THE EFFECT OF NON-WOVEN FLEECE ON THE YIELD AND PRODUCTION CHARACTERISTICS OF VEGETABLES

Margit Olle*, Ingrid Bender

Jogeva Plant Breeding Institute, J. Aamisepa 1 Jõgeva alevik 48309 Estonia
margit.olle@jpbi.ee

ABSTRACT. *The aim of present investigation was to give an overview about the effect of non-woven fleece on the yield and production characteristics of vegetables. Non-woven fleece increased early yield, total yield, germination, development and growth speed, plant height, number and area of leaves of plants and protects against low temperature and frost. Use of non-woven fleece reduced insect pests damage, and protection quality regarding to lower content of pigments, vitamin C, dry matter and sugar.*

Keywords: *vegetables, non-woven fleece, yield, quality, production characteristics.*

Introduction

Non-woven fleece is used to modify a plants natural environment in order to optimize plants growth. It is also used to protect plants from insects, cold and wind. Protecting from frost is important to extend the growing season of a crop. By using non-woven fleece as plant cover generally results in early crop production, which gives higher crop prices at local markets.

Non-woven fleece is generally used to enclose one or more rows of plants in order to enhance crop growth and production by increasing both air and soil temperatures and reducing wind damage.

A medium weight non-woven fleece will give from 2 to 6 degrees of frost protection and has about 70 to 85 percent light transmission. The heavier materials offer up to 8 degrees of frost protection, but they inhibit daylight transmission down to as much as 50%.

The lighter non-woven fleece is so light that it can 'float' right on top of most seedlings. As the plants grow, they push the row cover fabric up. Medium and heavier grades need to be supported on wire hoops to form a low tunnel in which plants thrive.

Non-woven fleece is known under several other names: Agribon cover of polypropylene, agrotextile, agryl cover, Agryl cover sheet, floating row cover, Grow-Web fleece, non-woven fabrics, non-woven fabrics row cover, non-woven polypropylene, non-woven polypropylene agrotextile, polypropylene, polypropylene cover, polypropylene film, polypropylene fleece, polypropylene needled cloth, polypropylene non-woven fabric Agryl P-17, polypropylene sheeting cover, row cover, spunbonded polypropylene, spunweb covering. Covers are sold under several trade names, including Agribon, Agronet, Harvest Guard and Agryl, Reemay, Spunweb, Typar, all available in a variety of widths and lengths.

Several investigations have been carried out to assess the effect of non-woven fleece on the yield of vegetables. Few investigations are carried out considering the effect of non-woven fleece on the production characteristics of plants. The aim of present investigation was to give an overview about the effect of non-woven fleece on the yield and production characteristics of vegetables.

Growth of vegetables

Row covers promoted earlier growth of lettuce (Rekika *et al*., 2009). Covering the squash crop with polypropylene cover improved vegetative growth (Lopez, 1998). Covering carrots with non-woven polypropylene enhanced growth (Grudzien, 1994). Lettuce plants covered with Agryl cover sheet grew faster than uncovered plants (Anonym, 2006). Hamamoto (1996) showed that spinach plants covered with spunbonded polypropylene grew more rapidly than non-covered ones. Covering cabbages with non-woven fabrics row cover increased the daytime temperature by about 3^0C in comparison to cabbages grown without covers, which promoted plant growth (Morishita, Azuma, 1990). **Conclusions:** Vegetables covered with non-woven fleece grew faster than uncovered plants.

