CONTROLLING PARASITIC NEMATODES IN AN ESTABLISHED VINEYARD IN CYPRUS

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Summary. In an established vineyard the nematicides cadusafos and carbofuran, at the rates of 2.5 g and 3.5 g a.i. per plant, respectively, controlled *Xiphinema index, Mesocriconema xenoplax* and *Paratylenchus hamatus* and increased yields. On an overall three-year basis, cadusafos reduced the total number of all three species near the root zone between 60.2 to 70.7 per cent while carbofuran was inferior, reducing nematode numbers by only 21.2 per cent, respectively, as compared to the untreated control. In the cadusafos treated plots commerciable yields were significantly increased by 20.7-21.9 per cent while in the carbofuran treated plots yields were increased by only 10.7 per cent.

Among the various pests and diseases associated with grapevine in Cyprus there are twenty species of nematodes (Philis, 1995) of which *Mesocriconema xenoplax, Paratylenchus hamatus* and *Xiphinema index* have been shown to be damaging (Raski and Lider, 1959; Wyss, 1978). In addition to causing direct damage, *X. index* is the natural vector of the Grapevine Fanleaf nepo virus (GFLV) (Hewitt *et al.*, 1958) and therefore high levels of nematode control are required to prevent its spread in established plantations. In Cyprus, *X. index* was firstly reported by Philis and Siddiqi (1976) while the GFLV disease was confirmed for the first time by Ioannou (1990).

In the past, the fumigant 1,2, dibromo-3-chloropropane (DBCP) has been used for the control of parasitic nematodes in established vineyards (Raski and Schmit, 1964) but it is no longer available and alternatives are being sought.

This paper describes an experiment with cadusafos and carbofuran conducted over a three year period for the control of *X. index* Thorne *et* Allen, *M. xenoplax* (Raski) Loof *et* De Grisse and *P. hamatus* Thorne *et* Allen in an established vineyard at Kolossi.

MATERIALS AND METHODS

Soil samples containing feeding rootlets of the grapevines were taken during spring and autumn of each year at 15-20 cm depth and at a distance of 20-30 cm away from the trunk. They were put in plastic bags and immediately placed in a cooler box. They were then transported within 2-3 hours to the laboratory where they were kept at 8-10 °C, for a maximum of three days. Two hundred and fifty grams of soil were processed using a modification of the sieving-decantation method. One litre of water was poured in a bucket containing the soil, which was then left for about 30 minutes to disperse. After stirring, it was passed twice through a coarse sieve (850 µm aperture) into another bucket, to get rid of any stones and/or debris. The suspension, after settling for approximately eight seconds, was passed through a 75 µm sieve, on which most of the dagger and ring nematodes were retained while the rest of the suspension, which passed through the 75 m sieve, was set aside undisturbed for approximately 10 minutes for further processing. The nematodes collected from the 75 µm sieve, after being concentrated in small beakers, were poured immediately onto a 115 µm (aperture) round nylon mesh sieve, standing in a glass Petri dish while enough water was added just to cover the sieve surface (Philis, 1993) whereas the nematode suspension already passed through the 75 µm aperture sieve was allowed to settle for ten minutes and then poured onto a nest of 45 and 38 µm aperture sieve. The nematodes collected from these two sieves, were then poured carefully onto a cotton-wool filter (Hygia, Milac, Germany), and transferred to a small round watch glass, already half filled with tap water. More water was added, if needed, just to touch the filter. Nematodes were left undisturbed overnight. They were then collected, mixed together and concentrated in small beakers. Counting was made under a compound microscope at X100, using the 1 cc Hawksley counting slide.

Cadusafos and carbofuran were used at the rate of 3.5 and 5.0 gr a.i. per m^2, respectively (Table I). Granular nematicides were applied by hand around each plant (r= 0.5 m) and incorporated into the soil with a rotovator, to a depth of 12-15 cm. In February, 1999, cadusafos (CS 200) was applied through drip irrigation while in March, 2000, it was applied with a large watering can into small individual basins around the basin of the grapevine. In both cases, enough water was given to each plant to penetrate the soil to 60-80 cm depth. A Randomised Complete Block design was used. There were four treatments, including the control, replicated three times, with twelve plants for each individual treatment.

Table I. Nematicides and methods and times of application.

Nematicide and formulation	Application rate (a.i.)		Amount per ha (a.i.)	Application time and method	
	per m^2	per plant		February 1999	March 2000
Cadusafos Gr 10	3.5	2.5	4.3 kg	Soil incorporation	Soil incorporation
Cadusafos CS* 200	3.5	2.5	4.3 lit	Drip irrigation	Basin irrigation
Carbofuran Gr 10	5.0	3.5	5.9 kg	Soil incorporation	Soil incorporation
Control	-	-	-	-	-

* microcapsules.

