Influence of non-woven fleece on the yield formation of early potatoes

K. Hamouz, J. Lachman, P. Dvořák, E. Trnková

Czech University of Agriculture in Prague, Czech Republic

ABSTRACT

In the years 1999–2003 the effect of covering rows of early potatoes with non-woven fleece on the yield formation, dry matter content in tubers, temperature of soil and of air in ground layer was investigated. Covering of rows enhanced the market yield of tubers at early harvest 60 days after planting in average by 35.8% in comparison with the uncovered control. At harvest 67 days after planting the difference in advantage of the covered variant were 17.2% and 85 days after planting the difference in yield between variants was already non significant. The yield effect of the fleece was affected by year (higher effect in the years with cold spring) and by variety (Impala responded at 60 days after planting by yield increase under fleece 43.7%, Adora 27.9%). Higher dry matter content of tubers by 0.87% was found in covered plants 60 days after planting in comparison with control. Cover enhanced average air temperature in ground layer by 2.0°C, in soil in depth 100 mm by 1.8°C.

Keywords: early potato; non-woven fleece; yield; dry matter content; variety; soil temperature

Early potatoes in Czech Republic are cultivated in the warmest localities in the South Moravia and Polabí lowland. Producers need to begin their harvest in the earliest term to use favorable actual prices and to insure their position on the market in time. They use common technological procedures (Zrůst and Jůzl 1996, Zrůst et al. 1999, Mustonen 2004) supporting early harvest, especially pre-germinated seed potatoes of very early varieties and irrigation, in order to reach good yields already during the turn of May and June. Covering of rows after the planting with non-woven polypropylene fleece facilitates an increase in yields of early potatoes and their stability in individual years (Jablońska-Ceglarek and Wadas 2005). Also a satisfactory dry matter content of tubers is a requirement for early harvest.

According to Jablońska-Ceglarek and Wadas (2005) in the cultivation with non-woven polypropylene covering, the marketable tuber yield at 60 days after planting was higher by 23.34% in average and at 75 days after planting by 10.92% in the six-year period of the study, compared with the cultivation with no plant covering. In previous experiments of these authors (Wadas and Jablońska-Ceglarek 2000) with cover with polypropylene fleece (Pegas Agro 17 UV) from planting to full emergence increased the marketable yield of tubers by an average of 33%. In the long-term experiments of Demmler (1998), the use of horticultural fleece accelerated the date of harvest and increased the yield of early harvest by an average of 50%. Soil temperature under the fleece increased by 1.2°C in comparison with the control. A higher increase in the tuber yield as a result of covering was obtained in the years with a cold spring. In France and Wales in the potato cultivation under polyethylene sheets, tuber yields higher by 4–24 t/ha and by 6–14 t/ha, respectively were obtained in comparison with the traditional cultivation (Le Corre 1988, Jenkins and Gillison 1995), depending on the vegetation conditions. In the conditions of central part of Poland, the potato covering with non-woven polypropylene resulted in a 20% increase of tuber yield at the early date of potato harvest in the year with warm spring and 30% increase in the year with cold spring (Lutomirska 1995). According to yield forming

Supported by the Ministry of Agriculture of the Czech Republic, Project No. 1G46058, and by the Ministry of Education, Youth and Sports of the Czech Republic, Project No. 6046070901.

factors, the increase of tuber mass from one bunch under fleece covering is a result of enhancing of average mass of one tuber, whereas the number of tubers under bunch was not changed (Dvořák and Hamouz 2006).

The change of conditions of the initial growth and development of potato plants by covering influences not only the yield level, but also tuber quality (Prosba-Bialczyk and Mydlarski 1998, Lachman et al. 2003). Nelson and Jenkins (1990) determined that the dry matter content was higher in tubers of potato cultivated under perforated polyethylene sheet. Demmler (1998) determined at early harvest a higher starch content in potatoes cultivated under fleece as compared to uncovered plants.