Development of vegetables

Floating row covers can be used to stimulate germination of radish (Rekika *et al*., 2008 a). Covering cucumber plants with non-woven polypropylene reduced the period from seeds sowing to seedlings emergence in a coal year (Rumpel, 1994). The floating row cover decreased emergence time of carrots plants by 0.5 day compared to control plants (Rekika *et al*., 2008b). Leaves of spinach plants covered with spunbonded polypropylene appeared and extended more rapidly than non-covered ones (Hamamoto, 1996). Cerne (1994) reported that covering cucumbers with agrotextiles increased the vegetative development rate. Reghin *et al.* (2002a) found that non-woven polypropylene promoted faster chinese cabbage plant development. Row covers promoted earlier maturity of lettuce (Rekika *et al.*, 2009). Broccoli heads grown under polypropylene non-woven fabric Agryl P-17 were 3–4 days earlier ready to harvest in comparison with the control plants (Kunicki *et al*., 1996). **Conclusions:** Vegetables covered with non-woven fleece germinate faster and reach earlier maturity than plants in control. The development rate of vegetables is increased when plants are grown under non-woven fleece.

Yield of vegetables

Head weights of lettuce were heavier, when plants were grown under polypropylene cover than in control (Rekika *et al*., 2009). Head weights of lettuce under agrotextile low tunnels were higher than those from the control plots (Jenni *et al*., 2003). Anonym (2006) harvested lettuce 10 to 14 days earlier under Agryl cover sheet as compared with uncovered plants. Moreover, Agryl cover sheet increased the total yield, number of exportable lettuce and increased the head quality compared with lettuce grown in open field. White polypropylene row cover produced positive results in yield and early harvest of lettuce (Reghin *et al*., 2002 b). Rekowska and Skupien (2007) reported that covering with non-woven polypropylene was found to increase the yield of spring garlic in comparison to open field cultivation. The highest yield was obtained, when dill plants were grown under polypropylene film (Slodkowski *et al*., 1999). Broccoli heads grown under polypropylene non-woven fabric Agryl P-17 were significantly heavier than those from control plants (Kunicki *et al.*, 1996). Chinese cabbage heads grown under non-woven fleece were heavier than those from control plants (Moreno *et al*., 2001a; Moreno *et al*., 2001b). Fresh weight of chinese cabbage was greater under non-woven fleece polypropylene cover compared to control (Pulgar *et al*., 2001). Hernandez *et al.* (2004) found that under polypropylene sheeting cover the yield of chinese cabbage increased compared to control plants. Under non-woven polypropylene grown chinese cabbage plants had higher fresh weight compared to control plants (Reghin *et al.*, 2002a). Polypropylene cover increased early yield and total yield of sweet pepper (Ibarra-Imenez, Rosa-Ibarra, 2004). The use of polypropylene cover significantly increased sweet pepper yield compared to plants in control (Gajc-Wolska, Skapski, 2002). The same results by sweet pepper were found by Rumpel, Grudzien (1990). Lopez (1998) concluded that covering the squash crop with polypropylene cover increased fruit yield. Yield of carrots increased under polypropylene cover compared to uncovered plants (Anyszka *et al*., 1996). In contrast Peacock (1991) findings demonstrate that covering the crop with polypropylene cover did not significantly increase carrot yield. Furthermore Grudzien (1994) concluded that covering with non-woven polypropylene brought about twice as high early yield of carrots as compared that of the uncovered control. The floating row cover increased fresh weight of carrot leaves and roots during early development compared to control plants (Rekika *et al*., 2008b). Covering cucumbers with agrotextiles increased the early yield and total yield compared to plants in the open field (Cerne, 1994). Covering cucumber plants with non-woven polypropylene increased the early yield, whereas total marketable yield increased only in the less favourable years (Rumpel, 1994). Higher early yield and total yield of cucumber were recorded in treatments, where plants were covered with Agribon cover of polypropylene compared to plants in control (Ibarra-Jimenez *et al*., 2004). Covering plants with a spunbonded non-woven polypropylene fabric increased beet root biomass compared to uncovered plants (Gimenez *et al*., 2002). Biesiada (2008) demonstrated that the application of flat covers as non-woven polypropylene agrotextile provided significantly higher early and marketable yield of kohlrabi in comparison to the non-covered control. By using polypropylene row cover marketable yield of tomatoes on open land could be significantly higher than in control (Žnidarcic *et al*., 2003). The early yield of tomatoes was significantly increased by the use of spunbonded polypropylene cover compared to control (plants grown on open field) (Reiners, Nitzsche, 1993). Covering by polypropylene non-woven fabric increased the yields of beetroot, carrot, radish and spinach (Sodkowski, Rekowska, 2004a). The yield of vegetables grown under polypropylene non-woven fabric cover was significantly higher in comparison to the control (non-covered) (Sodkowski, Rekowska, 2004b). **Conclusions:** Early and total yields are higher when plants are grown under non-woven fleece compared to non-covered plants.

