ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN – POLONIA
VOL. LXIV (3) SECTIO E 2009

Department of Plant Cultivation, University of Podlasie, B. Prusa 14, 08-110 Siedlce, Poland
e-mail: plaza@ap.siedlce.pl

ANNA PŁAZA, FELIKS CEGLAREK

Tuber quality of edible potato fertilized with catch crops and barley straw

Jakość bulw ziemniaka jadalnego nawożonego międzyplonami i słomą jęczmienia jarego

Summary. The work presents research results from the years 2000–2003. The research aimed to examine the possibilities of replacing farmyard manure, in edible potato cultivation, with catch crops and barley straw without reducing the level and quality of the tuber yield. Two factors were examined. I. Catch crop fertilization: a control object, farmyard manure, undersown catch crop (red clover, red clover + Italian ryegrass), stubble catch crop – biomass incorporated in autumn (fodder radish), stubble catch crop overwintering biomass mulch (fodder radish). II. Straw fertilization: straw-fertilized sub-block, a not-straw-fertilized sub-block, a not-straw-fertilized sub-block. Undersown catch crops were sown after planting barley cultivated for grain whereas stubble catch crops were planted after barley harvest. Edible potato was cultivated in the first year after organic fertilizer application. The following characteristics were determined during potato harvest: commercial yield, starch, vitamin C, true protein and glycoalkaloid contents in the tuber samples. The conditions of the growing season significantly modified the commercial yield and the chemical composition of potato tubers. The highest commercial yield of potato tubers with the highest of starch, vitamin C, true protein, and the lowest of glycoalkaloid content was harvested from the treatment fertilized with either a mixture of red clover and Italian ryegrass, or red clover in combination with straw. Moreover, positive results were obtained when a fodder radish mulch + straw combination was applied.

Key words: green manures, mulch, straw, potato, commercial yield, chemical composition

INTRODUCTION

Potato for direct consumption should be characterized by the highest quality characteristics [Leszczyński 2002, Boligłowa and Gleń 2003, Płaza *et al.* 2004]. Most Euro-

pean countries are introducing a system of checking potato product. It aims at obtaining good quality potato and, at the same time, limiting the amount of substances contained in potato that are harmful for both humans and the natural environment [Spiertz *et al.* 1996, Burgess 1997]. What can be noticed is a positive impact of organic fertilization [Leszczyński 2002, Boligłowa and Gleń 2003, Makaraviciute 2003, Płaza *et al.* 2004]. Most works on this subject pertain mainly to farmyard manure fertilization. However, it is also green manures, like undersown catch crops, stubble catch crops incorporated in the autumn or overwintering as mulches and cereals straw, all applied as organic fertilization alternatives, that significantly influence quality characteristics of potato tubers. What is more, an introduction of new potato cyst nematode-resistant German varieties of fodder radish stimulates an interest in this kind of research. Unfortunately, the issue has not been examined in depth, which is confirmed by a small number of scientific papers pertaining to this subject. Hence, a need emerges to carry out research checking the possibilities of replacing farmyard manure with catch crops and spring barley in edible potato fertilization without reducing both the tuber yield and quality.

METHODS

A field experiment was carried out at the Experimental Farm in Zawady, owned by the University of Podlasie in Siedlce, in the years 2000–2003. The study site was the very good rye complex soil, belonging to the quality class IV a. The soil pH was neutral and the available phosphorus, potassium and magnesium contents were average. The humus content was 1.32%. The experiment was a three-replicate split-blocks design. Two factors were examined: I. catch crop fertilization: a control object (no catch crop fertilization), farmyard manure (30 t ha^{-1}), undersown catch crop (red clover – 20 kg ha^{-1}; red clover + Italian ryegrass, 10 + 15 kg ha^{-1}), stubble catch crop – biomass incorporated in autumn (fodder radish – 30 kg a^{-1}), stubble catch crop overwintering biomass mulch (fodder radish – 30 kg ha^{-1}); II. straw fertilization: a straw-fertilized sub-block, a non-straw-fertilized sub-block.

