Independently from other factors of the experiment the content of potassium in salsify roots was 0.82% of dry mass, on average (tab. 9). The use of plant mulches and the ridged cultivation had a significant influence on the potassium content in salsify roots. A positive influence of the ridged cultivation of salsify on the content of this nutrient in its root was found, while the intercrops were found to have a detrimental effect thereon. The highest content of potassium was found in plants from unmulched objects (0.97% of dry mass on average). The smallest content of potassium in salsify roots, with just 0.67% of dry mass, was found in cultures mulched with common vetch. The plough term for the intercrops did not significantly influence the content of this element in the roots of salsify.

DISCUSSION

The experimental factors exerted a great influence on the quantity and quality of salsify roots. All of them: the term of ploughing of the intercrop biomass, the species of intercrop plant and method of salsify cultivation (ridges or flat soil) played, in most of the cases, a significant role in shaping of the roots yield quantity, its structure and some of its quality characteristics. A significantly beneficial influence of ridged cultivation, as well as such influence of spring ploughing and the intercrops: common vetch, tansy phacelia, and oats on the marketable yield of roots were confirmed. Numerous authors confirmed the beneficial influence of ridged cultivation on the growth conditions of plants. This type of culture provides better water and air conditions for the plants [Tisdall and Hodgson 1990], a better soil structure [Benecsik 2007, Holland et al. 2007] and a higher temperature in the surface layer of the soil [Babik and Dudek 2000, Anyszka and Dobrzański 2006]. The forming of ridges raises the stand of the plants above the natural ground level [Hatfield et al. 1998] and enables the roots to penetrate deeper [Evers et al. 1997]. Good plant growth conditions conducive to a better yield. The crops of plants cultivated in ridges, especially rooted vegetables, are usually better than in case of flat-soil cultivation. Babik [2000] also demonstrated the positive influence of ridged cultivation of salad chicory on its crops. Konopiński [2008], similarly, during his experiments with scorzonera, yielded a higher crop in ridged cultivation. This type of plant cultivation also positively influenced the structure of root crops and its quality.

The experiment has also confirmed, that spring ploughing, the intercrops used to improve conditions for plants growth, and the ridged cultivation of salsify positively influenced the structure of root crops. These factors allowed for the highest percentage of marketable yield of roots in the crop and the lowest percentage of small and shapeless roots. Babik and Dudek [2000] by cultivating carrots and chicory on ridges have also proved a higher percentage of straight and long roots in the total crop. Similar results, in the cultivation of carrots, were also achieved by Cebulak and Sady [2000], in the cultivation of carrots and parsley by Polák et al. [1999] and in the cultivation of celery by Michalik [2003]. A bigger commercial crop of the carrot of the "Flacoro" cultivar was also achieved in ridged cultures by Wierzbicka et al. [2004]. The term of ploughing and the intercrop plants did not significantly influence the length and thickness of salsify roots. Only the influence of the plants method cultivation was significant. In plants cultivation in the ridges, the length of the roots was greater, and characterized by a reduced thickness of the head in comparison to the plants cultivated in the flat-soil. Longer roots of carrots and chicory in ridged cultivation were also found by Babik and Dudek [2000] and of scorzonera by Konopiński [2008].

Ploughing term of intercrop plants, the cultivation methods of salsify, and the intercrops used had no significant influence on the accumulation of phosphorus and nitrogen in the roots. A significantly positive influence on the content of potassium in the roots of salsify was found in the case of ridged cultivation. The experiments confirmed, that the applying of intercrops significantly decreased the potassium content in salsify roots. The term of ploughing had no significant influence on the content of potassium in the roots. Konopiński [2003], in experiment with scorzonera, has proved, that different conditions of the plants cultivation (in the ridges, in flat soil, with cover crops) had a major influence on the nutrients uptake. The plants cultivated in ridges have shown larger contents of phosphorus and potassium, compared to the plants cultivated in flat soil. The uses of plant mulches in the cultivation of scorzonera beneficially influenced the amount of nutrients absorbed from the soil. A significant influence on the nitrogen content in roots was found in the objects with mulching of the soil with common vetch, while the contents of phosphorus and potassium were best influenced by mulching with white mustard. Schuppenies [1993] has proved, that the mulching of the soil were able to gather nitrogen in fall and release it during spring, which led to the better crops of growing plant. According to Duer [1996] the cultivation of intercrops helps to prevent the processes of draining down of the nitrates to the deeper layers of the soil.

