UDK 634.711.044

DOES APPLICATION OF RAIN SHELTERS INFLUENCE PRODUCTION TRAITS IN RASPBERRY CV. 'MEEKER'?

[1]*D. Stojanov, J. Milivojević*, M. Ivanović, D. Radivojević*

Abstract

Raspberry production systems differ with modifacations in some regions depending on environment, cultivar, and harvest method. As demand for raspberries continues to increase, specialized production systems are being developed including application of rain shelters that can be used with existing trellis systems and provide row coverage. In this way, plants are being protected from intensive rainfall which can promote the development of fungal diseases (such as grey mold) and cause yield losses. Therefore, the objective of this study was to evaluate the use of polytunnel rain shelters and to determine whether such a system can benefit commercial production of raspberry cultivar 'Meeker'. The obtained results showed that the beginning of ripenning season was at the same time both under rain shelters and outside (2nd July, 2011). Number of fruiting laterals ranged from 19.4 (under rain shelters) to 20.7 (open field), whereas fruit yield appeared to be higher under protected cultivation (1.04 kg per cane). Fruit weight was also higher under rain shelters with an average value of 4.06 g. A similar trend was observed with number of drupelets per fruit by achieving the highest value under rain shelters (123.0). Preliminary results indicate that this system may lead to increased marketable yield with lower incidence of *Botrytis cinerea* infection as an important cause of decay in raspberry fruit.

Key words: raspberry, Meeker, rain shelters, generative potential, fruit quality

Introduction

High demand for raspberry fruit has stimulated much interest among potential and established growers in terms of application of new production techniques. Raspberry plants are adaptable to a variety of production systems besides field production, including high tunnels and greenhouse production, allowing lower number of spraying applications and better crop quality (Bjugstad and Hermansen, 2009; Pitsioudis et al., 2009; Bushway et al., 2008). Although these protected systems offer potential increases in yield and fruit quality as compared to field production, they also require significantly more investment in technology and operating capital (Njavro and Duralija, 2009). Thus many growers who are targeting fresh market try to find a less expensive system to produce high-quality raspberry fruit. By applying polytunnel rain shelters, that can provide complete plant row coverage, it is possible to accelerate the flowering and ripening time and increase of marketable fruit yield. This production system is of particular value during periods of rainy, wet weather right before harvest because *Botrytis cinerea* Pers. as a pathogen that causes gray mold on raspberry may significantly increase yield losses in commercial fields (Tanović et al., 2009). Accordingly, the aim of this study was to examine the effect of the difference in production system (open field and rain shelters) on commercial production traits of raspberry cultivar 'Meeker'. This

[1] University of Belgrade, Faculty of Agriculture, Nemanjina 6, 11080 Belgrade, Serbia
* Corresponding author: jasminka@agrif.bg.ac.rs

information would be very useful especially where a premium market exists for high-quality fruit produced with little or no pesticide use.

Materials and methods

Studies were conducted at commercial orchard of raspberry cv. 'Meeker' located near Priboj in the South Western Serbia during 2011. The orchard was established in 2002. in the form of vertical trellis system with 2 m high columns and two lines of single wire to which canes are fastened by a plastic rope. The planting distance was 0.3 m in the row and 3 m between the rows. Installation of plastic film above the structure of rain shelter was carried out slightly before flowering time. Drip irrigation system (hose at 60 cm height) was applied both under rain shelters and outside. Investigation of generative characteristics (number of fruiting laterals, inflorescences and fruits per cane) was carried out on samples of 40 canes in four replications. Each replicate consisted of 10 canes selected for their uniformity. Number of fruiting laterals, inflorescences and fruits were determined by counting from each cane and afterwards the fruits were weighed to determine yield per cane. Fruit samples were collected in four replications at the commercial maturity stage to investigate physical fruit properties (fruit weight and number of drupelets per fruit). Fruit weight was measured by scale in g, whereas number of drupelets was determined by counting the drupelets from each fruit. Each sample consisted of 30 fruits pooled to obtain a composite sample and analysed for soluble solids content using a digital refractometer (Pocket PAL-1, Atago, Japan). Titratable acidity was measured by neutralization to pH 7.0 with 0.1 N NaOH and acidity expressed as percent of malic acid equivalent. Vitamin C was quantified using the reflectometer set of Merck Co (Merck RQflex) as described by Pantelidis et al. (2007). Results were expressed as mg ascorbic acid 100 g^{-1} fresh weight (FW).
Influence of rain shelter on gray mold incidence was studied in fruits grown under protection and in the open field. A total of 600 fruits in four replicates were collected from each environment, each replicate consisting of 150 fruits. Suspected raspberry fruits with symptoms of grey mould were incubated in moist conditions for three days at room temperature before identification. Afterwards, phenotypic observations were performed macroscopically, and *B. cinerea* isolates were identified by morphology of the colony and microscopic observations of conidiophores and conidia (Williamson et al., 2007).
A statistical analysis was performed using software Statistica 6.0 for Windows (StatSoft Inc., Tulsa, OK, USA). Data from a 1-year investigation was calculated by ANOVA. Significant differences among the means were determined by LSD test at a level of $P \leq 0.05$.

