Impact of Nitrogen Fertilization Types on Leaf Miner, *Liriomyza trifolii* Infestation, Growth and Productivity of Pea Plants under Pest Control Program

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ABSTRACT: Pea (*Pisum sativum* L.) is a valuable grain legume crop, used as human food and fodder as well as fixed N element in soil with N-fixing soil bacteria called rhizobia. However, it could be infested by numerous pests that lead to great losses in yield production. Economically, the important pest in pea cultivation is serpentine leaf miner, *Liriomyza trifolii* in Egypt. Field experiment on pea variety, Master B was carried out to determine the occurrence percentages of *L. trifolii* larvae attack on pea plants cultivated under three types of nitrogen fertilizers i.e., Urea (46%N), Ammonium Sulphate (20.5%N), Ammonium Nitrate (33.5% N), along with management of *Liriomyza trifolii* using multiple control techniques as pesticides, plant-derived essential oils and plant extract during winter seasons of 2021 and 2022. Result showed that all treatments affected significantly on growth and yield characters as well as *L. trifolii* larvae infestation in both two seasons. The highest infestations of *L. trifolii* larvae was recorded with urea application (2.10 and 2.04 larvae/leaf) followed by ammonium nitrate (1.47 and 1.41 larvae/ leaf) fertilizers during two seasons, respectively. As highlighted above, 1-2 peaks of infestation have been found with urea and ammonium nitrate treatments during both two seasons. The highest levels of vegetative growth and yield characters obtained with soil application of ammonium nitrates followed by ammonium sulphate and urea occupied the last one. Integration between nitrogen sources and suggested control program was more effected to monitoring pea leaf miner, interaction between ammonium sulphate or ammonium nitrate with suggested control program have an important role for reducing of *L. trifolii* infestations. It could be concluded that from the research findings pea plant variety, Master B should be fertilized by ammonium nitrate or ammonium sulphate afford better performance growth and yield under selected control program throughout agro-climatic conditions.

Keywords: *Liriomyza trifolii*, Management, Nitrogen, Pea

INTRODUCTION

Pea, *Pisum sativum* L. is one of the most important cool season legume crops belonging to the Leguminosae: Fabaceae in Egypt for local consumption and exportation (Elsharkawy, 2013). Pea pods and seeds are considered important source in human nutrition, being its pods and seeds contain a great amount of protein, carbohydrates, vitamins, phosphorus, iron, magnesium, calcium, and amino acids, minerals supplement fibers and antioxidant compounds (Urbano *et al*., 2003 and Mohan *et al*., 2013). Besides, pea plants considered as a soil fertility building crop through N_2 fixation in symbiotic association with beneficial bacteria (Alam *et al*., 2010 and Elsharkawy 2013). Economically, pea is predominately exported vegetable crop from Egypt to numerous countries over the world (Zaghloul *et al*., 2015 and Chaney, 1995). The total cultivated area of green and dry peas in Egypt was about 46134.02 acres in 2020 with total production 153,440 tons according to FAO (2020). The legume crops were infested by different leaf miners causing significantly damages in leaves. The severe pests of vegetable plants are *Liriomyza* species (Diptera: Agromyzidae) which infested exceeded than 20 crops belonging to Fabaceae, Cucurbitaceae, Solanaceae, Brassicaceae, Malvaceous, Amaryllidaceae and Amaranthaceae families (Foba *et al*., 2015 and Foba *et al*., 2016). Leaf miner flies of *Liriomyza* were injurious dipterous insects infesting vegetable and horticultural plants (Jones *et al*., 1986 and Parrella *et al*., 1987). *Liriomyza* species are the most economic importance pests as *Liriomyza trifolii*, *L. pisi* and *L. congest* (Burgio *et al*., 2005

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and El-Sayed *et al*., 2007). It caused direct damages to plants and indirect by transmitting many microorganisms that are of economic importance to many crops. Feeding by adults, and the mining of leaves by larvae decreased photosynthetic tissue, dehydration and withering of leaves leading to significant losses in yield (Facknath and Lalljee, 2005).

The serpentine leaf miner, *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae) is a perennial pest of leguminous crops in the Mediterranean region especially in Egypt (Foba *et al*., 2015, Shaalan and El-Ghanam, 2016 and Bayoumy *et al*., 2018). Moreover, polyhouse crops also infested with *L. trifolii* (Vashisth *et al*., 2013). In addition, Doss *et al*. (1992) and Abdel-gawad (2008) reported that leaf miner is one of the most important field pests to vegetable and horticultural crops. Punctures or damages were made on leaves by *L. trifolii* larvae three to four days after oviposition and grow as the larvae matures (Capinera, 2001 and Wilkerson *et al*., 2005). The mine is irregular, can greatly depress the photosynthesis in plant, and also causes premature leaf drop (Bueno *et al*., 2007). Also, wounding in leaves by different stages of the pest allows to infect plants with bacterial and fungal diseases (Abou-fakhr Hammad and Nemer, 2000).

On the other side of the research, Nitrogen (N) is an essential macronutrient for plant development, chlorophyll, enzymes, and protein syntheses in plant, it is main fertilizer for plant development and yield of crops (Bhuvaneswari *et al*., 2014). Nevertheless, nitrogen is a major essential element for all organisms and a constituent of nucleic acids, proteins and other indispensable organic compounds (Ohyama, 2010). Nitrogen is an important for amino acid synthesis and proteins, which are determining nutrients for insect survival (Rashid *et al*., 2017). Nitrogen element could influence the presence of insects, positively or negatively. Nitrogen fertilizer increased the level of the population of piercing-sucking pests, including the leaf miner, *L. trifolii* (Elsayed *et al*., 2021). There are three types of chemical nitrogen fertilizers, most growers use it for enhancing growth and productivity of crops due to its easy and rapid availability to plants. The first is ammonium sulphate [$(NH_4)_2 SO_4$] (20.6% N and 24% S), it was applied by growers primarily where they need supplemental N and S to meet the nutritional requirement of growing plants and decrease pH of the soil (Nasim *et al*., 2012). The second is urea H_2NCONH_2 (46.5%N) where urea nitrogen enters the plant either directly, or in the form of ammonium or nitrate after urea degradation by soil microbes, and the third is ammonium nitrate NH_4NO_3 33.5% N (Chien *et al*., 2011 and El Mantawy, 2017).

Fertilization play important role in the plant physiology and growth characteristics, and it may be related to a higher incidence of a pea leaf miner (Nestel *et al*., 1994). Herbivorous insects frequently choose their plant hosts based on the availability of mineral nutrients since nutrients change the chemical composition, anatomy, morphology and phenology of plants (Han *et al*., 2014; Oliveira, 2014 and Uesugi, 2015). Availability of mineral nutrients usually influence host-plant selection by herbivorous insects as nutrients alter plants' chemical composition, morphology, phenology and anatomy (Han *et al*., 2014; Oliveira, 2014 and Uesugi, 2015). High quantity of nitrogen in soil increased leaf content of amino acids and proteins, as well as improving of vegetative growth, delaying maturity and lignification of plant tissues, as well as making the plant was more attractive to herbivorous insects (Coqueret *et al*., 2017).

