

Potential Loss in Soybean Yield Due to Root-Knot Nematode, *Meloidogyne Arenaria* in Sandy Soil

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Abstract

During 2015 summer season, relationship between the root-knot nematode damage (root galling) and growth and yield of soybean was studied in a field of sandy soil naturally infected with *Meloidogyne arenaria* for showing the effect of nematode infection on soybean yield. At soybean harvest, about 100 plants were randomly selected for assaying their root galling (damage) and yield. Top shoot weight and seed yield were negatively correlated with nematode damage with highly correlation coefficient (r) – 0.97 in case of shoot weight and -0.96 in case of seed yield. Observed loss in the top shoot weight was 36.47% and was 44.7% in seed yield at severely damage (GI-5). While the expected loss was 38.7% and 46.5% for shoot and seed yield, respectively.

Key words: Soybean, root-knot nematodes damage, yield loss.

Introduction

Soybean (*Glycine max* L.) was introduced to Egypt more than 50 years ago, but its commercial cultivation has been begun during the two last decades (**Kella et al., 2011**). Now it is successfully grown as an early summer crop in different localities of Egypt. Soybean is considered one of the important food crops for human and animals, so its cultivation rapidly increased in many parts of the world. Value of soybean depends the seed oil content which is ranged from 19-22% (**Harry and Kown, 1987**) and protein content that ranged from 30-50% (**Singh et al., 1987**).

The root-knot nematodes *Meloidogyne* spp. are of great economic and social importance, being serious plant pathogens worldwide distribution infecting a wide range of crops causing loss up to 80% in heavily infested fields with average yield losses ranging from 28% to 68% (**Chaudhary et al., 2011**). Thus they are considered one of major limiting factors in the production field and plantation crops, predominantly in warmer climatic but also in temperate regions (**Riggs & Niblack, 1993; Jepson, 1987; Siddiqi, 2000**). Soybean plants had been early included in the list of plants which are infected with the root-knot nematodes *Meloidogyne* species (**Goodey et al., 1965**). The root-knot nematodes. *M.incognita*, *M.javanica* and *M.arenaria* are dominant in warmer climatic regions and cause great losses in soybean yield, so they are important factors limiting soybean production (**Schmitt**

and Noel, 1984). Loss in soybean yield was estimated by 90% due to *M.incognita* in Florida (**Kinloch, 1974**). In the USA and Canada (Ontario), over 93000 metric tons of soybean were lost annually between 1999 and 2002 due to *Meloidogyne* species (**Wrather et al., 2003**). Also in Gorgea State, the yield of soybean grown in fields naturally infested with the root-knot nematodes treated with DBCP nematicide, increased by 48.1% (**Minton, 1979**). Recently during years of 2003-2005 the combined soybean yield loss due to *Meloidogyne* species and all other phytonematodes was ranged between 106 to 139 thousand tons in USA (**Noel, 2008**).

In Egypt many reports indicated that soybean plants are infected by the root-knot nematodes *Meloidogyne* spp. (**El-Sherif and Ismail, 2011; Ibrahim, 2011**). Most studies were done on effect of root-knot nematodes on vegetative growth parameters in pot experiment. Growth parameters of soybean were inhibited due to *M.incognita* by 37.3%, 31.9% and 42.8% for length, fresh weight of plants and number of leaves per plant, respectively (**El-Sherif et al., 2012**). Still loss in soybean yield due to root-knot nematodes is not yet accurately determined specially in natural infested fields of Egypt.

Estimating yield loss of a such crop due to root-knot nematodes can be determined by relating the yield with the nematode population in soil at planting or by relating the yield with the root knot severity (nematode damage). Relating between different nematode populations densities in the soil at planting and yield of plants is a good method for estimating the nematode threshold population levels (damage threshold, tolerance limit and economic threshold) including the yield loss (**Seinhorst, 1965**). But a reliable estimation of root-knot nematode population density in a natural field at planting is so difficult because (1) the spatial distribution of nematodes in the field is heterogeneous, (2) the egg masses remain intact in the soil free or attached to root fragments of the previous host, thus majority of soil analysis methods used will not always detect the egg masses in field with low root-knot infection (**Netscher and Sikora, 1990**). An accurate estimation of yield loss can be obtained by relating the crop yield with the root-knot severity at the end of vegetative period of plants (shortly before harvest). Therefore, the objectives of the present work were (1) to relate the yield of soybean with the root-knot damage (severity of root galling) at harvest for calculating yield loss caused by nematodes, (2) to depict the nematode damage-yield curves for estimating the expected yield loss.

Materials and Methods

Location of the study:

The experiment was conducted during 2015 summer season in a field of sandy soil naturally infested with root-knot nematode at the Experimental Station of

National Research Centre, Noharia Distruct, El-Beheira governorate, Egypt.

Test nematode:

The adult females of *Meloidogyne* were collected from the infected soybean roots at harvest. Then were identified according to the morphology of their perineal pattern (**Hunt and Handoo, 2009**).

