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Influence nitrogenous fertilization on pest infestation, productivity and quality of sugar beet

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Some sugar beet growers think that the over-use of nitrogen fertilizer leads to high root yield and good sugar content due to high vegetative growth and a great full canopy. Nevertheless, this study with a view of the impact of various nitrogen rates (69, 92, 115 and 138 Kg N\ Fed.), (Equivalent 150, 200, 250 and 300 Kg urea fertilizer in package weight 50 Kg.). The economic productivity includes crop roots yield and quality, as well as, their impact on the injured pest *i.e.*, beet fly, *Pegomya mixta* Villeneuve (Diptera: Anthomyiidae) ; tortoise beetle, *Cassida vittata* Villers (Coleoptera: Chrysomelidae) and cercospora leaf spot disease (CLS) *Cercospora beticola* Sacc. (Capnodiales: Mycosphaerellaceae) that attack the crop during the growth period until harvest. Therefore, field trials were carried out on an experimental farm, Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt during 2017/2018 and 2018/ 2019 seasons. The obtained findings revealed in both trials (Seasons) that the infestation of beet fly larvae and their blotches, tortoise beetle larvae and adults appeared on sugar beet plants from January 15th to May 30th but their peaks were detected on March 15th and April 15th for both insects, respectively. Further, cercospora leaf spot disease severity was low in January and increased gradually to record its peak at the end of May (Harvest time). Nitrogen application in the minimum used levels recorded the lowest infestation by the two studied insects and leaf spots disease infection, meantime, increasing nitrogen application gradually and significantly increased the insect and the disease attack. Data obviously revealed increasing nitrogen rates from 69 to 115 Kg N/Fed. did not show any vital changes in the coexistence percentage for both insects. At the same time, increasing nitrogen dressing to reach the maximum (138 Kg N/Fed.) reduced obviously beet fly coexistence percentage, on the contrary, a clear increase occurred for tortoise beetle. These findings indicate that the tortoise beetle insect is more ferocity in attacking, infesting and damaging the vegetative green leaf than the beet fly does, meantime, lessens the chance of the beet fly attacking sugar beet. Nitrogen application at the rate of 92 Kg N/Fed. covers beet requirement from nitrogen needs and is satisfied to maximize root yield (T/F) in both seasons. Data also cleared that excess nitrogen (115 and 138 Kg N/Fed.) decreased root yield (Statistically significant). Such effect may be due to the over-use of nitrogen improved vegetative growth of beet plant observed on average leaf wt./ plant and top yield (T/ F) attained instead of the expense of sugar storage in roots. Further, the lowest nitrogen rate (69 Kg N/Fed.) exhibited the highest Total Soluble Solids (TSS), sucrose and purity percentages. Meantime, the highest nitrogen rate (138 Kg N/Fed.) significantly decreased all studied quality traits recording the lowest quality values. Meantime, the lowest decrease in the total insect infestations has been detected corresponding to the lowest nitrogen rate, however, the increase in added nitrogen is accompanied by an increase in the spread of insect and disease infestations.

Introduction

Sugar beet and sugar cane are the main sources of sugar production globally as well in Egypt. Sugar beet in Egypt is ranked first in sugar production (67.7%) followed by sugar cane (32.3%). The total cultivated beet area in season 2020/2021 reached about 683 thousand feddans (About 287 thousand hectares) distributed among more than twenty Governorates extending from Delta to middle Egypt including Kafr El-Sheikh Governorate in northern Delta where the beet area occupied about 22.4% of the total area.

Nitrogen is the most important element supplied to sugar beet in fertilizers with optimum quantity because most soils are in short supply to provide for maximum growth and drastically reduced root yield and quality. Nitrogen has a remarkable effect on the appearance of the crop, most noticeable by improving the colour vigour of the leaf canopy by increasing leaf size and number. Moreover, nitrogen application to sugar beet increased the moisture content of the leaf, besides increasing the area, thickness and succulence of the leaves. Widespread over-use of nitrogen leads to increased vegetative growth, but in fact decreases sugar percentage, juice quality and root yield. In this connection, great attention to the optimum nitrogen rate maximized beet productivity and quality and the effect of nitrogen and/or excess levels are recently reviewed by Nemeata Alla *et al.* (2018), Elwan and Helmy (2018), Mohamed *et al.* (2019), EL-Mansoub *et al.* (2020) and El-Sharnoby *et al.* (2021).