The aim of this work was to investigate effectiveness of propylene fleece in early potatoes in conditions of early potato area in Czech Republic and to evaluate its effect on the dynamics of yield formation and on the portion of marketable tubers and dry matter content in tubers. Further to investigate the effect of covering of rows with fleece on microclimatic characteristics in potato vegetation and check its effectiveness against spring frosts.

MATERIAL AND METHODS

Precise field trials were performed on the locality Přerov nad Labem in Central Bohemia in the years 1999–2003. Locality is situated in Polabí lowland, where soil and temperature conditions are very favorable for cultivation of early potatoes and precipitation deficiency is balanced by irrigation. There is typical brown soil, sandy soil, and high content of phosphorus in soil (134 mg/kg), good K and Mg content (201 and 73 mg/kg) and pH 5.1 in this locality. Trials with white non-woven fleece Pegas Agro 17 UV (17 g/m^2) and with control variant in the open air were provided in four parallel determinations. Experimental variants have been grown using a uniform method according to the principles of the common farming practices for early potatoes. Seed potatoes pre-sprouted for forty days in early Adora and Impala varieties were

Table 1. Effect of covering with non-woven fleece on the yield of marketable potato tubers at different terms of harvest – Adora variety

Number of days from planting to harvest	Year	Control (C) (t/ha)	Fleece (F) (t/ha)	Difference (F–C)	LSD (P = 0.05)	F/C (%)
60	1999	11.76	17.23	5.47	2.02	146.5
	2000	16.89	19.40	2.51	2.12	114.9
	2001	18.96	24.04	5.08	2.89	126.8
	2002	19.11	23.59	4.40	2.21	123.4
	2003	3.44	17.84	14.40	1.95	519.0
	average 1999–2002*	16.68	21.07	4.37	2.31	127.90
67	1999	18.26	22.17	3.91	3.02	121.4
	2000	32.48	35.21	2.73	3.86	108.4
	2001	27.68	29.89	2.21	3.11	108.0
	2002	26.40	30.86	4.46	2.70	116.9
	2003	12.42	28.08	15.66	3.81	226.0
	average 1999–2002*	26.21	29.53	3.33	3.17	113.68
85	1999	32.64	31.77	–0.87	3.80	97.3
	2000	39.65	41.35	1.70	4.61	104.3
	2001	42.80	42.25	–0.55	6.03	98.7
	2002	44.08	42.69	–1.39	4.29	96.8
	2003	28.34	42.50	14.16	5.68	150.0
	average 1999–2002*	39.79	39.52	–0.28	4.68	99.28

*in average values year 2003 is not included (control vegetation was strongly damaged by frosts)

used. Industry compost Organic at dose 10 t/ha in the spring before planting was applied. Also mineral fertilizers at levels 130 kg N/ha, 35 kg P/ha, and 66 kg K/ha were applied. Row spacing was of 250 mm and 750 mm between rows. Immediately after the planting the rows were treated with herbicide Sencor 70 WP (70% metribuzin) at level 0.5 kg/ha and covered with fleece. The fleece was from the potato vegetation removed after increase of the highest daily temperatures above 20°C for several days, particularly 18.5.1999, 4.5.2000, 10.5.2001, 4.5.2002 and 17.5.2003. Germinated plants came to average height 200–400 mm after removing of the fleece. Dates and doses of supplementary irrigations were selected according to soil humidity determined gravimetrically. Total yield and marketable yield (tuber size above 30 mm) were evaluated at consecutive harvests at 60, 75 and 85 days after planting. In the year 2003 during the all vegetation period every 15 minutes air temperature under the fleece and out of it and soil temperature in the 100 mm depth were measured (data loggers Minikin TH and Tinitag Ultra, respectively). Among qualitative parameters dry matter content of tubers was determined after harvest. Results were statistically evaluated by variance analysis method – Tukey test at level of significance $P = 0.05$.