Vegetables characteristics

Row covers promoted the greater leaf area of broccoli (Kunicki *et al*., 1996). The use of polypropylene cover significantly increased sweet pepper plant height compared to plants in control (Gajc-Wolska, Skapski, 2002). Covering cucumbers with agrotextiles increased the length of vines and number of leaves per plant (Cerne, 1994). Salas *et al.* (2008) found that lettuce plants cultivated under agrotextile were superior with regard to the number of leaves per plant and height aboveground parts. Under non-woven polypropylene grown chinese cabbage plants had higher plant height and diameter (Reghin *et al*., 2002a). Leaf colour of winter spinach in control was superior to those under spunbonded polypropylene cover (Murakami *et al*., 2001). **Conclusions:** Vegetables grown under non-woven fleece had greater leaf area, increased number of leaves and increased plant height compared with non-covered plants.

Chemical composition of vegetables

Covering with non-woven polypropylene was found to decrease the amount of dry matter and vitamin C in spring garlic in comparison to open field cultivation (control) (Rekowska, Skupien, 2007). Polypropylene fleece favoured an increase in the levels of NO_3^- in chinese cabbage (Moreno *et al*., 2002). Moreno *et al.* (2001b) demonstrated that chinese cabbage heads grown under polypropylene contained lowest amount of chlorophyll a, chlorophyll b and carotene than those from control plants. They also found that at the same time the content of heavy metals as Pb and Cd was higher in plants grown under polypropylene compared to plants in control. Chinese cabbage heads grown under non-woven polypropylene contained higher amounts of lysine, methionine, serine and threonine than in control (Moreno *et al.*, 2005). The concentrations of soluble sugars and pigments of chinese cabbage shoots were lower under non-woven fleece polypropylene cover compared to control (Pulgar *et al.* 2001). Reghin *et al.* (2002a) found that under non-woven polypropylene was higher dry matter content in chinese cabbage plants. Polypropylene cover reduced the chlorophyll content in cauliflower (Anyszka, Dobrzanski, 2004). The content of chlorophyll in the cauliflower leaves was lower under polypropylene cover grown plants than in control plants (Anyszka, Dobranski, 2003). Covering the squash crop with polypropylene cover reduced leaf N, P, and K concentrations (Lopez, 1998). The application of flat covers as non-woven polypropylene agrotextile resulted in less dry matter and total sugars, but had little effect on the level of vitamin C in edible parts of kohlrabi in comparison to the non-covered control (Biesiada, 2008). Wierzbicka *et al.* (2007) found that the concentrations of N, Ca and Fe increased significantly in cucumber plants grown under polypropylene needled cloth. Under polypropylene sheeting cover the foliar Ca content in outer leaves of chinese cabbage was lower than in control plants, whereas reverse was true in the inner leaves (Hernandez *et al.*, 2004). Content of ascorbic acid and total sugar of winter spinach in control was superior to those under spunbonded polypropylene cover (Murakami *et al.*, 2001). **Conclusions:** Quality of plants, regarding to chemical composition, is lower, because the content of pigments, vitamin C, dry matter and sugar in vegetables is lower than in non-covered plants.