Sugar beet plants attract by numerous insect species during the entire growing season (Bassyouny,1998; Maareg *et al.*, 2005 ; Amin *et al.*, 2008; Saleh *et al.*, 2009; Sherif *et al.* , 2013; Abdel-Moniem *et al.*, 2014 and Bazazo *et al.*, 2017). In Egypt, reported that the key insect pests of sugar beet and the most serious and destructive insect pest of sugar are beet fly, *Pegomya mixta* Villeneuve (Diptera: Anthomyiidae) and tortoise beetle, *Cassida vittata* Villers (Coleoptera: Chrysomelidae) . Both tortoise beetle larvae and adults feed on the lower side of the sugar beet leaves, where, they eat the lower epidermis and inner tissue, but the upper epidermis remains intact looking like glass. In addition, adults feed on leaf tissue, causing regular circular holes (Abo El-Ftooh, 1995). Regarding beet fly, *P. mixta* larvae within produce large blotches or meandering tunnels and then the leaves were dying and affecting plant health (Abo El-Ftooh *et al.*, 2012), causing losses up to 20% of the foliage and 15% of the yield losses (Ebieda, 1998).

Further, cercospora leaf spot disease (CLS) is one of the most widespread and destructive foliar diseases of sugar beet. Ziedan and Farrag (2011) demonstrated that CLS was more epidemic than the other foliar diseases of sugar beet leaf and was caused by the fungus *Cercospora beticola* Sacc. (Capnodiales: Mycosphaerellaceae) and has a harmful effect on the quality and quantity of sugar beet, causing 42% reduction in sugar yield (Shane and Teng, 1992). Reduces root weights, extractable sucrose, yield and increases impurity concentrations resulting in higher losses during processing (Lamey *et al.*, 1996 and Skaracis *et al.*, 2010). CLS symptoms are delimited circular spots that develop on older leaves, enlarging to 2.5 mm when mature (Ruppel, 1986). Lesions are tan to light brown with dark brown or reddish-purple margins. Elongated lesions occur on petioles, and circular lesions may occur on sugar beet crowns not covered by soil (Giannopolitis, 1978).

Both insects and CLS diseases seriously damage the beet leaf canopy and are closely related to the amount of solar radiation, which is intercepted by the green foliage and this is greatly reflected in the magnitude of loss in root yield and quality. Meantime, the damage is largely and positively related to the amount of nitrogen applied. Therefore, much attention has been reviewed by many workers on the effect of nitrogen on pest insects and disease attack sugar beets such Abo-Saied (1987), Aly (1988), Afify *et al.* (1994), Talha (2001), Maareg *et al.* (2005), Shalaby *et al.* (2012), Ata *et al.* (2013) and Mohamed *et al.* (2019).

The objectives of this study were to evaluate the different doses of nitrogen fertilizer on the key of sugar beet insect and Cercospora leaf spot disease as well as productivity, quality and sugar yield.

Material and methods

This work was carried out at an experimental farm, Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt during the 2017/2018 and 2018/ 2019 seasons to study the influence of nitrogen fertilizer on beet fly, tortoise beetles and cercospora leaf spot disease as well as productivity and quality of sugar beet (*Beta vulgaris*, L.). Nitrogen is used as urea (46% N) form in four rates 69, 92, 115 and 138 kg N/Fed (Applied as 150, 200, 250 and 300 kg urea fertilizer in package weight 50 kg) and added in two equal split doses the first being at the full establishment of seedlings (Three weeks after sowing) and the second one month later. Treatments were arranged in a complete randomized block design with four replications. Superphosphate a source of phosphorus was applied in a single dose at land preparation. Potassium in the form of potassium sulfates (48% K_2O) at the rate of 50 kg/fed was added in a single dose at the same time as the second nitrogen dose. Multi-germ variety named Sultan was used.