RESULTS AND DISCUSSION

The covering of rows with non-woven fleece positively affected the yield of tubers and its stability. At the first samplings of bunches 60 days after planting the yield of marketable tubers in covered variant statistically significantly exceeded the yield of control treatments. Yield of cultivar Adora (Table 1) experimentally treated with fleece reached 146.5% in 1999, 114.9% in 2000, 126.8% in 2001, 123.4% in 2002 and 519% in 2003 and in average of 1999–2002 it was 127.9% of yield of control variant. In cv. Impala (Table 2) it reached in the same years 158.6%, 127.6%, 142.9%, 145.6%, 608.0%, and 143.7% of the yield of control variant. This increase of yield in the treatment under the

Table 2. Effect of covering with non-woven fleece on the yield of marketable potato tubers at different terms of harvest – Impala variety

Number of days from planting to harvest	Year	Control (C) (t/ha)	Fleece (F) (t/ha)	Difference (F–C)	LSD ($P = 0.05$)	F/C (%)
60	1999	8.88	14.08	5.20	2.38	158.6
	2000	15.53	19.81	4.28	1.87	127.6
	2001	12.74	18.21	5.47	1.98	142.9
	2002	12.67	18.45	5.78	2.02	145.6
	2003	2.45	14.89	12.44	2.12	608.0
	average 1999–2002*	12.46	17.64	5.18	2.06	143.68
67	1999	16.42	20.81	4.39	2.72	126.7
	2000	34.48	37.68	3.20	4.25	109.3
	2001	22.81	27.98	5.17	2.92	122.7
	2002	20.00	24.80	4.80	2.07	124.0
	2003	13.20	26.36	13.16	4.44	199.0
	average 1999–2002*	23.43	27.82	4.39	2.99	120.68
85	1999	34.40	35.51	1.11	4.56	103.2
	2000	50.35	51.82	1.47	4.98	102.9
	2001	44.96	45.97	1.01	5.09	102.3
	2002	45.24	46.50	1.26	4.05	102.8
	2003	32.70	39.92	7.22	6.60	122.0
	average 1999–2002*	43.74	44.95	1.21	4.67	102.80

*in average values year 2003 is not included (control vegetation was strongly damaged by frosts)