Undersown catch crops were sown after planting barley cultivated for grain whereas stubble catch crops were planted after barley harvest. During the harvest, grain yield amounting to 4.2 t ha^{-1} (a three-year mean), was recorded for each plot. On straw-fertilized plots the cut straw was left whereas on the non-straw-fertilized plots the straw has collected and taken away from the experimental site. A supplemental nitrogen dose of 7 kg per 1 tone of straw was applied to all the straw-fertilized plots, excluding the plot where red clover was grown. In the autumn, catch crop fresh matter yield, including the root mass and 30-cm soil layer, was determined on each plot. The average yield for red clover, the red clover-Italian ryegrass mixture, and fodder radish amounted: 26.4, 35.4 and 31.2 t ha^{-1}, respectively. Next, cattle farmyard manure was applied to the scheduled plots and incorporated (pre-winter ploughing). The aforementioned fertilization was not applied to the plots where fodder radish had been planted because the plants were left to serve as winter mulch.

Edible potato was cultivated in the first year after organic fertilizer application. In early spring mineral fertilizers were distributed. Their amounts depended on soil fertility and anticipated yields and equalled: 90 kg N, 39.6 P and 99.6 K per 1 ha. On the plots

that had been ploughed in the autumn the fertilizers were incorporated by means of a cultivator combined with a harrow. On the mulched plots disc harrowing was followed by cultivator application. Potatoes were planted in the third decade of April. On the potato lantation mechanical-and-chemical cultivation was made. Until plant emergence every 7 days hilling and harrowing were carried out, and immediately prior to potato emergence Afalon 450 SC was applied at the dose of 2 dm^3 ha^{-1}, while after emergence (at 15–20 cm plant growth), when weed infestation with monocotyledonous weeds was observed, Fusilade Super 125 EC herbicide was used at the dose of 2 dm^3 ha^{-1}. Colorado beetle was controlled with Fastac 10 EC preparation (0.1 dm^3 ha^{-1}) and potato blight with Ridomil MZ 72 WP fungicide (2 dm^3 ha^{-1}). Potatoes were harvested in the second decade of September. During the potato harvest commercial yield (the yield of tubers whose diameter was larger than 40 mm) was recorded. Next, 5-to-7-kg samples were collected from each plot to carry out chemical analyses. The starch, vitamin C and glycoalkaloid contents were determined in potato tuber fresh matter. The true protein content was determined in tuber dry mass be means of the Kjeldahl method which was applied after trichloracetic acid precipitation. Each of the characteristics was subjected to analysis of variance according to the split – block model. Means for significant sources of variation were compared by the Tukey test.

Years when researches were carried out characterised with changeable weather conditions (tab. 1). The most favourable was year 2002, a little bit worse weather conditions were noticed in 2001 and the worse in 2003. It was dry year, during the whole vegetation period strong deficiency of rainfall was noticed.

RESULTS

The statistical analysis indicated significant effects of vegetation period conditions and investigated factors and their interaction on potato tuber commercial yield (tab. 1). The highest commercial yield was noticed in favourable year 2002. Less favourable weather conditions of vegetation period in year 2001 caused commercial yield fall (about 4.9%), and unfavourable were noticed in dry year 2003 caused significant fall of tuber yield (about 26.2%). Quite big influence on researched feature had catch crop fertilization. The highest potato tuber yields were recorded for the red clover-Italian ryegrass mixture-fertilized and red clover-fertilized plots. The tuber commercial yield of potato fertilized with fodder radish was no different than the yield recorded for farmyard manure- fertilized potato. However, the yield was significantly lower than the yield of fodder radish mulch-fertilized potato. Straw fertilization differentiated potato tuber yields, too. The potato commercial yield recorded for straw-fertilized plots was on average by 8.3% higher than the yield obtained on non-straw-fertilized plots. An interaction was found to be significant and it indicated that the highest potato tuber yield was recorded for the plots fertilized with a red clover-Italian ryegrass mixture, and the red clover + straw-fertilized plots, whereas the lowest yields were found for the non-catch crop-fertilized control treatment. The fact should be stressed that the commercial yield of fodder radish-mulched potato was similar to the yield of farmyard manure-fertilized potato.