The planting dates took place on October 30 in the first and second seasons, respectively. While harvesting was carried out seven months from the sowing date. The plot area was 30 m^2, which consisted of 5 rows of 10 m long and 60 m wide, with 20 cm spacing between hills. All recommended agricultural practices for optimal production were carried out during the growing season without insecticide applications.

Population fluctuation of the insects started in mid-January and continued until harvest. Bi-weekly samples consisted of 20 plants, 5 plants randomly taken from each replicate and from each treatment. Each plant was completely introduced into a plastic bag and cut at the soil surface; the confined plants were transformed into the lab. To avoid the escape of insects during the inspection, a piece of wool cotton moistened with chloroform was put into the bag for 15 minutes to anesthetize the insect. These plants were visually examined in the lab., counting *P. mixta* (Larvae and blotches) and *C. vittata* (Larvae and adults).

Symptoms of natural infection by *C. beticola* were detected from the first week of January (5th of Jan.) and continued every 15 days until 20 of May. Each sample consisted of 5 plants randomly taken from four replicates of each treatment. cercospora leaf spot severity was assessed using the scale of Shane and Teng (1992) for disease severity. The scale ranged from 0-10 categories where: (0): no visual infection; (1) 1-5 spots/leaf (0.1% severity), (2) 6-12 spots (0.35 % severity); (3) 13-25 spots/leaf (0.75% severity); (4) 26-50 spots/leaf (1.5% severity); (5) 51-75 spots/leaf (2.5 % severity); (6) At higher disease incidences, the average affected area per leaf was estimated from standard area diagrams, and categories 6 through 10 represented 3, 6, 12, 25, and 50% disease severity, respectively.

Harvest was carried out after 210 days from the planting dates, a sample of ten guarded sugar beet plants was taken randomly from each plot to determine the following characteristics including root specifications and quality traits: Root attributes *i.e.,* root diameter (cm), root length (cm), root weight (kg) and leaf weight (kg). Three rows per plot were used to calculate Root yield/fed (ton) and Top yield/fed (ton).

Quality traits:

1. Total Soluble Solids percentage (TSS) was determined in fresh roots by using a hand refractometer.

2. Sucrose percentage was estimated polarimetrically on lead acetate extract of fresh macerated root according to the methods of Le-Docte (1927).

3. Purity percentage was calculated by dividing Sucrose% X 100 / TSS% according to the

Sugar yield per Fadden was calculated according to the following equation:

Sugar yield/fed (ton) = Root yield/fed (ton) × Sucrose % × purity%

Statistical analysis:

Percentage data were transformed to arc-sine before statistical analysis. The proper statistical analysis of the recorded data was carried out according to Steel and Torrie (1980) using the “MSTAT” computer software package. The differences between means of the treatment were compared using the least significant difference (LSD) at 5% level of probability.

Results and Discussion

1. Fluctuation and dynamic of *Pegomya mixta* population on sugar beet:

Data Tables (1 and 2) indicated that the infestation of *P. mixta* larvae and their blotches appeared on sugar beet leaves from January 15th to May 30th, where, the survey was made every fifteen days intervals during 2017/2018 and 2018/2019 seasons. One peak was recorded in mid-March in the first season representing 56.31 larvae and 8.38 blotches/ 5 plants, respectively, while, in the second one, data in Table (2) illustrated three peaks, the first was in mid-January (14.25 larvae and 3.00 blotches/ 5 plants), the second was at mid-March (115.50 larvae and 30 blotches), while, the third ones was at the end of April (8.75 larvae and 2.25 blotches). The detected findings coincide with those of Mohisen (2012), Sherif *et al.* (2013) and El-Dessouki *et al.* (2014) who stated that peaks of *P. mixta* larvae by late February, late March, late April and late May.