Rodrigues *et al*. (2009) found negative relation between nitrogen and population of leaf miner, *Liriomyza* sp. and its control by biological agents, *Metarhizium anisopliae* and *Beauveria bassiana* on bean, *Phaseolus vulgaris* influencing by N fertilization rates. Additionally, the highly percentage of leaf miner attack in common bean under N excessed was recorded by (Cruz *et al*., 2012). As well as, soil-applied complex fertilizer effect on the insect-host plant interaction between *L. trifolii* infestations and potato plant, where the increase of nitrogen concentrations in potato leaves increased the *L. trifolii* development (Facknath and Lalljee, 2005). The control of the leaf miner, *Liriomyza* sp. has been tackled on faba bean by El-Nahal and Assem,(1970) and Li *et al*. (2009) on pea crop. Chemical control was conducted by Cyromazine (insect growth regulator used as an insecticide) on controlling *Liriomyza* sp. in kidney beans (Xu *et al*., 2009), and neem extract on tomato (Salas and Mendoza, 2001). A direct relationship between synthetic NPK fertilizer and bean fly (agromyzid) densities was reported by Letourneau (1994). Moreover, the impact of N levels on epidemiology of pests in winter wheat cultivars grown under conventional, integrated, and biodynamic cropping systems in Netherlands with a high N levels stimulated epidemics of leaf miners as reported by (Daamen *et al*., 1989). From the previous view , the objective of this research is to determine the effect of nitrogen types on the infestations with the serpentine leaf miner, *Liriomyza trifolii* Burgess (Diptera: Agromyzidae), as well as , growth and productivity of pod yield of pea plants cultivated under the conditions of proposed control program.

MATERIALS AND METHODS

Field site description

In a field experiment conducted in a private farm in Kafer Singerg, Menoufia governorate, Egypt, during winter season on 26th of September 2021 and 2022, respectively depending on the day by the year. Pea (*Pisum sativum* L.) cv. Master B was grown in a traditional soil cultivation system. Soil physical and chemical characteristics was performed by the Faculty of Agriculture Menoufia University, Soil Testing Laboratory according to the standard procedures of Jackson (2005) and the obtained results are presented in Table (1).

Table 1: Principal characteristics of the soil physical and chemical analysis

Practical size distribution			**pH**	**Organic matter %**	**Cation meq/L**			**Anion meq/L**			**Bulk density**
Sand%	**Silt%**	**Clay%**			**Ca^{++}**	**Mg^{++}**	**Na^{++}**	**Cl^-**	**HCO_3^-**	**SO_4^{--}**	**g/cm^3**
32.49	23.23	44.28	7.5	1.73	0.75	0.56	0.3	4.35	0.6	2	1.55
Texture Clay loam											

Experimental design

The experiment was set up in a randomized complete block design with three replications.

The area of each plot was 36 m^2 (4 ridges with 12 meters long and 3 m width, and the distance between plants was 15 cm. The seeds were sown on the two sides of every ridge in which one ridge was left between the plots as a guard ridge, on a clay loam soil under surface irrigation system.

Nitrogen treatments

The experiments were carried out to study the influence of three nitrogen types on the serpentine leaf miner, *Liriomyza trifolii* infestation, as well as pea growth parameters and components of the yield. The recommended dose of N fertilizer was (80 kg $feddan^{-1}$) was added at two equal portions during soil preparation, and at 30 days from sowing during flowering stage. Nitrogen fertilizer treatments were added in the form of urea 46% as (172 kg), ammonium nitrate 33.5% as (239 kg) and ammonium sulphate, 20.5% N as (390 kg $feddan^{-1}$), respectively and unfertilized control._While potassium sulphate, 48% K_2O was added at two equal doses during soil preparation and during filling of the fruit, meanwhile calcium super phosphate 16.5% P_2O_5 and organic manure (10 m^3 $feddan^{-1}$) was added during soil preparation. Other agriculture practices for pea production were practiced as usual in the commercial production of green pod yield.

Control program

Pea seeds (Master B) were selected for uniformity by choosing those of equal size and same color and soaked in mixture of Imidacloprid + Pencycuron (Moncyrin G 37% FS) solution for about 6 h before sowing. All pea plots were subjected to the proposed control program as presented in Table (2). Control program consisted of foliar sequential sprays of some insecticides. Insecticide applications were applied using the calibrated Hand-Held compression sprayer (Kwazar) before the foliar application, while control plot was sprayed with water.

Table 2: Applied insecticide program in pest control against *L. trifolii* during 2021 and 2022 winter seasons.

Treatment date 2021/2022	Trade name	Active ingredient (Group)	Biochemistry & mode of action	Rate of application/hl*
23rd Oct.	Trigard 75% WP (Wettable powder)	Cyromazine	It has contact action, chitin synthesis inhibitor, as well as insect growth regulator which interferes moulting and pupation.	**50 g**
6th Nov.	Benevia 10% OD (Oil Dispersion)	Cyantraniliprole (Diamide: Pyridylpyrazole)	It has systemic action as well as It has larvicidal activity when sprayed on leaves, it change the Ca_2+ balance, second generation ryanodine receptor.	**80 ml**
20th Nov.	Kemgera 10% SC (Suspension concentrate)	Broflanilide (Meta-diamide)	Metabolises to desmethyl-broflanilide which the acts as a noncompetitive resistant-to-dieldrin (RDL) gamma-aminobutyric acid (GABA) receptor antagonist.	**45 ml**
27th Nov.	Oikos 3.2% EC (Emulsifiable concentrate)	Azadirachtin (Plant extract)	Ecdysone antagonist, disrupts insect moulting, , fungicidal and miticidal of the hydrophobic extract.	**100 ml**
11th Dec.	Top-Healthy 60 % EC (Emulsifiable concentrate)	Jojoba oil	It acts as physical barrier between pest and the surface of leaf, clogging the insect spiracles, and it may be disrupting the egg laying and feeding as a repellent.	**400 ml**

***hl** = 100 liter water

Inspection of leaf miner infestations:
Weekly randomized leaf samples of pea plants (20 leaves/ replicate) were taken after 15 days of sowing prolonged to the end of experiment. Each sample was kept in paper bags and transferred to the laboratory for examination under a stereomicroscope to count the number larvae of *L. trifolii*. The mean numbers of *L. trifolii* larvae among the three tested N types was statistically compared.

Recorded plant data:
Randomly sample of five plants were chosen from each plot at 45 days from seed sowing to measure the following:

1- Vegetative growth parameters: Number of leaves, and branches/ plant, plant height (cm) and plant fresh & dry weight (g).

At harvest time, green pods, and its components, as well as pod and seed quality were measured.

2- Green pod yield and its components: Number of pods per plant, average pod weight average (g), total green pod yield (ton) / feddan, pod length and width (cm), and number of seeds per pod.

Statistical analysis: Data were statistically analyzed using SAS v 9.3 (2003, SAS Institute Inc., Cary, NC, U.S.A.) including f-test, t-test, and simple correlation. The revised least significant differences (LSD) were used for comparing means at 5% levels of probability.