Table 1. The weather conditions in the period of conducting investigations according to the Meteorological Station in Zawady; a) temperature (°C), b) rainfalls (mm)
Tabela 1. Warunki pogodowe w okresie prowadzenia badań wg stacji Meteorologicznej w Zawadach; a) temperatura (°C), b) opady (mm)

a)

Years Lata	Months – Miesiące						Means Średnie
	IV	V	VI	VII	VIII	IX	
2001	8.7	15.5	17.1	23.8	20.6	12.1	16.3
2002	9.0	17.0	17.2	210	20.2	12.9	16.2
2003	7.1	15.6	18.4	20.0	18.5	13.5	133
Means from Średnie z lat 1951–2000	7.2	13.2	16.2	17.6	16.9	12.7	14.0

b)

Years Lata	Months – Miesiące						Sum Suma
	IV	V	VI	VII	VIII	IX	
2001	69.8	28.0	36.0	55.4	24.0	108.0	321.2
2002	12.9	51.3	61.1	99.6	66.5	18.7	310.1
2002	13.6	37.2	266	26.1	4.7	24.3	132.5
Means from Średnie z lat 1950–2000	29.4	543	69.3	70.6	59.8	48.2	331.6

Potato tuber chemical composition was significantly influenced by weather conditions, the experimental factors and their interaction (tab. 2–5). The highest concentration of starch, vitamin C and true protein, and the lowest of glycoalkaloids had potatoes which were harvested in 2002. Deterioration in weather conditions in 2001 caused significant fall of starch, vitamin C and true protein content and the height of glycoalkaloid content. Such a tendency was noticed also in unfavourable year 2003. The starch content in the tubers of catch crop- fertilized potato was not significantly different from the content determined for farmyard manure-fertilized potato (tab. 2). Only for the control treatment the starch content in potato tubers was by 0.6% lower than the content for farmyard-manure fertilized potato. Straw fertilization increased starch concentration in potato tubers. The interaction of the factors indicates that fodder radish-mulched potatoes as well as the potatoes fertilized with a red c1over- Italian ryegrass mixture both with and without straw, contained the most starch. Only red clover fertilization significantly reduced the starch content in potato tubers, compared with farmyard manure fertilization. However, even if it being so, the tuber starch content still remained higher than the content recorded for the control treatment. The highest vitamin C and true protein contents were determined in the tubers of red clover-fertilized potato (tab. 3, 4). Their contents in potato tubers obtained for the remaining catch crop-fertilized treatments were insignificant1y different from the values determined in the farmyard manure-fertilized potato tubers. Also, straw fertilization facilitated vitamin C and true protein accumulation in potato tubers. An interaction was found and it indicated that the highest vitamin C and true protein contents were accumulated in the tubers of red clover-fertilized and red

Table 2. The commercial yield of potato tubers, in t · ha^{-1}
Tabela 2. Plon handlowy bulw ziemniaka w t · ha^{-1}

Catch crop fertilization Nawożenie międzyplonami	Straw fertilization – Nawożenie słomą								Means Średnie			
	subblock without straw – bez słomy				subblock with straw – ze słomą							
	2001	2002	2003	means średnie	2001	2002	2003	means średnie	2001	2002	2003	means średnie
Control object Obiekt kontrolny	20.5	22.7	12.3	18.5	35.9	38.1	27.3	33.8	28.3	30.4	19.8	26.2
Farmyard manure Obornik	40.6	42.8	31.8	38.4	39.2	41.0	30.5	36.9	39.9	41.9	31.2	37.7
Red clover Czerwona koniczyna	40.7	43.2	32.2	38.7	45.0	47.2	36.9	42.8	42.8	45.2	34.5	40.8
Red clover + Italian ryegrass Czerwona koniczyna + życica wielokwiatowa	46.2	47.9	37.6	43.9	42.6	44.4	33.5	40.2	44.4	46.2	35.6	42.1
Fodder radish Rzodkiew oleista	40.7	42.6	31.6	38.3	38.7	40.6	30.2	36.5	39.7	41.6	30.9	37.4
Fodder radish – mulch Rzodkiew oleista – mulcz	35.1	36.9	26.1	32.7	40.0	41.9	31.2	37.7	37.6	39.4	28.7	352
Means – Średnie	37.3	39.4	28.6	35.1	40.2	42.2	31.6	38.0	38.8	40.8	30.1	-
$LSD_{0.05}$ $NIR_{0,05}$ years = 2.1; catch crop fertilization = 1.0; straw fertilization = 1.3; years × catch crop fertilization = 1.4; years × straw fertilization = n.s.; catch crop fertilization × straw fertilization = 1.5 lata = 2.1; nawożenie międzyplonami = 1,0; nawożenie słomą = 1,3; lata × nawożenie międzyplonami = 1,4; lata × nawożenie słomą = nieist.; nawożenie międzyplonami × nawożenie słomą = 1,5												