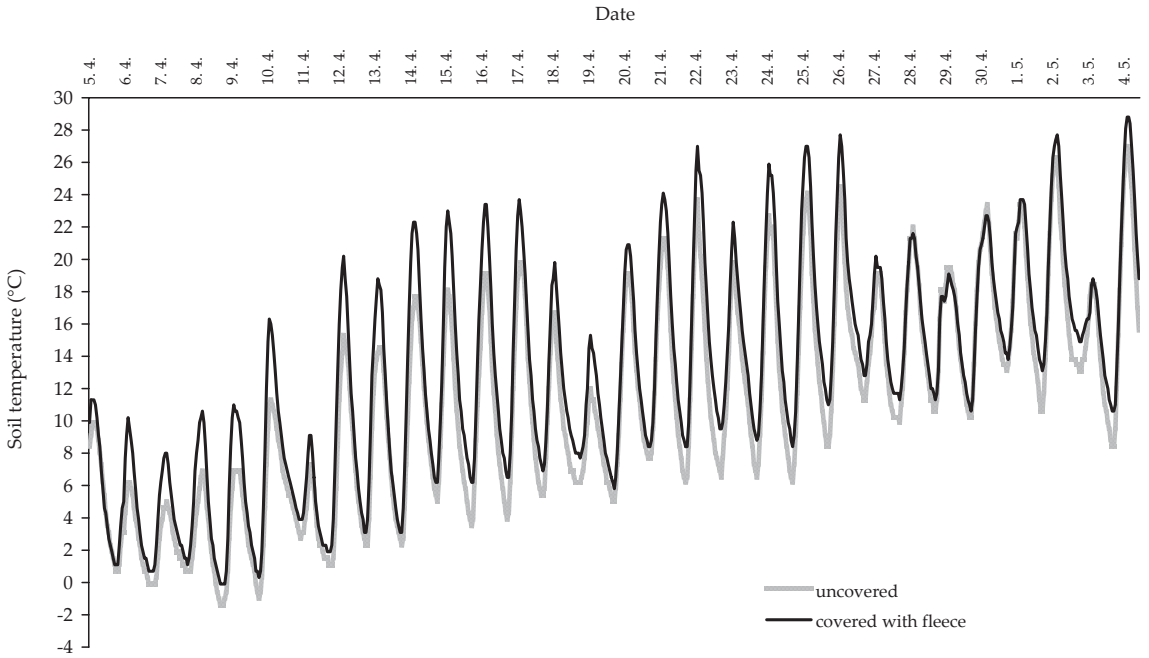

Figure 1. Soil temperature course in covered and uncovered vegetation in the year 2003

fleece at early harvest is in relation with results obtained by other authors (Le Corre 1988, Nelson and Jenkins 1990, Lutomirska 1995, Demmler 1998, Jablońska-Ceglarek and Wadas 2005, Hamouz et al. 2005). Favorable effect of cover with the fleece on the yield at early harvest was related to microclimatic conditions under the fleece that accelerated emergence by 4 up 8 days against control variant and accelerated further growth and vegetation development in the period, when climatic conditions for early potatoes were less favorable. Results of measurements of temperature in the soil in 2003 (Figure 1) confirm this fact. Higher values of daily temperature maxima and higher values of minima under fleece are apparent. Our results related to soil temperature under the fleece correspond well with the results obtained by Prosba-Bialczyk and Mydlarski (1998). Impala variety reached higher yield increase under cover with the fleece in comparison of both varieties (in average of 1999–2002 years by 15.8% higher value than in Adora variety; Tables 1 and 2, Figure 2). Also Wadas and Jablońska-Ceglarek (2000) found a dissimilar level of yield increase in different varieties cultivated under fleece cover. Abnormal are the results from the year 2003, which cold weather (Table 3) with frequent ground frosts in the first and second ten days in April (April 9 and 10 minima were about –7°C) very influenced. Soil temperature in depth 100 mm in uncovered variant decreased under 0°C three times (Figure 1). Potatoes were not yet emerged in this period. On the tubers of control variant substantial part of sprouts froze, vegetations emerged with high irregularity, they

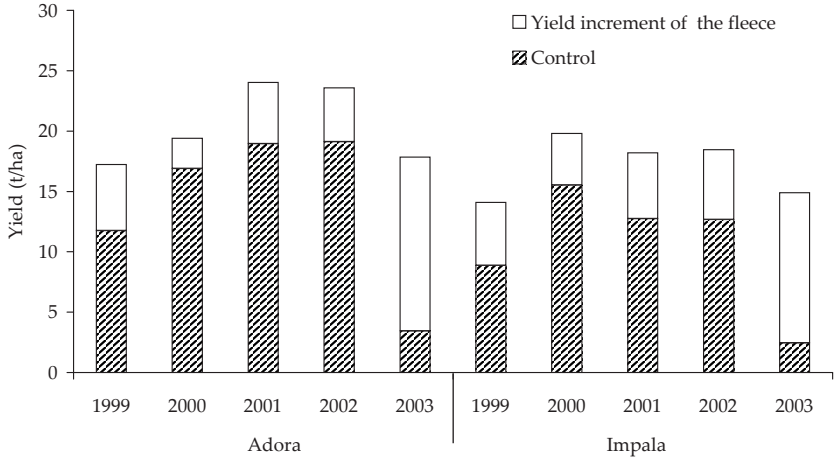

Figure 2. Effect of covering with the fleece, variety and year of cultivation on the yield of marketable potato tubers 60 days after planting

Table 3. Absolute extremes (t_{min}, t_{max}) and average values ($t_{average}$) of ground air temperature in uncovered and covered potato growth in year 2003

