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EFFECTS OF FOUR CROPPING SYSTEMS ON POPULATION DENSITIES OF *MELOIDOGYNE INCOGNITA* (ROOT–KNOT NEMATODE) ON CARROT

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ABSTRACT

The research was conducted on two farms previously under carrot *(Dacucus carota)* monoculture and intercropped sweet potato *(Ipomoea batatas)* and carrot, respectively, for the past three years. The pre-plant population densities of *Meloidogyne incognita* were highly significantly reduced (P = 0.001) under cabbage-carrot, chives-carrot and onion-carrot, as compared to sole cropping of carrot, after four months' growth. The initial root-knot nematode population densities in both farms combined were increased by 235% when carrot was grown in pure stands. Under the three crop combinations there was also a significant 40–60% reduction in root-knot gall indices of carrots, compared with carrots grown in monoculture. The potential of the three intercropping systems to manage the root-knot nematode on carrot in small farms in St. Vincent is discussed.

RESUMEN

La investigación se llevó a cabo, en dos fincas cultivadas anteriormente con zanahoria *(Daucus carota)* en monocultivo y, con relévo de camote *(Ipomoea batatas)* y zanahoria respectiveamente, durante los últimos tres años. El número de *Meloidogyne incognita* antes del plantío, fué reducido considerablemente (P = 0.001) cuando se plantó, cultivos mixtos de: repollo-zanahoria, cebollino-zanahoria y cebolla-zanahoria, comparados con el monocultivo de zanahoria, despues de cuatro meses de crecimiento. La cantidad inicial del Nodulador, en ambas fincas combinadamente fué incrementada por un 235% cuando zanahoria solamente, fué plantada. Durante el cultivo de las tres combinacionces mencionadas anteriormente se observó, un índice de reducción notable, del 40 al 60%, del Nodulador en la zanahoria, comparado con zanahoria cultivada en monocultivo. En esta presentación discutiremos el potencial de controlar el Nodulador en la zanahoria, que tienen los tres cultivos en asociación en pequenas fincas en la isla de St. Vincent.

Keywords: *Meloidogyne incognita;* Cabbage-carrot, Chives-carrot; Onion-carrot.

Cropping Systems research is assisting small farmers in the developing world to identify low cost, alternative pest management technologies.

Plant parasitic nematodes have been shown to be effectively controlled by crop rotation (Good et al., 1973, Wilson and Caveness, 1980; Hutton et al., 1982; Netscher, 1985), and by short-term fallows and certain cropping sequences (Brodie and Murphy, 1975). However, fallow may have adverse effects on organic matter and structure of soil (Good, 1968; Murphy et al., 1972).

The practice of intercropping or polycultures in traditional agriculture has several advantages. One is the occurrence of less pest damage in polycultures, because of differential susceptibility to pests, pathogens and nematodes (Altieri, 1983). Cropping sequences and intercropping are being researched for different regions of the tropics to identify those which most effectively control plant parasitic nematodes, including the root-knot nematode (Hutton et al., 1982; Netscher, 1985; Rhodes, 1985; Sasser, 1985).

Carrots in St. Vincent are traditionally grown on small farms (0.08 – 0.4 ha), and the rot-knot nematode *(Meloidogye incognita* (Kofoid & White)*)* has been associated with the steep decline in production of the crop over the past nine years (Singh, 1982).

The study reported here sought to identify intercropping systems which could limit population densities of *M. incognita*, and thereby reduce root-knot damage on carrot in St. Vincent.

Materials and methods

The experiment was located on two farms at Belmont (Farm 1) and Schwartz (Farm 2) on the Leeward side of the island. The soil is a loam classified as "Volcanic Ash".

Both farms had a history of root-knot nematode infestations on carrot over the past three years.

The four selected cropping systems were row-intercropping of onion-carrot, chives-carrot, cabbage-carrot, and pure stands of carrot. Plot size was 5.5m x 3.0m, with 30cm separating each plot. There were four ridges per plot. In the row-intercropping plots, each ridge was planted with two rows of carrot and one row of the respective intercrop. In the pure stands, carrot was seeded in three rows per ridge. Cabbage seedlings were planted 45cm apart. Chive setts, onions, and carrots were sown to give an intra-row spacing of 15cm. after the onions and carrots were thinned out as a normal cultural practice.

The treatments were arranged in a randomised complete block design, replicated four times on each farm.

In both farms, 800kg ha^{-1} of the compound fertilizer, 12:8:24, was applied along the ridges in two split applications and incorporated in the soil by trowels. Handweeding was done as needed and a fortnightly application of Decis at 0.003% a.i. was used to control onion thrips *(Thrips tabaci)* and *Plutella xylostella* on cabbage. Three sprays of Trimiltox Forte at 0.31% a.i. concentration were applied to control Early Blight disease *(Alternaria solani)* on carrot.

Preplant soil samples were collected from each plot and a further set of samples taken after four months' of crop growth. In each plot, at each sampling, 10 random cores of 200cc soil to a depth of 20cm were taken. Each plot sample was a composite of 1.5 to 2.0kg of soil. A sub-sample of 200 cc of soil was processed, and extraction of nematodes done using the pie-pan method (Gowen and Edmunds, 1973).

Analysis of variance was done on transformed, pre-plant nematode density counts [$y=\log_{10}(x + 1)$] The population density counts recorded after four months of crop growth were also adjusted for the pre-plant counts, using co-variance analysis.

Yield of marketable carrots and root-galling indices were also statistically analysed.

Results and Discussion

There was no significant difference between the means of the pre-plant population densities of *Meloidogyne incognita* in the two farms (Table 1). The post plant population densities of the two farms were, however, found to be very highly significant ($P = 0.001$), while the adjusted post-plant population counts for initial counts using co-variance analysis were also very highly significant (Table 1).

The Farms x Treatments interaction was highly significant ($P = 0.01$), indicating that in Farm 2 the three treatments, onion-carrot, cabbage-carrot, and chives-carrot significantly reduced the root-knot nematode (RKN) population, whereas in Farm 1 only the onion-carrot combination significantly reduced the nematode population ($P = 0.05$). Where carrots were grown as a monoculture there was a very large increase in nematode counts (Table 1).

Singh (1982) demonstrated the reduction in *M. incognita* population densities in land that was cropped under sweet potato-cassava and sweet potato-tannia, but did not report the corresponding root-knot indices. Population densities of the root-knot nematode *(M. incognita)* were also reduced under onion and chives after four months of growth in a mixed intercropping study (McDonald, 1985). The suitability of the host plant for nematode reproduction is perhaps the major determinant of population densities (Good et al., 1965; Brodie et al., 1970a; Brodie et al., 1970b).

Yields of marketable carrots were not significantly different among the three treatments, when compared with the carrot alone system as control, but reduction in root-knot gall indices of carrots was significant ($P = 0.05$) under the three di-cultures, as compared to those of carrots grown in single stands (Table 2). Galling of roots was found to increase with increase of nematode population, using co-variance analysis [$y=\log_{10}(x + 1)$].

Seinhorst (1965) found that population damage and yield losses are directly related to pre-plant nematode population densities.

The lack of significant differences in marketable yield of carrots can be explained by the differences in plant populations found in the four cropping systems. The onion-carrot, cabbage-carrot and chives-carrot crop combinations had a third less carrot plants than in the pure stands of carrots. Despite this difference, the chive-carrot cropping system in fact outyielded the single carrot cropping system.

It is intended to follow up this work with further trials, and to use economic analyses to determine the profitability of two of the three tested cropping systems which at the same time would reduce RKN infestations and hence damage.

The findings of this present intercropping study seem to confirm the view of Brodie and Murphy (1975) that other alternatives to chemicals such as relay intercropping, crop rotation, short-term fallow, and non-host crops, when used in combination, can result in greater nematode control and increased crop yields than when used alone.

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Table 1. Effect of four cropping systems on mean soil population densities of *Meloidogyne incognita* [a,b]

Cropping system	Nematadoes per 200cc soil[c]		
	Pre-plant count	Post-plant count	Post-plant count (adjusted for per-plant count)
Onion-Carrot	125 (2.09)	60 (1.78)	69 (1.84)
Cabbage-Carrot	149 (2.17)	104 (2.02)	109 (2.04)
Chive-Carrot	208 (2.32)	129 (2.11)	115 (2.06)
Carrot (alone)	188 (2.27)	445 (2.65)	417 (2.62)
CV	9.5%	9.62%	8.74%
LSD (P=0.05)	NS	- (0.22)	- (0.21)

[a] Data were transformed (log x + 1) for analysis of variance and calculating LSD (0.05) values and were de-transformed for presentation in the table above. Transformed values are given in parentheses.

[b] Based on four replications per farm of four observations (aliquots).

[c]Juveniles only.

[d]Post plant count = counts after 4 months growth of crops.

Table 2 Effect of four cropping systems on marketable yield and root galling of carrot[a]

Cropping system	Wt. of carrot (kg/ha)	Root gall index[b]
Onion-Carrot	6727	1.875 a[+]
Cabbage-Carrot	5515	1.875 a
Chive-Carrot	8866	1.25 a
Carrot (alone)	7091	3.125 b
	CV 36.5% SE = 4.8	30.1%

[a] Based on means of four replications per farm

[b] Mean root gall index based on: 0 = no root infected; 1 = root with a few small galls; 2 = root with many small galls; 3 = root with a few large galls; 4 = root with many large galls; 5 = root with knotted growth

[+]Means followed by a common letter are not significantly different at P = 0.05 as determined by Duncan's multiple range test

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