Table (1): Average number of *Pegomya mixta* (Larvae and blotches / 5 plants) as affected by nitrogenous fertilization during 2017/2018 season.

Experiment Date	Larvae					Blotches				
	Nitrogen Dose (kg N/Fed)									
	69	92	115	138	Averag	69	92	115	138	Averag
15 Jan.	6.50	12.2	10.0	16.0	11.19	1.2	6.00	3.00	4.00	3.56
30	13.0	15.0	16.2	26.0	17.56	2.0	2.25	4.50	5.50	3.56
15 Feb.	16.0	31.0	30.0	35.0	28.00	4.2	10.0	10.0	6.25	7.63
30	30.2	50.2	55.7	61.5	49.44	6.0	5.25	6.00	8.00	6.31
15 Mar.	49.2	49.2	57.5	69.2	56.31	6.5	6.50	10.2	10.2	8.38
30	40.0	39.0	49.0	41.0	42.25	8.0	4.75	6.75	6.00	6.38
15 Apr.	16.0	16.0	18.0	18.2	17.06	3.0	3.00	2.75	3.50	3.06
30	10.0	4.25	2.00	9.00	6.31	2.2	1.00	1.25	1.50	1.50
15 May	0.00	1.00	4.25	3.00	2.06	0.0	1.00	1.00	1.00	0.75
30	4.00	0.00	2.25	2.00	2.06	1.0	0.00	1.00	1.00	0.75
Average	18.5	21.8	24.4	28.1	23.22	3.4	3.97	4.65	4.70	4.19
LSD at 5% for nitrogen	**2.60**					**0.21**				

Table (2): Average number of *Pegomya mixta* (Larvae and blotches / 5 plants) as affected by nitrogenous fertilization during 2018/2019.

Experiment Date	Larvae					Blotches				
	Nitrogen Dose (kg N/Fed)									
	69	92	115	138	Averag	69	92	115	138	Averag
15 Jan.	12.00	10.00	16.00	19.00	14.25	3.00	3.00	4.00	2.00	3.00
30	6.00	10.00	14.00	12.00	10.50	2.00	3.00	4.00	1.00	2.50
15 Feb.	9.00	19.00	22.00	17.00	16.75	3.00	6.00	6.00	3.00	4.50
30	110.0	101.0	100.0	112.0	105.75	14.0	19.0	21.0	36.0	22.50
15 Mar.	110.0	109.0	130.0	113.0	115.50	22.0	25.0	30.0	43.0	30.00
30	10.00	16.00	11.00	13.50	12.63	3.00	3.00	3.00	6.00	3.75
15 Apr.	3.00	5.00	8.00	14.00	7.50	1.00	2.00	2.00	6.00	2.75
30	6.00	9.00	8.00	12.00	8.75	2.00	2.00	2.00	3.00	2.25
15 May	0.00	1.00	0.00	0.00	0.25	0.00	1.00	0.00	0.00	0.25
30	0.00	1.00	1.00	0.00	0.50	0.00	1.00	0.00	0.00	0.25
Average	26.60	28.10	31.00	31.25	29.24	5.00	6.50	7.20	10.0	7.18
LSD at 5% for nitrogen	**0.97**					**0.36**				

2. Fluctuation and dynamic of *Cassida vittata* population on sugar beet:

Data in Tables (3 and 4) showed that the activity period of *C. vittata* larvae +adults/ 5 plants was extended from mid-January and continued to late May in both seasons, respectively. The population density of tortoise beetles (Table 3) indicated four peaks, during mid-January, mid-March, mid-April and late May in the first season represented by 17.88, 98.06, 133.81 and 102.56 larvae + adults /5 plants, respectively. However, in the second season, two peaks only occurred during mid-January and mid-April recording 14.38 and 180.00 larvae + adults/ 5 plants, respectively (Table 4). Therefore, results clarified that the highest number of tortoise beetle infestation (Larvae and adults) and its peak existence were recorded in mid-April represented by 133.81 and 180.00 larvae + adults/ 5 plants in both seasons, respectively.

3. Fluctuation and dynamic of *Cercospora beticola* infection on sugar beet:

A gradual increase in average disease severity of *Cercospora beticola* in both seasons has been detected (Tables 5 and 6). CLS severity fluctuated from 2.26 and 1.96 on 5^{th} January to 20.03 and 18.07 on 20 May in both seasons, respectively. Such results may give evidence to the relationship between temperature and humidity prevailing and cercospora disease activity in this work. The obtained findings are in harmony with those reviewed by Khan *et al*. (2009).

Table (3): Average number of *Cassida vittata* (larvae and adult/ 5 plants) as affected by nitrogenous fertilization during 2017/2018 season.

Experiment Date	Nitrogen Dose (kg/Fed)				Mean
	69	92	115	138	
15 Jan.	13.00	13.75	14.25	16.50	14.38
30	13.50	13.00	14.75	14.25	13.88
15 Feb.	6.25	9.50	9.00	10.75	8.88
30	8.00	12.25	11.50	17.75	12.38
15 Mar.	69.00	70.75	69.25	77.25	71.56
30	55.75	70.00	92.00	100.50	79.56
15 Apr.	160.50	169.25	180.00	210.25	180.00
30	89.25	99.00	100.75	179.00	117.00
15 May	90.25	100.50	119.00	120.75	107.63
30	99.75	91.50	66.25	110.00	91.88
Average	60.53	64.95	67.68	85.70	69.72
LSD at 5% for nitrogen	1.2				

Table (4): Average number of *Cassida vittata* (larvae and adult/ 5 plants) as affected by nitrogenous fertilization during 2018/2019 season.

Experiment Date	Nitrogen Dose (kg N/fed)				Mean
	69	92	115	138	
15 Jan.	11.25	17.75	16.00	26.50	17.88
30	13.00	6.50	21.25	21.00	15.44
15 Feb.	9.75	19.00	14.25	18.50	15.38
30	6.25	8.25	10.00	27.75	13.06
15 Mar.	91.00	80.75	115.25	105.25	98.06
30	80.00	101.00	80.50	130.25	97.94
15 Apr.	77.50	161.00	130.75	166.00	133.81
30	63.00	61.25	97.00	200.50	105.44
15 May	66.25	59.50	100.00	100.75	81.63
30	100.50	99.00	80.50	130.25	102.56
Average	51.85	61.40	66.55	92.68	68.12
LSD at 5% for nitrogen	0.76				

Table (5): Average disease severity of *Cercospora beticola* as affected by nitrogenous fertilization during 2017/2018.

Experiment Date	Nitrogen Dose (kg N/Fed)				
	69	92	115	138	Mean
5 Jan.	1.45	1.91	2.41	3.26	2.26
20	2.73	3.14	4.51	5.09	3.87
5 Feb.	4.48	5.10	6.08	7.18	5.71
20	6.49	7.60	8.54	9.41	8.01
5 Mar.	8.12	9.07	10.50	11.14	9.71
20	10.37	11.29	12.42	13.19	11.82
5 Apr.	12.37	13.73	14.24	15.75	14.02
20	15.19	15.43	16.55	17.27	16.11
5 May	16.56	17.30	18.26	19.55	17.92
20	18.47	19.71	20.62	21.33	20.03
Average	9.62	10.43	11.41	12.32	10.95
LSD at 5% for nitrogen	0.75				

Table (6): Average disease severity of *Cercospora beticola* as affected by nitrogenous fertilization during 2018/2019.

Experiment Date	Nitrogen Dose (kg N/Fed)				
	69	**92**	**115**	**138**	**Mean**
5 Jan.	1.33	1.54	2.15	2.82	1.96
20	2.47	2.81	3.87	4.48	3.41
5 Feb.	3.82	4.52	5.78	6.47	5.15
20	5.11	5.78	7.56	8.18	6.66
5 Mar.	6.50	7.21	9.52	10.16	8.35
20	8.45	9.35	10.64	11.96	10.10
5 Apr.	10.32	11.45	12.61	13.45	11.96
20	12.44	13.60	14.35	15.47	13.97
5 May	14.35	15.36	17.71	17.55	16.25
20	16.51	17.65	18.48	19.65	18.07
Average	8.13	8.93	10.27	11.02	9.59
LSD at 5% for nitrogen	**0.72**				

4. Nitrogen fertilizer effect:

4.1. The effect of nitrogen on *Pegomia mixta* infestation:

Regarding the nitrogen influence on beet fly infestation, data from Tables (1 and 2) showed that the lowest numbers of *P. mixta* infestation were 18.50 larvae and 3.43 blotches/5 plants in the first season and 26.60 larvae and 5.00 blotches/5 plants in the second season were countervailed beet plants fertilized by 69 kg N/ Fed, extra nitrogen (138 kg N/Fed) application increased infestation gradually and significantly to reach the highest 28.10 and 31.25 larvae and 4.70 and 10.00 blotches/ 5 plants in both seasons, respectively. Such effect may be due to that excess nitrogen promotes vegetative growth in terms of leaf weight, number and area. Moreover, nitrogen application, especially over-use level of sugar beet increased the moisture content of the leaf and hence its thickness and succulence which provide a favorable environment for pest infestation. These findings are in accordance with those reported by Nemeata Alla *et al.* (2018), Elwan and Helmy (2018), Mohamed *et al.* (2019), EL-Mansoub *et al.* (2020) and El-Sharnoby *et al.* (2021).

4.2. The effect of nitrogen on *Cassida vittata* infestation:

Average data presented in Tables (3 and 4) revealed increasing nitrogen fertilizer rates from 69 to 138 kg N/ Fed gradually and significantly increased *C. vittata* infestation in both seasons. Further, the highest infestations by the insect expressed as larvae and adult number in both seasons were attained corresponding with 138 kg N/ Fed, recording 92.68 and 85.70 insect/ 5 sugar beet plants. Otherwise, the lowest number of insects which was recorded at 51.85 and 60.53 insects / 5 plants in both seasons was countervailed beet plants fertilized by 69 kg N/ Fed **.**

4.3. The effect of nitrogen on *Cercospora beticola* infection:

Data in Table (5) showed the effect of nitrogen fertilization rates on the severity of cercospora leaf spot disease of sugar beet. Results in the first season showed that the average disease severity significantly increased from 9.62 % by applying nitrogen at 69 Kg N/Fed. (low infection) to 12.32% corresponding to the highest nitrogen dose of 138 kg N/ Fed. The tabulated results in the second season (Table 6) as detected in the first season illustrated that the average Cercospora leaf spot disease severity was significantly and gradually increased from 8.13% when the sugar beet plants were fertilized by 69 kg N/ Fed, respectively (Low infection and the lowest nitrogen level) to 11.02% when sugar beet plants supplied with 138 g N/ Fed (The highest infection and the highest nitrogen level). Generally, the obtained results visibly showed that cercospora leaf spot disease severity was positively correlated with the applied amount of nitrogen fertilizer. The obtained results are in accordance with those reviewed by Sexton and Howlett (2006), Huber and Haneklaus (2007), Veresoglou *et al.* **(2012)** and El-Mansoub *et al.* (2020) who stated that extra nitrogen fertilization over the optimum level increased plant susceptibility to pathogens. Some literature showed that less favorable conditions for the disease can be created by limiting excessive leaf canopy development, a result of adjusting nitrogen fertilization and water supply in irrigated areas (Meriggi *et al.*, 2000). Further, Mutebi and Ondede (2021) clarified that nitrogen fertilization at an optimum rate could potentially be used as an additional means of suppressing *C. moricola* in mulberry.

5. Coexistence:

Specification of biotic and abiotic factors indicates the preference of the insect pests to attack such a plant, known as the coexistence of the insect on the plant. Therefore, the results in Table (7) summarized the coexistence percentage of beet fly (*P. mixta*) and tortoise beetle insects (*C vittata*) infesting sugar beet through different nitrogen rates fertilizers. Accordingly, data revealed increasing nitrogen rates from 69 to 115 kg N/Fed did not show any vital changes in the coexistence percentage for both insects. At the same time, increasing nitrogen dressing to reach the maximum (138 kg N/Fed) reduced obviously beet fly coexistence, on the contrary, a clear increase occurred for the tortoise beetle. This trend is true in both seasons and insects. Further, data Table (7) illustrated that the coexistence value of beetles was increased twice or more than beet fly coexistence. Such effect may be that the excess nitrogen increment leads to apparent improvements in vegetative growth in terms of the number of leaves, area and thickness (Juicy beet leaf) [the relationship between nitrogen and green leaf weight and top yield as mentioned later in Tables 8 and 9] which forms the advantage of the insect tortoise beetle to attack and infest plants, in other words, increased the coexistence or preference of the insect on such plant than others. These findings indicate that the tortoise beetle insect is more ferocity in attacking, infesting and damaging the vegetative green leaf than the beet fly does, meantime, lessens the chance of the beet fly attacking sugar beet.

6. Effect of nitrogen on beet productivity:

Nitrogen application at the rate of 92 kg N/Fed covers beet requirement from nitrogen needs and is satisfied to maximize root yield (Ton/Fed) in both seasons (Tables 8 and 9). This may be due to that soil was initially incapable to supply beet nitrogen needs. Moreover, the highest root yield detected was reflections of the good effect of the used rates of nitrogen on the individual root characteristics i.e., root weight, length and diameter (Tables 8 and 9).

Table (7): Coexistence percentage of some insect pests attack sugar beet plants and its relationship to nitrogen fertilizer.

Seasons	2017/2018			2018/2019		
Insects	**Beet fly (No of larvae)**	**Tortoise beetles (No of larvae +Adult)**	**Total**	**Beet fly (No of larvae)**	**Tortoise beetles (No of larvae +Adult)**	**Total**
Nitrogen level	**69 kg N/Fed**					
Aver. No of insect	18.50	51.85	70.35	26.60	60.53	87.13
Coexistence %	26.30	73.70	100.00	30.53	69.47	100.00
Nitrogen level	**92 kg N/Fed**					
Aver. No of insect	21.80	61.40	83.20	28.10	64.85	93.05
Coexistence %	26.20	73.80	100.00	30.19	69.81	100.00
Nitrogen level	**115 kg N/Fed**					
Aver. No of insect	24.48	66.55	91.03	31.00	67.68	98.68
Coexistence %	26.89	73.11	100.00	31.42	68.59	100.00
Nitrogen level	**138 kg N/Fed**					
Aver. No of insect	28.10	92.68	120.78	31.25	85.70	116.95
Coexistence %	23.27	76.74	100.00	26.72	73.28	100.00

Table (8): Nitrogen fertilizer impact on sugar beet productivity and quality traits (2017/2018 season)

Nitrogen rate (Kg N\Fed.)	Total insects infestation	Av. Root weight (g)	Root length (cm)	Root diameter (cm)	Root yield (T/F)	Leaf weight (g)	Top yield (T/F)	TSS %	Sucrose %	Purity %	Sugar yield (T/F)
69	70.35	1175	23.10	13.57	29.73	381	9.51	20.43	18.15	88.85	4.80
92	83.20	1401	24.50	13.96	36.08	494	12.36	20.32	18.03	88.74	5.77
115	90.03	1445	24.58	14.01	36.00	534	13.35	20.30	17.89	88.13	5.68
138	120.78	1452	24.15	13.98	35.30	562	14.40	19.10	17.76	87.63	5.49
LSD at 5%:	**33**	**N.S.**	**0.13**	**0.49**	**22**	**0.29**	**0.16**	**0.20**	**N.S.**	**0.15**	