Pest control

Different trials have been carried out to discover the effect of non-woven fleece on the number of vegetables damaging insects. Floating row covers could be used to reduce insect pests like cabbage maggots (*Delia radicum* L.) and beetle (*Phyllotreta* ssp.) in radish (Rekika *et al.*, 2008a). Aphids and tarnished plant bug damage on crisphead lettuce were almost completely excluded by covers (Rekika *et al.*, 2009). The agrotextile was effective as a physical barrier against insect pests in lettuce, reducing infestation (Salas *et al.*, 2008). Broccoli plants grown under polypropylene non-woven fabric Agryl P-17 showed a good control of the cabbage fly (*Delia brassicae*), which destroyed a large number of plants in the control plots (Kunicki *et al.*, 1996). Cebenko (1997) showed that row covers are especially useful against very mobile pests like cabbage moth and most aphids. Non-woven fabrics row cover protected cabbage from insect pests such as aphids and lepidopterous larvae (Morishita, Azuma, 1990). The non-woven fleece gave a good control on both cabbage and carrot plots by reducing damage by the cabbage root fly, and the carrot fly (Nawrocka, 1996). Polypropylene film covers applied to carrots to exclude adult flies reduced carrot fly damage compared to plants in control (Davies and Collier, 2000). The floating row cover reduced carrot weevil damage compared to control plants (Rekika *et al.,* 2008 b). Jeraša *et al.* (2003) reported that lesser extent of damage caused by feeding of onion thrips on leek was found in plots with polypropylene cover compared to plants in control. Covering turnips with non-woven fleece excluded both Myzus persicae and Bemisia tabaci injury on plants compared to control plants (Bedford *et al.*, 1994). **Conclusions:** Non-woven fleece can be used to reduce insect pests damage on vegetables.

Frost protection

Floating row covers can be used to protect radish crops from low temperature (Rekika *et al.*, 2008 a). White polypropylene row cover protected lettuce plants against the frost (Reghin *et al.*, 2002 b). Covering cucumber plants with non-woven polypropylene prevented cucumber seedlings from frost damage at late spring frost of −3.2°C (Rumpel, 1994). Reghin *et al.* (2002a) found that non-woven polypropylene protected the chinese cabbage plants against frost. **Conclusions:** Non-woven fleece protects vegetables against low temperature and frost.

Discussion

Early yield of vegetables is higher when plants are grown under non-woven fleece compared to non-covered plants. Non-woven fleece is important tool to use gathering vegetables yield earliness. The mechanism is simple: in the spring time, when vegetables are sown or planted the temperature is not reached the optimum of each plant type, therefore covering plants with non-woven fleece helps to increase the air and soil temperature (Cerne, 1994). If temperature increases and it will be more near optimum the development of vegetables fastens.

The total yield of vegetables is higher when plants are grown under non-woven fleece compared to non-covered plants. The total yield of vegetables is influenced by higher temperature under the non-woven fleece, but it is influenced by the factor that temperature under the fleece is more even regarding the lower temperature during the nights and higher temperature during the days. Low temperatures can result in poor growth. Photosynthesis is slowed down at low temperatures. Since photosynthesis is slowed, growth is slowed, and this results in lower yields. Plants grown at low temperatures have a lower capacity for water and solute uptake than those grown under non-woven fleece, where the temperature is higher. In May and June, when temperatures are not reached optimum for each crop, under non-woven polypropylene cover the temperature was higher and the yield of sweet pepper was also higher (Gajc-Wolska, Skapski, 2002). Therefore the greatest advantage of non-woven fleece gained from soil warming occurred early in the growing season, but the advantages decreased as the season progressed (Gimenez *et al.*, 2002). High temperatures it means temperature over the optimum (normally over 30°C) decreases the yield of several agronomical crops (McKeown *et al*., 2006).