Period	Variant	t_{min}	t_{max}	$t_{average}$
5.4.–15.4.	with fleece	–5.2	31.2	6.6
	uncovered control	–7.3	23.3	4.2
16.4.–25.4.	with fleece	3.0	36.9	14.0
	uncovered control	0.2	28.7	11.7
26.4.–4.5.	with fleece	6.6	36.2	17.4
	uncovered control	3.8	28.7	16.1
5.4.–4.5.	with fleece			12.7
	uncovered control			10.7

were considerably wrong proportioned and only subsequently with delay further bunches emerged (the last ones even in the half of May). On contrary the vegetation under fleece emerged commonly integrated with balanced bunches. Thermal isolation effect of the fleece significantly appeared in critical days with ground frosts (Table 3, Figure 1). Soil temperature under fleece increased in average during the period with covering by 1.8°C and air temperature by 2.0°C. Also the cover with textile holds more favorable temperature during cold weather and partly protects potatoes against spring frosts. In experimental years 1999–2002 cover with textile has the highest yield effect in the year 1999 (in average of both varieties yield increase against control was 52.6%, 21.25%, 34.9% and 34.5% in the years 1999, 2000, 2001 and 2002, respectively). It is in correlation with the course of daily air temperatures in April and May, when in the year 1999 the weather was cooler and the fleece had to be left on vegetation for 49 days, whereas in the years 2000, 2001 and 2002 the fleece was removed after 30, 35 and 37 days after planting. Also Jabłońska-Ceglarek and Wadas (2005) show that the higher profitable effect of covering was obtained in the years with a cold spring. To the same conclusion came Dvořák and Hamouz (2006). At the second samplings of bunches 67 days after the planting higher yield in Adora variety with the exception of 2000 year was recorded and higher yield effect of cover with textile in cv. Impala was confirmed. Yield increase in treatment with fleece against control however decreased as compared with the first samplings (Tables 1 and 2). At the third samplings 85 days after the planting differences between covered variants and control nearly equalled (with the exception of the year 2003) or even the control yield exceeded the yield of covered variant, but differences were non significant every time. The results show that covering with non-wo-

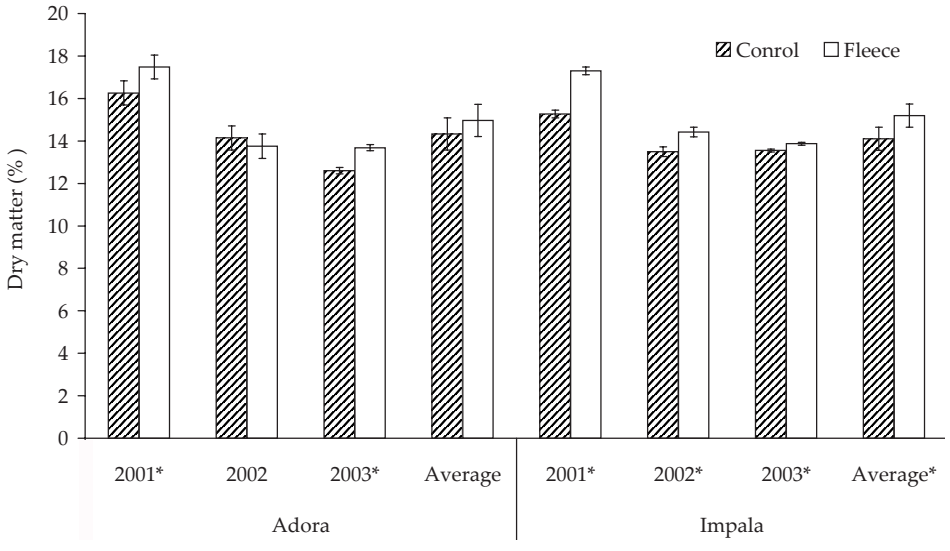

Figure 3. Content of dry matter in tubers of Adora and Impala varieties 60 days after planting

*significant differences at level of significance $P = 0.05$

ven fleece enhanced yields only in the vegetation designated to early harvest, whereas in the period of favorable weather consequently higher vitality of air open vegetation showed and it nearly balanced out yield handicap of June. Also Jablońska-Ceglarek and Wadas (2005) determined the same tendency, i.e. decrease of yield effect in vegetation under textile with latter term of harvest.

