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EFFECT OF FLAT COVERS AND PLANT DENSITY ON YIELDING AND QUALITY OF KOHLRABI

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Abstract

Kohlrabi is a fast growing, cool season vegetable cultivated primarily for its enlarged stem, which is rich in nutritional components, especially vitamin C and potassium. In two factorial experiment conducted in 2004-2006 there was estimated the effect of plastic covers (perforated plastic film, non woven agrotextile) and plant density (20x15, 25x20 cm) on yield and nutritional value of kohlrabi cultivated in spring season. The significant highest early and marketable yields were obtained from plots covered with agrotextile. The higher density of plants resulted in increased kohlrabi yield. Kohlrabi cultivated under covers had lower level of dry matter, reducing and total sugars. There was not observed the effect of covers on vitamin C concentration. Kohlrabi grown in spacing 20x15 cm contained higher amount of nitrates, vitamin C and reducing sugars in comparison to spacing 25x20 cm.

Key words: kohlrabi, flat covers, spacing, yield, nutritional value.

WPŁYW OKRYĆ PŁASKICH I ROZSTAWY NA PLON I JAKOŚĆ KALAREPY W UPRAWIE WIOSENNEJ

Abstrakt

Kalarepa jest rośliną klimatu umiarkowanego o krótkim okresie wegetacji, uprawianą głównie dla jej smacznych, soczystych, zgrubiałych pędów bogatych w składniki odżywcze,

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w tym witaminę C i potas. W doświadczeniu dwuczynnikowym przeprowadzonym w latach 2004-2006 oceniano wpływ okryć płaskich (folia perforowana, włóknina polipropylenowa) i rozstawy (20x15, 25x20 cm) na plonowanie i wartość odżywczą kalarepy w uprawie wiosennej. Wykazano, że zastosowanie okryć płaskich zapewniło istotnie większy plon wczesny i handlowy zgrubień. Największy plon zgrubień uzyskano osłaniając rośliny włókniną polipropylenową. Większe zagęszczenie roślin w rozstawie 20x15 cm umożliwiło uzyskanie istotnie większego plonu kalarepy, a jednocześnie zmniejszenie jednostkowej masy zgrubienia. Okrycia płaskie przyczyniły się do spadku zawartości suchej masy, cukrów redukujących i ogółem, lecz miały mały wpływ na zawartość witaminy C w częściach jadalnych. W kalarepie uprawianej w rozstawie 20x15 cm stwierdzono większą zawartość azotanów, witaminy C oraz cukrów redukujących niż w rozstawie 25x20 cm.

Słowa kluczowe: kalarepa, okrycia płaskie, rozstawa, plon, wartość odżywcza.

INTRODUCTION

Kohlrabi, which belongs to an agriculturally important family of *Brassicaceae*, is a fast growing cool season vegetable crop. It is valued for its sweet taste and crisp and juicy texture of a turnip-like edible stem, which contains 6.2 g of carbohydrates, 1.7 g proteins and 3.6 g dietary fiber in 100 g of fresh matter (USDA National Nutrient Database 2006). It is also a source of vitamins (vitamin C – 65 mg, thiamin – 0.05 mg, niacin – 0.02 mg, riboflavin – 0.02 mg, pantothenic acid – 0.65 mg, vitamin B_6 – 0.15 mg and folate 16 µg)) and minerals: potassium – 350 mg, phosphorus – 46 mg, magnesium – 22 mg, copper – 0.13 mg and manganese – 0.14 mg (KUNACHOWICZ et al. 2004). Its young leaves, which are richer in vitamins and minerals than stems (120–200 mg vitamin C, 3 mg β-carotene, 1.5 g fiber, 3.6 mg iron and 500 mg calcium per 100 g of f.w.), are used in Western Europe as a component of salads or cooked like spinach (BIELKA 1968, NURZYŃSKA-WIERDAK 2005).

Kohlrabi is a short growing season vegetable, which can be eaten fresh all year because it can be grown for early, summer and autumn market supply. Nowadays there are many cultivars which can produce high yields of good quality stems suitable for fresh market as well as for freezing (VANPARYS 1999, 2000, BIESIADA, KOŁOTA 2007).