Table 3. The content of starch in potato tubers, in %
Tabela 3. Zawartość skrobi w bulwach ziemniaka, w %

Catch crop fertilization Nawożenie międzyplonami	Straw fertilization – Nawożenie słomą								Means Średnie			
	subblock without straw – bez słomy				subblock with straw – ze słomą							
	2001	2002	2003	means średnie	2001	2002	2003	means średnie	2001	2002	2003	means średnie
Control object Obiekt kontrolny	12.4	16.7	11.4	13.5	13.2	17.4	12.3	14.3	12.8	17.1	11.9	13.9
Farmyard manure Obornik	13.4	17.2	12.6	14.4	13.5	17.4	12.6	14.5	13.5	17.3	12.6	14.5
Red clover Czerwona koniczyna	13.2	17.0	12.1	14.1	13.5	17.4	12.3	14.4	13.4	17.2	12.2	14.3
Red clover + Italian ryegrass Czerwona koniczyna + życica wielokwiatowa	13.7	17.6	12.7	14.6	13.8	17.5	12.8	14.7	13.8	17.6	12.8	14.7
Fodder radish Rzodkiew oleista	13.5	17.2	12.5	14.4	13.6	17.4	12.5	14.5	13.6	17.3	12.5	14.5
Fodder radish – mulch Rzodkiew oleista – mulcz	13.7	17.7	12.6	14.6	13.9	17.8	12.7	14.8	13.8	17.7	12.7	14.7
Means – Średnie	13.3	17.2	12.3	14.3	13.6	17.5	12.5	14.5	13.5	17.4	12.5	-
$LSD_{0.05}$ $NIR_{0,05}$ years = 0.5; catch crop fertilization = 0.2; straw fertilization = 0.1; years × catch crop fertilization = 0.4; years × straw fertilization = n.s.; catch crop fertilization × straw fertilization = 0.2 lata = 0,5; nawożenie międzyplonami = 0,2; nawożenie słomą = 0,1; lata × nawożenie międzyplonami = 0,4; lata × nawożenie słomą = nieist.; nawożenie międzyplonami × nawożenie słomą = 0,2												

Table 4. The content of vitamin C in potato tubers, in g · kg^{-1} f.m.
Tabela 4. Zawartość witaminy C w bulwach ziemniaka w g · kg^{-1} świeżej masy

Catch crop fertilization Nawożenie międzyplonami	Straw fertilization – Nawożenie słomą								Means Średnie			
	subblock without straw – bez słomy				subblock with straw – ze słomą							
	2001	2002	2003	means średnie	2001	2002	2003	means średnie	2001	2002	2003	means średnie
Control object Obiekt kontrolny	207.2	215.1	205.3	209.2	219.0	227.4	214.1	220.2	213.2	221.3	210.1	214.9
Farmyard manure Obornik	221.3	229.3	216.0	222.2	219.3	229.3	215.3	221.3	220.1	229.0	216.2	221.8
Red clover Czerwona koniczyna	224.0	231.2	223.4	226.2	226.2	236.1	224.2	228.8	225.3	233.2	224.3	227.6
Red clover + Italian ryegrass Czerwona koniczyna + życica wielokwiatowa	223.4	230.2	219.1	224.2	225.1	233.2	220.4	226.2	224.0	232.4	219.0	225.1
Fodder radish Rzodkiew oleista	223.1	229.3	220.2	224.2	222.4	231.3	220.1	224.6	223.3	230.1	220.2	224.5
Fodder radish – mulch Rzodkiew oleista – mulcz	223.5	232.0	220.3	225.3	221.2	232.4	219.3	224.3	222.1	232.3	220.4	224.9
Means – Średnie	220.4	227.9	217.4	221.9	222.2	231.6	218.9	224.2	221.3	229.7	218.4	-