Covering with non-woven fleece had at harvest 60 days after the planting as a consequence increase of dry matter in tubers – in cv. Impala by 1.09% and in cv. Adora by 0.64% against control (Figure 3). This fact could be explicated by an earlier emergency, the effect of higher temperatures on plants under textile cover and hence their higher physiological age. Jablońska-Ceglarek and Wadas (2005) indeed did not determine differences in dry matter content between covered treatment and control 60 days after planting, but they also recorded higher dry matter content in the variant with textile after 75 days from the planting. Nelson and Jenkins (1990) came to the identical conclusion as our results and furthermore Demmler (1998) also, who studied starch content, which correlates with dry matter content.

REFERENCES

Demmler D. (1998): Comparison on plastic film and fleece for harvest advancement in early potato crops. Kartoffelbau, *49*: 429–430. (In German)

Dvořák P., Hamouz K. (2006): Influence of early potatoes growing under floating row cover on structure of yield components. Sci. Agr. Bohem., *37*: (Submitted).

Hamouz K., Dvořák P., Čepl J., Pivec J. (2005): The effect of polypropylene fleece covering on the yield of early potatoes. Hort. Sci. (Prague), *32*: 56–59.

Jablońska-Ceglarek R., Wadas W. (2005): Effect of non-woven polypropylene covers on early tuber yield of potato crops. Plant Soil Environ., *51*: 226–231.

Jenkins P.D., Gillison T.C. (1995): Effects of plastic film covers on dry-matter production and early tuber yield in potato crops. Ann. Appl. Biol., *127*: 201–213.

Lachman J., Hamouz K., Hejtmánková A., Dudjak J., Orsák M., Pivec V. (2003): Effect of white fleece on the selected quality parameters of early potato (*Solanum tuberosum* L.) tubers. Plant Soil Environ., *49*: 370–377.

Le Corre P. (1988): Two techniques to increase the precocity of potatoes early products: covering and mulching. Pomme Franc., *444*: 9–14. (In French)

Lutomirska B. (1995): Usage of agro-textile to forcing the yielding of potatoes. Ziemniak Pol., *3*: 14–19. (In Polish)

Mustonen I. (2004): Yield formation and quality characteristics of early potatoes during a short growing period. Agr. Food Sci., *13*: 390–398.

Nelson D.G., Jenkins P.D. (1990): Effects of physiological age and floating plastic film on tuber dry-matter percentage of potatoes, cv. Record. Potato Res., *33*: 159–169.

Prośba-Bialczyk U., Mydlarski M. (1998): Growth potato on early harvest under cover with polypropylene sheets. Fragm. Agron., *57*: 74–84. (In Polish)

Wadas W.R., Jablońska-Ceglarek R. (2000): Effect of covers in early crop potato cultivation. Ann. Univ. M. Curie-Sklodowska Sect. EEE-Hort., *8*: 137–142. (In Polish)

Zrůst J., Jůzl M. (1996): Rates of photosynthesis and dry matter accumulation of very early potato varieties. Rostl. Výr., *42*: 293–300. (In Czech)

Zrůst J., Hlušek J., Jůzl M., Přichystalová V. (1999): Relationship between some chosen growth characteristics and yield of very early potato varieties. Rostl. Výr., *45*: 503–509. (In Czech)

Received on December 6, 2005

Corresponding author:

Doc. Ing. Karel Hamouz, CSc., Česká zemědělská univerzita v Praze, 165 21 Praha 6-Suchdol, Česká republika
phone: + 420 224 382 548, fax: + 420 224 382 535, e-mail: hamouz@af.czu.cz