

EFFECT OF GRANULAR NEMATICIDE APPLICATIONS ON THE POPULATION DENSITY OF *DITYLENCHUS DIPSACI* IN GARLIC

M. F. Andres and S. Lopez-Fando

Departamento de Protección Vegetal, Centro de Ciencias Medioambientales CSIC. C/Serrano 115, 28006 Madrid, Spain.

RESUMEN

Andrés, M. F. y S. Lopez-Fando. 1996. Efecto de las aplicaciones de nematicidas granulados sobre la densidad de población de *Ditylenchus dipsaci* en cultivo de ajo. *Nematrópica* 26:167-170.

Se estudió la influencia de la época de aplicación de tres nematicidas granulados: fenaminphos (Nemacur 10G), carbofuran (Furadan 5G) y ethoprop (Mocap 10G) en la reducción de la densidad de población de *Ditylenchus dipsaci* en suelo y en planta de ajo en un campo infestado con el nematodo. Las aplicaciones de los tratamientos se realizaron en cuatro fases diferentes, la primera coincidiendo con el momento de la siembra y luego consecutivamente un mes después. Las dosis empleadas fueron de 5 kg i.a./ha, aplicadas en bandas localizadas al lado del bulbo. Todas las parcelas tratadas en el momento de la siembra presentaron dos meses después un nivel de población de *D. dipsaci* en suelo significativamente inferior al de las parcelas testigo, así mismo en estas parcelas al final del cultivo se observó una importante disminución del nivel de infección de las plantas. Las aplicaciones realizadas un mes después de la siembra fueron menos eficaces, pero también produjeron una reducción significativa del grado de infección de las plantas al final del cultivo; sin embargo en suelo sólo ethoprop provocó la disminución de la densidad de población del nematodo dos meses después de la aplicación. Las aplicaciones nematicidas posteriores resultaron menos efectivas o nulas y la eficacia varió según las condiciones ambientales, la fase del cultivo y el tratamiento empleado. Ethoprop fué el tratamiento más eficaz, en todas las aplicaciones produjo la mayor disminución del nivel de infestación final en planta.

Palabras clave: *Allium sativum*, carbofuran, *Ditylenchus dipsaci*, ethoprop, fenaminphos, manejo de nematodos, nematodo de los tallos.

Garlic (*Allium sativum* L.) is of great economic importance in Spain, which ranks fourth among world producers and is one of the main exporting countries. This plant is grown in every Spanish province, but the Castilla-La Mancha region provides 45% of the national production grown on 22 000 ha.

The stem and bulb nematode, *Ditylenchus dipsaci* Filipjev, is a serious pest of garlic. Losses of 40-60% have been reported in the Castilla-La Mancha region. Infections can arise from planting in nematode-infested soil or from planting infected garlic seed cloves. Eradication of the nematode population in the soil is not practical, but control methods may be used to reduce population densities. Nonhost rota-

tion requires several years to reduce the soil nematode population sufficiently to enable the grower to plant the garlic without risk of infection (Hague and Gowen, 1987). Granular nematicide treatments are widely accepted and frequently applied by farmers. However, most research with granular nematicides on garlic has been conducted on infected seed cloves. This study assessed the effects of three granular nematicides applied at different stages of crop growth on the population density of *D. dipsaci* in soil and on the final infection levels in the plants.

The experiment was conducted in a field that had been under garlic cultivation for several years at "El Provencio" in the Castilla-La Mancha region. The field was

heavily infested with *D. dipsaci* (> 50 nematodes/100 cm³ soil at garlic harvest). The soil was a clay loam containing 44% clay and 56% sand, with a pH of 7.5-7.8. The treatments consisted of three granular nematicides, fenaminphos (Nemacur 10G), carbofuran (Furadan 5G) and ethoprop (Mocap 10G), applied at 5 kg a.i./ha in bands next to the bulb at one of four stages of plant growth. The times of application were at planting (January) and at monthly intervals thereafter (February, March and April). The 13 treatments plus one control were arranged in a randomized complete block design with 8 replications. Each plot consisted of five 4 m long rows (0.5 m apart). Nematode population densities in soil were estimated two months after every treatment. Soil samples were composites of 10 cores (2.5-cm-diam, 20-cm-deep) from the rhizosphere of the center three rows of each plot. Nematodes were extracted from five random subsamples of 100 cm³ using a centrifugal-sugar flotation method (Nombela and Bello, 1983). The final nematode population density in plants was assessed at harvest. Twenty plants were removed at random

from each plot, and the nematodes were extracted from four random subsamples of 250 g, using the Baerman funnel technique (Southey, 1970). The nematode population from soil and plant samples were log₁₀(x+1) transformed, and the means were compared by the Student's t-test (P ≤ 0.05).

