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Effect of selected planting dates on root- knot nematodes population and productivity of sugarbeet variety, Pleno

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Abstract

The effect of three planting dates (August 25, September and October) on infectivity of root- knot nematode species and productivity of sugar beet var. Pleno was evaluated. The results indicated that the 1st planting date showed the highest values of nematode infection parameters (i.e. numbers of galls, eggmasses, development stages root system^{-1}, juveniles in soil and final population as well as reproduction factor) followed by 2nd planting date. However, the 3rd planting date achieved the lowest values of those nematode parameters. In addition, the data revealed that the 1st planting date obtained only the highest values for sucrose and purity percentages. On the other hand, the 3rd planting date recorded the highest values of roots, top, biological and sugar yields (tons fed^{-1}). Therefore, the 3rd planting date (during October) was the most effective date against concerned species of root-knot nematodes on naturally infested sugar beet grown in sandy soil using drip irrigation system.

Key words: planting dates, root- knot nematodes, control sugar beet productivity, Pleno.

Introduction

Sugar beet represents the corner stone to reduce the gap between production and consumption of sugar in Egypt, which estimates as 0.8 million tons of sugar in 2014/ 2015. Since its introduction to the Egyptian farming system in 1982, the beet cultivated area increased from 16943 to 480000 feddans in 2014/ 15 season. The sugar produced from beet also increased from 2.5% of the total sugar produced in 1982 to 56% of the total sugar produced in 2014/ 15 season.

In Egypt, the west Nubaryia region is growing sugar beet to secure optimal processing two or more parasitic nematodes are known to cause serious problems to beet fields at West Nubaryia region. to secure optimal processing amount of beet sugar factories (Alexandria, Nil and Nubaryia) in this area. Root- knot nematodes species, *Meloidogyne incognita* and *M. javanica* have been reported as major nematode pests of sugar beet in Egypt **(Ibrahim, 1982; Oteifa and El- Gindi, 1982; Abd-El- Massih, 1985; Maareg *et al*., 1988 a& b, 1998. 2005 and 2009; Ismail *et al*, 1996; Gohar, 2003; Gohar and Maareg, 2005 and Gohar *et al* 2012)**.The *M. incognita* and *M. javanica* are attacking all sugar beet varieties in newly reclaimed soils. Total varieties failures frequently occur when varieties are planted in areas with high nematode population levels **(Maareg *et al*, 1998, 2005; Maareg and Hassanen, 1999; Gohar, 2003 and Gohar and Maareg, 2005)**. The average loss in sugar beet yield in Egypt due to *M. incognita* in different areas and at West Nubaryia was estimated to be > 50% in sugar yield and > 68% in roots yield for susceptible varieties **(Gohar and Maareg, 2005)**.

Plant parasitic nematodes need to be managed to maintain the quality and abundance of food and fiber produced by growers around the world **(Pal and Mcspadden, 2006)**. Eliminating nematodes is not possible; the goal is to manage their population and reduce their numbers below the damaging levels. Conventional management methods used include planting resistant crop varieties, rotating crops, land fallowing, and flooding, plugging, rouging, incorporating soil amendments, time of planting, nematode suppressive plants, bio control practices and applying pesticides. In some cases, soil solarization also may be practical.

Pesticides may case heavy environmental pollution, for example water contamination and toxicity to animals and humans. These negative effects on the environmental led to restrictions in nematicide use and are nowadays less widely applied than in the past, The use of synthetic pesticides for plant protection against agriculture pests during the last 50 years created many problems. Namely, pest resistance, environmental pollution and disturbance in natural balance. To overcome this problem many researchers all over the world are looking to discover new safe types of pest control agents Gaaboub 2005 and 2012.

Hence, this work was outlined to study the effect of selected planting dates as a management method of *Meloidogyne* species and improving of sugar beet productivity in naturally infested soil of Ahmed Badawy village at West Nubaryia region.

Materials and Methods

This work was carried out during 2012/ 13 and 2013/ 14 seasons at Ahmed Badawy village, West Nubaryia region, Al- Behera governorate, Egypt to study the effects of selected sowing dates (as agricultural method) on root- knot nematodes, *Meliodogyne* species, (as common species in this area) and the performance of sugarbeet variety, Pleno. The

three planting dates used in this work were as follows: (i) the first date is August 25, the second date is September 25 and the third one is October 25.

The experimental fields were naturally infested with a mixture of the root-knot nematodes, *M. incognita* and *M. javanica* and was grown by sugarbeet for the last ten years. The soil type was sandy (89% sand, 5% silt, 6% clay; 0.3% organic matter) with pH of 7.8 and 9.3% $CaCO_3$.Drip irrigation system was applied in the experimental plots.

Each growing season experiment was laid out in a completely randomized block design. The plot was six rows wide by 7 m long, with 0.5 m row spacing. The preceding crop of the first and the second seasons was watermelon. Seeds of sugarbeet were sown at 20 cm between hills. Seedlings were thinned to one plant per hill at the four leaf stage. Nitrogen fertilization was added according to the recommendation of Sugar Crops Research Institute (SCRI). The rate of 100 Kg of nitrogen per feddan in the form ammonium nitrate (33.5%) was applied at two doses after thinning and one month later. Also phosphate fertilization was applied at the rate of 200 Kg per feddan in the form calcium super phosphate (15.5% P_2O_5) during soil preparation. The other agricultural practices for growing sugarbeet were done as for newly reclaimed soils without pesticide application. Soil temperature was recoded at a depth of 25 cm for each plot at planting. (Table1)

Table 1. Average of soil temperature at first, second and third planting dates

Seasons	25- 8	25- 9	25- 10
2013- 2014	29.9º c	21.3º c	17.1º c
2014- 2015	29.3º c	23.4º c	15.3º c
Average	29.6º c	22.4º c	16.2º c

Nematode samples consisted of 10- 15 cores (5 cm diameter x 25 cm deep) taken from the two center rows of each plot at planting and at harvesting dates to determine the initial and final root- knot nematodes population, respectively. The 10- 15 cores were mixed manually and a 250 cm^3 subsample was collected for nematode analysis. Three replications were tested for each nematode parameter. The subsamples were wet-sieved through nested 100, 200 and 325 mesh sieves. The material retained on the 325 mesh sieves was processed by baermann- pan technique Barker **(1985)**. The extracted nematodes were dispersed in water in a gridded counting dish, identified and enumerated. All nematode counts from soil were standardized to 250 cm^3 of soil. At harvest (210 days after planting), five root systems were taken at random from the two center rows of each plot and washed. The number of galls per root system was recorded. A 15 gram fresh weight subsample was randomly taken, and nematode juveniles were extracted using a Baermann- Pan technique. After 5 days, nematodes were counted and then standardized to the number per gram fresh weight of root. Other subsamples (15 gram fresh weight) were randomly taken, washed, stained with acid fuchsine in lactophenol, and stored for 24 hours. The number of nematode juveniles, females and eggmasses were counted and standardized to the numbers per gram fresh weight of root system. Three replications were tested for each nematode parameter. Reproduction factor was calculated as follows:

$$RF = \frac{\Sigma \text{ Final nematodes in soil and roots}}{\text{Initial population}}$$

Samples of roots were taken and submitted for analysis on the same harvesting day to beet reception laboratory in Alexandria Sugar Company to measure the following trails: sugar percentage according to **De Whalley (1964)**, purity% and expected sugar yield per feddan.

From each plot, the outer two rows were considered as a belt, while plants of the 2nd and 5th rows were kept for determination of yield, yield components and quality. The other rows, 3rd, 4th were used for nematode parameters.

The determined trails or parameters during both growing seasons for each planting date experiment were as follows:

I- Nematode parameters:

1. Number of galls (G) root $system^{-1}$.
2. Number of egg- masses (E.M) root $system^{-1}$.
3. Number of development stages (D.S) root $system^{-1}$.
4. Number of juveniles (J_2) in soil.
5. Number of final population.
6. Reproduction factor (R.F).

II- Yield and yield components:

1. Root yield tons fad^{-1}
2. Top yield tons fad^{-1}
3. Biological yield tons fad^{-1}
4. Sugar yield tons fad^{-1}

III -Technological parameters:

1. Sucrose percentage.
2. Juice purity percentage.

Statistical analysis:

The obtained data of the two seasons and their combined analysis were calculated according to **Mc Intosh, (1983)**. The treatment means were compared by using the least significant difference (L.S.D) test (**Steel and Torrie, 1980)** at 5% level of significance.

Results and Discussion

I- Effect of selected planting dates on of root- knot nematode parameters on sugar beet:

The reduction of root- knot nematode species parameters (number of galls, eggmasses and developmental stages root system^{-1}, juveniles (J_2) in soil, and final population as well as reproduction factor) is the major purpose of this study. Differences among plant genetic, climatic parameters and reduction influences were selected.

The data in Table (2) showed the effect of three planting dates (25th August, September and October) on parameters of root- knot nematodes infection using sugar beet var. Pleno.

I-1- Number of galls (G) root system^{-1}:

The 2nd planting date showed the highest G root system^{-1} (100.33) followed by the 3rd planting date (97.33) and the 1st one (74.17) root system^{-1}, respectively, with insignificant differences among them. The reduction percentage of G root system^{-1} than the 2nd planting date was 26.07 and 2.99% for the 1st and 3rd planting date, respectively (Table 2).

I-2- Number of eggmasses (E.M) root system^{-1}:

The E.M root system^{-1} decreased with delaying planting dates. Therefore, there were position correlation between planting dates and reduction of E.M root system^{-1}. The first planting date significantly reduced the E.M. compared to the other two planting dates. The differences of E.M reduction root system^{-1} between the1st and the 2nd planting date were 33.85% while was 35.29% when comparing the 1st with the 3rd one.

I-3- Number of developmental stages (N.D.S) root system^{-1}:

Data concerning the number of developmental stages (D.S) root system^{-1} indicated that the 3rd planting date was the best planting date to significantly reduce nematode parameters compared to the other two planting dates. The relative reduction percentage of D.S root system^{-1} between the 1st planting date and the 2nd one was 13.46%, while this reduction recorded 64.84% between the 1st and the 3rd one (Table, 2).

I-4- Number of juveniles (J_2) 250 cm^3 soil^{-1}:

The juvenile's population (J_2) in soil was significantly decreased with delaying planting dates. Therefore, position correlations were found between planting dates and juveniles reduction in soil. The relative reduction percentage of J_2 between the 1st and the 2nd planting date were 64.25% and 78.21% with the 3rd one.

Table 2. Effect of selected planting dates on population of root- knot nematodes on sugar beet variety, Pleno by combined analysis of growing seasons (2013/ 14- and 2014/ 15).

Planting dates	Number of galls root system^{-1} (N.G)	Number of eggmasses root system^{-1} (N.E.M)	Number of developmental stages root system^{-1} (N.D.S)	Number of juveniles in soil (J_{2s})	Number of final population (P_f)	Reproduction factor (R.F)
25 Aug.	74.17b (26.07%)*	150.67a	331.83a	6726.90a	7209.40a	4.26a
25 Sep.	100.33a	99.67b (33.85%)	287.17a (13.64%)	2404.66b (64.25%)	2791.49b (61.30%)	2.16b (49.30%)
25 Oct.	97.33a (2.99%)	97.50b (35.29%)	116.67b (64.84%)	1465.50c (78.21%)	1679.67c (76.70%)	2.05b (51.88%)
LS.D$_{0.05}$	8.47	38.99	72.89	811.75	846.11	0.87

*Relative reduction percent to the highest value.

I-5- Number of final population (P_f):

Also, the final population (P_f) tended to be decreased as intervals advanced in planting dates. The highest value of P_f was recorded with the 1st planting date (7209.4) followed by the 2nd date (2791.49) and 3rd one (1679.67). There were significant differences among them. The relative reduction percentages of P_f between the 1st planting date and the 2nd or the 3rd one was 61.30 or 76.70%, respectively (Table, 1).

1-6- Reproduction factor (R.F):

Data in Table (1) emphasized reproduction factor (R.F) of root- knot nematode species under stress of three planting dates. The highest effective planting date on R.F was the 3rd planting date (2.05), while the least effective date was the 1st one (4.26). In regard to the relative reduction percentage between the 1st and other applied dates, the 3rd date (51.88%) recorded higher reduction than the 2nd one (49.30%). Raw data of R.F clarified that the first planting date significantly increased R.F value than the other two planting dates. The 1st planting date achieved double value of the 2nd and the 3rd ones. Where, R.F value was more than four (4.26) in the 1st planting date, and was around 2 for other applied planting dates.

Therefore, all nematode parameters decreased as planting dates were delayed except for G root system^{-1}.

Generally speaking, careful view of data indicated that the 1st planting date (25th August) recorded the highest parameters of root- knot nematodes infection

(i.e. E.M, D.S, J_2, P_f and R.F), followed by the 2nd planting (25th September). However, the 3rd planting date (25th October) achieved the lowest values of those parameters.

Our findings are in harmony with those recorded throughout the research work of **Gohar (2003), Maareg *et al* (2004) and Farahat *et al* (2008)** on fluctuation of the root- knot nematodes, *M. incognita* and *M. javanica* populations in sandy soil at Al-Bostan and West Nubaryia regions. It was obvious that the soil population increased gradually through early Spring season (Feb.- May) and peaked at July and August when soil temperature > 25°c. In Summer season (July and August), soil population almost remained stable forming one peak during the year. Thereafter, when soil temperature decreased, fast break down in the numbers of juveniles (Js) was observed at early Autumn season (September). Thenceforth, the juveniles population continued to decrease during Winter season to reach the lowest values in December and January (mid Winter). It could be accordingly concluded that the root- knot nematode juveniles peaked once a year in the Nubaryia sandy soil correlating to soil temperature. However, no correlation between soil moisture and nematodes population in soil could be observed, especially, variations in soil humidity along the year were not quite enough (±5%) due to the drip irrigation system applied in the areas.

In addition, **Maareg, *et al* (2016)** reported that population of root- knot nematodes, *M. javanica* and *M. incognita* on sugar beet fields increased with increasing thermal time. The earliest planted beets in August showed the highest juveniles in soil, different stages root system^{-1} and final population numbers as well as reproduction factor. The lowest values of these nematode parameters were achieved when beets were planted in mid- December. Values of nematode parameters were variable. There were remarkable differences between planting dates in nematode population parameters on sugar beet crops.

Eventually, the population of root- knot nematodes is positively correlated to the soil temperature. The highest values of nematode populations were recorded during Summer, while the lowest were recorded in the Winter seasons. Also, **Westerdahl *et al* (2014)** recoded that planting sugar beet when soil temperature is below 17°c reduced damage and slows down the nematode population build up. From obtained data, all nematode parameters decreased as planting dates were delayed except for G root system^{-1}. The G root system^{-1} is not an essential or reliable factor in assessing the damage since most researchers could not distinguish and watch the merged galls (**Maareg and Hassnen, 1999**).

II- Effect of selected planting dates on yield and yield components of sugarbeet crop:

Table (3) elucidated the effect of tested planting dates on roots, top, biological and sugar yields as well as sucrose and purity percentages of Pleno sugarbeet variety.

Table 3. Effect of selected planting dates on yield and yield components of sugarbeet variety, Pleno by combined analysis of growing seasons (2013/ 14- and 201415).

Planting dates	Roots yield (tons fed^{-1})	Top yield (tons fed^{-1})	Biological yield (tons fed^{-1})	Sugar yield (tons fed^{-1})	Sucrose %	Purity %
25 Aug.	8.93b (22.82%)*	4.82a (3.21%)	13.74b (16.98%)	1.63 (11.89%)	18.22a	81.15a
25 Sep.	10.01b (13.48%)	2.92b (41.37%)	12.93b (21.87%)	1.56 (15.68%)	15.56b (14.60%)	70.63b (12.96%)
25 Oct.	11.57a	4.98a	16.55a	1.85	15.97b (12.13%)	72.68b (10.44%)
L.S.D$_{0.05}$	1.15	1.23	1.51	N.S	2.18	6.22

*Relative reduction percent to the highest value.

II-1- Roots yield (tons fed^{-1}):

The 3rd planting date (11.57 tons fed^{-1}) significantly increased the roots yield than the 1st (8.93 tons fed^{-1}) and 2nd (10.01 tons fed^{-1}) planting dates. Where, this planting date increased the roots yield by 22.82% than the 1st one and by 13.48% than the 2nd one as shown in Table (3).

II-2- Top yield (tons fed^{-1}):

The 2nd planting date (2.92 tons fed^{-1}) significantly decreased the top yield than both the 1st (4.82 tons fed^{-1}) and 3rd (4.95 tons fed^{-1}) ones. The heavier top yield was recorded during the 3rd planting date followed by 2nd one, without significant differences between them. The top yield of 3rd planting date increased by 41.37% more than the 2nd one. However, this value was only 3.21% than the 1st (Table 3).

II-3- Biological yield (tons fed^{-1}):

As compared with the planting dates, the 3rd planting date achieved the highest biological yield (16.55 tons fed^{-1}) with significant differences followed by the 1st (13.74 tons fed^{-1}) and the 2nd (12.92 tons fed^{-1}) ones, respectively. The biological yield of the 3rd planting date was increased by 16.98% more than 1st date and by 21.87% for the 2nd one.

II-4- Sugar yield (tons fed^{-1}):

The 3rd planting date recorded the highest sugar yield (1.85 tons fed^{-1}) followed by the 1st and 2nd planting dates with an average of 1.63 and 1.56 tons fed^{-1}, respectively, with no significant differences among them. The 3rd planting date significantly produced more sugar yield than the 1st and 2nd ones by 11.89 and 15.68%, respectively (Table, 3).

II-5- Sucrose percentage:

The 1st planting date gave the highest value (18.22%) of sucrose% and significantly increased in sucrose content than the 2nd (15.56%) and 3rd (15.97%) planting dates. The 1st planting date achieved more sucrose content by 12.96 and 10.44% than the 2nd and 3rd ones, respectively.

II-6- Juice purity percentage:

Also, the 1st planting date had the highest value of purity% and significantly increased than the 2nd and 3rd dates by 12.96 and 10.44%, respectively (Table, 2).

Briefly, the presented data revealed that the first planting date recorded only the highest sucrose and purity% values. However, the 3rd planting date achieved the highest values of roots, top, biological and sugar yield. Therefore, the 3rd planting date was more suitable for planting sugar beet.

The previous data of yield and yield components suggest that the 3rd planting data (during October) significantly increased values of roots, top, biological and sugar yields than both 1st and 2nd planting dates (during Aug. and Sep.).Similar results were stated by **Abdou (2000), Abou- Salama and El- Sayed (2002), Agami (2005), El- Agamy *et al*. (2007) and Maareg *et al* (2016)** reported that the maximum average of roots, top, biological and sugar yields ton fed^{-1} were achieved when sugarbeet planted during October. The increase in yield and yield components with October planting might be due to the suitable weather conditions especially temperature during plant duration from planting to harvest that helped in formation of strong canopy. Moreover, the increase in length, perimeter and fresh weight of root, leaves fresh weight per plant and sucrose percentage could be the reason for more roots yield, top yield, biological yield and sugar yield tons fed^{-1}.

The results of technological quality declared that the 1st planting date (during August) increased sucrose and purity percentages. On the contrary, **El- Agamy *et al*. (2007)** reported that the earlier planting of sugarbeet during August decreased sucrose percentage and quality index. On the other hand, **Abdou (2000), Abou- Salama and El- Sayed (2002), Agami (2005) and El- Agamy *et al*. (2007)** indicated that planting of sugabeet during September achieved the highest value of sucrose and purity%.

Conclusion:

- The 3rd planting date significantly decreased parameters of nematode infection (i.e. E.M., G.,.D.S., J_2, P_f and R.F) and significantly increased values of root, top, biological and sugar yields. Therefore, this date is recommended as a suitable time for planting sugar beet.

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تأثير بعض مواعيد الزراعة على نيماتودا تعقد الجذور وإنتاجية محصول بنجر السكر الصنف بلينو

، أ.د/ جاد حمادة حسن راضى، أ.د/ ابراهيم عبدالله جعبوب، أ.د/ ابراهيم محمد عبده جوهر, د/ حازم محمد عليوه, /تامر فتحى يونس

تناول هذا البحث دراسة تاثير ثلاث مواعيد لزراعة بنجر السكر (25 أغسطس، 25 سبتمبر، 25 أكتوبر) كأحد الطرق الزراعية فى مقاومة نيماتودا تعقد الجذور (*M. incognita* and *M. javanica*) السائدة فى منطقة الدراسة) وأثر ذلك على محصول بنجر السكر الصنف بلينو فى أراضى رملية ملوثة طبيعيا بهذه النيماتودا تحت نظام الرى بالتنقيط.

ووجد من النتائج المتحصل عليها أن الميعاد الأول للزراعة (25 أغسطس) سجل أعلى قيم لعناصر النيماتودا المعبرة عن حجم الاصابة ودرجة الضرر (تعداد التعقدات الجذرية، أكياس البيض، الأطوار المختلفة على جذر البنجر وعدد الطور المعدى فى التربة وكذلك التعداد النهائى ومعدل التضاعف) يليه الميعاد الثانى. أما الميعاد الأخير (25 أكتوبر) وجد أنه سجل أقل القيم لهذه العناصر.

كما وجد أن الميعاد الأول سجل فقط أعلى قيم لنسبة كل من السكروز والنقاوة لبنجر السكر– أما الميعاد الأخير فقد سجل أعلى قيم لمحصول الجذور ومحصول العرش والمحصول البيولوجى ومحصول السكر (طن/ فدان).

لذا يعتبر الميعاد الأخير (25 أكتوبر) أنسب وأفضل المواعيد لزراعة هذا المحصول (الصنف بلينو) فى مثل هذه الأراضى الرملية الملوثة بنيماتودا تعقد الجذور تحت نظام الرى بالتنقيط لمكافحة هذه الآفة ورفع إنتاجية المحصول تحت مثل هذه الظروف.