CONCLUSIONS

1. The cultivation of salsify in ridges, spring ploughing and intercrop plants: common vetch, tansy phacelia and oats, had a significant influence on the increase of marketable salsify roots yield.
2. The cultivation of salsify in ridges, spring ploughing and the intercrop plants used to preserve the soil had a beneficial influence on the structure of root crops. This influence included the largest percentage of marketable yield of roots in the total crop and the least proportion of small and shapeless roots. Among the intercrops common vetch proved to be the most beneficial in this aspect.
3. The investigated factors of the experiment had no significant influence on the mass of salsify root. The date of ploughing and intercrop plants did not influence the length and thickness of roots. Substantial influence on the length of the roots was found in ridged crops, while flat cultivation largely influenced the thickness of roots.
4. The methods of plant and soil cultivation, as well as the kind of intercrop plants did not have a significant influence on the nitrogen and phosphorus content in salsify roots. Only a significant, beneficial influence of plants cultivation in the ridges on potassium content in roots was found. The use of intercrop plants did significantly lower of the potassium content in salsify roots.

ACKNOWLEDGEMENTS

Research financed by Ministry of Science and Higher Education within the frames of Project No 2P06R 014 29

REFERENCES

Anyszka Z., Dobrzański A., 2006. Zachwaszczenie w uprawie marchwi, w zależności od sposobu uprawy. Fol. Hort. Suppl., 1, 43–47.

Babik J., 2000. Wpływ metody uprawy, nawadniania i zagęszczenia roślin na plon i jakość korzeni cykorii sałatowej (*Cichorium intybus* L. var. *foliosum* Hegi). Annales UMCS sec. EEE, Horticultura, VIII, Suppl., 211–217.

Babik J., Dudek J., 2000. New, complex machine for ridge forming, and simultaneous sowing vegetable crops. Veg. Crops Res. Bull. 53, 103–110.

Benecsik K., 2007. Effect of tillage methods on the agronomical structure of the soil. Agrokemia es Talajtan, 56 (1), 21–28.

Błażewicz-Woźniak M., Kęsik T., Wach D., Konopiński M., 2008. The influence of conservation tillage on the mineral elements content in soil land chemical composition of onion. Acta Sci. Pol., Hortorum Cultus, 7(2), 61–72.

Borowy A., Konopiński M., Jelonkiewicz M., 2000. Effect of no-tillage and rye mulch on soil properties, weed infestation and yield of carrot and red beet. Annales AFPP Dijon – France, 339–345.

Cebulak T., Sady W., 2000. Effect of cultivation methods on nutritive compounds in the carrot. Fol. Hort. 12 (1), 77–84.

Duer I., 1996. Mulczujący wpływ międzyplonu na plonowanie jęczmienia jarego oraz zawartość wody i azotanów w glebie. Fragm. Agron. (XIII), 1 (49), 29–43.

Evers A.M., Tuuri H., Hägg M., Plaami S., Häkkinen U., Talvitie H., 1997. Soil forming and plant density effects on carrot yield and internal quality. Plant Foods Human Nutr., 51, 283–294.

Holland J.E., White R.E., Edis R., 2007. The relation between soil structure and solute transport under raised bed cropping and conventional cultivation in south-western Victoria. Austral. J. Soil Res., 45 (8), 577–585.

Kęsik T., Konopiński M., Błażewicz-Woźniak M., 2006. Wpływ uprawy przedzimowej i mulczu z roślin okrywających na retencję wody, zagęszczenie i porowatość dyferencyjną gleby po przezimowaniu. Acta Agrophysica, 7(4), 915–926.

Konopiński M., 2003. Wpływ zróżnicowanych systemów uprawy na kształtowanie warunków wzrostu, plonowanie i wartość biologiczną skorzonery (*Scorzonera hispanica* L.). Rozpr. Nauk. AR w Lublinie, 271.

Konopiński M., 2008. The effect of different soil and plants cultivation methods on yield and chemical composition of scorzonera roots. Veg. Crops Res. Bull. 68, 101–110.