$LSD_{0.05}$ $NIR_{0,05}$
years = 0.32; catch crop fertilization = 0.3; straw fertilization = 0.14; years × catch crop fertilization = 0.43; years × straw fertilization = n.s.; catch crop fertilization × straw fertilization = 0.41
lata = 0,32; nawożenie międzyplonami = 0,30; nawożenie słomą = 0,14; lata × nawożenie międzyplonami = 0,43; lata × nawożenie słomą = nieist.; nawożenie międzyplonami × nawożenie słomą = 0,41

Table 5. The content of the true protein in potato tubers, in % d.m.
Tabela 5. Zawartość białka właściwego w bulwach ziemniaka w % s.m.

Catch crop fertilization Nawożenie międzyplonami	Straw fertilization – Nawożenie słomą								Means Średnie			
	subblock without straw – bez słomy				subblock with straw – ze słomą							
	2001	2002	2003	means średnie	2001	2002	2003	means średnie	2001	2002	2003	means średnie
Control object Obiekt kontrolny	3.57	4.63	3.14	3.78	4.62	5.71	4.19	4.84	4.10	5.17	3.67	4.31
Farmyard manure Obornik	4.89	5.97	4.47	5.11	5.10	6.17	4.68	5.32	5.00	6.07	4.58	5.22
Red clover Czerwona koniczyna	5.64	6.73	5.21	5.86	5.76	6.83	5.32	5.97	5.70	6.78	5.26	5.92
Red clover + Italian ryegrass Czerwona koniczyna + życica wielokwiatowa	5.02	6.12	4.58	5.24	5.14	6.23	4.71	5.36	5.08	6.18	4.65	5.30
Fodder radish Rzodkiew oleista	4.95	6.08	4.51	5.18	5.07	6.17	4.63	5.29	5.01	6.13	4.57	5.24
Fodder radish – mulch Rzodkiew oleista – mulcz	4.70	5.83	4.23	4.92	4.86	5.94	4.41	5.07	4.78	5.88	4.32	5.00
Means – Średnie	4.80	5.89	4.36	5.02	5.09	6.18	4.66	5.31	4.95	6.04	4.51	-
$LSD_{0.05}$ $NIR_{0,05}$ years = 0.16; catch crop fertilization = 0.32; straw fertilization = 0.11; years × catch crop fertilization = 0.42; years × straw fertilization = n.s.; catch crop fertilization × straw fertilization = 0.44 lata = 0,16; nawożenie międzyplonami = 0,32; nawożenie słomą = 0,11; lata × nawożenie międzyplonami = 0,42; lata × nawożenie słomą = nieist.; nawożenie międzyplonami × nawożenie słomą = 0,44												

Table 6. The content of the glycoalkaloids in potato tubers, in g · kg^{-1} f.m.
Tabela 6. Zawartość glikoalkaloidów w bulwach ziemniaka, w g · kg^{-1} świeżej masy