Kohlrabi can be grown from seeds, but more frequently it is cultivated from transplants, especially for early market supply. In that case, plants are covered with plastic flat covers to create favourable conditions for growth and development of field grown vegetables, to accelerate harvest by 7-10 days and to improve the quality of crop (FELCZYŃSKI 1995, RUMPEL, GRUDZIEŃ 1996).

The quality of vegetables grown in the open field and under flat covers is quite similar (SIWEK, LIBIK 2005). CAPECKA et al. 2003 did not observe any significant changes in the chemical composition (sugars, vitamin C, fiber, thiocyanates) of Japanese radish cultivated under covers.

The aim of the experiment conducted in 2004-2006 was to evaluate the effects of flat covers and planting density on yielding and nutritional value of kohlrabi.

MATERIAL AND METHODS

A field experiment was established in a two factorial split-plot design in four replications. The first factor involved two types of flat covers: non-woven polypropylene agrotextile P-17 and perforated PE film (with 50 holes per 1 m^2). The second factor was plant spacing: 20x15 and 25x20 cm. The plot area was 1.8 m^2.

The seeds of kohlrabi cv. 'Dworsk«ego' were sown to multicells filled with peat substrate. Individual cells of plug trays contained approximately 76.2 cm^3 of substrate. Four weeks old, well hardened transplants were planted in the first decade of April on plots supplied by ammonium nitrate in the dose of 100 kg $N \cdot ha^{-1}$. Flat covers were used after planting of seedlings and removed 5 weeks later. The kohlrabi was harvested four times at one week intervals, starting at the beginning of June, when the size of kohlrabi stem reached over 3 cm in diameter.

Each time, the total yield of plants (tubers and leaves) and marketable yield of tubers were evaluated. Plants from the first harvest were included in the early yield.

Fresh kohlrabi stems were assayed for vitamin C (according to PN-90/A--75101/11), total and reducing sugars (according to PN-90/A-75101/07) and dry matter (according to PN-90/A-75101/03). Nitrates were determined by the method described in PN-92/A-75112. The content of macronutrients: phosphorus, potassium, magnesium and calcium was determined according to Nowosielski method.

The results were analyzed with a standard statistical procedure and the least significant differences were calculated by Tukey's test at α=0.05.

RESULTS AND DISCUSSION

The data of the study presented as the means for three years showed that plant protection with flat covers was favourable for kohlrabi yield (Table 1). The significantly highest total yield of leaves and stems was obtained when plants were covered with non woven agrotextile, followed by treatment covered with plastic film and control. Early yield of kohlrabi stems in treatments with both flat covers was significantly higher than the control. The early yield of tubers obtained on plots covered with plastic film

Table 1

The effect of nitrogen fertilization on yielding of radicchio ($kg \cdot m^{-2}$)

Type of cover	Spacing (cm)	Total yield tubers+ +leaves	Marketable yield	Early yield	Mean weight of tubers in early yield (g)
Control	20x15	95.9	48.41	5.83	175.3
	25x20	79.6	41.39	4.63	177.3
Mean		87.75	44.90	5.23	176.3
Agrotextile	20x15	110.4	56.47	7.38	193.5
	25x20	93.8	51.76	6.89	235.3
Mean		102.1	54.12	7.13	214.4
Perforated foil	20x15	104.0	53.63	7.80	199.8
	25x20	85.3	42.82	7.19	249.5
Mean		94.65	48.22	7.50	224.7
Mean	20x15	103.4	52.84	7.00	189.5
	25x20	86.23	45.32	6.23	220.7
LSDα=0.05 for cover for spacing		 8.31 9.22	 3.11 4.75	 0.56 0.59	 13.56 16.27

was on average 7.50 $t \cdot ha^{-1}$, thus not considerably different compared to the treatment covered with plastic film – 7.13 $t \cdot ha^{-1}$.

