Volume CSIEA (1). Published November, 01, 2017
www.jnsciences.org
E-ISSN 2286-5314

Management of Potato Cyst Nematode (*Globodera rostochiensis*) with Oxamyl

L. HAJJI-HEDFI [1*], W. HLOUA[1], W. GAMAOUN[2], N. CHIHANI[1], H. REGAIEG[1], N. HORRIGUE-RAOUANI[1]

[1] Department of Biological sciences and Plant Protection, Higher Agronomic Institute of Chott-Mariem, Sousse University, Tunisia
[2] General Directory of Protection and Control of the quality of agricultural products, Tunisia

*Corresponding author: elhajjilobna@yahoo.fr

Abstract - Potato Cyst Nematodes (PCN) are a serious problem for potato production causing yield losses in most potato growing regions in Tunisia. Chemical nematicide, the most widely used and efficient method of nematode management. Researching of novel molecules is essential to reduce pathogen resistance and environment risks. The study evaluated the control potential of new chemical product based on oxamyl, carbamate nematicide, against potato cyst nematodes (PCN) and its effect on potato growth and yield. Field trial investigated the effect of oxamyl product compared with common product ethoprophos on population levels of *Globodera rostochiensis* and the resulting potato growth and yield. Potato growth and production were measured and levels of PCN juveniles and cysts were assessed after 3 months of tubers planting. Results revealed that both oxamyl and ethoprophos enhanced significantly (P<0,05) fresh and dried plant weight when compared with untreated control plots. Root and tubers weight were insignificantly increased with oxamyl. Although, levels of potato cyst nematode in terms of cysts on soil and juveniles on roots were reduced by oxamyl treatment as compared by untreated plots. Oxamyl residue on potato tubers and soil quantified by LC/MS/MS revealed that the molecule was absent on two samples and confirmed the absence of phytotoxicity. Based on results obtained from field experiment, oxamyl nematicide could be used for Potato Cyst Nematode control on potato crop.

Keywords: *Globodera rostochiensis*, potato, oxamyl, chemical control, potato growth, phytotoxicity.

1. Introduction

Potato (Solanum tuberosum L.) is one of the most important crops grown in worldwide and Tunisia for local consumption, export and processing (B'Chir and Namouchi-Kachouri 1993; Wang et al. 2008). The main production areas in Tunisia are the north eastern Mediterranean coast (Horton et al. 1986).
Potato Cyst Nematodes (PCN) are a serious problem for potato production causing yield losses on most potato growing regions in worldwide and Tunisia (Brodie 1984; Evans and Trudgill 1992; B'chir 1990; Trifonova 2000). Two species are now recognized, Globodera rostochiensis (Golden; Wollenweber 1923) and G. pallida (white; Stone 1973), which they differ genetically. They are obligate parasites of potato (Manduric et al. 2004) and are recognized as quarantine pests internationally (Anon 1991) .
Cysts of both species are resistant to unfavorable environmental conditions and persist more than 10 years in the soil which makes their management difficult (Williamson and Hussey 1996). Chemical nematicides are considered the most useful and efficient method of nematode management. Researching of novel molecules is essential to reduce pathogen resistance and environment risks. Chemical control involves the application of volatile (fumigants) and non-volatile nematicides (Alan and Suzan 1998). Fumigant nematicides are effective against plant parasitic nematodes; however, they are expensive and require specialized application equipment and require a long period of time between treatment and planting date due to the phytotoxicity risk. The most widely used nonfumigant nematicides used in vegetable production are the carbamates and organophosphates (Rich et al. 2004).
The main objective of the present study is to evaluate the control potential of a chemical product, a carbamate, against golden cyst nematode and its effect on potato growth and yield. For this purpose, the experiment carried out under filed conditions during 2015 in order to assess the effect of commercial

compound oxamyl (carbamate) against potato cyst nematode (Globodera rostochiensis) which infect potato plants (Solanum tuberosum L. var. spunta).