Vegetables covered with non-woven fleece grew faster than uncovered plants. Under the fleece the microclimate is favoured, temperature is higher and it is more even and therefore the plants grow faster (Hamamoto, 1996). Some authors (Hamouz *et al*., 2006a); (Hamouz *et al*., 2006b); (Morishita, Azuma, 1990) have recorded that the temperature under the non-woven fleece can be 2−3°C higher than plants grown without covers. In general, growth is promoted when temperature rises and inhibited if the temperature falls. Each species has a minimum temperature, below which it fails to grow; an optimum at which the growth rate is highest; and a maximum, above which, growth comes to an end. The optimum temperature may vary with each stage of development and with the length of time the temperature prevails.

Vegetables covered with non-woven fleece germinate faster and reach earlier maturity than plants in control. Seeds from different species and even seeds from the same plant germinate over a wide range of temperatures. Often seeds have a set of temperature ranges where they will germinate and will not do so above or below this range, many vegetables seeds germinate at temperatures slightly higher than room-temperature (16–24°C), while others germinate just above freezing and others germinate only in response to alternation in temperature between warm and cool. Those main part of seeds, which germinate at temperatures slightly higher than room-temperature (16–24°C), are responding very quickly to the changes of temperature, and if the temperature is already 3 degrees higher (normally in the spring time the temperature is not too high in Northern countries) then it fastens up germination process. Germination is mostly influenced by the soil temperature. Covering plants with non-woven fleece of course increases the soil temperature, which results in quicker germination process.

The vegetative development of vegetables is increased when plants are grown under non-woven fleece. Under non-woven fleece plants are grown in higher temperature conditions. All stages of development are sensitive to temperature. It is the main factor controlling the rate of crop development. Development generally accelerates as temperature increases, a phenomenon that is often described as a linear function of daily average temperature. The growing degree day concept is a common example of a linear model of developmental response to temperature.

Vegetables grown under non-woven fleece had greater leaf area, increased number of leaves and increased plant height compared with non-covered plants. Soil temperature is increased under non-woven fleece. Early-season soil temperature affects leaf appearance and expansion rates. Under higher temperature in the beginning of growing season the leaf area development encahnces (Gimenez, 2002). The shoot length is shorter at lower temperatures, because plants grown at low temperatures have a lower capacity for water and solute uptake than those grown under non-woven fleece, where the temperature is higher.

Quality of plants, regarding to chemical composition, is lower, because the content of pigments, vitamin C, dry matter and sugar in vegetables is lower than in non-covered plants. Plant quality may be evaluated by the combination of any number of plant characteristics, like pigments, vitamin C and sugar content. Covered plants received higher air and root temperatures and showed the lowest chlorophyll a, chlorophyll b and carotene contents (Moreno *et al.*, 2001b). A temperature higher than optimum during the growing season for each crop decreases the content of carotene (Ibrahim *et al*., 2006). Carotene content may be reduced by high temperatures prevailing in the hot summer period. High temperatures decreased the content of chlorophyll (Ibrahim *et al*., 2006). Highest content of total ascorbic acid can be found at lower temperatures than optimum for each crop (Proietti *et al*., 2009). A temperature higher than optimum for each crop increases respiration rates, reducing sugar content of produce (Pulgar *et a*l., 2001). Vegetables grown in heat will be less sweet. The general conclusion drawn from the reports of several other investigators is that too high temperatures decelerate and under certain conditions inhibit photosynthesis.

Non-woven fleece can be used to reduce insect pests and birds damage on vegetables, because it protects vegetables and therefore pests and birds can not damage plants. Non-woven fleece protects vegetables against low temperature, wind and frost.

Non-woven fleece have many positive effects on the growth of vegetables, but still it has also negative effects like the contents of important vitamins and sugars are lower.

Conclusions

Non-woven fleece increased early yield, total yield, germination, development and growth speed, plant height, number and area of leaves of plants and protects against low temperature and frost. Use of non-woven fleece reduced insect pests damage, and protection quality regarding to lower content of pigments, vitamin C, dry matter and sugar.

