ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume LXI 28 Number 1, 2013
http://dx.doi.org/10.11118/actaun201361010233

NEMATOCID EFFECTS OF WATERCRESS (*NASTURTIUM OFFICINALE* R. BR.)

Helena Zahradníková, Kristína Petříková

Received: December 3, 2012

Abstract

ZAHRADNÍKOVÁ HELENA, PETŘÍKOVÁ KRISTÍNA: *Nematocid effects of watercress (Nasturtium officinale R. Br.).* Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 2013, LXI, No. 1, pp. 233–236

The watercress *(Nasturtium officinale* R. Br.*)* is often grown as a forced leaf vegetable rich in vitamins and minerals. Its specific taste and curative effects result from the presence of mustard glycosides (glucosinolates) that may also show nematocidic effects. The aim of this study was to evaluate the effect of watercress eluate and juice on tomato plants inoculated with the northern root-knot nematode (NRKN) *Meloidogyne hapla*. It was found out that after the treatment of plants with solutions derived from watercress the yield of fruit was highly significantly increased. The highest yield increase (by 96 % to 165 %) was observed in the variant with the highest concentration of watercress extracts (macerate + 200 ml of juice). Although at lower concentrations of watercress solution the increase in yields was also reduced (by 57–118 %), the difference was still statistically highly significant. The effect of this treatment on the content of vitamin C was similar and the increase was also highly significant and ranged from 24 to 67 %. When evaluating the occurrence of nematodes on roots of tomato plants, the presence of pathogens was equal to zero percent in all treated variants. The treatment with this phyto-solution corroborated not only a nematocidic effect of watercress but also its positive influence on the yield and level of vitamin C in dependence on increasing concentrations of the effective agent. It can be therefore concluded that the watercress solution showed a promoting effect on tomato plants.

watercress, nematocidic effects, tomato, yield, vitamin C

The watercress *Nasturtium officinale* R. Br. is a member of Brassicaceae family and is cultivated as a perennial, nutritionally valuable and tasty forced vegetable that is popular in a number of countries. It is rich in chemoprotective substances. The watercress contains in 1 kg of fresh leaves 620 mg of vitamin C, 14.6 mg of vitamin E as well as members of B-group vitamins; of minerals, it contains 1,700 mg Ca, 520 mg P, 2,300 mg K, 22 mg Fe, 150 mg Mg, 7 mg Zn, traces of Se (KOPEC, 1998), and 30 mg of beta carotene (VOGEL, 1996). As all members of Brasicaceae family, it contains also glucosinolates (mustard oil glucosides), which show a specific composition typical for each individual plant species. The high number of glucosinolates is a consequence of chemical diversity of their side chain (R-group), which is derived from several amino acids. In plant tissues, glucosinolates are accompanied with the enzyme myrosinase, which catalyses their decomposition. Isothiocyanates and nitrils are the most frequent products of this decomposition and they considerably contribute to the typical burning taste of vegetables from the Brassicaceae family. In addition to an intensive sensory activity, thiocyanates show also a number of toxic and other pharmacological effects. They are slightly strumigenous and some of them show marked antimicrobial, insecticidic, fungicidic and nematicidal effects so that they can be used for the sanitation of soil. Some products of glucosinolates decomposition (e.g. gluconasturtiin in watercress or glucorafanin that can be found out above all in broccoli) show anti-carcinogenic effects and reduce the risk of the occurrence of chemically-induced cancer (VELÍŠEK, HAJŠLOVÁ, 2009). A similar conclusion was published by MURPHY *et al.* (2001) who studied effects of phenylethyl isothiocynate produced by hydrolysis of watercress

gluconasturtiin. Also cyanides originating from cyanogenic glycosides (thiocyanates – rhodanid), which are either products of their metabolism or result from the decomposition of glucosinolates contained in some vegetables, may show toxic effects (VELÍŠEK, HAJŠLOVÁ, 2009). Watercress extracts are used also for therapeutic purposes under commercial names amarum, cholagogum, metabolicum and roborans (RUBATZKY, YAMAGUCHI, 1999). In the period of growth, the leaves and stems might be contaminated by *Fasciola hepatica*. The preventive measures against human fascioliasis consist of prohibition of eating watercress in endemic areas of its occurrence (MAS-C OMA *et al.*, 2005).

Nematicidal effects of watercress against root-knot nematodes *Meloidogyne* ssp. were described by KONONKOV *et al.* (1997) and TOENSMEIER (2007). Similar effects were observed after the application of phytoncides derived from other essential-oils containing plant species, e.g. *Allium cepa, A. sativum, Menta spicata, Tagetes erecta, Nigella sativa,* and *Azadirachta indica (*ABO-ELYOUSR *et al.*, 2009) or *Thymus vulgaris, Artemisia absinthum* and *Punica granatum* (KORAYEM *et al.*, 1993; LASHEIN, 2002). After their application, both the health condition of plants and yields improved.