On the plots with flat covers, the plants grew better, which resulted in higher mean weight of one tuber in the early yield than in the control.

The use of both types of flat covers for five weeks considerably increased marketable yield in comparison to the non-covered control. The highest yield of kohlrabi was obtained on plots covered with non woven agrotextile – 54.12 $t \cdot ha^{-1}$. The use of plastic film was less efficient, providing yield of 48.22 $t \cdot ha^{-1}$, while in the control treatment the marketable yield decreased to 44.90 $t \cdot ha^{-1}$.

Similar relations were observed by RUMPEL and GRUDZIEŃ (1993), who found better effects obtained with non-woven flat cover in comparison to plastic film in early cabbage production, but in the studies conducted by REKOWSKA et al. (1995) and RUMPEL and GRUDZIEŃ (1996) no significant differences were observed in yield of early broccoli and melon covered with non-woven agrotextile and plastic film. ADAMCZEWSKA-SOWIŃSKA (1996) stated that in the cultivation of leek for early cropping, the use of flat plastic film with was more advantageous than that of non-woven agrotextile.

Significantly higher early yield of edible parts of kohlrabi was obtained in the treatment with plant spacing 20x15 cm, in comparison to the spacing 25x20 cm. It is in agreement to DOBROMILSKA (2005). According to the author, increased fennel planting density resulted in higher yield of the bulb, despite its lower unit weight.

CAPECKA et al. (2000) noted a lack of negative effect of flat covers on nutritional value of daikon radish. In the present experiment, too, only a negligible effect of covers on vitamin C concentration was noticed. However, the dry matter content of edible parts of kohlrabi covered with both materials was lower than in the control treatment (Table 2).

Table 2

Effect of flat covers and spacing on nutritional value of kohlrabi grown for spring cropping (mean for 2004-2006)

Type of cover	Spacing (cm)	Nitrates ($mg \cdot kg^{-1}$ f.m.)	Dry matter (%)	Vitamin C	Reducing sugars	Total sugars
				($mg \cdot kg^{-1}$ f.m.)		
Control	20x15	860	8.91	835.3	33.0	38.0
	25x20	720	9.93	684.8	30.5	34.0
Mean		790	9.42	760.0	31.7	36.0
Agrotextile	20x15	740	8.64	739.9	32.0	3.35
	25x20	700	8.39	868.8	23.5	26.5
Mean		720	8.51	804.4	27.8	30.0
Perforated foil	20x15	780	8.34	792.7	32.5	32.5
	25x20	630	8.48	704.3	26.0	28.0
Mean		705	8.41	748.5	29.3	30.3
Mean	20x15	793	8.63	809.3	31.8	33.3
	25x20	683	8.93	754.3	26.7	30.8
LSDα=0.05 for cover for spacing		 46.7 58.5	 0.78 0.85	 71.3 82.4	 1.2 1.5	 1.9 1.2

The level of reducing and total sugars in kohlrabi was the highest in the control treatment (31.7 and 36.0 $mg \cdot kg^{-1}$ f.m. respectively), while in tubers of plants covered with non- woven agrotextile and plastic film, it decreased to 27.8 and 30.0 and 26.7 and 30.8 $mg \cdot kg^{-1}$ f.m., respectively.

The tubers of kohlrabi grown at the spacing of 20x15 cm contained considerably higher amounts of nitrates, vitamin C as well as reducing and total sugars than those grown at the lower planting density.

CONCLUSIONS

1. The application of flat covers with perforated polyethylene film and non- woven polypropylene agrotextile provided significantly higher early and marketable yield of kohlrabi in comparison to the non-covered control.

2. The planting of seedlings at a higher density resulted in a significant increase of early and marketable yield as well as a decrease of mean weight of kohlrabi tubers.

3. The application of flat covers resulted in less dry matter. reducing and total sugars, but had little effect on the level of vitamin C in edible parts of kohlrabi.

4. The stems of kohlrabi grown at the spacing of 20x15 cm contained more nitrates, vitamin C as well as total and reducing sugars in comparison to those grown at 25 x 20 cm.

REFERENCES

ADAMCZEWSKA-SOWIŃSKA K. 1996. *Badania nad opracowaniem technologii produkcji pora na zbiór wczesny.* Zesz. Nauk. AR Wrocław, Rol., 68: 11-26.

BIELKA R. 1968. *Feldgemüsebau*. VEB Deutscher Landwirtschaftverlag. Berlin.

BIESIADA A.. KOŁOTA E. 2007. *Evaluation of some kohlrabi (Brassica oleracea var. gongylodes L.) cultivars for early cropping.* In: *Spontaneous and induced variation for the genetic improvement of horticultural crops*. P. NOWACZYK (ed.) Univ. Press Univ. of Technology and Life Sciences in Bydgoszcz, 39-44 pp.

CAPECKA E., SIWEK P., LIBIK A. 2000. *Wpływ osłon do przykrycia płaskiego na zawartość wybranych składników organicznych w zgrubieniach rzodkwi japońskiej.* Ann. UMCS Sect. EEE, 8: 103-109.

DOBROMILSKA R. 2003. *Wpływ metody uprawy i rozstawy na plonowanie fenkułu uprawianego w szklarni nieogrzewanej*. Zesz. Nauk. AR Wrocław, 515 : 103-109.

FELCZYŃSKI K.1995. *Wpływ osłaniania włókniną na plonowanie kapusty pekińskiej w uprawie wiosennej*. Mat. Konf. Nauka Praktyce Ogrodniczej, AR Lublin, ss. 625-628.

KUNACHOWICZ H. NADOLNA J., IWANOW K., PRZYGODA B. 1997. *Wartość odżywcza wybranych produktów spożywczych i typowych potraw*. PZWL, Warszawa.

NURZYŃSKA-WIERDAK R. 2005. *Plon i skład chemiczny liści kalarepy w zależności od odmiany i rodzaju nawożenia azotowego*. Zesz. Nauk. AR Wrocław, 515: 379-385.

PN-90/A-75101/03 *Oznaczenie zawartości suchej masy.*

PN-90/A-75101/07 *Oznaczenie zawartości cukrów*.

PN-90/A-75101/11 *Oznaczenie zawartości witaminy C.*

PN-92/A-75112 *Oznaczenie zawartości azotanów*.

REKOWSKA E., ORŁOWSKI M., SŁODKOWSKI P., DOBROMILSKA R. 1995. *Wpływ stosowanych osłon oraz metod produkcji rozsady na wielkość i jakość plonu brokuła włoskiego*. Ogóln. Konf. Nauk. pt. Nowe technologie a jakość plonu warzyw. Wrocław, SS. 79-82.

RUMPEL J.. GRUDZIEŃ K. 1993. *Wpływ osłon z włókniny polipropylenowej na plonowanie wczesnego kalafiora i kapusty.* Ogóln. Symp. pt. „Nowe rośliny i technologie w ogrodnictwie", Poznań, ss. 56-58.

RUMPEL J., GRUDZIEŃ K. 1996. *Możliwość polowej uprawy melona w Polsce*. Ogóln. Symp. pt. „Nowe rośliny i technologie w ogrodnictwie", Poznań, 24-29.

SIWEK P., LIBIK A. 2005. *Wpły osłon z folii i włókniny w uprawie selera naciowego na wielkość i jakość plonu.* Zesz. Nauk. AR Wrocław, 515: 483-490.

USDA *National Nutrient Database for Standard Reference*. Release 19. 2006. http:// www.nal.usda.gov/fnic/foodcomp

VANPARYS L. 1999. *Cultivar choice for supply to the vegetable processing industry*. Provincial Onderzoeks-en Voorlichtingscentrum voor Land en Tuinbouw. Beitem-Roeselare, 410: 1-4.

VANPARYS L. 2000. *Cultivar choice of kohlrabi for marketing for fresh market*. Mededeling-Provinciaal Onderzoek-en Voorlichtingscentrum voor Land-en Tuinbow. Beitem-Roeselare, 415: 1-4.