Test plant and layout of the experiment:

Seeds of soybean cv. Giza-21 which was previously categorized as susceptible cultivar (**El-Sherif et al., 2012**) were obtained from Legume Research Department, Field Crops Research Institute, Agriculture Ministry. Area of the experiment about 4000 m², was prepared before planting in rows of 50 cm width. Seeds were planted in hills at rate of 2-3 seeds per hill in 1-5-2015. Mixture of calcium superphosphate (15% P₂O₅) at rate of 400kg/h and potassium sulphate (48.5% K₂O) at rate of 200 Kg/h was added during seed bed preparation. Ammonium nitrate (33.5% N) at rate of 400 Kg/h was added in two equal portions one and two months after seed germination.

Nematode damage assaying:

Shortly before harvest (12-9-2015) more than one hundred soybean plants were randomly selected, and processed for assaying severity of nematode damage (root gall indices, GI) according to **Barker (1985)** as follows: 1= no galls, 2= 1-25% galls, 3= 26-50% galls, 4= 51-75% galls, 5= 76-100% galls.

Soybean growth and yield assessment:

Same selected plants were also processed for determining their fresh shoot weights and seed yield.

Statistical analysis:

Data were subjected to analysis of variance (ANOVA) and averages of fresh shoot weights and seed yield per plant were compared according Tukey test (**Neler et al., 1985**). Relationships between root-gall indices (GIs) and soybean growth and yield were depicted as regression lines for derivation linear and quadratic equations and for determination correlation coefficient (r) between nematode infestation and soybean growth and yield.

Results

Data presented in Table (1) indicated that growth and yield of soybean (cv. Giza -21) were significantly influenced by the nematode infection (root-galling). Significant reductions (P=0.05) 12.66%, 31.66% and 36.47% in top shoot weight of plants were occurred at 3, 4 and 5 root gall indices, respectively, while at GI-2 no significant reduction was obtained. Also, seed yield per plant was significantly reduced by 13.5%, 39.3% and 44.7% at GI 3, 4 and 5, respectively. A lower

infection (GI-2), seed yield was not affected. Root gall indices (GIs) were plotted against the shoot weight per plant (Fig. 1) and seed yield per plant (Fig. 2) for depicting the regression lines. Data showed that the relationship between nematode infection and both growth and yield of soybean were negative with high correlation coefficient (r) -0.98 in case of shoot weight and -0.97 in case of seed yield. According to the quadratic equation, the expected loss of soybean severely infected with nematodes (100% root galling = GI-5) were more than loss obtained from the experiment. Expected loss in shoot weight was 38.7% and it was 46.5% in case of seed yield (Table -1).

Table (1): Relationship between *M.arenaria* root galling and growth and yield of Giza -21 soybean.

Root gall index (GI)	Fresh shoot weight g/plant	Red. %	Expected* reduction%	Seed yield g/plant	Red %	Expected * reduction %
1	97.9 a (n=18)	-	-	97.6 a	-	-
2	95.0 a (n=17)	2.96	5.6	89.5a	8.3	8.2
3	85.5 b (n=20)	12.66	14.8	84.4 b	13.5	19.2
4	66.9 c (n= 19)	31.66	25.8	59.2 c	39.3	31.9
5	62.2 c (n= 18)	36.47	38.7	55.0 c	44.7	46.5

n: Number of replicates.

Means having different letter are significantly ($P=0.05$) according to Tukey test.

* Based on the quadratic regression equations.

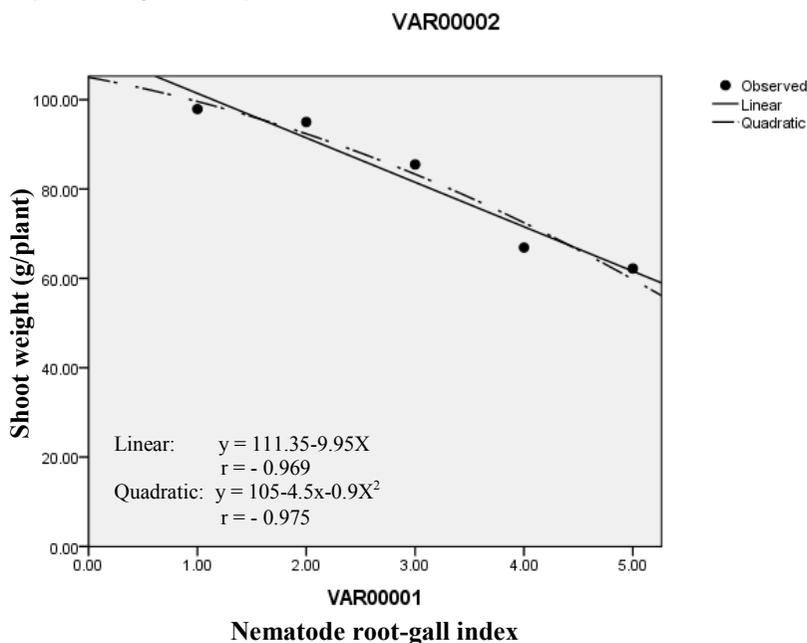


Fig. (1): Relationship between nematode root-gall index and the top fresh shoot weights of soybean.

