Zagazig J. Agric. Res., Vol. 40 No. (2) 2013 295-312

Zagazig Journal of Agricultural Research
www.zu.edu.eg/agr/journals

EFFECT OF CHEMICAL CONTROL, DIFFERENT FERTILIZATION RATES AND ENTOMOPATHOGENIC NEMATODES ON SOME PESTS ATTACKING COTTON PLANTS

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ABSTRACT

Field experiments were undertaken during 2009 and 2010 seasons at Toukh Tanbisha village, Berkat El-Sabaa region, Minufiya Governorate, Egypt. The obtained results indicated that cotton seeds treated with imidacloprid increased emergence of cotton seedings, improved germination and increased stem length. The systemic insecticide (imidacloprid) was found to be most effective recording the least populations of aphids, leafhopper, thrips, green bug, whitefly and mite, protected cotton plants from sucking insects. Understanding the relationship between fertilization and the incidence of insect pests is essential for the management of chemical fertilization and insect pests in recent agroecosystem. Effects of combination of phosphorus, nitrogen and potassium fertilizers on the population dynamics and density of cotton pests *Aphis gossypii*,*Thrips tabaci* and *Empoasca* spp. were studied. Results indicated that numbers of adult or immature stages of *Tetranychus urticae* significantly varied among nitrogen treatments .This study indicated that increasing nitrogen level in the range of 60 to 90 kg /faddan, enhanced mite population on cotton leaves. But, nitrogen fertilizer significantly reduced the population density of *Empoasca* spp. whereas; it enhanced the population densities of both *A. gossypii* and *T. tabaci* in the two seasons of study. Phosphorus fertilizer proved to be very effective in lowering the incidence of *T. urticae* on treated plants, but it significantly increased the density of *Empoasca* spp. Increasing potassium fertilizer caused considerable reduction in aphids population, whereas the opposite case was true with mite numbers . Laboratory study on the activity of the entomopathogenic nematode, *Steinernema carpocapsae* (Weiser) (Rhabditida: Steinernematidae) killed 25-37% of cotton leafworm larvae within 48 and 96 h from treatment, prevent progress to pupation and adult insect. *S. carpocapsae* was quite tolerant to methomyl. Percent mortalities of infective juveniles varied from 11.11to 66.66% within 96 hours.

Key words: Pests management, seed dressing, imidacloprid, NPK fertilization, sucking pests, *Steinernema carpocapsae*.

INTRODUCTION

Cotton (*Gossypium barbadense* L.) popularly kNown as "the white gold", is still among the most important commercial crops in Egypt and occupies a preeminent place in the Egyptian national ecoNomy (Mesbah *et al.*, 2004). It is preliminary grown for providing fibre, an important raw material for textile industry. Textile industry is supposed to be a number one enterprise which consumes nearly 70 percent of total fibre produced (Itnal, 2004), but its seed provides edible oil (15-25%) for human and cake after extraction of oil is an important protein concentrate (40% protein) for livestock. During last few decades, many sucking insects such as whitefly, *Bemisia tabaci* (Gennadius); cotton aphid, *Aphis gossypii* (Glover); jassid, *Empoasca* spp. and thrips, *Thrips tabaci* (Linnman), became very serious pests of cotton and many other crop plants in tropical and subtropical areas of the world (Butler *et al.*,

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1985 and Leclant and Deguine, 1994). Cultural control methods are very important component of integrated pest management programs, including adequate iNorganic fertilization kinds and amounts that affect the metabolism of the host plant and consequently may improve the living conditions and the defense system of the plant to pest invasion. But balance of nutrient can makes the crop risk free. Excess nutrient resulting flush rank of growth that attracts more pests and increases the problem of the control and loss of matured bolls due to fungus rots (Hossain and Baqui, 2010). Cotton leaf worm *Spodoptera littoralis* (Boisd.), (Lepidoptera: Noctuidae), the most destructive pest, attacks all parts of cotton plant including green bolls. In pest control programs, one should try to use selective pesticides or those which have less adverse impact on Non-target organisms. At the same time, looking to pest complexities and it is difficult to totally eliminate the chemical component from the pest management strategies. Entomopathogenic nematodes of the Genera *Steinernema* (=Neoaplectana) (Family: Steinernematidae and *Heterorhabditis* (Heterorhabditidae) are regarded as having excellent potential as biological control agents. The broad host range and high virulence of these nematodes make them attractive candidates for industrial development (Georgis *et al.*, 1989). The profitable cotton production in Egypt depends on successful and efficient pest management programs which reduce the disaster of crop losses particularly caused by insect pests. These problems suggest that pest control technique should be selective and environmental compatible. Pest control strategy aims to reduce the pest population to be lower than its ecoNomic injury level. To achieve this aim, other pest control agents, simultaneously with using conventional insecticides, were taken into consideration. The aim of this work was to throw light on integrated control of pests attacking cotton plants as follows:

1. Effects of early and late sowing dates on the population of some pests attacking cotton plants.
2. Effects of certain different fertilizers on the population of some pests attacking cotton plants.
3. Effects of certain chemical control methods on the population of some pests attacking cotton plants.
4. Using of some entomopathogenic nematodes for controlling cotton leafworm.