Results and disscusion

One of the most important features determining cultivar suitability for growing is its ripening season (Milivojević et al., 2011a). Data of harvest period of raspberry cultivar 'Meeker' affected by production system are presented in Table 1. The obtained results showed that the same beginning of ripenning season was observed both under rain shelters and outside (2nd July, 2011), whereas slightly longer harvest season was observed in the open field (25 days).
Yield is usually estimated from the relative values of several generative characteristics considered together. Results of generative characteristics of raspberry cv. 'Meeker' affected by two productions systems are presented in Table 2. Number of fruiting laterals per cane ranged from 19.4 (under rain shelters) to 20.7 (open field), whereas number of inflorescens and fruits per cane showed higher values by applying rain shelters (133.9 and 256.9, respectively). Furthermore cv. 'Meeker' yielded somewhat higher under protected cultivation

(1.04 kg per cane) compared to the open field (0.95 kg per cane). Clever (2002) did not find higher yields under a plastic shelter (cover during blossom and harvest time) in a long-term experiment. He explained this result with a lower yearly average temperature measured in 50 cm height, but a higher (plus 0.8°C) minimum temperature. A previous study (Baab, 2007) showed that the light reduction under plastic shelter making longer internodes and a loss of 30% of light transmission leads to a loss of productivity of apple trees. In our experiment, there were no negative influences found on yield or fruit quality. Obtained results of physical fruit properties (Table 3) indicate a positive influence of rain shelters on the fruit weight and number of drupelets per fruit (4.06 g and 123.0, respectively). Clever (2002) found a 10% higher fruit weight under the plastic cover which is in accordance with our presented results. As opposed to our results, Milivojević et al. (2010) found lower number of drupelets per fruit in raspberry cv. 'Meeker' grown in Western Serbia, that can be explained by environmental effect of different growing areas.

Besides environmental conditions, genetical characteristics of cultivar may also influence raspberry biochemical components (Milivojević et al. 2011b; Riaz and Bushway, 2007). A small decrease of soluble solids content in fruits harvested under rain shelters in comparison to those obtained in the open field can also be observed (Table 3) and explained by the influence of microclimatic conditions. No significant difference was found in titratable acidity values in raspberry cultivar 'Meeker' based on production systems applied. Vitamin is C known as dietary compound in raspberry fruit with antioxidant activity and is considered as protective micronutrients due to its intake relationships with protective effects against several degenerative diseases (Ancos et al., 1999). In the present study, significant difference was found in vitamin C content by achieving higher value in the fruits grown under rain shelter (50.4 mg 100 g^{-1}). This result is not in accordance with value reported by Nikolić et al. (2009) where cv. 'Meeker' grown in open field was expressed lower content of vitamin C.

All *B. cinerea* isolates obtained in this study derived from decaying raspberry fruits with characteristic symptoms of gray mould. After incubation large decayed lesions accompanied by abundant sporulation of the pathogen was recorded on some raspberry fruits. Thick velvety mycelium developed on raspberry fruits after 5-day incubation in moist chamber. Based on morphology of the colony and microscopic observations of conidiophores and conidia, the pathogen was identified as *Botrytis cinerea* Pers., the anamorph of *Botryotinia fuckeliana*. In our study rain shelter provided less favorable conditions for development of gray mould. *B. cinerea* was more frequently isolated from raspberry fruits grown in the open field than under rain shelter (Figure 1).