RESULTS AND DISCUSSION

Influence of nitrogen types on leaf miner infestations

The combination between the types of N fertilizers and the pest control program had been an important effect on leaf miner, *L. trifolii* infestation on pea plants. The data summarized in Table (3) show that the three N types stated a high significant effect on leaf miner density comparing to control plot (Prob. > |T| ranged from 0.001 to 0.0001). The infestation of *L. trifolii* larvae was extended between 1.23 – 2.10 larvae/leaf on pea plants with the three tested fertilizers under the application of pest control program. Contrariwise, it was exceeded than 4 larvae/ leaf with the control of these three N types without pest control program. The infestation of *L. trifolii* larvae recorded 1-2 peaks on all tested N types in pea plants during winter season 2021 (Table 3). Under pest control program, the nitrogen application significantly affected *L. trifolii* larvae infestation between ammonium sulphate and both of urea and ammonium nitrate applications during the investigated season (F value equal 3.96 and LSD=0.6313). The highest population of *L. trifolii* larvae were recorded with urea and ammonium nitrate fertilizers (2.10 and 1.47 larvae/leaf, respectively) (Table 3). During winter season 2022, a significant effect was reported with the three nitrogen types (Table 4). In the same direction throughout the first season, larval infestation of *L. trifolii* on pea plants did not exceed 2 peaks throughout the second winter season 2022, but the infestation level was very low compared with that of the 1st season. The greatest infestations of *L. trifolii* larvae were also recorded with urea fertilizer (2.04 and 4.83 larvae/leaf) and ammonium nitrate (1.41 and 4.33 larvae/ leaf), followed by ammonium sulphate (1.18 and 4.58

larvae/ leaf) with and without pest control program during second season 2022, respectively (Table 4). It was evident from the present data that the combination between ammonium sulphate or ammonium nitrate and the suggested pest control program have an important role in reducing the leaf miner, *L. trifolii* infestation to pea plants. The main drivers of N fertilizer in this experiment had been identified as N formulation. In the present study, the nitrogen application significantly affected *L. trifolii* larvae infestation between ammonium sulphate and both of urea and ammonium nitrate applications during both investigated seasons of 2021 and 2022 respectively. The obtained data was harmony with that obtained by Cruz *et al*. (2012) who found that the leaf miner attack was higher in common bean plants without stress nitrogen , while more leaves, and miner attack % in bean plants under stress of nitrogen. The present results may be due to the role of N in synthesis of proteins, oils, enzymes, vitamins in plants, specially, the nitrogen source of ammonium sulphate which contained sulphur the main constituent of amino acids, Cystine (27% S), Methionine (21%S) and Cysteine (26%S), there are mainly the building amino acids of proteins (Patra *et al*., 2013). However, N nutrition levels have affected the life cycle of tomato leaf miner, *T. absoluta* on tomato plants. (Larbat *et al*., 2016). Moreover, the population of leaf miner, *Liriomyza* sp. on bean, *Phaseolus vulgaris* was related with N fertilization (Rodrigues *et al*. 2009). Additionally, the insect-host plant interaction show that *L. trifolii* development increased with increasing nitrogen levels in potato leaves (Facknath and Lalljee 2005).

Table 3: Population fluctuation of *Liriomyza trifolii* **larvae infested pea leaves as affected by different N sources and pest control program during winter season of 2021**

Inspection dates	**Mean no. of *Liriomyza trifolii* larvae/ leaf**					
	Urea		**Ammonium sulphate**		**Ammonium nitrate**	
	With pest control	**Without pest control**	**With pest control**	**Without pest control**	**With pest control**	**Without pest control**
23rd Oct., 2021	1.17	3.97	0.31	3.25	0.61	2.64
30th	1.62	6.95	2.59	9.62	1.4	4.86
6th Nov., 2021	3.77	6.29	2.37	8.43	3.98	8.74
13th	3.72	10.02	1.8	6.63	1.79	9.08
20th	2.6	8.61	1.4	4.9	0.99	5.61
27th	1.97	1.24	0.39	2.17	1.33	2.39
4th Dec., 2021	1.27	0.6	0.58	0.85	1.05	0.63
11th	0.64	1.24	0.4	1.08	0.59	0.99
Overall Mean ± SE	**2.10 a ± 0.42**	**4.87 ± 1.29**	**1.23 b ± 0.33**	**4.61 ± 1.19**	**1.47 ab ± 0.39**	**4.37 ± 1.16**
Prob. > |T|	**0.001**		**0.0001**		**0.0001**	
t value	**-3.67 ****		**-4.79 ****		**-4.18 ****	
F value	**3.96**					
LSD	**0.6313**					

** = Highly significant, Means signed by the same letter in the row were non-significant

Table 4: Population fluctuation of *Liriomyza trifolii* larvae infested pea leaves as affected by different N sources and pest control program during winter season of 2022

Inspection dates	Mean no. of *Liriomyza trifolii* larvae/ leaf					
	Urea		Ammonium sulphate		Ammonium nitrate	
	With pest control	Without pest control	With pest control	Without pest control	With pest control	Without pest control
23rd Oct., 2022	1.07	4.07	0.21	3.35	0.51	2.74
30th	1.46	6.95	2.42	9.62	1.24	4.86
6th Nov., 2022	3.47	6.09	2.07	8.23	3.68	8.54
13th	3.75	10.02	1.83	6.63	1.82	9.08
20th	2.80	8.71	1.60	5.00	1.19	5.71
27th	2.07	1.14	0.49	2.07	1.43	2.29
4th Dec., 2022	1.27	0.50	0.65	0.75	1.05	0.53
11th	0.44	1.14	0.20	0.98	0.39	0.89
Overall Mean ± SE	**2.04 ± 0.42**	**4.83 ± 1.30**	**1.18 ± 0.32**	**4.58 ± 1.18**	**1.41 ± 0.36**	**4.33 ± 1.16**
Prob. > |T|	**0.001**		**0.0001**		**0.0001**	
t value	**-3.63 ****		**-4.79 ****		**-4.22 ****	
F value	**4.06**					
LSD	**0.621**					

** = Highly significant, Means signed by the same letter in the row were non-significant

In the present study, *L. trifolii* larvae population was differed according to nitrogen types as presented in Tables (3, 4) where the nitrification of nitrogen was higher with urea and ammonium nitrate than in ammonium sulphate, as well as other studies reported that N_2O emissions were higher from NO_3 −based fertilizers than from urea (Dobbie and Smith, 2003; Kuikman *et al*., 2006 and Jones *et al*., 2007). This may be due to the role of nitrogen on the syntheses of protein and amino acids that play an important role in leaf miner development (Facknath and Lalljee 2005). Additionally, in the current study, the levels of N fertilizers in pea plant may be related to N absorbance and the N stabilizers, in which, the source of nitrogen, ammonium sulphate may be more stable than other N sources in this study, so that, this treatment had been less infestation of *L. trifolii* larvae than others which confirmed with the research of Misselbrook *et al*., (2004), who found that the N_2O emissions from calcium nitrate were higher than urea. Harty *et al*. (2016) reported that the stability or reducing of N nitrification was established by using N stabilizer as Dicyanodiamide (DCD) or N-butyl thio-phosphoric tri-amide (NBPT) with urea and calcium nitrate, due to the bad effect on the syntheses of protein and amino acids that play an important role in leaf miner *L. trifolii* development. Moreover, fertilization interferes in the physiological process and growth development of pea plants, and it may be related to higher density of pea leaf miner (Nestel *et al*., 1994). Also, the connection between plants and herbivorous insects is typically influenced by the mineral nutrients' compliance because nutrients change the chemical composition, morphology, anatomy, and phenology of plants (Uesugi, 2015).

Effects on growth and yield characteristics:

The influence of these three tested types of nitrogen on pea growth characters illustrated that no significant effect was statistically detected on the plant height and the mean numbers of branches per plant with the three treatments (38.67, 43.26 and 47.59 cm) for plant height and 2.17, 3.33 and 2.67 branches per plant during season 2021. However, a significant effect between these tested nitrogen fertilizers for the numbers of leaves per plant (Table 5). Contrariwise, no significant differences between all types of fertilizers and pest control treatment throughout the first season 2021.Concerning the effect of different methods of N applications, the present data reported that , the lowest value of plant weight was recorded with the treatment of urea for two additions (185.0, 40.0 g/ 5 fresh and dry plants, respectively) while the highest value was found with ammonium nitrate during winter season 2021 (330.0, 61.3 g/ 5 fresh and dry plants, respectively).

Data in Table (5) reported the interaction between the nitrogen fertilizers and the pea pods and seeds in the 1st season, where there were no significant effects on the length and diameter of pods and the mean numbers of seeds/ pod, where the pod length and diameter were ranged between 7.67 – 8.83 cm and 4.22 – 5.67 cm, respectively. The mean numbers of seeds per pod was ranged from 6.83 – 8.00 seeds/pod, and the highest pod parameters were recorded with ammonium sulphate applications (Table 5). A significant effect was noticed between urea & ammonium sulphate or ammonium nitrate treatments on the numbers of pods per plant and the weight of these pods through the first season. The highest number of pods per plant was 17.00 followed by 12.33 and 11.67 with ammonium nitrate, ammonium sulphate and followed by urea applications, respectively. The same trend was stated for the weight of pod with all treatments at the winter season of 2021(Table 5).

Regarding to the obtained data through the winter season 2022 Table (6), a similar trend was noticed for impacting of N types on growth and yield characteristics of pea plant. No significant effects were recorded on the plant height, no. of branches per plant, length & diameter of pods, no. of seeds per pod and the weight of 5 dry plants during season 2022 with an average ranged from 39.97-48.66 cm, 2.36-3.97 mean numbers/plant, 7.27-8.77 cm, 3.85-5.60 cm, 5.04-7.93 mean numbers/ pod and 51.67-87.92 g., respectively through winter season 2022. On the other direction, there was significant effects for nitrogen types on the mean numbers of leaves, mean numbers of pods per plant, the weight of pod and the weight of 5 fresh plants with average between 17.10- 28.10 mean numbers/ plant, 8.62-16.93 mean numbers/plant, 3.6-7.18 g. and 116.69- 356.67 g., respectively. Additionally, no significant differences were recorded between fertilizer types and pest control treatment throughout the 2nd season 2022 (Table 6).

Table 5: Effect of three nitrogen sources on the vegetative growth and yield of pea plant, *Pisum sativum* under pest control program during winter season of 2021.

Treatments	Plant characteristics									
	Plant height (cm)	No. of leaves/ plant	No. of branches/ plant	No. of pods/ plant	Pod Length (cm)	Pod Diameter (cm)	Pod Weight (g)	No. of seeds/ pod	Weight of 5 fresh plants (g)	Weight of 5 dry plants (g)
Urea with pest control	38.67 a	17.41 b	2.17a	11.67 b	7.67a	5.67a	4.51 b	6.83 a	185.0 c	40.0 b
Urea without pest control	35.59	17.17	1.72	8.69	7.30	4.92	3.67	5.11	135.0	35.0
Prob. > |T|	0.39 NS	0.90 NS	0.27 NS	0.14NS	0.73NS	0.48NS	0.43NS	0.18NS	0.003**	0.44NS
A*. sulphate with pest control	43.26 a	22.22 ab	3.33 a	12.33 b	8.83a	4.83 a	6.33 ab	6.83 a	290.0 b	57.5 a
A. sulphate without pest control	39.33	22.17	2.31	12.22	7.79	4.69	5.58	6.52	180.0	40.0
Prob. > |T|	0.18 NS	0.99 NS	0.31 NS	0.94NS	0.42NS	0.90NS	0.23NS	0.78NS	0.001**	0.0004**
A. Nitrate with pest control	47.59 a	28.17 a	2.67 a	17.00 a	7.92a	4.22 a	7.25 a	8.00 a	330.0 a	61.3 a
A. Nitrate without pest control	46.33	24.35	2.56	12.20	7.34	3.92	5.83	6.44	90.0	25.0
Prob. > |T|	0.82 NS	0.45 NS	0.89 NS	0.07NS	0.69NS	0.79NS	0.42NS	0.25NS	0.0001**	0.001**
F value	2.84	6.38	0.97	6.22	0.30	0.76	3.17	0.38	64.61	8.70
LSD	9.17	7.38	2.05	4.03	3.91	2.87	2.71	3.78	32.24	13.31

A*. Ammonium

Table 6: Effect of three nitrogen sources on the vegetative growth and yield of pea plant, *Pisum sativum* under pest control program during winter season of 2022.

Treatments	Plant characteristics									
	Plant height (cm)	**No. of leaves/ plant**	**No. of branches/ plant**	**No. of pods/ plant**	**Pod Length (cm)**	**Pod Diameter (cm)**	**Pod Weight (g)**	**No. of seeds/ pod**	**Weight of 5 fresh plants (g)**	**Weight of 5 dry plants (g)**
Urea with pest control	48.66 a	17.34 b	2.80 a	11.60 b	7.60 a	5.60 a	4.44 b	6.77 a	211.67 c	66.67 a
Urea without pest control	46.40	17.10	2.36	8.62	7.23	4.85	3.6	5.04	161.67	61.67
Prob. > |T|	0.39 NS	0.90 NS	0.26 NS	0.15 NS	0.70 NS	0.42 NS	0.37 NS	0.14 NS	0.01**	0.63 NS
A. sulphate with pest control	43.89 a	22.16 ab	3.97 a	12.27 b	8.77 a	4.77 a	6.27 ab	6.77 a	316.67 b	84.17 a
A. sulphate without pest control	39.97	22.10	2.95	12.15	7.72	4.63	5.52	6.45	206.67	66.67
Prob. > |T|	0.18 NS	0.99 NS	0.32 NS	0.94 NS	0.36 NS	0.89 NS	0.36 NS	0.76 NS	0.001**	0.15 NS
A. Nitrate with pest control	48.23 a	28.10 a	3.30 a	16.93 a	7.85 a	4.16 a	7.18 a	7.93 a	356.67 a	87.92 a
A. Nitrate without pest control	46.97	24.29	3.19	12.14	7.27	3.85	5.77	6.38	116.69	51.67
Prob. > |T|	0.82 NS	0.46 NS	0.89 NS	0.07 NS	0.66 NS	0.77 NS	0.40 NS	0.20 NS	0.0001**	0.02*
F value	2.92	6.57	0.82	8.07	0.39	1.04	3.56	0.50	64.61	2.70
LSD	9.03	7.27	2.24	3.54	3.42	2.46	2.56	3.28	32.24	23.87

** = Highly significant * = Significant NS= non-significant

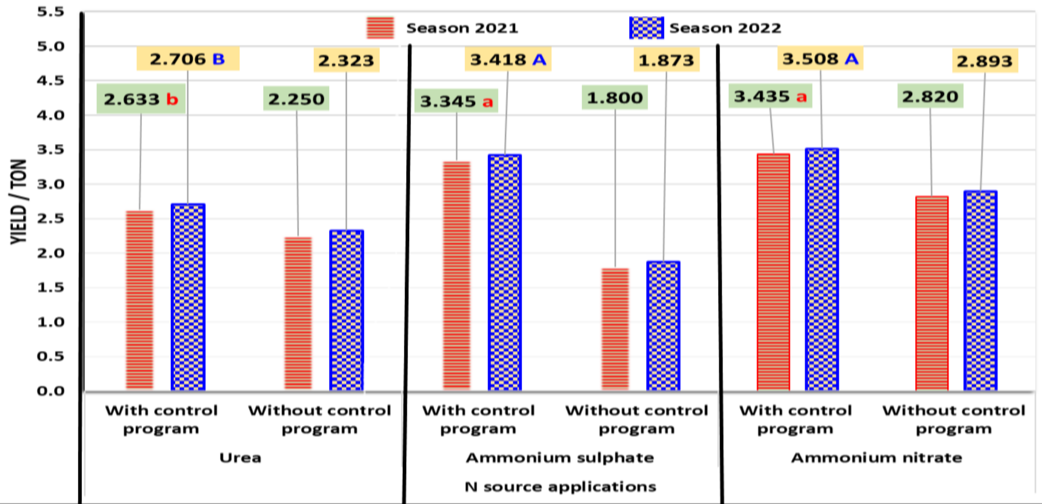
Overall means was signed by the same lowercase letter in the same column were non-significant

Accordingly, the application of nitrogen sources were encouraged the pea vegetative growth. This increase of N fertilizers may be promoting the pea growth as well as cell division and elongation. Application of nitrogen fertilizers in form of ammonium sulphate recorded the highest values of the tested pea growth throughout both two tested seasons, this growth development can be ascribed to sulfur which enhance the plant growth as reported by Elmar (2001).

The obtained data resulted different growth and vegetative characters with the used formulation of nitrogen, which may be due to the positive effects of nitrogen fertilizer in photosynthesis, growth, stress resistance, development and oxidative-stress signaling. These results are in harmony with those reported by Abd El- Hakim (2006) and Abd El- Naem and Abd El- Hakim (2009) on some legumes.

The present study reported that ammonium sulphate was the suitable source of nitrogen compared with other nitrogen sources, and this may be due to that ammonium sulphate contains sulphur, which is a component of succinyl Co-A, a component of chlorophyll in leaves, and similar to the study of Ralsool *et al*. (2013) who found that these components are accelerated photosynthesis, which eventually encourages vegetative growth.

As shown in Figure (1) nitrogen fertilizer types have a substantial impact on pea production. During the two investigated seasons, 2021 and 2022, both ammonium sulphate and ammonium nitrate applications yielded the highest production of pea crop (3.345 and 3.435 tones/ feddan during 2021 and 3.418 and 3.508 tones/ feddan during 2022, respectively) with significant differences to the lowest production (2.633 and 2.706 tones/ feddan throughout 2021 and 2022, respectively) after fertilized by urea under pest control program (Figure 1) (Prob. > |F|, F value equal 25.23 & 20.00 and LSD= 302.91 & 340.20 during 2021 and 2022, respectively.



		Urea	Ammonium sulphate	Ammonium nitrate
Season 2021	Prob. > |T|	0.29 NS	0.004 **	0.01 **
	F value		25.23	
	LSD		302.91	
Season 2022	Prob. > |T|	0.29 NS	0.004 **	0.02 *
	F value		20.00	
	LSD		340.20	

** = Highly significant, * = Significant, NS= non-significant ,
Means was followed by the same lowercase and uppercase letters in the same season were non-significant
Figure 1: Pea production under pest control program during winter seasons of 2021 and 2022.

Fertilization with the selected nitrogen sources can increase pea crop yields compared with no. N fertilization with significant difference between them except with urea application which reported no significant effect under pest control program against leaf miner, *L. trifolii* infestations. Without utilizing a pest control program, the treatments with ammonium nitrate, urea and ammonium sulphate recorded 2.82, 2.25, and 1.8 tons per feddan during the 1^{st} season and 2.893, 2.323, and 1.873 tons per feddan during the 2^{nd} season, respectively (Figure 1).

Under the pest control program, nitrogen fertilizations have the potential to increase pea yields in comparison to no pest control program. These results are in harmony with those obtained by Sainju *et al*. (2019). Moreover, Metwaly (2018) found that the N fertilization sources (ammonium nitrate, ammonium sulphate, calcium nitrate and urea) significantly affect growth and yield of spinach plants. Also, El Mantawy (2017) reported that the N sources improved the sunflower production. Contrariwise, Muhammad *et al.* (2007) found that no significant improvement in seed yield of canola, *Brassica napus*. In the present study, ammonium sulphate and ammonium nitrate produced the highest pea pods compared with urea application, which are in harmony with those conducted by Malik *et al*. (1996) who stated that ammonium sulphate produced more weight seeds of sunflower crop than other N treatments compared with urea application. These differences in pea vegetative growth and yield may be due to exceed the accumulation of chlorophyll pigments in plants (El Mantawy, 2017). High N levels in soil increases leaf content of amino acids and proteins, as well as improving vegetative growth, delaying maturity and lignification of plant tissues, and making the plant more attractive to insect herbivores (Coqueret *et al*., 2017). Also, application of N in form of ammonium sulphate was exceeded pea growth, this growth development can be ascribed to sulfur which enhance the plant growth as reported by Elmar (2001). So that, ammonium sulphate was more suitable to produce pea crop in the present work.

Correlation matrix between *L. trifolii* larvae with N applications and yield

Regarding to the relationship between pea yield, N Applications and *L. trifolii* larvae infestation, Table (7) statistical analysis reported that there is a significant positive relation between N applications and population of *L. trifolii* larvae on pea plant in which the increasing of N applications will increase pest abundance during the two investigated seasons of 2021 and 2022. The correlation coefficient (r) recorded its highest value (0.96) with the probability 0.01 in case of N applications and *L. trifolii* infestation. On the other direction, the relationship between *L. trifolii* population (Larvae) and pea yield was significantly negative during both two tested seasons of 2021 and 2022 recording (- 0.93 and 0.02) in correlation coefficient value and probability, respectively, moreover, the increasing of *L. trifolii* population will decrease the pea production through two tested seasons (Table 7).

Table 7: Mean correlation matrix between *L. trifolii* larvae with N applications and yield during two winter seasons of 2021 and 2022

Correlation matrix		Mean no. of *L. trifolii* larvae/ leaf	N Applications	Yield
Mean no. of *L. trifolii* larvae/ leaf	r value	1.00	0.96	- 0.93
	Prob.	-	0.017	0.024
N Applications	r value	0.96	1.00	- 0.80
	Prob.	0.017	-	0.041
Yield	r value	- 0.93	- 0.80	1.00
	Prob.	0.024	0.041	--

r value = correlation coefficient Prob. = Probability

The obtained results agree with those reported by Elsayed *et al*. (2021) who emphasized that the nitrogen played an important role in increasing the level of the population of piercing-sucking pests, including the leaf miner, *L. trifolii*. In addition, N directly affects plants as well as it indirectly affects herbivorous insects Gao *et al*. (2018 a). Also, in response to nitrogen fertilization it was significantly increased the plant amino acid levels, and consequently increased the levels of many essential amino acids in pea aphid, which it could be used as potential target for pest control. In the obtained results, a positive relationship between *L. trifolii* infestation and nitrogen soil additions which confirmed by findings of Facknath and Lalljee (2005) who conducted that the increased of nitrogen concentrations in potato leaves increased the *L. trifolii* development. Additionally, Gao *et al*. (2018 b) recorded positive effects of nitrogen on the reproduction of pea aphid. On the other direction, Yildirim and Unay (2011) reported that the combination of fulvic acid and calcium nitrate had a negative effect on *L. trifolii* population in tomato plants. Generally, the soil-applied complex of nitrogen types with pest control program affects the insect-host plant interaction between *L. trifolii* infestation and pea growth & yield.

Conclusions

From the obtained results It could be concluded that pea plant, Master B cultivar should be fertilized by 390 and 239 kg feddan^{-1} of nitrogen in form of ammonium sulphate or ammonium nitrate for better performance in pea plant growth and yield under pest control program throughout the agro-climatic conditions of Egypt.

REFERENCES

Abd EI- Hakim, W.M. (2006). Effect of some antioxidant treatments on chemical constituents, antinutritional factors and yield of some vegetable legumes. Ph.D. Thesis, Fac. of Agric., Minia Univ., Egypt.

Abd El-Gawwad (2008). Study of integrated PEST management on some pests of common bean plant. Ph.D. Thesis Fac. Sci. AL-Azhar, Univ. 409 pp.

Abd El-Naeem, G.F. and Abd El-Hakim, W.M. (2009). Evaluation of yield, chemical constituents and antioxidative activities of phenolic compounds in some vegetable legume treated with some antioxidants. Minia J. Agric. Res. Develop., 29(3), 459–495.

Abou-Fakhr Hammad, E.M. and Nemer, N.M. (2000). Population densities, spatial pattern and development of the pea leaf miner (Diptera: Agromyzidae) on cucumber, swisschard and bean. The Journal of Agricultural Science, 134(1), 61-68. doi:10.1017/S0021859699007297.

Alam, M.K.; Uddin, M.M.; Ahmed, M.; Latif, M.A. and Rahman, M.M. (2010). Growth and green pod yield of garden pea varieties under different nutrient levels. J. Agro-fore. Environ., 4(1): 105- 107.

Bayoumy, M.; Awadalla, H.S.; Michaud, J.P. and Ramadan, M.M. (2018). A life table for *Liriomyza trifolii* Diptera:Agromyzidae in a temperate zone of Northeast Egypt with key factor analysis.Environmental Entomology,47(4):56-58. https://doi.org/10.1093/ee/nvy086

Bhuvaneswari, G.; Sivaranjani, R.; Reetha, S. and Ramakrishan, K. (2014). Application of nitrogen fertilizer on plant density, growth, yield and fruit of bell peppers (*Capsicum annuum* L.). Int. Lett. Nat. Sci., 13: 81–90.

Bueno, A.F.; Zechmann, B.; Hoback, W.W.; Bueno, R.C.O.F. and Fernandes, O.A. (2007). Serpentine leaf miner (*Liriomyza trifolii*) on potato (*Solanum tuberosum*): Field observations and plant photosynthetic responses to injury. Ciencia Rural, 37(6):1510-1517.

Burgio, G.; Lanzoni, A.; Masetti A. and Manucci, F. (2005). Spatial Patterns and Sampling Plan for *Liriomyza huidobrensis* (Diptera: Agromyzidae) and Related Parasitoids on Lettuce, Environmental Entomology, 34(1):178–183, https://doi.org/10.1603/0046-225X-34.1.178

Capinera, J.L. (2001). American Serpentine Leafminer, *Liriomyza trifolii* (Burgess) (Insecta: Diptera: Agromyzidae). Entomology and Nematology Department, Florida Cooperative

Extension Service, Institute of Food and Agricultural Sciences, University of Florida.

Chaney, W.E. (1995). The pea leaf miner as a pest of vegetable, crops. Crop, 4 pp Notes, P.4. Monterey Co. Extension Office. http://dx.doi.org/10.32473/edis-in268-1999

Chien, S.H.; Gearhart, M.M. and Villagarcía, S. (2011). Comparison of Ammonium Sulfate with Other Nitrogen and Sulfur Fertilizers in Increasing Crop Production and Minimizing Environmental Impact. A Review. Soil Science, 176 (7): 327-335. http://dx.doi.org/10.1097/SS.0b013e31821f0816

Coqueret, V.; Le Bot, J.; Larbat, R.; Desneux, N.; Robin, C. and Adamowicz, S. (2017). Nitrogen nutrition of tomato plant alters leafminer dietary intake dynamics. J. Insect Physiol., 99:130-138. https://doi.org/10.1016/j.jinsphys.2017.04.002

Cruz, W.P. da; Salgado, F.H.M.; Ferreira Junior, D.F. and Fidelis, R.R. (2012). Nutrition and genetics in the occurrence of pests, natural enemies and attack leaf miner in common bean (*Phaseolus vulgaris*). Journal of Biotechnology and Biodiversity, 3(1):74-81. https://doi.org/10.20873/jbb.uft.cemaf.v3n1.cruz

Daamen, R.A.; Wijnands, F.G. and Vliet, G. van der (1989). Epidemics of diseases and pests of winter wheat at different levels of agrochemical input. A study on the possibilities for designing an integrated cropping system. Journal of Phytopathology, 125(4):305-319. https://doi.org/10.1111/j.1439-0434.1989.tb01075.x

Dobbie, K.E. and Smith, K.A. (2003). Impact of different forms of N fertilizer on N_2O emissions from intensive grassland. Nutrient Cycling in Agroecosystems, 67: 37–46. .https://doi.org/10.1023/A:1025119512447

Doss, A.S.; Adam, K.M.; Herakly, F.A. and El-Hamaky, M.A. (1992). Population densities of the broad bean leafminer, *Liriomyza trifolii* (Burgess) and the cotton whitefly, *Bemisia tabaci* (Genn.) on protected cultivation. Minia. J. Agric. Res. & Dev., 14(3): 787- 797.

El Mantawy, R.F. (2017). Physiological Role of Antioxidants in Improving Growth and Productivity of Sunflower under Different Sources of Nitrogen Fertilizers. Egypt. J. Agron., 39(2):167- 177. https://doi.org/10.21608/agro.2017.761.1060

Elmar, S. (2001). The importance of ammonium sulphate nitrate (ASN) as highly efficient sulfate Sudanese crops (FertivaCmbH, Germany). Fertilizer Workshop on May 26, 2001 Khartoum, Sudan.

El-Nahal, A.K.M. and Assem, M.A. (1970). The chemical control of the broad bean leaf-miner, *Liriomyza trifolii* (Burgess). Bull. Ent. Soc. Egypt. Econ. Ser., 4: 205-217.

El-Sayed, A.M.; Sheded, M.L. and Soliman, M.H.A. (2007). Biological study on *Liriomyza trifolii* and its parasitoids on *Vicia faba* field. Egypt. J. Appl. Sci., 22 (4B): 643-654.

Elsayed, E.G.A.; Salman, A.M.A. and Abdel-Rahman, M.A.A. (2021). Incidence of certain insect pests infesting faba bean *Vicia faba* cultivars under some agriculture practices. Egyptian Journal of Plant Protection Research Institute, 4(3):440-444.

Elsharkawy, G.A. (2013). Growth, Yield and Chemical Composition of Peas (*Pisum sativum*) as Affected by Potassium Levels and Different Methods of Yeast Application. Alexandria Science Exchange Journal, 34(4): 360 – 368.

Facknath, S. and Lalljee, B. (2005). Effect of soil-applied complex fertiliser on an insect– host plant relationship: *Liriomyza trifolii* on *Solanum tuberosum*. Entomologia Experimentalis et Applicata., 115: 67–77. https://doi.org/10.1111/j.1570-7458.2005.00288.x

FAO (2020). Food and Agriculture Organization of the United Nations, Cairo, Egypt. https://www.fao.org/faostat/en/#data/QCL

Foba, C.N., Salifu, D., Lagat, Z.O., Gitonga, L.M., Akutse, K.S., Fiaboe, C.N. (2015). Species composition, distribution, and seasonal abundance of *Liriomyza* Leafminers (Diptera: Agromyzidae) under different vegetable production systems and agroecological zones in Kenya. Environ. Entomol., 44(2): 223–232. https://doi.org/10.1093/ee/nvu065.

Foba, C.N.; Salifu, D.; Lagat, Z.O.; Gitonga, L.M.; Akutse, K.S. and Fiaboe, K.K.M. (2016). *Liriomyza* leafminer (Diptera: Agromyzidae) parasitoid complex in different agroecological zones, seasons, and host plants in Kenya. Environmental Entomology, 45(2): 357–366. http://doi.org/10.1093/ee/nvv218

Gao, J.; Guo, H.J.; Sun, Y.C. and Ge, F. (2018 a). Differential accumulation of leucine and methionine in red and green pea aphids leads to different fecundity in response to nitrogen fertilization. Pest Management Science,74(8):1779-1789. 1002/ps.4875"https://doi.org/ "https://doi.org/10.1002/ps.4875"10.1002/ps.4875

Gao, J.; Guo, H.J.; Sun, Y.C. and Ge, F. (2018 b). Juvenile hormone mediates the positive effects of nitrogen fertilization on weight and reproduction in pea aphid. Pest management science, 74 (11): 2511-2519. https://doi.org/10.1002/ps.4932

Han, P. (2014). Nitrogen and water availability to tomato plants triggers bottom-up effects on the leafminer *Tutaabsoluta*. Scientific Reports, London, . 4, 1–8 p.

Harty, M.A.; Forrestal, P.J.; Watson, C.J.; McGeough, K.L.; Carolan, R.; Elliot, C.; Krol, D.; Laughlin, R.J.; Richards, K.G.; Lanigan, G.J. (2016). Reducing nitrous oxide emissions by changing N fertiliser use from calcium ammonium nitrate (CAN) to urea based formulations, Science of The Total Environment, 563–564: 576-586. 10.1016/j.scitotenv.2016.04.120

Jackson, M.L. (2005). Soil Chemical Analysis, 2nd ed.; Parallel Press: Madison, WI, USA, 2005.

Jones, S.K.; Rees, R.M.; Skiba, U.M. and Ball, B.C. (2007). Influence of organic and mineral N fertiliser on N_2O fluxes from a temperate grassland. Agric. Ecosyst. Environ., 121 (1–2): 74–83. http://dx.doi.org/10.1016/j.agee.2006.12.006.

Jones, V.P.; Parrella, M.P. and Hodel, D.R. (1986). Biological control of leaf miners in green house chrysanthemum Calf. Agric., 40 (1 and 2): 10-12.

Kuikman, P.J.; van der Hoek, K.W.; Smit, A. and Zwart, K.A. (2006). Update of Emissions Factors for Direct Emissions of Nitrous Oxide from Agricultural Soils on the Basis of Measurements in the Netherlands. Alterra Report 1217, 40pp., Alterra, Wageningen.

Larbat, R.; Adamowicz, S.; Robin, C.; Han, P.; Desneux, N. and Bot, J. le (2016). Interrelated responses of tomato plants and the leaf miner *Tuta absoluta* to nitrogen supply. Plant Biology, 18(3):495-504. https://doi.org/10.1111/plb.12425

Letourneau, D.K. (1994). Bean fly, management practices, and biological control in Malawian subsistence agriculture. Agriculture, Ecosystems & Environment, 50(2):103-111. https://doi.org/10.1016/0167-8809(94)90129-5

Li, Y.L.; Yang, Y.G. and Zhang, H.S. (2009). Field drug efficacy experiments for controlling *Liriomyza sativae* Blanchard in soft legume pea by several kinds of pesticides. China Vegetables, (8):67-68.

Malik, R.S. and Kumar, K. (1996). Effect of drip irrigation levels on yield and water use efficiency of pea. J. Indian Soc. Soil Sci., 44: 508-509.

Metwaly, E. (2018). Response of Spinach Plants to Foliar Application by Ascorbic Acid Under Different Sources of Nitrogen Fertilization. Journal of Plant Production, 9(1): 109-115. https://doi.org/10.21608/jpp.2018.35265

Misselbrook, T.H.; Sutton, M.A. and Scholefield, D. (2004). A simple process-based model for estimating ammonia emissions from agricultural land after fertilizer applications. Soil Use Manag., 20: 365–372. http://dx.doi.org/10.1111/j.1475-2743.2004.tb00385.x.

Mohan, N.; Aghora, T.S.; Wani, M.A. and Divya, B. (2013). Garden pea improvement in India. J. Hort. Sci., 8(2): 125-164.

Murillo-Amador, B.; Jones, H.G.; Kaya, C.; Aguilar, R.L.; García-Hernández, J.L.; Troyo-Diéguez, E.; Ávila-Serrano, N.Y. and Rueda-Puente, E. (2006). Effects of foliar application of calcium nitrate on growth and physiological attributes of cowpea (*Vigna unguiculata* L. Walp.) grown under salt stress, Environmental and Experimental Botany, 58(1–3): 188-196. https://doi.org/10.1016/j.envexpbot.2005.08.003

Nasim, W.; Ahmad, A.; Bano, A.; Olatinwo, R.; Usman, M.; Khaliq, T.; Wajid, A.; Mohkum, H.; Hammad Mubeen, M. and Hussain, M. (2012). Effect of nitrogen on yield and oil quality of sunflower (*Helianthus annuus* L.) hybrids under sub humid conditions of Pakistan. American Journal of Plant Sciences, 3: 243–251. http://dx.doi.org/10.4236/ajps.2012.32029

Nestel, D.; Dickschen, F. and Altieri, M.A. (1994). Seasonal and spatial population loads of a tropical insect: the case of the coffee leaf-miner in Mexico. Ecol. Entomol., 19(2): 159–167. 10.1111/j.1365-2311.1994.tb00406.x

Ohyama, T. (2010). Nitrogen as a Major Essential Element of Plants. In: Nitrogen Assimilation in Plants, Ohyama, T. and K. Sueyoshi (Eds.). Chapter 1, Research Signpost, Trivandrum, Kerala, India, ISBN: 978-81-308-0406-4, 1-17 pp.

Oliveira, M. D. (2014). Reproductive performance of striped mealybug *Ferrisia virgata* Cockerell (Hemiptera: Pseudococcidae) on water stressed cotton plants subjected to nitrogen fertilization. Arthtopod Plant Interactions, Berlim, 8(5): 461–468.

Parrella, M.P.; Jones, V. and Christie, G.D. (1987). Feasibility of parasites for biological control of *Liriomyza trifolii* (Diptera: Agromyzidae) on commercially grown chrysanthemum. Environ. Entomol., 16: 832-837. https://doi.org/10.1093/ee/16.3.832

Patra, P.; Pati, B.K.; Ghosh, G.K.; Mura, S.S. and Saha, A. (2013). Effect of Biofertilizers and Sulphur on Growth, Yield, and Oil Content of Hybrid Sunflower (*Helianthus annuus*. L) In a Typical Lateritic Soil. 2: 603. http://doi.org/10.4172/scientificreports.603

Rashid, M. M. D.; Jahan, M. and Islam, K. S. (2017) Effects of nitrogen, phosphorous and potassium on host-choice behavior of brown plant hopper, *Nilaparvata lugens* (Stål) on Rice Cultivar. Journal Insect Behavior, Berlim, 30 (1): 1–15.

Rasool, Faisul-ur, Hasan, Badrul., Aalum, I. and Ganie, S.A. (2013). Effect of nitrogen, sulphur and farmyard manure on growth dynamics and yield of sunflower (*Helianthus annuus* L.) under temperate conditions. Scientific Research and Essays, 8 (43): 2144–2147. http://dx.doi.org/10.5897/SRE2013.5618

Rodrigues, G.A.; Romão, M.M.; Calafiori, M.H.; Andrade, R.C. and Alves, S.B. (2009). Nitrogeneous fertilization influencing leafminer fly population, *Liriomyza* sp., and its control by *Beauveria bassiana* and *Metarhizium anisopliae* on bean (*Phaseolus vulgaris* L.). Ecossistema, 34/35(1/2): 5-8.

Sainju, U.M.; Ghimire, R. and Pradhan, G.P. (2019). Nitrogen Fertilization I: Impact on Crop, Soil, and Environment. In E. C. Rigobelo, & A. P. Serra (Eds.), Nitrogen Fixation. Intech Open. https://doi.org/10.5772/intechopen.86028

Salas, J. and Mendoza, O. (2001). Evaluation of a neem extract for the control of *Bemisia tabaci* and *Liriomyza sativae* in tomato. Agronomia Tropical, 51(2): 221-234.

SAS Institute (2003). SAS version 9.1. SAS Institute Inc, Cary, NC, USA.

Shaalan, H.S. and El-Ghanam M.S. (2016). Effect of Planting Space, Some Weather Factors and Plant Age on the Population Density of *Liriomyza trifolii* (Burgess) Infesting Pea Plants. Egypt. Acad. J. Biolog. Sci. (A. Entomology), 9 (3): 21- 30. https://dx.doi.org/10.21608/eajbsa.2016.12771

Uesugi, A. (2015). The slow- growth high-mortality hypothesis: Direct experimental support in a leafmining fly. Ecological Entomology, 40(3): 221–228. https://doi.org/10.1111/een.12177

Urbano, G.; Aranda, P. and Gomez –Villalva, E. (2003). Nutritional evaluation of pea (*Pisum sativum*) protein diets after mild hydrothermal treatment and with and without added phytase. Journal of Agricultural and food chemistry, 51:2415-2420.

Vashisth, S.; Chandel, Y.S. and Kumar, S. (2013). Observations on insect-pest problems of polyhouse crops in Himachal Pradesh. J. Entomol. Res., 37(3): 253-258.

Wilkerson, J.L.; Webb, S.E. and Capinera, J.L. (2005). Vegetable Pests I: Coleoptera -Diptera -Hymenoptera. UF/IFAS CD-ROM. SW 180.

Xu, B.Y.; Chang, X.L.; Wang, R.; Zhu, G.R. and Zhang, Y.J. (2009). Evaluation on the effect of 50% Cyromazine SP on controlling kidney bean *Liriomyza sativae*. China Vegetables, (10): 51-54.

Yildirim, E.M. and Unay, A. (2011) Effects of different fertilizations on *Liriomyza trifolii* in tomato. Afr. J. Agric. Res., 6(17), 4104-4107.

Zaghloul, R.A.; Abou-Aly, H.E.; El-Meihy, R.M. and El-Saadony, M.T. (2015). Improvement of growth and yield of pea plants using integrated fertilization management. Univ. J. Agric. Res., 3(4): 135-143.

الملخص العربي

تأثير مصادر مختلفة للتسميد النيتروجينى على الإصابة بحشرة صانعة أنفاق الأوراق *Liriomyza trifolii* ونمو وإنتاجية محصول البسلة تحت ظروف برنامج لمكافحة الآفات

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1 مركز البحوث الزراعية ، معهد بحوث وقاية النباتات، قسم بحوث آفات الخضروالنباتات الطبية والعطرية والزينة ، الجيزة ، مصر.

2 قسم البساتين ،كلية الزراعة ، جامعة المنوفية ، مصر

تعتبر البسلة من أهم محاصيل الخضر البقولية الشتوية التي تنتمي إلى العائلة البقولية وتعد أحد مصادر البروتين الهامة فى الصناعات الغذائية والأعلاف ، وتصاب نباتات البسلة بالعديد من الآفات الحشرية التى تؤثر على المحصول كماً ونوعاً ، وتعتبر حشرة صانعة أنفاق الأوراق ***Liriomyza trifolii*** **(Burgess)** **(Diptera: Agromyzidae)** من الآفات الأساسية التى تصيب المحاصيل البقولية في منطقة البحر الأبيض المتوسط وخاصة في مصر. لذا أجريت تجربة حقلية لتحديد التذبذب العددي ليرقات ***L. trifolii*** على نبات البسلة صنف ماستر– بي ودراسة مدى تأثير استخدام ثلاثة انواع من الاسمدة النيتروجينية المختلفة (اليوريا – نترات النشادر – سلفات النشادر) تحت ظروف برنامج المكافحة المختبر خلال الموسم الشتوي لعامى 2021 ، 2022 بقرية كفر سنجرج ، المنوفية ، مصر وقد تم تصميم التجربة في قطاعات كاملة العشوائية بثلاث مكررات . وتمت إضافة معدلات التسميد النيتروجيني على أساس المعدل الموصي به للفدان 80 وحدة أزوت بمعدلات / فدان 390 كجم من كبريتات الأمونيوم ، 239 كجم من نترات النشادر و172 كجم من اليوريا.

وأظهرت النتائج أن النمو الخضرى وصفات المحصول لصنف البسلة ماستر بي والتذبذب العددي لحشرة صانعة أنفاق الأوراق ***L. trifolii*** على نبات البسلة قد تأثرت معنويا بمصادر التسميد الأزوتى المختبرة خلال موسمى الدراسة 2021 ، 2022 . وسجلت النتائج أعلى إصابة بيرقات ***L.trifolii*** في حالة التسميد بسماد اليوريا بمتوسط 2.10 و 2.04 يرقة/ ورقة ، يليها التسميد بسماد نترات النشادر بمتوسط 1.47 و 1.41 يرقة/ ورقة خلال موسمي 2021 ، 2022 على التوالى.

وقد سجلت الدراسة من 1–2 قمة إصابة بيرقات ***L. trifolii*** مع جميع أنواع السماد النيتروجيني المختبرة في محصول البسلة خلال موسمي الدراسة. وقد أوضحت الدراسة وجود تأثير معنوي لإضافة النيتروجين فى صورة سلفات النشادر وبين كلا من التسميد باليوريا ونترات النشادر على الإصابة بيرقات ***L. trifolii*** خلال موسمى الدراسة.

ايضا تبين أن أنواع التسميد النيتروجينى المستخدمة قد شجع ودفع نبات البسلة للنمو الخضري، وكذلك انقسام الخلايا وإستطالتها، وقد سجل أعلى إنتاج للمحصول مع إضافة الأسمدة النيتروجينية في صورة سلفات النشادر ، وأقل إنتاجية فى حالة التسميد باليوريا.

وأخيرا توصى الدراسة باستخدام التسميد النيتروجينى فى صورة سلفات النشادر أو نترات النشادر بمعدل 390 و 239 كجم / فدان مع برنامج مكافحة الآفات الحشرية المختبر حيث كان لهما دورا معنويا في خفض نسبة الإصابة بحشرة صانعة أنفاق الأوراق، ***L. trifolii*** ومردودا معنويا على محصول البسلة صنف ماستر– بي تحت ظروف المناخ الزراعى بجمهورية مصر العربية .