Catch crop fertilization Nawożenie międzyplonami	Straw fertilization – Nawożenie słomą								Means Średnie			
	subblock without straw – bez słomy				subblock with straw – ze słomą							
	2001	2002	2003	means średnie	2001	2002	2003	means średnie	2001	2002	2003	means średnie
Control object Obiekt kontrolny	0.062	0.059	0.071	0.064	0.055	0.052	0.065	0.057	0.059	0.056	0.068	0.061
Farmyard manure Obornik	0.052	0.049	0.062	0.054	0.052	0.049	0.061	0.054	0.052	0.049	0.061	0.054
Red clover Czerwona koniczyna	0.050	0.047	0.059	0.052	0.049	0.046	0.058	0.051	0.049	0.046	0.059	0.051
Red clover + Italian ryegrass Czerwona koniczyna + życica wielokwiatowa	0.047	0.044	0.057	0.049	0.049	0.045	0.058	0.050	0.048	0.045	0.057	0.050
Fodder radish Rzodkiew oleista	0.053	0.050	0.062	0.055	0.052	0.048	0.061	0.054	0.052	0.049	0.061	0.054
Fodder radish – mulch Rzodkiew oleista – mulcz	0.051	0.048	0.061	0.054	0.050	0.047	0.060	0.052	0.051	0.048	0.060	0.053
Means – Średnie	0.053	0.050	0.062	0.055	0.051	0.048	0.060	0.053	0.052	0.049	0.061	-
$LSD_{0.05}$ $NIR_{0,05}$ years = 0.003; catch crop fertilization = 0.003; straw fertilization = 0.001; years × catch crop fertilization = 0.003; years × straw fertilization = n.s.; catch crop fertilization × straw fertilization = 0.002 lata = 0,03; nawożenie międzyplonami = 0,003; nawożenie słomą = 0,001; lata × nawożenie międzyplonami = 0,003; lata × nawożenie słomą = nieist.; nawożenie międzyplonami × nawożenie słomą = 0,002												

clover + straw fertilized potatoes. The potato tuber vitamin C and true protein contents determined for the remaining catch crop-fertilized and catch crop + straw-fertilized treatments were not significantly different from the values recorded for the farmyard manure-fertilized treatment. The content of both characteristics was significantly lowest for the control treatment where no catch crop fertilization had been applied. In contrast, farmyard manure application and catch crop fertilization significantly reduced the glycoalkaloid concentration in tubers, compared with the concentration recorded for control treatment potato tubers (tab. 5). An increase in the amount of soil organic matter, resulting from a combined application of catch crops and straw, reduced the content of glycoalkaloids in potato tubers. An interaction of the examined factors indicates that the highest glycoalkaloid concentration was recorded for potatoes fertilized with undersown catch crops and a combination of undersown catch crops and straw, whereas the highest concentration was typical of the control treatment.

DISCUSSION

Farmyard manure shortages resulting from reduction in the number of farm animals raised, low agricultural production profitability, and conditions favouring integrated production, stimulate researehers to look for alternative and energy-effective methods of potato fertilization which also have a positive impact on the soil environment. A special attention ought to be paid to green manures in the form of undersown and stubble catch crops, and straw remaining in the field after cereal harvest Dzienia *et al.* [2004] and Marks *et al.* [2004] point to a clear advantage of green manures over farmyard manure, which follows from the fact that nutrients contained in green manure are in general more available than farmyard manure components, as a result of the faster rate of organic matter decomposition. The present study has confirmed this finding. The highest commercial yield of potato tubers was obtained form the treatment which had been fertilized with a mixture of red clover and Italian ryegrass, and the combination of red clover and straw. However, the effect of red clover was markedly poorer. The possible explanation of the fact is that the decomposition of legumes can be accompanied by substantial nitrogen losses. The losses depend on temperature, humidity and decomposition duration and can amount to as much as 50%. In order to prevent the losses, one should add carbon-rich material, e.g. grass or straw, to the decomposing legume biomass in order to increase the C:N ratio Mauromicale *et al.* [2003]. What is worth stressing is the fact that, in the present work, the tuber commercial yield of potato fertilized with fodder radish mulch combined with straw, was not significantly different from the yield of the farmyard manure-fertilized potato. It has been confirmed in the studies by Dzienia and Szarek [2000] on potato fertilization with white mustard mulch. The beneficial impact of catch crop mulch follows from the fact that when the plant remains in the field, it reduces the organic matter mineralization rate, prevents nitrate leaching, stores water from autumn-winter rains, improves soil structure and enriches the soil with organic matter [Boligłowa and Gleń 2003, Dzienia *et al.* 2004]. In addition, an application of potato cyst nematode-resistant fodder radish variety naturally protects potato plants from the dangerous pest.