Conclusion

This study indicates that production of consistently high-quality raspberries must be combined with application of new production systems (such as rain shelters) which can also improve fruit yield and enable harvesting even when it is raining. This system holds great promise for the commercial raspberry production, particularly in regions with an over-abundance of rains during the growing season and/or a high risk of fungal diseases. Laboratory experiments in this study demonstrated that the incidence and severity of grey mould were reduced in cv. 'Meeker' grown under rain shelters when compared to the raspberry grown in the open field. Possible explanation for this appearance might be in specific, non-favorable conditions under the polytunnel rain shelters which supress the development of *B. cinerea*. This pathogen produces many spores which are easily blown or splashed onto healthy foliage. Rain shelter can provide a barrier around the rows disabling the pathogen to spread from one row to another.

In general, the obtained data are of high relevance for both raspberry producers as well as researchers striving to optimize the production technologies.

Acknowledgements

This study was supported by the Serbian Ministry of Education and Science, through the Project III46008.

Literature Cited

Ancos, B., Gonzalez, E., Cano, M.P. 1999. Differentiation of raspberry varieties according to anthocyanin composition. Y Lebensm Unters Forsch A 208: 33-38.

Baab, G., Blanke, M. 2007. Einfluss von Hagelnetzen auf Mikroklima, Wuchsverhalten, Ertrag und Qualität. Obstbau (4):186-192.

Bjugstad, N., Hermansen, P. 2009. Operator exposure when spraying in a strawberry and raspberry tunnel system. Agricultural Engineering International: the CIGR Ejournal, Vol. XI: 1049.

Bushway, L., Pritts, M., Handley, D. 2008. Raspberry and Blackberry Production Guide for the

Northeast, Midwest, and Eastern Canada. NRAES-35, Ithaca, NY.

Clever, M. 2002. Folienüberdachung bei Himbeeren und Johannisbeeren. Obstbau 7: 361-362.

Milivojević, J., Nikolić, M., Dragišić Maksimović, J., Radivojević, D. 2011a. Generative and fruit quality characteristics of primocane fruiting red raspberry cultivars. Turkish Journal of Agriculture and Forestry 35 (3): 289-296.

Milivojević, J., Maksimović, V., Nikolić, M., Bogdanović, J., Maletić, R., Milatović, D. 2011b. Chemical and antioxidant properties of cultivated and wild *Fragaria* and *Rubus* berries. Journal of Food Quality 34 (1): 1-9.

Milivojević, J., Nikolić, M., Bogdanović Pristov, J. 2010. Physical, chemical and antioxidant properties of cultivars and wild species of *Fragaria* and *Rubus* genera. Journal of Pomology 44 (169/170): 55-64.

Nikolić, M., Radović, A., Fotirić, M., Milivojević, J., Nikolić, D. 2009. Pomological properties of promising raspberry seedlings with yellow fruit. Genetika 41 (3): 255-262.

Njavro, M., Duralija, B. 2009. Economic impacts of climate variability in berry fruit – a decision analysis approach. Acta Horticulturae 838: 115-119.

Pantelidis, G.E., Vasilakakis, M., Manganaris, G.A., Diamantidis, G., 2007. Antioxidant capacity, phenol, anthocyanin and ascorbic acid contents in raspberries, blackberries, red currants, gooseberries and cornelian cherries. Food Chemistry 102: 777-783.

Pitsioudis, F., Odeurs, W., Meesters, P. 2009. Early and late production of raspberries, blackberries and red currants. Acta Horticulturae 838: 33-38.

Riaz, M.N., Bushway, A.A. 2007. Compositional analysis of four red raspberry cultivars grown in Maine. Journal of Food Quality 19 (6): 457-465.

Tanović, B., Delibašić, G., Milivojević, J., Nikolić, M. 2009. Characterization of *Botrytis cinerea* isolates from small fruits and grapevine in Serbia. Archives of Biological Sciences, Belgrade, 61 (3): 419-429.

Williamson, B., Tudzynski, B., Tudzynski, P., Van Kan, I. 2007. *Botrytis cinerea*: the cause of grey mould disease. Molecular Plant Pathology, 8: 561-580.

Table 1. Harvest period of raspberry cv. 'Meeker' affected by production system

Cultivation system	Harvest period		
	Beginning	End	Duration (days)
Under rain shelters	2nd July	24th July	23
Open field	2nd July	26th July	25

Table 2. Generative potential of raspberry cv. 'Meeker' affected by production system

Cultivation system	Number of fruiting laterals per cane	Number of inflorescens per cane	Number of fruits per cane	Yield per cane (kg)
Under rain shelters	19.4±1.24 a	133.9±6.87 a	256.9±13.0 a	1.04±0.07 a
Open field	20.7±0.50 a	125.0±5.82 a	246.3±8,64 a	0.95±0.03 a
ANOVA (F test)	0.91^{ns}	0.98^{ns}	0.46^{ns}	1.48^{ns}

* Data are the means of four replications ± standard error. Values within column followed by the same letter are not significantly different at $P \leq 0.05$ (LSD test). ns non significant; * significant at $P \leq 0.05$.