Members of the genus *Meloidogyne* sp. infest a wide spectrum of guest plants (above all potatoes, carrots, cucumbers, lettuce, gherkins, tomatoes and scorsonera). Roots of infested plants are shorter, with a high number of small roots, on which there are knots (cecidia) of various size, filled up with fungal tissue. In crop stands they occur in typical foci and the only method of plant protection is to include some non-guest plants (e.g. maize, rye or raps) into the crop rotation. In greenhouses, it is necessary to use and maintain lower soil temperatures. As a tool of biological control of nematodes (ROD *et al.*, 2005) fungi of the genus *Arthrobotrys* sp. can be also used.

MATERIALS AND METHODS

The experiment was established in Lednice in the greenhouse of the Faculty of Horticulture Mendel University in Brno, within the period of 2005–2006. Seedlings of tall tomato variety Tornado F1 (originating from Semo Smržice) were cultivated from sowings performed on 17 March 2005 and 12 March 2006. On 18 May 2005 and 14 May 2006, these seedlings were planted into pots with the volume of 25 litres, which contained 10 kg of soil substrate. Pots were placed into a cold greenhouse on tables covered with five layers of hardened PVC foil welded on edges to prevent greenhouse contamination with nematodes. During the cultivation period, the greenhouse temperature ranged from 22 to 28 °C, the relative air humidity was 75–80% and the plants were fertilised with the universal fertiliser called "Kristalon květ a plod". To prevent the occurernce of *Phytopthora infestans,* a biological preparation Polyversum 0.01% was applied and for the protection against aphids the preparation Pirimor 0.02% was used.

Individuals of the northern root-knot nematode *Meloidogyne hapla* originated from the Parasitological Institute of the Biological Centre, Academy of Sciences of the Czech Republic in České Budějovice and were applied into pots in the form of a solution containing approximately 300 invasive larvae in 200 ml of solution applied into each pot. Inoculated were all pots (including control). The macerate was prepared from 1 kg of fresh leaves placed into three litre of water and the juice was obtained by means of squeezing (Juicer Omega). The final phyto-solution was applied three times in the dose of 2 litres per pot and in intervals of four weeks (HASABO and NOWEER, 2005). Established were the following experimental variants:

Variant 1: Control
Variant 2: Application of water cress macerate plus 200 ml of juice
Variant 3: Application of water cress macerate diluted with water (1:2) plus 100 ml of juice
Variant 4: Application of water cress macerate diluted with water (1:4) plus 20 ml of juice.

The experiment was established in three replications and in each of them there were three tomato plants. Fruits were harvested during the whole period of cultivation, which in individual years was finished on 26 September 2005 and 27 September 2006, respectively. In addition of evaluation of yields, harvested fruits were analysed for the content of vitamin C using the HPLC method. After the end of the experiment, the presence of northern root-knot nematode (NRKN) *Meloidogyne hapla* gall on roots of tomato plants was determined under the microscope OLYMPUS BX 41. Obtained values were analysed statistically using the statistical software package UNISTAT v. 453.

RESULTS AND DISCUSSION

As compared with untreated Control, the treatment of NRKN-inoculated tomato plants with watercress macerate and juice increased significantly yield of fruits. The highest increase (by 96–165%) was recorded in Variant 2 (i.e. with the highest concentration of the phyto-solution). In Variants 3 and 4, fruit yields were increased by 77–118% and 57–84%, respectively. This means that yields increased with the increasing concentration of the phyto-solution (Tab. I, Tab. II). KONONKOV *et al.* (1997), as well, reported increased yields of tomato fruits and reduced numbers of galls on roots after the application of watercress juice.

As shown in Tab. II, there were not only significant differences in yields among individual experimental variants because, with the exception of Variant 3, the fruit yields were significant influenced also by the year.