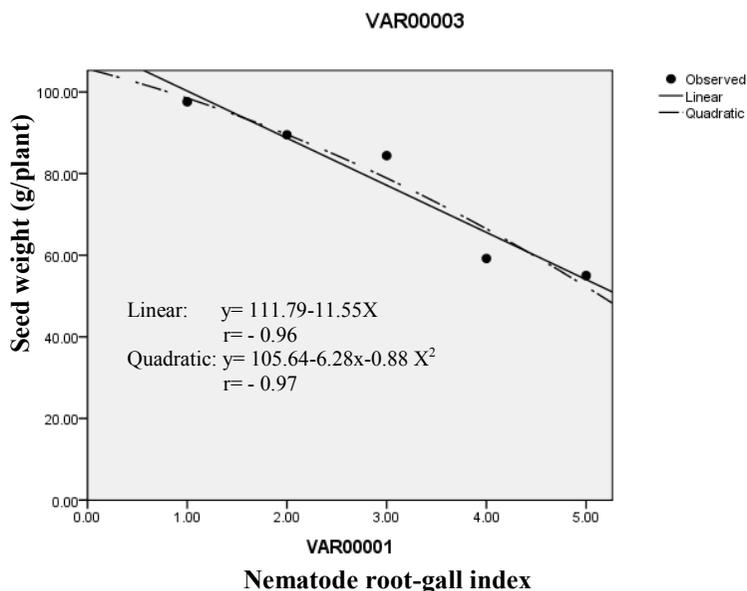


Fig. (2): Relationship between nematode root-gall index and seed weight of soybean.

Discussion

Information on the extent of damage the nematode may cause to plant yield, especially the yield loss, is basic in making management decisions. In the present study, observed loss in soybean yield caused by the root knot nematode *M.arenaria* under natural infestation was estimated at harvest stage. Relationship between nematode damage (root galling) and yield was depicted as linear and quadratic regressions, then expected loss in soybean was assessed. Determination of loss in yield caused by the root knot nematodes by relating severity of root galling at harvest with yield may be more accuracy than determination of yield loss by relating the initial nematode population (P_i) before planting with yield. Since estimation of nematode density in soil before planting is difficult because reasons which previously mentioned in the introduction, moreover in many cases, plants at harvest were found to be heavily galled (infected) still soil nematode analysis was negative at planting ie soil was nematode free.

Our data suggested that soybean cv. Giza-21 is infected with the root-knot nematode *M.arenaria*, and its yield is subjected to great reduction. As the top shoot weight and seed yield were reduced by 36.47% and 44.7%, respectively at severe infection (GI-5), while expected reductions were 38.7% and 46.55, respectively.

The root-knot nematodes (*Meloidogyne* species) infect soybean plants in many parts of the world causing great loss in its yield. In USA, the combined crop

loss due to *Meloidogyne* spp. and all other nematode species ranged from 106000 to 139000 tons during the years of 2003-2005 (**Wrather and Koenning, 2006**). Loss in yield was sometimes dramatic, reached 100% in yield of highly susceptible soybean cultivars (**Riggs and Niblack, 1993**). Finally, results showed that soybean is severely infected with the root-knot nematodes when is grown in sandy soil infected with nematodes and the expected loss in its yield is highly significant. So the producers and growers should take this fact in their consideration before make a decision of cultivation.

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الخسارة المتوقعة في محصول فول الصويا بسبب نيماتودا تعقد الجذور (*Meloidogyne arenaria*) تحت ظروف التربة الرملية

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الملخص العربي

في أثناء الموسم الزراعي الصيفي لعام ٢٠١٥، تم دراسة العلاقة بين شدة الإصابة (درجة التعقد الجذري) بنيماتودا تعقد الجذور من النوع *Meloidogyne arenaria* وبين نمو محصول فول الصويا المنزوع في أرض رملية مصابة طبيعياً بالنيماتودا، وذلك لبيان نوع ودرجة الارتباط بينهما وكذا حساب الفاقد المتوقع في المحصول. تم اختيار حوالي (١٠٠) نبات عشوائياً وتقدير درجة التفقد الجذري وكذا الوزن الخضري ومحصول البذور لكل نبات على حده وأوضحت النتائج ما يلي:

١- العلاقة بين وزن كل من المجموع الخضري والبذور وبين درجة الإصابة كانت سالبة بمعامل ارتباط قوي قدره سالب ٠.٩٧ وسالب ٠.٩٦ في حالة وزن المجموع الخضري ووزن البذور، على التوالي.

٢- كمية الفاقد التجريبي (المشاهد) في الوزن الخضري وفي وزن البذور في حالة الإصابة الشديدة (نسبة تعقد ١٠٠%) كان ٣٦.٤٧%، ٤٤.٧% على التوالي، في حين أن الفاقد المتوقع (المحسوب من المعادلات الرياضية) كان ٣٨.٧%، ٤٦.٥% على التوالي، أي أعلى من الفاقد المشاهد.

الكلمات الدالة: فول الصويا، نيماتودا تعقد الجذور، نسبة الفاقد، الضرر.