References

Anonym. 2006. Effects of Agril (Polypropylene) Cover Film on the Microclimate, Yield and Quality of Lettuce. − Egyptian Journal of Applied Sciences, 21(5), p. 279−295.

Anyszka, Z., Dobranski, A. 2003. Weed infestation and herbicides performance in early cauliflower grown under non-woven polypropylene cover. − Sodininkyste ir Darzininkyste, 22(3), p. 488−496.

Anyszka, Z., Dobranski, A. 2004. Influence of herbicides on some ecophysiological factors on the growth and chlorophyll content in leaves of vegetables. – Progress in Plant Protection, 44(2), p. 580−583.

Anyszka, Z., Dobranski, A., Paczynski, J. 1996. Weed control in carrots under covers of non-woven polypropylene. − *Proceedings of the second international weed control congress, Copenhagen, Denmark, 25−28 June 1996*, Volumes 1−4, p. 1049−1052.

Bedford, I. D., Markham, P. G., Strauss, P. A. 1994. Astudy of the effectiveness of crop covering with IPM, using an Amoco non-woven fleece as a barrier to aphids, whiteflies and their associated plant viruses. − *Proceedings – Brighton Crop Protection Conference, Pests and Diseases, 1994, vol. 3*, p. 1163−1168.

Biesiada, A. 2008. Effect of flat covers and plant density on yielding and quality of kohlrabi. − J. Elementol., 13(2), p. 167−173.

Cebenko, J. J. 1997. Organic pest controls. − Organic gardening, 44(5), p 45–48, 50.

Cerne, M. 1994. Different agrotextiles for direct covering of pickling cucumbers. − Acta Horticulturae, 371, p. 247−252.

Davies, J., Collier, R. 2000. Strategies for controlling carrot fly while minimizing pesticide inputs. − Acta Horticulturae, 533, p. 575−582.

Gajc-Wolska, J., Skapski, H. 2002. Yield of field grown sweet pepper depending on cultivars and growing conditions. − Folia Horticulturae, 14(1), p. 95−103.

Gimenez, C., Otto, R. F., Castilla, N. 2002. Productivity of leaf and root vegetable crops under direct cover. − Scientia Horticulturae, 94(1−2), p. 1−11.

Grudzien, K. 1994. Timing of early carrots by means of direct covers. − Acta Horticulturae, 371, p. 323−326.

Hamamoto, H. 1996. Effect of non-woven rowcover on plant environment and growth. − Japan Agricultural Research Quarterly, 30(1), p. 49−53.

Hamouz, K., Lachman, J., Dvorak, P., Trnkova, E. 2006a. Influence of non-woven fleece on the yield formation of early potatoes. − Plant, Soil and Environment, 52(7), p. 289−294.

Hamouz, K., Dvorak, P., Pazdera, J. 2006b. Influence of non-woven fleece on the yield of early irrigated potatoes. − Collection of Scientific papers, Faculty of Agriculture in Ceske Budejovice, Series of Crop Sciences, 23(2), p. 69−74.

Hernandez, J., Soriano, T., Morales, M. I., Castilla, N. 2004. Row covers for quality improvement of Chinese cabbage (Brassica rapa subsp. Pekinensis). − New Zealand Journal Crop and Horticultural Science, 32(4), p. 379−388.

Ibarra-Jimenez, L., Rosa-Ibarra, M. 2004. Comparison between microtunnels with polyethylene and polypropylene in cucumber and sweet pepper with plastic mulching. − Revista Chapingo, Serie Horticultura, 10(2), p. 133−139.

Ibarra-Jimenez, L., Quezada-Martin, M. R., Rosa-Ibarra, M. 2004. The effect of plastic mulch and row covers on the growth and physiology of cucumber. − Australian Journal of Experimental Agriculture, 44, p. 91−94.