All nematicides significantly reduced nematode populations in soil following at least one application time interval (Table 1). Nematicide application at sowing (January) resulted in significantly lower population levels after two months than the control plots in each case. Fenaminphos applications were the most effective. For treatments applied one month after planting (February), plots that were treated with ethoprop had a significantly lower population level of *D. dipsaci* in soil than the untreated control and fenaminphos and carbofuran treatments. Nematicide applications made two months after planting (March) did not affect nematode populations in soil. Applications of carbofuran and ethoprop made three months after planting (April) resulted in significantly lower numbers of nematodes in soil than

Table 1. Effect of different nematicide treatments applied at four stages of growth of garlic on *D. dipsaci* population levels in soil two months after treatment application and at harvest.^{a,c}

Treatment	Application date							
	January		February		March		April	
	Soil	Plant	Soil	Plant	Soil	Plant	Soil	Plant
Fenaminphos	23 a	7 b	26 a	158 a	20 a	266 ab	175 ab	397 a
Carbofuran	56 b	1 a	28 a	157 a	23 a	208 ab	88 b	140 b
Ethoprop	41 ab	2 ab	14 b	292 a	36 a	133 a	95 b	29 c
Untreated	76 c	560 c	26 a	560 b	49 a	560 b	343 a	560 a

^aNematode numbers are expressed as a mean of 8 replications for each treatment.

^cData were transformed to log₁₀(x+1) for analysis. Means followed by the same letter within a column do not differ according to Student's t-test (P ≤ 0.05).

those treated with fenaminphos and the untreated control. Comparison of *D. dipsaci* population levels in plants at harvest revealed that nematicide applications made at planting (January) suppressed the final nematode infection level (Table 1). Applications of each nematicide made one month after planting were less effective than at-planting treatments, but they still resulted in significant suppression of the infection level in plants compared with the untreated control. Only ethoprop significantly suppressed plant infection when applications were made two and three months after planting.

The results suggest that the most effective time for granular nematicide application in *D. dipsaci* infested soils is at garlic planting. This application time significantly reduced the nematode population density in soil and suppressed plant infection. These results confirm those obtained in other studies (Pacheco Covarrubias, 1986; Zurmaran *et al.*, 1993). Nematicide application after sowing was less effective probably because the bulb had already sprouted and the elongating leaves had become infected (Bunt, 1975; Lewis, 1979). The effect of nematicide treatments applied after planting on *D. dipsaci* population densities in soil varied considerably with the growth stage of the crop. Climatic factors, such as rain and temperature, are of major importance since they not only affect crop development but population dynamics of the nematode. The lack of effectiveness of the March and April treatments may be due to the influence of high rainfall compared with that in February and to average air temperature of about 15°C. Both the moisture and soil temperature would provide ideal conditions for nematode multiplication and plant infection.

In this study, ethoprop was the most effective nematicide. Ethoprop was found to control *D. dipsaci* quite well in infested

garlic seed (Siti *et al.*, 1982) and in strawberry (Lewis, 1979). Carbofuran has been reported to be effective in garlic although its direct application on the seed has phytotoxic effects (Roberts and Grathed, 1986). When carbofuran is applied at sowing, the population density of *D. dipsaci* in plant tissues can be suppressed in garlic (Toro *et al.*, 1988), onion (Greco *et al.*, 1974), lucerne (Whitehead and Tite, 1987) and broad bean (Whitehead and Tite, 1988). Fenaminphos had a higher nematicidal capacity in soil than through its systemic in plants (Bromilow and Lord, 1979), and it was most effective when applied at planting in our experiment. This is in agreement with results obtained by others (Mansilla *et al.*, 1987; Pacheco Covarrubias, 1986). No phytotoxic effects of the products were observed in our study, but others have reported phytotoxicity with carbofuran and ethoprop at similar dosage rates (Roberts and Grathed, 1986).