2. Material et methods

2.1. Pathogen Isolation and Identification

Before starting field trial, five soil cores (2.5-cm diam. × 30-cm deep) were collected from the middle of plots prior to treatment application to assess densities of cysts number existing on soil before treatment. The morphometrics measurements from juveniles (J2) and females (cyst vulval cones) were assessed for nematode identification. Morphological identification realized according recent taxonomic keys and a compendium for identification of Globodera spp. (Golden 1986; Baldwin and Mundo-Ocampo 1991).

2.2. Field experiment

The field experiment was carried out in naturally infested soil with potato cyst nematodes in Sidi Bou Ali, Sousse, Tunisia at a mean of temperature 23 ± 2° C and relative humidity 60-80% and were terminated after 12 weeks after planting. The area of experimental plot equal 1/100 of acre. Treatment were applied through irrigation before potato (cv. spunta: susceptible to potato cyst nematodes) planting. Treatments consisted of a soil application of ethoprophos at a rate of 50 Kg/ha, oxamyl at a rate of 20 Kg/ha and an untreated infested control (positive control). The experimental design adopted was randomized complete block design with five blocks containing each one 3 plots (treatments). Three experimental treatments were implemented, namely control infested potato with PCN without any treatment (C), infested potato and treated with ethoprophos (M) and potato infested and treated with oxamyl (V).

2.3. Assessment Parameters

At sampling, five plants by plot were collected. After separation of plant parts, the plant growth parameters (plant height, fresh and dry weights of shoots and length of root per plant) were measured after 90 days from cultivation. Moreover, the number of tubers and average of tuber weight/plant were measured at harvesting plants.

The roots were washed to get rid of the adhering sand particles to extract nematodes from roots according modified method by De Grisse (1969). Soil nematode population determined in 250 cm^3 of soil by Fenwick technique (Fenwick 1940) after air drying soil for 5 days. Each soil sample suspended in acetone drained through filter funnels. The cysts were then collected in filter paper, labeled and left to dry. Cysts were handpicked under a stereoscopic microscope. The number of cysts and their content were estimated by standard methods (Southey 1970).

2.4. Phytoxicity Evaluation

One kg sample of potato tubers and of soil were collected from each plot of oxamyl treatment and were completely homogenized. Three replicates of 100g each were taken for extraction. QuEChERS method adopted to analyze residue of tested pesticide (oxamyl substance) on soil and potato tubers according to Anastassiades et *al.* (2002) technique.

2.5. Statistical analysis

All data were subjected to statistical analysis. Means were compared by the Least Significant Difference test "LSD" at 5 % level of probability by Duncan `s multiple range test (Steel and Torrie 1980) using SPPS 20 software for windows.

3. Results and Discussion

3.1. Potato Growth and Yield

At the end of experiment, the naturally infested field with Globodera rostochiensis showed yellowing and severe wilting on aerial part of potato crop coupled by colonizing roots and disqualifying potato tubers (Figure 1).

Figure 1. Effect of *Globodera rostochiensis* on potato tubers (a), aerial parts of plant (b) and plant roots (c)

Applied chemical treatments exhibited an effect on potato growth parameters. In fact, results depicted on Figure 2 revealed that both oxamyl and ethoprophos enhanced significantly ($P<0.05$) fresh and dried plant weight when compared with untreated control plots. Otherwise, root weight was insignificantly increased with oxamyl and with ethoprophos (Figure 3).

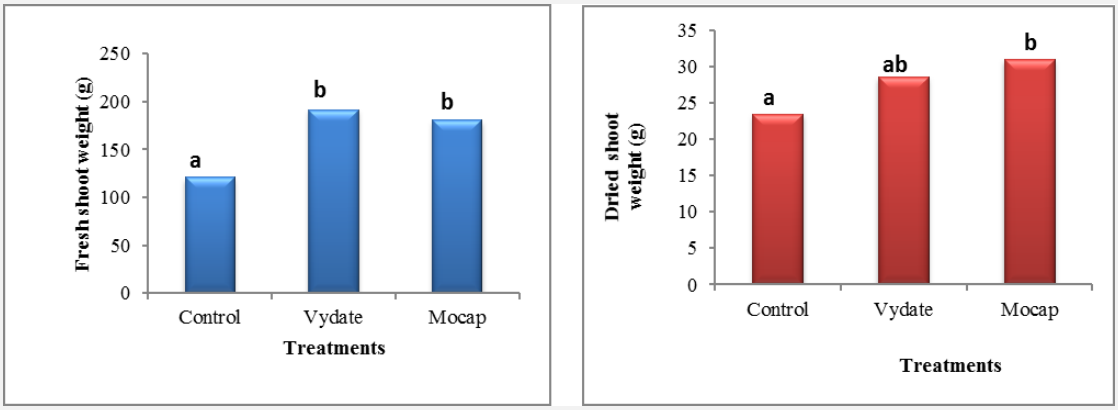

Figure 2. Effect of treatments on aerial part of potato plant (a: fresh shoot weight; b: dried shoot weight) at 3 months cultivation

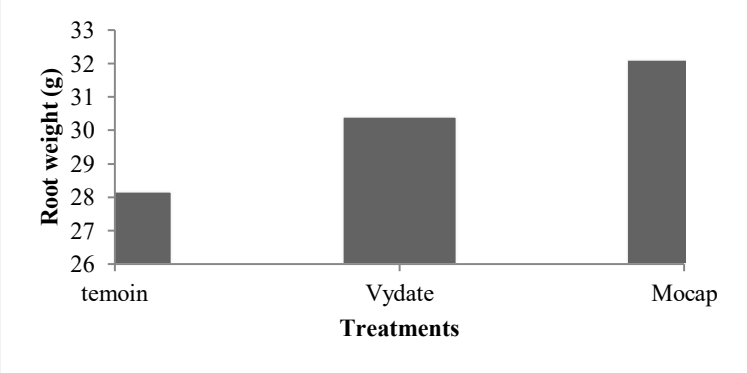

Figure 3. Effect of chemical treatments on root weight (g) of potato plant at 3 months cultivation

Potato production by plant showed a slightly increase with chemical treatment as comparing with untreated plots. This insignificant increase was higher with ethoprophos (most common commercial product) followed by oxamyl. However, the highest decrease of tubers number per plant was recorded with oxamyl (tested product). A such decrease suggested that oxamyl could improve the quality of tubers by enhancing the weight by each tuber (Figure 4a and 4b).

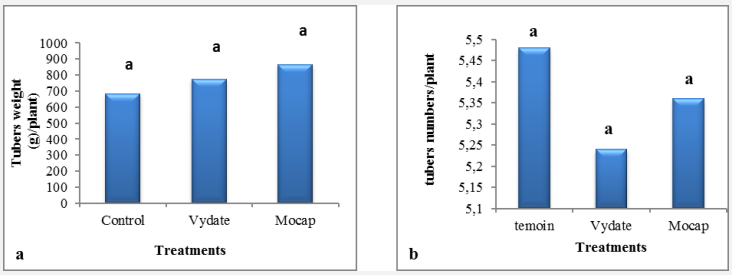

Figure 4. Effect of chemical treatments on potato production (a: production/plant; b: tubers number/plant)

3.2. Nematode Reproduction

Levels of Potato Cyst Nematode in terms of cysts on soil and juveniles on roots were reduced significantly by oxamyl and ethoprophos treatments as compared by untreated plots. The best control of nematode population on soil was provided by oxamyl by 154.12 followed by ethoprophos by 166.04 cyst/500g of soil (Figure 5a). However, the greatest decrease in the nematodes on roots occurred with ethoprophos treatment by 8 followed by oxamyl by 9.04 J2 (juveniles)/plant (Figure 5b).

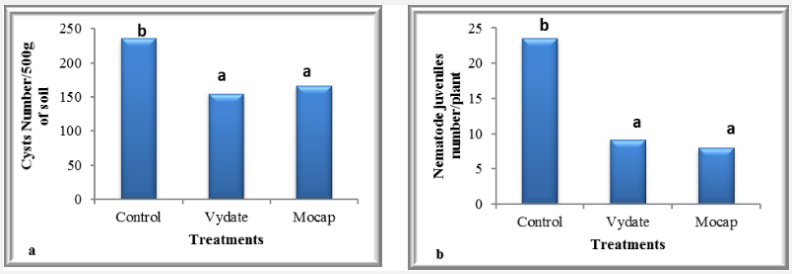

Figure 5. *Globodera rostochiensis* Reproduction at 3 months post-planting (a: cysts number on soil; b: Nematode *juveniles* number on root)

3.3. Phytoxicity

Data on Table 1 showed that oxamyl residue on potato tubers and soil quantified by LC/MS/MS revealed that the molecule was absent on two samples and confirmed the absence of phytotoxicity. The low level of oxamyl residue on tubers and soil than MRL (limits of the amount or residue that can be legally present in foods) could be due the non-persistence of these pesticide or the conscious use of pesticide with appropriate waiting period, rate and number of application.

Table .1 Oxamyl residue on Tubers and Soil by QuEChERS method

	LQ(ppm)	MRL(ppm)	Oxamyl Residue (ppm)
Soil	0.01	0.01	ND
	0.05		<LQ
Tubers	0.01	0.01	<LQ

(ND: not detectable ; MRL: maximum residue limits, LQ: limit quantification)

Our results indicated that Oxamyl as carbamate nematicide enhance some growth parameters, is able to suppress the nematode density and it could be used for the control of cyst nematode *Globodera rostochiensis.* The results are in agreement with those reported by Whitehead et *al*. (1991) which showed that in soil moderately or heavily infested with *G. pallida*, oxamyl frequently increased tuber yields of susceptible and partially resistant potatoes and lessened nematode (Pf/Pi). These results were agree with Brodie (1983) and Morris et *al*. (1973) reported that soaking potato seed pieces with oxamyl before planting has also been attempted to control the golden nematode *Globodera rostochiensis.*

Moreover, a successful control of other plant parasitic nematodes genera has been achieved in the past using oxamyl. This nematicide provided protection from *P. penetrans* damage and increased marketable yield by as much as 44.4% (Olthof et *al.* 1985). *Meloidogyne* spp. populations in carrots could be significantly reduced by this carbamate pesticide (Gugino et al. 2006). Furthermore, *Rotylenchus reniformis* controlled successfully by oxamyl (Lawrence and McLean 2000).

Our results suggest that application of the tested products can provide effective control of potato cyst nematode and use an alternative method of plant disease control.

4. Conclusion

The survey data suggested the usefulness of oxamyl product due its high control potential of golden cyst nematode *Globodera rostochiensis* and absence of pesticide residues on tubers and soil samples. Otherwise, as every chemical nematicide, it can't offer a complete control of PCN, and their effectiveness depends on various factors including soil conditions, weather, the method and timing of application.

5. References

Alan GW, Susan JT (1998) Management and regulatory control strategies for potato cyst nematodes (Globodera rostochiensis and G. pallida). In: Marks RJ, Brodie BB (eds) Potato cyst nematodes: biology, distribution, and control. CAB International, Oxford, pp 135–152.

Anastassiades M, Lehotay SJ, Stajnbaher D (2002) Quick, easy, cheap, effective, rugged and safe (QuEChERS) approach for the determination of pesticide residues. In 18 th Annual waste testing and quality symposium proceeding. Arlington, VA, pp.231-241.

Anon (1991) Quarantine procedure No. 30. Globodera pallida and G. rostochiensis. Soil sampling methods, EPPO Bulletin, 21, pp. 233-240.

Baldwin JG, Mundo-Ocampo M (1991) Heteroderinae, Cyst-and Non-cyst-forming Nematodes. In: Nickle WR, editor. Manual of Agricultural Nematology. New York: Marcel Dekker; pp. 275–362.