Table 3. Fruit quality attributes of raspberry cv. 'Meeker' affected by production system

Cultivation system	Physical fruit properties		Chemical fruit properties		
	Fruit weight (g)	Number of drupelets per fruit	Soluble solids content (%)	Titratable acidity (%)	Vitamin C (mg 100^{-1} g)
Under rain shelters	4.06±0.16 a	123.0±1.04 a	1.20±0.03 a	1.20±0.03 a	50.4±1.93a
Open field	3.79±0.14 a	110.7±3.94 b	1.30±0.04 a	1.30±0.04 a	44.2±1.86b
ANOVA (F test)	1.66^{ns}	9.03*	4.03^{ns}	4.03^{ns}	5.46*

- Data are the means of four replications ± standard error. Values within column followed by the same letter are not significantly different at $P \leq 0.05$ (LSD test). ns non significant; * significant at $P \leq 0.05$.

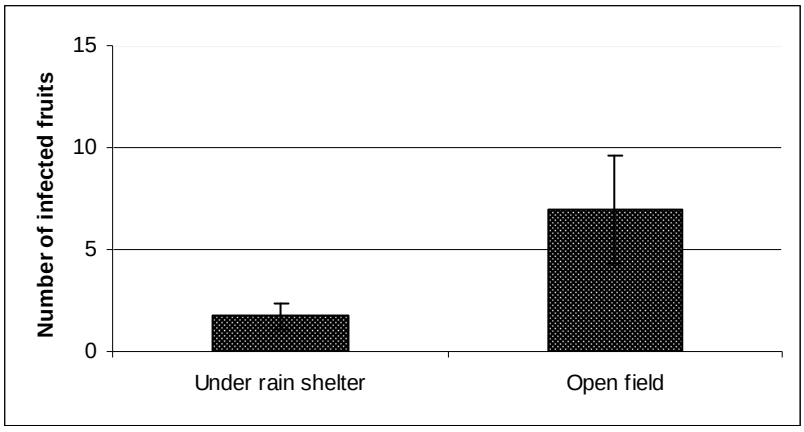

Fig. 1. Incidence of *B. cinerea* on the fruits of raspberry cv. 'Meeker' affected by production system. Data represent average values of four replications ± standard error.

ДА ЛИ ПРИМЕНА «ЗАШТИТНИХ КАПА» УТИЧЕ НА ПРОИЗВОДНЕ ОСОБИНЕ СОРТЕ МАЛИНЕ ‘МИКЕР’?

Д. Стојанов, Ј. Миливојевић, М. Ивановић, Д. Радивојевић

Резиме

Системи гајења малине се разликују у неким регионима са извесним модификацијама у зависности од спољашње средине, сорте и начина бербе. Пошто потребе за малинама континуирано расту, специјализовани производни системи се развијају укључујући примену „заштитних капа“, које могу бити коришћене у већ постојећим шпалирима малине као покривке изнад редова. На овај начин биљке се заштићују од интензивних падавина које могу подстаћи развој гљивичних болести (као нпр. сива трулеж плода) и изазвати губитке у приносу. Стога, циљ ових истраживања је био да се испита употреба политунелских „заштитних капа“ и одреди да ли такав систем гајења може користити комерцијалној производњи сорте малине Микер. Добијени резултати су показали да је сезоне зрења почела у исто време и под „заштитним капама“ и на отвореном пољу (2 Јул, 2011). Број родних гранчица по изданку се кретао од 19,4 (под „заштитним капама“) до 20,7 (отворено поље), док је принос био већи у заштићеним условима (1,04 кг/изданку). Маса плода је такође била већа испод „заштитних капа“ са просечном вредношћу од 4,06 г. Сличан тренд је био опажен и код броја коштуница у плоду достижући највишу вредност под „заштитним капама“ (123.0). Прелиминарни резултати указују да овај систем гајења може водити ка повећању тржишног приноса са нижим степеном инфекције патогеном *Botrytis cinerea* као важним проузроковачем пропадања плода малине.

Кључне речи: малина, Микер, заштитне капе, генеративни потенцијал, квалитет плода