RESULTS AND DISCUSSION

Cadusafos and carbofuran controlled nematodes and substantially increased marketable yields. Over the three year period (1999-2001) each of the nematicide treatments resulted in a significant per cent decrease in the total number of parasitic nematodes (Table II). However, considering the overall mean treatment effect throughout 1999-2001 on each nematode species separately, as achieved with cadusafos Gr, cadusafos CS and carbofuran Gr, 44.9, 63.6 and 25.2 per cent significant reduction occurred for *X. index* while the reduction of *M. xenoplax* reached 57.1, 68.3 and 26.3 per cent, respectively. *P. hamatus* was also significantly reduced with cadusafos Gr and cadusafos CS by 75.2 and 83.9 per cent, respectively, while carbofuran controlled this species by only 14.5 per cent, as compared to the untreated. Carbofuran was inferior to both formulations of cadusafos in controlling each of the three parasitic nematodes, its effectiveness reaching 38.4, 42.0 and 69.4 per cent less than that of cadusafos CS for *X. index, M. xenoplax* and *P. hamatus*, respectively.

All treated plants increased marketable yields of fresh grapes compared to the untreated ones. In 1999, the first year of experimentation, all nematicides increased yields over the untreated (Table III). Both for-

Table II. Effect of nematicide treatments on nematode populations.

Treatment	Nematode species *									Total nematode population (mean of 3 years)
	X. index			*M. xenoplax*			*P. hamatus*			
	1999	2000	2001	1999	2000	2001	1999	2000	2001	
Cadusafos Gr	821 a	450 a	258 a	512 a	342 a	175 a	583 a	83 a	208 a	1.144 a
Cadusafos CS	821 a	58 b	133 a	637 a	117 a	108 a	317 a	42 a	175 a	802 b
Carbofuran Gr	904 a	708 a c	467 b	679 a	850 b	242 ab	1.483 b	650 b	708 b	2.230 c
Control	1.378 b	883 c	517 b	1.116 b	917 b	367 b	1.433 b	1.137 b	750 b	2.833 d

* Nematode numbers (250 g of soil) refer to the mean of two sampling seasons (Spring-Autumn).
Treatments having the same letter in any column are not significantly different, using the Duncan's Multiple Range test (P=0.05).

Table III. Effect of nematicide treatments on yield.

Treatment	1999			2000			2001			Mean (3 year period)		
	kg/ plant	Tons*/ ha	% incr.	kg/ plant	Tons/ ha	% incr.	kg/ plant	Tons/ ha	% incr.	kg/ plant	Tons/ ha	% incr.
Cadusafos Gr	15.2 a	25.8	15	21.4 a	36.4	12	16.8 a	28.6	40	17.8 a	30.3	20.7
Cadusafos CS	15.3 a	26.0	16	21.6 a	36.7	13	17.2 a	29.2	43	18.0 a	30.6	21.9
Carbofuran Gr	13.9 b	23.6	5	20.2 ab	34.3	6	15.0 a	25.5	25	16.3 ab	27.8	10.7
Control	13.2 b	22.4	-	19.1 b	32.5	-	12.0 a	20.4	-	14.7 b	25.1	-

* Number of plants/ha: 1,700.
Treatments having the same letter in any column are not significantly different, using the Duncan's Multiple Range test (P = 0.05).

mulations of cadusafos gave an increase of 15-16 per cent while carbofuran increased the yield by only five per cent. In 2000, both cadusafos CS and cadusafos Gr maintained their beneficial effect on yield with a significant increase of 12-13 per cent over the untreated, while there was an increase of only six per cent with carbofuran. In the third year of the experiment, however, there was an overall reduction in yield throughout the entire experimental site, mainly due to a serious outbreak of powdery mildew. In spite of this, plants in the treated plots were able to withstand, to a great extent, the damage caused by this disease and yielded more than the controls, thus emphasizing the ability of the treated grapevines to better withstand the disease. Considering yields on an overall basis for the three consecutive years, the cadusafos treatments gave a significant yield increase of 20.7 to 21.9 per cent while carbofuran was inferior, increasing yields numerically by only 10.7 per cent, over the untreated. The better response of grapevines to yield more in the cadusafos-treated plots coincided with better overall nematode control which, for this nematicide, ranged between 60.2 to 70.7 per cent, as compared to the untreated. In conclusion, the use of effective nematicides to control parasitic nematodes in established vineyards, as indicated in this trial, can be profitable. The profit:treatment cost ratio, based on producer's price, reached four, thus greatly outweighing the cost of treatment. Chemical analysis of grapes during harvest, carried out by authorized officials, did not reveal any nematicide residues in the fruit (Dept. of Agriculture, Nicosia, Cyprus).

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