B'chir MM (1990) Evaluation de la nuisibilité de quelques groupes de nématodes en fonction des particularités agro-météorologiques régionales. Symposium OMM/OEPP/NAPPO, Decemeber 4-7, Florence, Italy, Joint, WMO EPPO NAPPO Symposium on Practical Applications of Agrometeorology in Plant Protection, pp: 88-89.

B'Chir MM, Nammouchi-Kachouri N (1993) Evaluation de la nuisibilité réelle de Globodera spp. dans les conditions d'une culture de pomme de terre de saison en Tunisie. Med.Fac. Landbouww.Univ. Gent, 59/1: 25-36.

Brodie, BB (1983) Control of Globodera rostochiensis in relation to method of applying nematicides. Journal of Nematology 4:491-495.

Brodie, BB (1984) Nematode parasites of potato. In Plant and Insect Nematodes (Nickle, W.R., ed.). New York : Marcel Dekker, pp. 167–212.

De Grisse AT (1969) Redescription ou modification de quelques techniques utilisée dans l'étude des nématodes phytoparasitaires. Mededelingen Rijksfaculteti der Landbouveten Gent: 351–369.

Evans K, Trudgill DL (1992) Pest aspects of potato production. Part 1. The nematode pests of potatoes. In the Potato Crop, 2nd edn (Harris, P., ed.). London: Chapman & Hall, pp. 438–475.

Fenwick DW (1940) Methods for the recovery and counting of cysts of Heterodera schachtii from soil. Journal of Helminthology 18: 155–172.

Gugino BK, Abawi GS, Ludwig JW (2006) Damage and Management of Meloidogyne hapla Using Oxamyl on Carrot in New York. J Nematol.; 38(4):483-90.

Golden AM (1986) Morphology and identification of cyst nematodes. In: Lamberti F, Taylor CE, editors. Cyst Nematodes. New York: Plenum Press; pp. 23–45.

Horton D, Cortbaoui R, Hattab H, Monares A (1986) Impact of Agricultural Research and Development: A seed Potato Project in Tunisia. International Potato Centre, Lima.

Lawrence GW, McLean KS (2000) Effect of Foliar Applications of Oxamyl with Aldicarb for the Management of Rotylenchulus reniformison Cotton. J Nematol.; 32(4S):542-9.

Manduric SE, Olsson JE, Englund, Andersson S (2004) Separation of Globodera rostochiensis and G. pallida (Tylenchida: Heteroderidae) using morphology and morphometris. Nematology, 6:171-181.

Morris RF, Proudfoot KG (1973) Biology and control of the golden nematode. Pesticide Report, ECPUA, Ottawa, pp. 358-359.

Olthof, ThHA, McGarvey BD, Chiba M (1985) Oxamyl in the control of Pratylenchus penetrans on potatoes. Canadian Journal of Plant Pathology 7:155-160.

Rich JR, Dunn RA, Noling JW (2004) Nematicides: Past and present uses. Pp. 1179–1200 in Z. X. Chen, S. Y. Chen, and D. W. Dickson, eds. Nematology advances and perspectives: Nematode management and utilization. Wallingford, CT: CABI Publishing.

Steel RG, Torrie JH (1980) Principles and Procedures of Statistics. McGraw-Hill Book Co., New York, U.S.A., pp. 633.

Southey JF (1970) Laboratory methods for work with plant and soil nematodes. Technical bulletin 2. Ministry of Agriculture, Fisheries and Food, London: Her Majesty's Stationary Office. 202pp.

Trifonova Z (2000) Distribution of Globodera rostochiensis (Woll.) in Bulgaria. Macedonian Agricultural Review, 1: 63-65.

Wang Q, Zhang E, Li F (2008) Runoff efficiency and the technique of microwater harvesting with ridges and furrows, for potato production in semi-arid areas. Water Res Manag 22: 1431-1443

Williamson VM, Hussey RS (1996) Nematode pathogenesis and resistance in plants. Plant Cell, 8, 1735–174

Whitehead AG, Nichols AJF, Senior JC (1991) Control of potato pale cyst-nematode, Globodera pallida, with a granular nematicide and partially resistant potatoes. Annals of Applied Biology, 118(3): 623-636