Ibrahim, M. A., Nissinen, A., Prozherina, N., Oksanen, E. J., Holopainen, K. 2006. The influence of exogeneous monoterpene treatment and elevated temperature on growth, physiology, chemical content and headspace volatiles of two carrot cultivars (*Daucus carota* L.). − Environmental and experimental Botany, 56(1), p. 95−107.

Jenni, S., Dubuc, J. F., Stewart, K. A. 2003. Plastic mulches and row covers for early and midseason crisphead lettuce produced on organic soils. − Canadian Journal of Plant Science, 83(4), p. 921−929.

Jeraša, M., Milevoj L., Osvald, J., Trdan, S. 2003. Control of pests and diseases of leek (Allium porrum L.). - *Lectures and papers presented at the 6th Slovenian Conference on Plant Protection, Zrece, 4–6 March 2003*, p. 537−541.

Kunicki, E. Cebula, S., Libik, A., Siwek, P. 1996. The influence of row cover on the development and yield of broccoli in spring production. − Acta Horticulturae, 407, p. 377−384.

Lopez, M. V. 1998. Growth, yield and leaf NPK concentrations in crop-covered squash. − Journal of Sustainable Agriculture, 12(4), p. 25−38.

McKeown, A. W., Warland, J., McDonald, M. R. 2006. Long-term climate and weather patterns in relation to crop yield: a minireview. − Canadian Journal of Botany, 84(7), p. 1031−1036.

Moreno, D. A., Villora, G., Hernandez, J., Castilla, N., Romero, L. 2001a. The response of shoot accumulation of trace elements in Chinese cabbage to microclimate modification. − Journal of Environmental Science and Health, A36(9), p. 1611−1620.

Moreno, D. A., Lopez-Lefebre, L. R., Villora, G., Ruiz, J. M., Romero, L. 2001b. Floating row covers affect Pb and Cd accumulation and antioxidant status in Chinese cabbage. − Scientia Horticulturae, 89(1), p. 85−92.

Moreno, D. A., Villora, G., Soriano, M. T., Castilla, N., Romero, L. 2002. Floating row covers affect the molybdenum and nitrogen status of Chinese cabbage grown under field conditions. − Functional Plant Biology, 29, p. 907−907.

Moreno, D. A., Villora, G., Soriano, M. T., Castilla, N., Romero, L. 2005. Sulfur, chromium, and selenium accumulated in Chinese cabbage under direct covers. − Journal of Environmental Management, 74(1), p. 89−96.

Morishita, M., Azuma, K. 1990. Use of row cover to protect cabbage from diamondback moth, Plutella xylostella L. − Proceedings of the Kansai Plant Protection Society, 32, p. 29−34.

Murakami, K., Inoue, S., Kumakura, H., Iwamami, H., Araki, Y. 2001. Effect of plastic films and row covers on growth and quality of winter spinach. − Acta Horticulturae, 559, p. 103−105.

Nawrocka, B. 1996. The use of non-woven polypropylene fleece and polythene nets for protecting cabbage and carrot crop from attacks by pest Diptera. − Bulletin OILB/SROP 19(11), p. 195−199.

Peakock, L. 1991. Effect of weed growth of short term cover over organically grown carrots. − Biological Agriculture & Horticulture, 7(3), p. 271−279.

Proietti, S., Moscatello, S., Famiani, F., Battistelli, A. 2009. Increase of ascorbic acid content and nutritional quality in spinach leaves during physiological acclimation to low temperature. – Plant Physiology & Biochemistry, 47(8), 717–723.

Pulgar, G., Moreno, D. A., Villora, G., Hernandez, J., Castilla, N., Romero, L. 2001. Production and composition of Chinese cabbage under plastic rowcovers in southern Spain. − Journal of Horticultural Science and Biotechnology 76(5), p. 608−611.

Reghin, M. Y., Otto, R. F., Vinne, J. van der, Feltrin, A. L. 2002a. Yield of pack choi crop under non woven polypropylene. − Horticultura Brasilera, 20(2), p. 233−236.