I: *Yields and contents of vitamin C (in %) in tomato fruits after the inoculation of plants with root-knot nematode and their treatment with watercress phyto-solutions*

Year	Variant 1		Varianta 2		Varianta 3		Varianta 4	
	Yield	**Vit. C**	**Yield**	**Vit. C**	**Yield**	**Vit. C**	**Yield**	**Vit. C**
2005	100%	100%	265%	167%	218%	145%	184%	126%
2006	100%	100%	196%	159%	177%	137%	157%	124%

II: *Average yield of tomato fruits (kg/replication) after the inoculation of plants with root-knot nematode and their treatment with watercress phyto-solutions*

Year	Variant 1	Variant 2	Variant 3	Variant 4
2005	8.2 ± 0.6 a* A**	21.7 ± 0.8 b A	17.9 ± 0.4 c A	15.1 ± 0.3 d A
2006	10.6 ± 0.6 a B	20.8 ± 0.6 b A	18.8 ± 0.4 c A	16.7 ± 0.4 d B

* significant differences (P ‹ 0.01) between average yields (± SD) in individual years are indicated with different small letters
** significant differences (P ‹ 0.05) between years are indicated with different capital letters

III: *Average contents of vitamin C (mg/kg) in tomato fruits after the inoculation of plants with root-knot nematode and their treatment with watercress phyto-solutions*

Year	Variant 1	Variant 2	Variant 3	Variant 4
2005	201.3 ± 2.5 a* A**	337.3 ± 0.9 b A	291.2 ± 0.9 c A	253.2 ± 5.6 d A
2006	212.2 ± 2.2 a B	338.0 ± 1.6 b A	291.5 ± 1.1 c A	263.7 ± 4.6 d A

* significant differences (P ‹ 0.01) between vitamin C contents (± SD) in individual years are indicated with different small letters
** significant differences (P ‹ 0.05) between years are indicated with different capital letters

When evaluating numbers of NRKN gall on roots of tomato plants to the end of this experiment, the occurrence of this pathogen was equal to zero in treated experimental variants. Although there were no NRKN gall in any of the treated variants, the highest yield was recorded in Variant 2 (i.e. with the highest concentration of phyto-solution). This means that yields increased in dependence on increasing concentration of the phyto-solution in both years and that the phytoncides contained in watercress plants showed a protective effect against NRKN-infestation of tomatoes. Besides, they also showed a promoting effect on fruit yields.

Basing on this nematicidal effect, KONONKOV *et al.* (1997) recommended the application of watercress macerate as an ecologically safe method of reduction of the index of soil infestation with root knot nematodes both under field and greenhouse conditions. Also some other plant phytoncides showed a similar nematicidal effect. LASHEIN (2002) mentioned a significant positive effect of aromatic plant extracts on inoculated tomatoes, eggplants, and cucumbers (with the elimination of pathogens up to 97 %). JOYMATI *et al.* (1998) and ABO-ELYOUSR *et al.* (2009) observed in tomatoes inoculated with 300 juvenile stages of *M. incognita* per plant both increased yields and improved health condition of plants treated with various mixtures of essential oils, extracts and macerates made from aromatic plants. ALSHALABY, NOWEER (2003) corroborated the elimination of nematodes after the application of extracts from aromatic plant species *Tagetes erecta* and *Azadirachta indica*. These authors also stressed the effects of temperature and relative humidity on the result of application of these plant extracts; according to them, they should be 26–28 °C and 75–85%, respectively. In our experiments these conditions were fully respected.

The application of the phyto-solution increased the content of vitamin C by 24–67%. The highest increase was again observed in Variant 2 with the highest concentration of watercress macerate and juice. KALT (2005) mentioned that the health condition of plants could influence the content of some nutrients (e.g. vitamin C) and this observation was corroborated also in our experiment (Tab. III).

SUMMARY

The watercress *Nasturtium officinale* R. Br. is rich in vitamins and chemoprotective substances. As all members of Brasicaceae family, it contains glucosinolates (mustard oil glucosides), which is believed to have curative effects. Along with decomposition process there can appear the toxic substances performing against nematodes. We investigated effects of the macerate and juice of water cress on presence of nematodes, yield, and content of vitamin C by tomatoes, inoculated with the northern root-knot nematode (NRKN) *Meloidogyne hapla*.

Tomato variety Tornado F1 (originating from Semo Smržice) were cultivated in the greenhouse into pots with the volume of 25 litres, which contained 10 kg of soil substrate. Fourteen days after planting

of tomatoes, there was applied into each pot 200 ml of solution containing approximately 300 invasive larvae of northern root-knot nematode.

The following experimental variants were established: application of water cress macerate plus 200 ml of juice of watercress; application of water cress macerate diluted with water (1:2) plus 100 ml of juice; application of water cress macerate diluted with water (1:4) plus 20 ml of juice.

The phyto-solution was applied three times in the dose of 2 litres per pot and in intervals of four weeks. It was found out that after the treatment of plants with solutions derived from watercress the yield of fruit was highly significantly increased. The highest yield increase (by 96% to 165%) was observed in the variant with the highest concentration of watercress extracts (macerate + 200 ml of juice). Although at lower concentrations of watercress solution the increase in yields was also reduced (by 57–118 %), the difference was still statistically highly significant.

The effect of this treatment on the content of vitamin C was similar and the increase was also highly significant and ranged from 24 to 67%. When evaluating the occurrence of nematodes on roots of tomato plants, the presence of pathogens was equal to zero percent in all treated variants. Although there were no the northern root-knot nematode (*Meloidogyne hapla*) gall in any of the treated variants, the highest yield was recorded in variant treatment with the highest concentration of phyto-solution.

Acknowledgement

This research was supported by the Ministry of Education, Youth and Sports of the Czech Republic, Project No. 435100002 MSM.

REFERENCES

ABO-ELYOUSR, K. A. M., EL-MORSI, M. A., ABDEL GAID, M. A., 2009: Management of tomato root-knot nematode *Meloidogyne incognita* by plant extract and essential oils. *Plant Pathology Journal,* 25: 189–192.

ALSHALABY, M. E. M., NOWEER, E. M. A., 2003: Effect of five plant extracts on *Meloidogyne incognita*. *Indian Journal Nematol*, 28: 225–230.

HASABO, S. A., NOWEER, E. M. A., 2005: Management of root-knot nematode *Meloidogyne incognita* on eggplant with some plant extracts. *Egypt. Journal Phytopathol*. 33: 65–72.

JOYMATI, L., DHANACHAND, C., DEVI, L. S., 1998: Effect of plant extracts on *Meloidogyne incognita*. *Indian Journal Nematol.*, 28: 225–230.

KALT, W., 2005: Effects of production and processing factors on major fruit and vegetable antioxidants. *Journal of Food Science* 70: 11–19.

KONONKOV, P. F., KOZAR, E. G., ŠESTAKOVA, E. V., KOTOVA, V. V., 1997: Vodjanoj kress – perspektivnaja ovoščnaja kuľtura dlja zaščiščennogo grunta (Watercress – a prospective vegetable species for greenhouses, in Russian). *Gavrish- Scientific- Informative Journal for Glasshouse Industry*, Moscow, 3: 7–9. ISSN 5-86785-027-7.

KOPEC, K., 1998: Tabulky nutričních hodnot ovoce a zeleniny (Tables of nutritional values of fruit and vegetables, in Czech) Prague, ÚZPI. ISBN 80-86153-64-9.

KORAYEM, A. M., HASABO, S. A., AMEEN, H. H., 1993: Effect and mode of action of some plant extracts on certain plant parasitic nematodes. Nz. *Pflanzenschutz, Schädlingskunde, Umweltschutz*, 66: 32–35. ISSN 1612-4766.

LASHEIN, A. M. S. A., 2002: Biological control of root - knot nematode in some vegetables. *M.Sc. Thesis Fac. Agric. Cairo Univ.*: 107.

MAS-COMA, S., BARGUES, M. D., VALERO, M. A., 2005: Fascioliasis and other plant- borne trematode zoonoses.. *Int J Parasitol.* (35), 11-12: 1255–78

MURPHY, S. E., JOHNSON, L. M., LOSEY, L. M., CARMELLA, S. G., HECHT, S. S., 2001: Consumpion of watercress fails to alter coumarin metabolism in humans. *Drug Metabolism and Disposition* 29: 786–788.

ROD, J., HLUCHÝ, M., ZAVADIL, K., PRÁŠIL, J., SOMSSICH, M., ZACHARDA, M., 2005: Obrazový atlas chorob a škůdců zeleniny střední Evropy (Picture Atlas of Central European Vegetable Diseases and Pests, in Czech). Biocont Laboratory, s. r. o., Brno: 392 p. ISBN 80-901874-3-9.

RUBATZKY, V. E., YAMAGUCHI, M., 1999: World Vegetables, 2nd edd. New York: 831 p. ISBN 0-8342-1687-6.

TOENSMEIER, E., 2007: Perennial vegetables. Chelsea Green Publishing, 241 p. ISBN 13978-1-9313948-401.

VELÍŠEK, J., HAJŠLOVÁ, J., 2009: Chemie potravin II. (Foodstuff Chemistry II, in Czech) 3. Ed. Tábor, OSSIS: 623 p.

VOGEL, G., 1996: Handbuch des speziellen Gemüsebaues. Stuttgart, Eugen Ulmer: 421–428. ISBN 3-8001-5285-1

Address

Ing. Helena Zahradníková, Ph.D., doc. Ing. Kristína Petříková, CSc., Department of Vegetable Growing and Floriculture, Mendel University in Brno, Valtická 337, 691 44 Lednice, Czech Republic, e-mail: petrk@zf.mendelu.cz