Catch crop and straw fertilization not only increases the yields but also improves their quality, so it conditions the reciprocal relation of the elements found in the potato tuber. In the current work, the highest starch content was determined in the tubers of fodder radish-mulched potato and the potato fertilized with a mixture of red clover and Italian ryegrass, both with and without straw application. By contrast, Boligłowa and Gleń [2003] and Dzienia *et al.* [2004] did not find any significant differences in the starch content between farmyard manure-fertilized potatoes and the potatoes cultivated after autumn and spring (mulch) incorporation of white mustard. In the discussed experiment, the starch content in potato tubers was reduced when potato was fertilized with red clover, compared with farmyard manure. It agrees with the findings of Mondy *et al.* [1993], but is in disagreement with the reports by Marks *et al.* [2004] who point to a beneficial response of potato, in terms of the starch content, to fertilization with a legume, compared with farmyard manure. Under the conditions of the discussed study, catch crop fertilization, (red clover in particular) stimulated vitamin C accumulation in potato tubers. Also, straw fertilization favourably influenced the aforementioned characteristic. Similar conclusions were formulated by many authors [Weber and Putz 1999, Leszczyński 2002, Boligłowa and Gleń 2003, Płaza *et al.* 2004]. They also mentioned the correlation between organic fertilization and vitamin C content in potato tubers. In the works by Płaza *et al.* [2004] and Kołodziejczyk *et al.* [2007] in the present study an increase in the true protein content was observed in the tubers of organically fertilized potatoes. An application of red clover in combination with straw, and red cover only most positively influenced the above-mentioned characteristic. Also, Mondy *et al.* [1993] point to the reduced starch content and increased protein content in potato tubers following an addition of nitrogen-rich material. It results from the fact that nitrogen from the legume biomass undergoes gradual mineralization and is gradually made available for the potato plant, the process assuring that all the mineral nitrogen is converted into proteinaceous nitrogen. The glycoalkaloid content in the tubers of catch crop-, straw- and farmyard manure-fertilized potatoes was significantly lower than in the tubers cultivated without catch crop fertilization. According to Frydecka-Mazurczyk and Zgórska [2002] the surface layer of small tubers contains most glycoalkaloids which are found in or just under the skin. As a result small tubers contain more glycoalkaloids than big tubers, and the former tubers dominated on the control treatment. Under the conditions of the discussed experiment, the significantly lowest concentration of glycoalkaloids was obtained for the potatoes fertilized with catch crops with or without straw. Bejarano *et al.* [2000] and Leszczyński [2002] report that organic fertilizers reduce the content of harmful substances in potato tubers because they enrich soil in organic matter which hinders the synthesis of glycoalkaloids and increases the accumulation of nutrients. Benefits resulting from an application of these fertilization forms seem to be undisputable.

CONCLUSIONS

1. The conditions of the growing season significantly modified the commercial yield and chemical composition of potato tubers.

2. The highest tuber commercial yield was obtained for the treatment fertilized with a mixture ofred clover and Italian ryegrass, and red clover and straw.

3. The catch crops and straw stimulated starch, vitamin C and true protein concentrations and hindered the accumulation of glicoalkaloids in tuber potatoes.

4. The red clover – Italian ryegrass mixture and the combination of red clover and straw had the most beneficial impact on the above – mentioned characteristics. Positive results were also obtained when fodder radish mulching was applied in combination with straw.

REFERENCES

Bejarano L., Mignolet E., Devaux A., Espinola N., 2000. Glicoalkaloids in potato tubers: the effect of variety and drought stress on the solanidyne and chaconine contents of potatoes. J. Sci. Agric. 80, 2096-2100.

Boligłowa E., Gleń K., 2003. Yielding and quality of potato tubers depending on the kind of organic fertilization and tillage method. EJPAU, ser. Agronomy, 1, 6, http: www.ejpau.media.pl

Burgess P., 1997. Produkcja ziemniaków w Wielkiej Brytanii. Mat. Konf. Nauk. „Stosowanie technologii odpowiadających wymaganiom rynku". IHAR Jadwisin, 18-19 czerwca 1997, 17-22.

Dzienia S., Szarek P., 2000. Efektywność uprawy bezpłużnej oraz międzyplonów i słomy w produkcji ziemniaka. Zesz. Probl. Post. Nauk Roln. 470, 145-152.

Dzienia S., Szarek P., Pużyński S., 2004. Plonowanie i jakość ziemniaka w zależności od systemu uprawy roli i rodzaju nawożenia organicznego. Zesz. Probl. Post. Nauk Roln. 500, 235-242.

Frydecka-Mazurczyk A., Zgórska K., 2002. Czynniki wpływające na akumulację glikoalkaloidów w bulwach ziemniaka. Zesz. Probl. Post. Nauk Roln. 489, 283-290.

Kołodziejczyk M., Szmigiel A., Kiełbasa S., 2007. Plonowanie oraz skład chemiczny bulw ziemniaka w warunkach zróżnicowanego nawożenia. Fragm. Agronom. 2(94), 142-150.

Leszczyński W., 2002. Zależność jakości ziemniaka od stosowania w uprawie nawozów i pestycydów. Zesz. Probl. Post. Nauk Roln. 489, 47-64.

Makaraviciute A., 2003. Effect of organic and mineral fertilizers on the yield and quality of different potato varieties. Agronom. Res. 1 (2), 197-209.

Mauromicale G., Signorelli P., Lerna A., Foti S., 2003. Effects of intraspecific competition on yield of early potato grown in mediterranean environment. Amer. J. Potato Res. 80, 281-288.

Marks N., Sobol Z., Kołodziejczyk M., 2004. Wpływ gleby i nawożenia na kształtowanie cech jakościowych bulw ziemniaka. Zesz. Probl. Post. Nauk Roln. 500, 341-350.

Mondy N.J., Chandra S., Munshi C.B., 1993. Zinc fertilization increase ascorbic acid and mineral contents of potato. J. Food Sci. 58, 1375-1377.

Płaza A., Ceglarek F., Buraczyńska D., 2004. Tuber yield and quality of potato fertilised with intercrop companion crops and straw. EJPAU, ser. Agronomy. 1, 7, http: www.ejpau.media.pl

Spiertz J.H.J., Haverkort A.J., Vereijken P.H., 1996. Environmentally safe and consumer-friendly potato production in The Netherlands. 1. Development of ecologically sound productions system. Potato Res. 39, 371-378.

Weber L., Putz B., 1999. Vitamin C content in potato. Proceedings of 14th Triennial Conference of the European Association for Potato Research, 3th–5th September 1999, Sorento, Italy, 230-231.

Streszczenie. W pracy przedstawiono wyniki badań z lat 2000–2003 mających na celu sprawdzenie możliwości zastąpienia obornika w nawożeniu ziemniaka jadalnego międzyplonami i słomą jęczmienia jarego bez obniżenia wielkości i jakości plonu bulw. Badano dwa czynniki. I. Nawożenie międzyplonem: obiekt kontrolny, obornik, wsiewka międzyplonowa (koniczyna czerwona, koniczyna czerwona + życica wielokwiatowa), międzyplon ścierniskowy – biomasa przyorana jesienią (rzodkiew oleista), międzyplon ścierniskowy – biomasa pozostawiona do wiosny w formie mulczu (rzodkiew oleista). II. Nawożenie słomą: bez słomy, ze słomą. Wsiewki międzyplonowe wsiewano w jęczmień jary uprawiany na ziarno, a międzyplony ścierniskowe wysiewano po jego zbiorze. W pierwszym roku po zastosowaniu nawożenia organicznego uprawiano ziemniak jadalny. Podczas zbioru ziemniaka określono plon handlowy, a w pobranych próbach bulw zawartość skrobi, witaminy C, białka właściwego i glikoalkaloidów. Warunki sezonu wegetacyjnego istotnie różnicowały plon handlowy i skład chemiczny bulw ziemniaka. Największy plon handlowy bulw ziemniaka, o największej zawartości skrobi, witaminy C i białka właściwego, a najmniejszej glikoalkaloidów otrzymano z obiektu nawożonego mieszanką koniczyny czerwonej z życicą wielokwiatową oraz koniczyną czerwoną ze słomą. Dobre rezultaty uzyskano również po zastosowaniu rzodkwi oleistej w formie mulczu w kombinacji ze słomą.

Słowa kluczowe: nawozy zielone, mulcz, słoma, ziemniak, plon handlowy, skład chemiczny