A more detailed study of the phytotoxicity potential of these nematicides on garlic is required to assess their effects on emergence and also to determine residue levels in the bulbs at harvest. In some countries, legislation may not permit the use of one or more of these nematicides on food crops for environmental or health reasons.

LITERATURE CITED

- BROMILOW, R. H., and K. A. LORD. 1979. Distinction of nematicides in soil and its influence on control of cyst nematodes *Globodera* and *Heterodera* spp. *Annals of Applied Biology* 92:93-104.
- BUNT, J. A. 1975. Effect and mode of action of some systemic nematicides. *Mededelingen Landbouwhogeschool Wageningen* 75:1-128.
- GRECO, N., F. LAMBERTI, and A. BRANDONISIO. 1974. La lotta chimica contro *Ditylenchus dipsaci* (Kuhn) Filipjev su cipolla in Puglia. *Nematologia Mediterranea* 2:117-139.
- HAGUE, N. G., and S. R. GOWEN. 1987. Chemical control of nematodes. Pp. 131-178 in R. H. Brown, and B. R. Kerry, eds. *Principles and Prac-*

- tice of Nematode Control in Crops. Academic Press, Sydney, Australia.
- LEWIS, S. 1979. Control of stem nematode *Ditylenchus dipsaci* in strawberry by granular nematicide. *Plant Pathology* 28:191-196.
- MANSILLA, J., M. E. MARTINES, and D. SALVADOR. 1987. Análisis nematológico en el cultivo del ajo. *Boletín de Sanidad Vegetal y Plagas* 13:3-13.
- NOMBELA, G., and A. BELLO. 1983. Modificaciones al método de extracción de nematodos fitoparásitos por centrifugación en azúcar. *Boletín del Servicio contra Plagas* 9:183-189.
- PACHECO COVARRUBIAS, J. J. 1986. Evaluación de nematicidas para el control del nematodo del ajo *Ditylenchus dipsaci* (Kuhn) Filipjev, en la Región de Aconchi, Sonora. *Agricultura Técnica Mexicana* 12:151-153.
- ROBERTS, P. A., and A. S. GREATHEAD. 1986. Control of *Ditylenchus dipsaci* infected garlic seed cloves by non-fumigant nematicides. *Journal of Nematology* 18:66-73.
- SITI, E., E. Cohn, J. Katan, and M. MORDECHAI. 1982. Control of *Ditylenchus dipsaci* in garlic by bulb and soil treatments. *Phytoparasitica* 10:93-100.
- SOUTHEY, J. F. 1970. Laboratory Methods for Work with Plant and Soil Nematodes. Technical Bulletin Ministry of Agriculture, Fisheries and Food, No. 2. HMSO, London, U.K., 148 pp.
- TORO, M. S., J. A. GARAY, and M. A. A. COLOMBINO. 1988. Experiencias para el control de *Ditylenchus dipsaci* (Kuhn) Filipjev, en ajo, cv. Colotrato en San Luis, Argentina. *Revista de Ciencias Agrarias, Mendoza* 24:35-4.
- WHITEHEAD, A. G., and D. J. TITE. 1987. Chemical control of stem nematode *Ditylenchus dipsaci* in field beans (*Vicia faba*). *Annals of Applied Biology* 110:341-349.
- WHITEHEAD, A. G., and D. J. TITE. 1988. Effects of seed row and foliar applied pesticides on the yield of lucerne in clay soil, in the presence or absence of lucerne stem nematode *Ditylenchus dipsaci*. *Journal of Agricultural Science* 110:279-283.
- ZURMARAN, G., M. DELGADO, E. GONZALEZ, and J. M. LUCENA. 1993. Empleo del Temik 15G (aldicarb) en el control de *Ditylenchus dipsaci* en ajo en Arequipa, Peru. *Nematropica* 23:132 (Abstract).

Received:

1.IV.1996

Accepted for publication:

2.IX.1996

Recibido:

Aceptado para publicación: