RELATIONSHIP BETWEEN CROP LOSSES AND INITIAL POPULATION DENSITIES OF ROOT-KNOT NEMATODE, *MELOIDOGYNE INCOGNITA* IN SOIL OF SUGARBEET GROWN IN WEST NUBARIYA DISTRICT

GOHAR, I. M. A. AND M. F. MAAREG

Sugar Crops Research Institute, Agricultural Research Center, Egypt.

(Manuscript received 25 October 2005)

Abstract

Field experiment was carried out in naturally infested soil with the plant parasitic nematode, *Meloidogyne incognita* Kofoid &White (Chitwood), at West Nubariya District throughout sugarbeet growing seasons of fall 1998 and summer of 1999. The objectives of this study were to determine the relationships between the yields (roots and sugar) of sugarbeet and population density levels of *M. incognita* at planting time, and estimating the tolerance levels and damage function parameters necessary to optimize control costs.

The initial population densities (Pi) in sugarbeet plots were determined before sowing time. The frequency distribution of population densities was made to classify them in density levels. Seeds of sugarbeet, *Beta vulgaris saccarifera* L. variety, Chems were planted. There was a negative linear relationship between roots and sugar yields of sugarbeet and levels of Pi of *M. incognita* and highly correlated value ($r = -0.988$, $P \geq 0.01$ and $r = -0.937$, $P \geq 0.01$, respectively)

From the data it can be concluded that *M. incognita* larvae attack sugarbeet plants resulting in decreasing in root and sugar yields. The yield loss % proportion to the initial population density of this nematode at planting time, generally, the rate of decrease or loss % in sugar yield was greater than in the root yield. Tolerance limit for var. Chems (Polygerm) according to calculations was at Pi = 48.0 larvae of *M. incognita* per 250 g soil, also Economic threshold (ET) was determined at Pi = 170 larvae per 250 g soil. Damage or loss levels of root yield were compared using chi-square (**X^2**) by analyzing frequency data to point out Economic injury level (EIL), which determined at Pi = 201 larvae of *M. incognita* per 250 g soil

INTRODUCTION

In the recently, reclaimed desert irrigated lands at West Nubariya and El-Bostan districts has shown that sugarbeet can be successfully grown under sandy soil area condition, but attention must be taken towards the great threat induced by plant parasitic nematodes.

Pest-induced crop losses are feature of both primitive and modern agricultural systems involved in food or fiber production. It is common knowledge among agricultural scientists that "yield gaps" exist among countries and even among farms in the same locality with comparable management and environment (Teng and Shane, 1983).

Plant parasitic nematodes, especially root-knot nematodes are known among the most serious pests of sugarbeet in many countries. Out of 50 described species of *Meloidogyne,* only few parasitized sugarbeet, viz, *M. arenaria, M. incognita, M. javanica, M. hapla and M. naasi* are economically important to sugarbeet production (Arnold, 1984). *M. arenaria, M. incognita* and *M. javanica* essentially are hot weather organisms and most important where beets are grown in districts with long, hot summers and short, mild winter. In Egypt, *M. incognita* and *M. javanica* were reported as major nematode pests of sugarbeet (Oteifa and El-Gindi, 1982; Abd El-Massih, 1985; Maareg *et al.*, 1988 a & b and 1998 and Ismail *et al.* 1996).

The average of the annual loss in yield of sugarbeet due to *M. incognita* in different states in U. S. A. was estimated to be as high as 10-50 % and in Italy as 5-15 % (Altman and Thomson, 1971). Although, yield loss estimates were based on nematode population, using earlier derived curves relating nematode densities with crop yields and on the average prices reported in certain period, no estimation for loss in sugar content due to *M. incognita* was reported in Egypt.

Reduction of crop losses due to nematodes is one way of increasing crop yields. Therefore, chemical control methods are soaring over all control methods in spite of governmental efforts to optimize the usage of nematicides through the frame of economic and environmental considerations, however, demand development of integrated pest management (IPM) programs. Fundamental to IPM approach is the development of information regarding nematode population levels below which a particular control method can be considered unnecessary (Ferris, 1978). Studies to determine damaging levels have been conducted for several nematode and crop species (Arens and Rich, 1981; Griffin, 1981; Olthof and Potter, 1972), but there is no information for sugarbeet as produced in West Nubariya district. Published reports that in most instances also were based on survey information. Although most administrators and nematologists agree that crop-loss assessments are important in order to justify public expenditures for research and education programs in nematology and plant pathology, increasingly the sources of such information are unavailable.

Therefore, the objectives of this study were to: (I) determine the relationships between the yields (roots and Sugar) of sugarbeet and population densities of *M. incognita* at planting time, and (II) estimate the tolerance levels and damage function parameters necessary to optimize control costs.

MATERIALS AND METHODS

Field experiment was carried out in 2100 m^2 area in naturally infested soil with the plant parasitic nematode, *Meloidogyne incognita* Kofoid &White (Chitwood), after primitive survey to insure the prominence of the target nematode at West Nubariya District throughout sugarbeet growing seasons of fall 1998 and summer of 1999. The site for these studies has a sandy soil contained distinctly low amount of organic matter (0.25%), and characterized by relatively low soluble cations (Ca^{2+}, Mg^{2+}, Na^+, and K^+ with values of 2.72, 1.82, 4.27 and 0.79 meq L^{-1}, respectively) and anions (CO_3^{-2}, HCO_3^-, CL^- and SO_4^{-2} with values of 0.0, 1.66, 6.81 and 1.13 meq L^{-1}, respectively). The soil had electrical conductivity of 0.96 ds/m, and pH 8.09. Also, it had 9.74 % $CaCO_3$, and relatively low N, P, and K with values of 31.20, 3.10 and 77.50 ppm, respectively.

Seeds of sugarbeet, *Beta vulgaris saccarifera* L. variety, Chems were planted on the second week of November, 1998. The trial was planted in a randomized complete block design with eight blocks. Each block consisted of 25 plots. Individual plot consisted of six ridges, 50 cm apart and 3.5 m long (about 1/400 feddan). Five holes per meter were planted to provide about 40,000 plants / feddan. With the exception of no nematicide usage, plots were managed throughout the growing season by standard grower practices and were irrigated as needed.

The initial population densities in sugarbeet plots (a total of 200 plots) were determined before sowing time. The frequency distribution of population densities was made to classify them in density levels according to the methods described by Bishr and El-Robbi (1979) as follows:

- Estimate the range of initial population (Pi) densities (i.e. the difference between the maximum value and minimum value of Pi).
- Determine the number of density levels by using Yule formula (Number of levels = $2.5 \times \sqrt[4]{N}$; where N = number of plots).
- Determine level interval by dividing range / number of levels.
- Estimate the level mark (i.e. the value of the level); this value is calculated on the basis of systematical distribution of the individuals within each level and could be deduced by dividing (the upper limit of the level + lower limit of the level)/2.
- Distributing plots according to their values of initial population densities on the density levels.
- Determine the frequency occurrence of each density level in the investigated plots.

The densities were plotted on scale with unity = 15 larvae / 250 g soil (0.06 larvae / g soil). The average yields in all densities level were calculated and expressed as proportion of average yield per plot with (0 to 387 larvae / 250 g soil and 0 to 1.55 larvae / g soil).

The proportion were plotted against the centers of the density levels curves according to the general model developed by Sienhorst damage function (1982) for determination of yield response to nematode population density levels and, tolerance limit, this model is:

$Y = m + (1\text{-}m)\, z^{p-T}$

Where Y = a ratio between yield at nematode density P and that in the absence of nematode;

m = the yield at nematode densities in which all available space is occupied by the nematodes (minimal yield);

z = a constant less than 1 (= to proportion of plants not attacked at population density P= 1);

P = the population density is usually ≥ T (Y = where P is equal to or less than T); and

T = the nematode density below which no detectable loss in yield occurs.

Whereas, relating initial nematode numbers to yield in this model, it is useful in predicting responses to differential population densities

Also, correlation and regression equations between initial population of *M. incognita* and yields (roots and sugar) and quality characters as well as number of galls / root were made. The chi-square analysis was then applied to the average population data (Pi) in relation to root yield data for each Pi level to assure if is there a relation between them and to detect the critical value for chi-square that at which the economic injury level of *M. incognita* could be deduced.

RESULTS AND DISCUSSION

1- Relationship between initial population density (Pi) of *M. incognita* and sugarbeet yields :

Nematodes found in the soil's trial were seven species of plant parasitic nematodes associated with sugarbeet plants. These species were; *Helicotylenchus dihystera* Cobb (Fam: Hoplaimidae), *Macroposthonia* (*Criconemoides*) sp . Raski & Luc (Fam: Criconemoidae), *Meloidogyne incognita* Chitwood, *Meloidogyne javanica* Chitwood (Fam: Meloidogynidae), *Pratylenchus* sp. Filipjev (Fam: Pratylenchidae), *Rotylenchulus reniformis* Linford & Oliveira (Fam: Hoplolaimidae) and *Tylenchorhynchus* sp. Cobb (Fam: Tylenchorynchidae). All these species are following order Tylenchida, their occurrence rate and absolute densities are presented in Figure (1). The highest absolute density (2115.25 X 10^3 individual / m^2 soil) was detected with the root-knot nematode, *M. incognita* and this revealed that *M. incognita* is a major pest species. The other plant-parasitic nematodes were present only in low numbers and thus considered to have negligible impact in this study. The root-knot nematode species was identified as *M. incognita* Race 1 from perineal patterns and a differential host test (Hartman and Sasser, 1985).

Relationships between numbers of the nematode, *M. incognita* in the soil at planting time and marketable yields of sugarbeet (cv. Chems) were studied in 200 plots on sand soil in the West Nubariya district.

Studied plots could be grouped according to the naturally occurring initial population density of the nematode, *M. incognita* into 13 levels as shown in Table (1). Their numbers ranked from 15 to 387 larvae per 250 g soil at planting. The influence of these levels of initial population on gall formation and yields (roots and sugar/ fad.) of sugarbeet was reported in Table (2) and Fig. (2 a, b, c, and d).

The results in Table (2) revealed that a general trend, however, was the gradual increase in the number of galls with increasing naturally initial population level (Pi). At harvest time, the number of galls per root was more greater (206) in case of high pi (387 larvae /250 g soil) than (20 galls) with low one (15 larvae /250 g soil). The increase in galls number was positively correlated ($P \geq 0.01$) with increasing of initial population level (Pi) as shown in Table (3).

Data in Table (2) and Fig. (2 a) also, show that sugarbeet yields per feddan were varied with the different levels of nematode densities at planting. All initial population levels for *M. incognita* seem to cause sugarbeet yields losses, which appeared in significant reduction of roots and sugar yields when compared with the low level as the check.

There was a negative linear relationship between roots yield of sugarbeet and levels of Pi of *M. incognita* and highly correlated value ($r = -0.988$, $P \geq 0.01$, Fig. 2a).The slope of the regression line relating roots yield was much steeper (-0.0569, Table, 4). Root yield decreased gradually with increasing the level of initial population density. Roots yield decreases in proportion to the initial population of the *M. incognita in* soil. The maximum yield of roots (43.9 tons/fed) was obtained with the lowest level of Pi, while, the minimum one was obtained with the highest Pi level. The percentage of proportional decrease from control in roots yield was more than 50 % only for level of 387 larvae /250 g soil for *M. incognita.* This response refers to that the Pi level resulted in stunted plants with small root weight, which can't support high population of nematode.

Also, a progressive decline in sugar yield was observed with the increasing of the level of population at planting time, the same relationship for sugar yield ($r = -0.937$, $P \geq 0.01$, Fig. 2c) the lowest sugar yield was obtained by the highest level of Pi. Loss of sugar yield increased gradually to attain 51.3, 59.2 and 68.4 % by initial population densities of 325, 356 and 387 larvae /250 g soil levels, respectively.

In the similar studies, the results indicated that the initial population of beet cyst nematode, *Heterodera shachtii* of 10 eggs + juveniles/g soil resulted in root yield of sugarbeet losses between 1 and 64 % (Cooke and Thomason, 1979; Greco *et al.* 1982 and Cook, 1984).

From the previous data it can be concluded that *M. incognita* larvae attack sugarbeet plants resulting in decreasing in root and sugar yields. Yield loss % proportion to the initial population density of this nematode at planting time, generally, the rate of decrease or loss % in sugar yield was greater than in the root yield.

The reduction in root and sugar yield was negatively correlated ($P \geq 0.01$) with increasing of initial population density of *M. incognita* nematode at planting. The expected yield of sugarbeet (cv. Chems) at any level of initial population density of *M. incognita* at the planting could be achieved by using the constant (a) and regression coefficient (b) {regression equation} as shown in Table (3). Finally, the relationships between total yield of roots and actual sugar can be described as a single damage function (Figs. 2 b and d).

2- Estimation of Tolerance limit

Analysis was performed with Sienhorst (1982) damage function as the model to relate yields to nematode densities in order to estimate Tolerance limit " T " (the nematode density below which no detectable loss in yield occurs) could be calculated according to the equation :

$$Y = m = (1-m)*0.95^{(P/T)-1}$$

with z^{-T} *equals The constant* 0.95^{-T}

where, Y = the ratio between the average yield in the level with mean larvae density P, from the data in table (2) and by the above equation.

The " Tolerance limit " of Chems variety could be deduced as follows:

for $P \geq T$ and $Y = 1$ for $P < T$

$0.99 = 0.49 + (1 - 0.49)*0.95\,(46/T)^{-1}$

$0.99 = 0.49 + (0.51)*0.95\,(46/T)^{-1}$

$0.99 = 0.49 + 0.48 / (46/T)$

$0.99 - 0.49 = 0.48 * T/46$

$0.50 = (0.48 * T)/46$

$23.0 = (0.48 * T)$

Hence, T = 23.0 /0.48 = 48.0 larvae per 250 g soil for var. Chems, i.e. the Tolerance limit for var. Chems is at Pi = 48.0 larvae of *M. incognita* per 250 g soil.

Economic threshold (ET)

The same damage function of Sienhorst can be used by the same way to determine economic threshold (ET) which is defined as the Pi at which the value of the crop loss is equal to the cost of the management option (Ferris, 1978). Thus, the data in Table (2) were used to calculate ET by using losses for a range of Pi values and selected the ET on the basis of the corresponding array of losses, ET was determined by this way at Pi = 170 larvae of *M. incognita* per 250 g also, ET can be deduced from the curves of yield losses in Figs. (2 b & d).

Economic injury level (EIL)

Damage or loss levels of root yield were compared using chi-square ($\mathbf{X}^2$) by analyzing frequency data for latency data, i.e., to point out Economic injury level (EIL) which is defined as the pest population that inflicts crop damage greater than the cost of control measures Rex Dufour (2001). The data shown in Table (4) revealed that the calculated $\sum \mathbf{X}^2$ (93.32) of the thirteen levels was greater than the tabulated $\mathbf{X}^2$ $P \geq 0.05$ (18.3 at df = 10), this proves that there is a strong relationship between Pi levels and root yield of sugarbeet. In regard to chi-square analysis of segregation for means of root yield plotted against Pi levels (13 levels), there was absence of any segregation till the sixth level of Pi (170 larvae\250 g soil), whereas, The critical value for $\mathbf{X}^2$ (25.03 $P \geq 0.05$ df 12) appeared at the seventh level (Pi = 201 larvae\250 g soil) which paralleled 34.1 ton roots/fad. Which denote to EIL. Therefore, we would obtain a useful diagnostic tool for EIL

REFERENCES

1. Abd El-Massih, M. I. 1985. Biological studies on major plant parasitic nematodes infecting sugar beet in Egypt. Ph. D. Thesis, Fac. of Agric., Cairo Univ., 90 pp.
2. Altman, J. and Thomsom, I. 1971. Nematodes and their control. In : Advances in sugarbeet production principles and practices. pp. 335-370 (T.J. Russell, T.A. John, E.R. George and R.H. George eds.). The Iowa State Univ. Press, Ames, Iowa, U.S.A.
3. Arens, H. L. and Rich, J. R. 1981. Yield response and injury levels of *Meloidogyne incognita* and *M. javanica* on the susceptible tobacco "McNair 944". J. Nematology 13: 196-201.

4. Arnold, E. S. 1984. Nematode parasites of sugarbeet. In: Plant and Insect Nematode. ed. Nickle, W.R. New York: Marcel Dekker, INC.PP.507-569.

5. Bishr, M. A. and El-Robbi, M.M. 1979. Introduction to statistical methods and experimental design. 2nd eddtion (in Arabic). Dar Al-Mattboat El-Gedidah, Alex., Egypt. PP 419.

6. Cooke, D. A . 1984. The relationship between numbers of *Heterodera shachtii* and sugarbeet yields on a mineral soil. Ann. Appl. Biology, 104: 121-129.

7. Cooke, D. A. and Tomason, I. J. 1979. The relationship between population density of *Heterodera schachtii*, soil temperature and sugarbeet yields. J. Nematology, 11: 124-128.

8. Ferris, H. 1978. Nematode economic thresholds: Derivation, requirements, and theoretical implications. J. Nematology, 10: 341-350.

9. Greco, N.; Brandonisio, A. and De Marinis, G. 1982. Tolerance limit of the sugarbeet to *Heterodera shachtii*. J. Nematology, 14: 199-202

10. Griffin, G. D. 1981. The relationship of *Heterodera shachtii* population densities to sugarbeet yields. J. Nematology, 13: 180-184.

11. Hartman , K. M. and J. N. Sasser 1985. Identification of *Meloidogyne* species on the basis of differential host test and perineal-pattern morphology. Pp. 69-77 in K. Barker, C. C. Carter, and J. N. Sasser, eds. An advance treatise on *Meloidogyne*, Vol. 2.; North Carolina State University Graphics Raleigh, NC.

12. Ismail, A. E.; Aboul Eid, H. Z. and Besheit, S. Y. 1996. Effects of *Meloidogyne incognita* on growth response and technological characters of certain sugarbeet varieties. Afro-Asian J. Nematology, 6(2): 195-202.

13. Maareg, M. F.; El-Deeb, M. H. and Ebieda, A. M. 1988 a. Susceptibility of ten sugarbeet cultivars to root-knot nematode, *Meloidogyne* spp. Alex. Sci. Exch., 9(3): 293-302.

14. Maareg, M. F.; Hassanein, M. A.; Allam, A. I. and Oteifa, B. A. 1998. Susceptibility of twenty six sugarbeet varieties to root-knot nematodes *Meloidogyne* spp. in newly reclaimed sandy soils of Al-Bostan district. Egypt. J. Agronematology, 2(1): 111-125.

15. Maareg, M. F.; Hassanein, M. A. and Ebieda, A. M. 1988 b. Diseases of sugarbeet (*Beta vulgaris* L.) in Egypt. Com. Dev. Res., 22: 65-73.

16. Olthof, T. H. A. and Potter J. W. 1972. Relationship between population densities of Meloidogyne hapla and crop losses in summer maturing vegetables in Ontario. Phytopathology, 62: 981-986.

17. Oteifa, B. A. and El-Gindi, D. M. 1982. Relative susceptibility of certain commercially important cultivars to existing biotypes of *Meloidogyne incognita* and *M. javanica* in Nile-Delta, Egypt. In: Proceeding of the 3rd Research and Planning. Conf. of Root-knot Nematodes, *Meloidogyne* spp. 13-17 September, 1982. Coimbra, Portugal. pp: 66-84.
18. Rex Dufour 2001. Biointensive integrated pest management (IPM)- Part one- Fundamentals of sustainable agriculture. publication of ATTRA - National Sustainable Agriculture Information Service. pp: 52.
19. Sienhorst, J. W. 1982. The relationship in field experiments between population density of *Globodera rostochiensis* before planting potatoes and yield of potato tubers. Nematologica 28: 277-284.
20. Teng, P. S. and Shane, W. W. 1983. Crop losses due to plant pathogens, Inter. Proc. 10th Inter. Confer. Plant Prot., Brighton, England. Vol. I. pp.:81-89.

Table (1): The frequency distribution of initial population densities of *Meloidogyne incognita* juveniles within plots of naturally infested sugarbeet experimental fields.

Serial level	Level boundaries	Frequency occurrence
1	0 - 30	5
2	31 – 61	6
3	62 – 92	9
4	93 – 123	14
5	124 – 154	17
6	155 – 185	32
7	186 – 216	35
8	217 – 247	32
9	248 – 278	18
10	279 – 309	13
11	310 – 340	7
12	341 – 371	7
13	372 - 402	5

Table (2): Roots and sugar yields response of sugarbeet crop (var. Chems) to initial population densities of *Meloidogyne incognita* infesting soil of sugarbeet fields at, West Nubariya District.

Level Rank	Pi as No. Larvae /250 g soil	No. of Galls /root system	Actual Root yield Per ton/fad.	Root yield (y) as a proportion of max. y (%)	Root Yield loss (%)	Actual sugar yield/ ton fad.	Sugar Yield (y) as a proportion of max. y (%)	Sugar Yield loss (%)
1	15	20	43.9	100.0	00.0	7.6	100.0	00.0
2	46	31	43.6	99.3	0.7	6.7	88.2	11.8
3	77	43	41.8	95.2	4.8	5.1	67.1	32.9
4	108	66	39.8	90.7	9.3	5.3	69.7	30.3
5	139	107	37.2	84.7	15.3	5.1	67.1	32.9
6	170	115	37.0	84.3	15.7	5.0	65.8	34.2
7	201	114	34.1	77.7	22.3	4.7	61.8	38.2
8	232	155	33.9	77.2	22.8	4.4	57.9	42.1
9	263	171	31.8	72.4	27.6	4.2	55.3	44.7
10	294	183	30.4	69.2	30.8	4.0	52.6	47.4
11	325	183	28.7	65.4	34.6	3.7	48.7	51.3
12	356	203	25.1	57.2	42.8	3.1	40.8	59.2
13	387	206	21.6	49.2	50.8	2.4	31.6	68.4

Table (3): The relationship between initial population of *Meloidogyne incognita* and sugarbeet yields.

Variables	Mean (Range)	Correlation coefficient(r) between X & Ys	Regression equation between X & Ys (y = a + bx)
Initial population (Pi=x) Larvae/250 g soil	201 (15-387)	___	___
Galls No./root system (Y_1)	122.8 (20-206)	+0.9820***	*** $Y_{1=16.3070\,+\,0.5408(Pi)}$
Root yield ton/ fad. (Y_2)	34.5 (21.6 - 43.9)	-0.9887***	*** $Y_{2=45.9595\,-\,0.0569(Pi)}$
Sugar yield ton/ fad. (Y_3)	4.7 (2.4-7.6)	-0.9371***	*** $Y_{3=6.8067\,-\,0.0169(Pi)}$

Table (4): Chi-square analysis of segregation for means of sugarbeet root yield (ton/fad.) resulted under different Pi levels of *Meloidogyne incognita.*

Pi levels	1	2	3	4	5	6	7	8	9	10	11	12	13
larvae/250 g soil	15	46	77	108	139	170	201	232	263	294	325	356	387
Root yield ton/fad.	43.9	43.6	41.8	39.8	37.2	37.0	34.1	33.9	31.8	30.4	28.7	25.1	21.6
Observed frequency	5	6	9	14	17	32	35	32	18	13	7	7	5
Expected frequency	1/13 X 200 = 15.38												
Chi-square (X^2)	7.01	5.72	2.65	0.12	0.17	17.96	25.03***	17.96	0.45	0.37	4.57	4.57	7.01

$\Sigma X^2 = 93.32$ *** critical value of X^2 at $P \geq 0.05$ df = 12

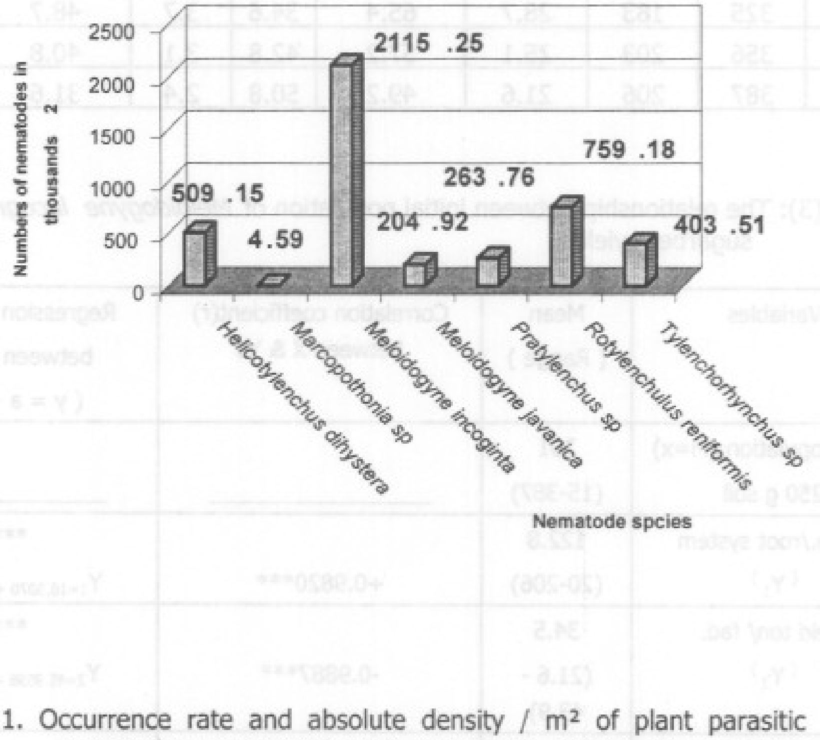

Fig. 1. Occurrence rate and absolute density / m² of plant parasitic nematodes associated with sugarbeet plants at the West Nubariya district.

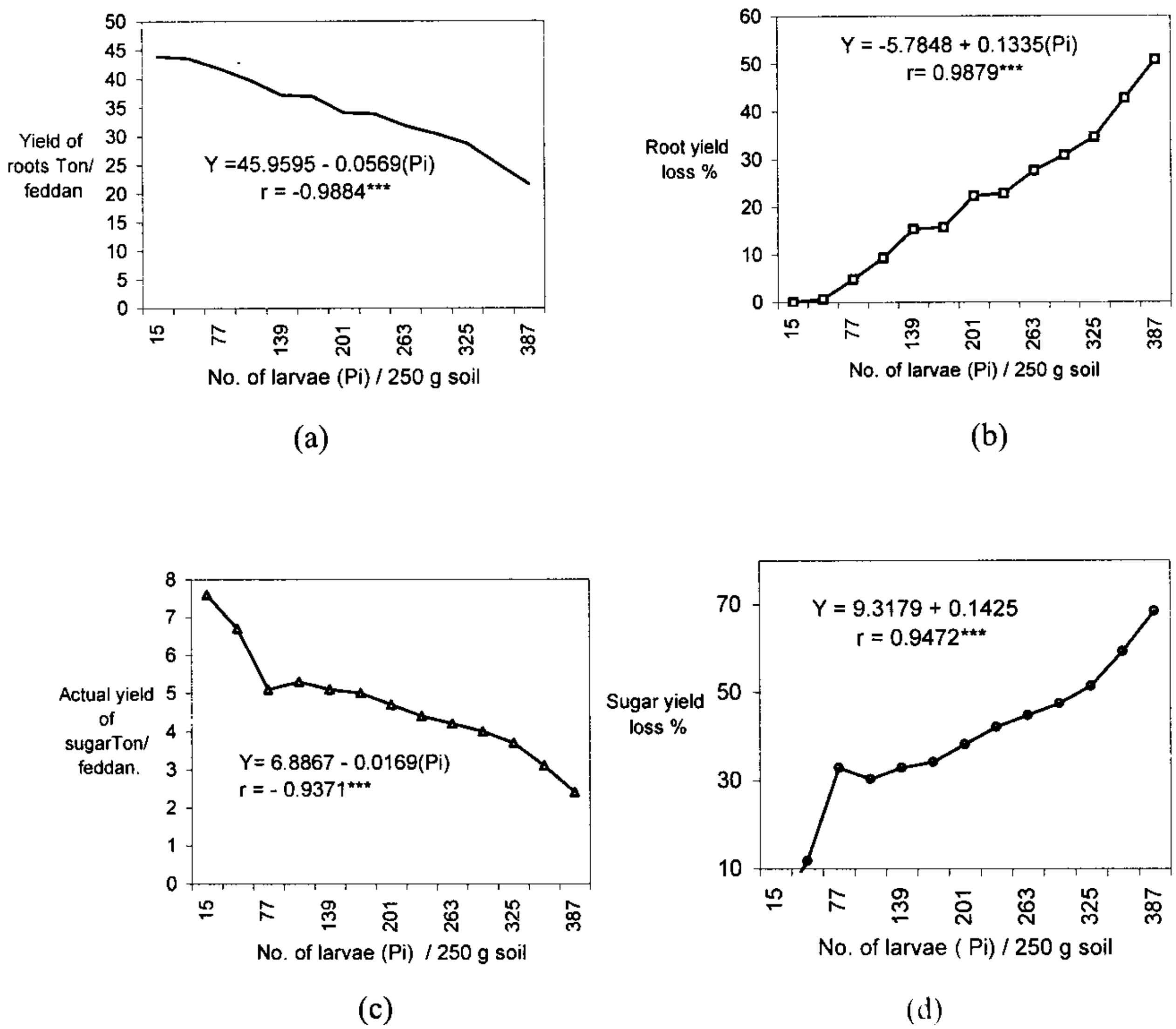

Fig. 2. Roots and sugar yields response of sugarbeet crop (var. Chems) to initial population densities of *Meloidogyne incognita* infesting soil of sugarbeet fields at the West Nubariya district.

العلاقة بين الفقد في المحصول والتعداد الابتدائي الطبيعي في التربة لنيماتودا تعقد الجذور مليدوجين إنكوجنيتا التي تصيب بنجر السكر في منطقة غرب النوبارية

إبراهيم محمد عبده جوهر **محمد فتحي معارج**

معهد بحوث المحاصيل السكرية – مركز البحوث الزراعية – جيزة – مصر

أجريت هذه الدراسة في أرض زراعية ذات تربة ملوثة طبيعياً بنيماتودا تعقد الجذور، مليدوجين إنكوجنيتا وذلك في منطقة غرب النوبارية في خريف ١٩٩٨ و صيف ١٩٩٩. كان الغرض من هذه الدراسة، هو تحديد العلاقة بين الخسارة أو الفقد في كلاً من محصولي الجذور و السكر لنبات بنجر السكر و مستويات كثافة التعداد الابتدائي لهذه النيماتودا عند الزراعة وحساب حد التحمل باستخدام معادلة حساب عوامل الضرر ذات الأهمية في تحسين تكاليف المكافحة إلى الحدود المثلى.

تم في هذه الدراسة تحديد الكثافات المختلفة لتعداد نيماتودا تعقد الجذور قبل الزراعة و تحديد التوزيع التكراري لمستويات هذه الكثافات ، و تم عمل التحليل الإحصائي لاكتشاف مدى الارتباط بين هذه المستويات من العدوى و كمية المحصول. وجدَ أن هناك تلازم و علاقة عكسية قوية بينهما وكانت قيمة معامل الارتباط (ر) عالية (ر = ٠,٩٨٨ و ر = ٠,٩٣٧ باحتمال ≥٠,٠١ لكلاً من محصولي الجذور و السكر على التوالي).

أوضحت النتائج أن عدد العقد الجذرية يزيد بزيادة مستوى كثافة التعداد الطبيعي الابتدائي، كما أتضح أيضاً من الدراسة ، أن مهاجمة يرقات مليدوجين إنكوجنيتا لنباتات بنجر السكر ينتج عنها انخفاض في محصول الجذور و إنتاج السكر. وأن الخسارة في المحصول كنسبة مئوية منسوبة إلى كثافة التعداد الابتدائي (ت.ا.) لهذه النيماتودا عند الزراعة، تكون أكبر في محصول السكر من محصول الجذور.

كما تمَ حساب مدى التحمل للصنف شيمس (عديد الأجنة) وكان عند ٤٨ يرقة من مليدوجين إنكوجنيتا / ٢٥٠ جم تربة، و كذلك تم حساب الحد الاقتصادى الحرج وكان عند ١٧٠ يرقة/ ٢٥٠ جم تربة. كما تم استخدام تحليل مربع كاي لتحديد الحد الاقتصادي للضرر وكان عند مستوى ٢٠١ يرقة من مليدوجين إنكوجنيتا /٢٥٠ جم تربة.