Reghin, M. Y., Purissimo, C., Feltrim, A. L. Foltran, M. A. 2002b. Mulching and row cover in lettuce crop. − Scientia Agraria, 3(1/2), p. 69−77.

Reiners, S., Nitzsche, P. J. 1993. Rowcovers improve early season tomato production. − HortTechnology, 3(2), p. 197−199.

Rekika, D., Stewart, K. A., Boivin, G., Jenni, S. 2008a. Reduction of Insect Damage in Radish with Floating Row Covers. − International Journal of Vegetable Science, 14(2), p. 177−193.

Rekika, D., Stewart, K. A., Boivin, G., Jenni, S. 2008b. Floating Rowcovers Improve germination and Reduce carrot Weevil Infestations in Carrot. − HortScience, 43(5), p. 1619−1622.

Rekika, D., Stewart, K. A., Boivin, G., Jenni, S. 2009. Row Covers Reduce Insect Populations and Damage and Improve Early Season Crisphead Lettuce Production. − International Journal of Vegetable Science, 15(1), p. 71−82.

Rekowska, E., Skupien, K. 2007. Influence of flat covers and sowing density on yield and chemical composition of garlic cultivated for bundle-harvest. − Vegetable crops research bulletin, 66, p. 17−24.

Rumpel, J. 1994. Plastic and agrotextile covers in pickling cucumber production. − Acta Horticulturae, 371, p. 253−260.

Rumpel, J., Grudzien, K. 1990. Suitability of nonwoven polypropylene for a flat covering in sweet pepper cultivation. − Acta Horticulturae, 267, p. 53−58.

Salas, F. J., Moraes, C. A. P., Garcia, S., Sabundjian, T. T. 2008. Evaluation of lettuce crop protected with floating row cover and its performance in different types of applications. − Arquivos do Instituto Biologico, 75(4), p. 437−442.

Slodkowski, P., Orlowski, M., Rekowska, E. 1999. Effect of using covers at dill cultivation on the quality and quantity of its yield. − Zeszyty Problemowe Postepow Nauk Rolniczych, 466, p. 165−171.

Sodkowski, P., Rekowska, E. 2004a. Effeciency of flat covers of some vegetable species grown for bunch harvest. − Agricultura, 93, p. 361−365.

Sodkowski, P., Rekowska, E. 2004b. The influence of flat covers on yielding of some vegetable species grown for early harvest. − Agricultura, 93, p. 355−359.

Žnidarcic, D., Trdan, S., Zlatic, E. 2003. Impact of various growing methods on tomato (*Lycopersicon esculentum* Mill.) yield and sensory quality. - Zb. Biotech. Fak. Univ. Ljubl. Kmet. 18–2, p. 341−348.

Wierzbicka, B., Majkowska-Gadomska, J., Nowak, M. 2007. Concentrations of some bionutrients in partenocharpic cucumber fruits in forced cultivation. − Acta Scientiarum Polonorum, Hortorum Cultus 6(1), p. 3−8.

Katteloori mõju köögiviljade saagile ja selle kvaliteedile

M. Olle, I. Bender

Käesoleva uurimistöö eesmärgiks oli anda ülevaade katteloori mõjust köögiviljade saagile ja selle kvaliteedile. Võrreldes avamaal kasvanud köögiviljadega oli kateloori all kasvanud köögiviljade varane saak suurem, kogusaak suurem, idanesid kiiremini, arenesid kiiremini, kasvukiirus suurem, taime kõrgus suurem, taime lehtede arv oli suurem. Katteloor kaitses madalate temperatuuride ja öökülmade vastu. Katteloori kasutamine vähendas kahjurite kahjustusi. Katteloori all kasvanud köögiviljad sisaldasid vähem pigmente, C vitamiini, kuivainet ja suhkrut.