Table (9): Nitrogen fertilizer impact on sugar beet productivity and quality traits (2018/2019 season)

Nitrogen rate (Kg N\Fed.)	Total insects infestation	Av. Root weight (g)	Root length (cm)	Root diameter (cm)	Root yield (T/F)	Leaf weight (g)	Top yield (T/F)	TSS %	Sucrose %	Purity %	Sugar yield (T/F)
69	87.13	1131	22.85	13.17	28.28	362	8.99	20.50	18.27	89.13	4.60
92	93.05	1380	23.99	13.29	35.60	497	12.11	20.40	18.16	89.01	5.76
115	98.68	1410	24.11	13.51	35.25	529	13.40	20.42	18.00	88.16	5.61
138	116.95	1399	24.27	13.65	34.98	560	13.60	19.80	17.35	87.64	5.32
LSD at 5%:	**26**	**0.23**	**0.18**	**0.12**	**30**	**0.18**	**0.21**	**0.23**	**N.S.**	**0.14**	

Data also cleared that excess nitrogen (115 and 138 kg N/Fed) slightly decreased root yield (Statistically insignificant). Such effect may be due to that excess nitrogen improves vegetative growth of beet plant observed on average leaf weight / plant and top yield (Ton/Fed) attained in this work. Moreover, it is noted that the over-use of nitrogen fertilizer is accompanied by an increase detected in insect infestation attack plants (Tables 8 and 9). Data also showed that the lowest nitrogen rate (69 kg N/Fed) reduced significantly root yield and individual root specifications and meantime achieved the lowest leaf weight/ plant and top yield.

7. Effect of nitrogen on beet quality:

Data Tables (8 and 9) illustrated that the lowest nitrogen rate (69 kg N/Fed) exhibited the highest Total Soluble Solids (TSS), sucrose and purity percentages. More addition of nitrogen up 115 and 138 kg/Fed diminished the three quality traits, meantime, the highest nitrogen rate (138 kg N/Fed.) significantly decreased all studied quality traits recording the lowest quality values. Higher nitrogen rates stimulate vegetative growth at the expense of sugar storage in the roots. Moreover, the reduction in the total insect attack was corresponding to the lowest added nitrogen, nevertheless, the increase in added nitrogen accompanied by increase in insect infestation and this may be due to the negative effect on the efficiency photosynthesis process of the plant and hence sugar synthesis.

8. Effect of nitrogen on sugar yield (Ton/Fed):

The highest sugar yield (Ton/Fed) was achieved with the addition of nitrogen at the rate of 92 followed by 115 kg N/Fed while, a slight reduction has been observed in both seasons (Tables 8 and 9). Otherwise, the use of nitrogen at the lowest rate (69 kg N/Fed) and /or the highest rate (138 kg N/Fed) decreased sugar yield markedly, but the reduction corresponding to the lowest rate was more clearly (Tables 8 and 9). Such an effect was greatly related to the effect of nitrogen on root yield and root quality observed before. Whereas, it is known that sugar yield is a result of root yield and quality.

The findings obtained on the effect of nitrogen on the productivity, quality and sugar yield in this work are in harmony with the recently reviewed by Shalaby *et al.* (2012), Ismail *et al.* (2016), Snyder (2017) and Paul *et al.* (2018), El-Mansoub *et al.* (2020) and Sarhan and El-Zeny (2020) who stated that nitrogen at an optimum rate maximized sugar beet productivity and quality, whereas, shortage in nitrogen fertilizer added to sugar beet could not produce a profitable crop. Meantime, high nitrogen dressing slightly enhanced root growth, but increase leaf weight and top growth at the expense of sugar storage, and the highest insect infestation has been also attained.

Accordingly, this study indicated that adding 92 kg N/Fed maximized the productivity and quality of sugar beet, moreover, covered or lessen the harmful effect of pest (Insect and disease) infestation.

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