Konopiński M., 2009. Influence of intercrop plants and varied tillage on yields and nutritional value of salsify (*Tragopogon porrifolius* L.) roots. Acta Sci. Pol., Hortorum Cultus, 8(2), 27–36.

Michalik Ł., 2003. Wpływ metody uprawy na plonowanie selera naciowego w warunkach klimatycznych Olsztyna. Fol. Hort. Suppl. 2, 322–324.

Ostrowska A., Gawliński S., Szczubiałka Z., 1991. Metody analizy i oceny gleb i roślin. Instytut Ochrony Środowiska, Warszawa.

Polák M., Poničan J., Jech J., Angelovič M., 1999. Comparison of cultivating root vegetables in soil prepared by the classical method and in ridges. Zĕmdĕlska Technika, 45(1),1–8.
Schuppenies R., 1993. Mulchsaaten von Silomais und die Bodeutang der Nmin-Untersuchung. Umweltgerecht Angebaut. Neue Landwirtschaft, 1, 27–28.
Tisdall J.M., Hodgson A.S., 1990. Ridge tillage in Australia: a review. Soil and Tillage Research, 18 (2–3), 127–144.
Wierzbicka B., Pierzynowska-Korniak G., Majkowska-Gadomska J., 2004. Wpływ metody uprawy i przechowywania na plon i jędrność korzeni spichrzowych dwóch odmian marchwi. Fol. Univ. Agricult. Stetin. Agricult. 239 (95), 415–418

WPŁYW MIĘDZYPLONU I TERMINU WYKONANIA ORKI NA STRUKTURĘ PLONU I NIEKTÓRE CECHY JAKOŚCIOWE KORZENI SALSEFII (*Tragopogon porrifolius* L.)

Streszczenie. W wyniku częstych zabiegów uprawowych i chemizacji upraw, w warstwie uprawnej gleby zachodzą niekorzystne zmiany właściwości fizycznych, chemicznych i biologicznych. Następuje zanikanie struktury agregatowej gleby, zmniejszenie zawartości substancji organicznej i osłabienie aktywności biologicznej. W celu reprodukcji substancji organicznej i poprawy właściwości gleby wprowadzane są do uprawy rośliny międzyplonowe na przyoranie. Doświadczenia polowe przeprowadzono w latach 2006–2008, na glebie płowej. Rośliną doświadczalną była salsefia (*Tragopogon porrifolius* L.) odmiany 'Mamut'. W badaniach uwzględniono trzy rośliny międzyplonowe: wykę siewną, facelię błękitną i owies; dwa sposoby uprawy roli: a) zespół uprawek przedsiewnych, siew roślin międzyplonowych w drugiej dekadzie sierpnia, orka przedzimowa (wymieszanie zielonej masy z glebą), b) zespół uprawek przedsiewnych, siew roślin międzyplonowych w drugiej dekadzie sierpnia, orka wiosenna (wymieszanie masy roślinnej z glebą) oraz dwie metody uprawy roślin: na redlinach i na płask**.** Uprawa roli pod salsefię z wykorzystaniem biomasy wyki siewnej, facelii błękitnej i owsa, jako źródła substancji organicznej, miała istotnie dodatni wpływ na wielkość plonu handlowego korzeni salsefii. Stwierdzono także jej dodatni wpływ na procentowy udział korzeni handlowych w plonie korzeni ogółem. Spośród badanych roślin międzyplonowych najkorzystniejszym wpływem na plonowanie salsefii wyróżniała się wyka siewna. Najlepszą metodą uprawy salsefii była uprawa roślin na redlinach, z której uzyskano największy plon korzeni i najwyższy procentowy udział plonu handlowego. Korzenie pochodzące z tej uprawy odznaczały się większą długością. Stwierdzono w nich także najwyższą zawartość potasu. Nie stwierdzono istotnego wpływu badanych czynników na zawartość azotu ogółem i fosforu w korzeniach salsefii. Pod względem wielkości plonu korzeni i jego struktury, najkorzystniejszym terminem przyorania biomasy międzyplonów był termin wiosenny.

Słowa kluczowe: salsefia, mulczowanie gleby, orka przedzimowa i wiosenna, redliny

Accepted for print: 17.10.2012