MATERIALS AND METHODS

Effect of Imidacloprid on the Emergence Rate of Cotton Seedlings

The experimental area of 32 kirats (one and one third of a faddan) located at Toukh Tanbisha village, Berkat El-Sabaa region, Minufyia GoverNorate was chosen during 2009 and 2010 cotton growing seasons. Four kirats (divided into 4 replicates) were planted with imidacloprid treated cotton seeds. Other 4 kirats were planted with untreated seeds and were considered as a check. In the first season, sowing dates were March 17, as an early date and April 3, as a late date. But in the second season, sowing dates were March 18, as an early date and April 4, as late date. Planting was carried out at intra-ridge spacing 55-60 cm. Fifteen cotton seeds of Giza 86 cultivar were delivered per each hill into the upper 4-6 cm of the soil. All plots were arranged in a complete randomized blocks design. All Normal agricultural practices except any pesticide application were followed as usual. After 2, 3 and 4 weeks from planting date 100 hills represented 4 treatments (*i.e.* 25 hills from each replicate) were chosen randomly and number of cotton seedlings were counted in the imidacloprid treated and untreated treatments to calculate the percentage of seed germination. Statistical analyses were carried out following ANOVA computer SAS program (2006).

Effect of Imidacloprid on Some Cotton Pests Attacking Cotton Seedlings

To evaluate the residual effect of seed dressing imidacloprid against insect pests attacking cotton plants, 25 leaves, were chosen at random from inner ridge of each plot (*i.e.* 100 leaves/ treatment) to estimate the population counts of spider mite on upper and the lower surfaces of the leaf at 3,4,5,6, 7, 8, 9 and 10 weeks after sowing. In case of thrips, jassids, aphids, green bug and whitefly (nymphs and adults), 25 plants per each treatment were chosen randomly and examined in the early morning (until 8 a.m.) at the same periods mentioned before. Percent reduction in each pest infestation was calculated according to Abbott's formula (1925).

All methods followed here depended mainly on the Official Protocol of the Ministry of Agriculture and Soil Reclamation, Egypt.

Effect of Nitrogen, Phosphorous and Potassium Fertilization on the Population Densities of Some Insect Pests Attacking Cotton Plants

Calcium superphosphate (15.50% P_2O_5) at 15 and 25 units per faddan was mixed with soil during soil preparation before planting. Also, potassium sulpahte (48% K_2O) at zero and 24 units / faddan were added after 3 weeks from sowing just at the first irrigation. Ammonium nitrate (33.50 % N) was added at the levels of 60, 75 and 90 units / faddan. The nitrogen fertilizer was added at 2 portions. The first portion *i.e.* ½ amount was added after 5 weeks from sowing and the second portion *i.e.* the second half of the nitrogeNous fertilizer was added after 7 weeks from sowing. Accordingly, ten treatments were arranged in a complete randomized blocks design with four replicates as shown in Table 1.

Plot area was about 42 m^2 and all agricultural practices were carried out as commonly followed without any chemical control treatments. To study the effect of soil fertilization on the population densities of insect pests attacking and found on cotton plants, samples of 25 cotton leaves were chosen randomly from each plot. Insect counts were made at weekly intervals till ten weeks after sowing. Statistical analyses were carried out following ANOVA computer SAS program (2006).

Application of an Entomopathogenic Nematode, in Combination with an Insecticide for Controlling Cotton Leafworm

Rearing of *Spodoptera littoralis* (Boisd.)

The susceptible strain was originally collected from cotton fields. To rear the cotton leafworm in the laboratory, the egg- masses were kept in glass jars, of 2 lb each, and covered with muslin cloth secured in place by a rubber band. The jars were provided daily with fresh castor leaves, *Recinus communis* L. as a source of food for the newly hatched larvae. Few days after hatching, the larvae were transferred to larger jars of 2 kg capacity and provided daily with castor leaves until the sixth larval instar. The full grown larvae were allowed to pupate in larger jars, each of 5 kg capacity, containing dry sawdust. The pupae were collected and placed in uncovered Petri dish containing tissue paper. The Petri dishes were kept in wooden cages (35 x 35 x35 cm). The emerging adults were fed on 15% sugar solution. They were allowed to lay their eggs on leaves of *Nerium oleander* L. that served as a physical surface for mating, oviposition and resting. The deposited egg masses were collected daily and transferred to clean small jars to start a new generation. These processes were repeated five generations to give the susceptible strain.

Rearing of *Galleria melonella* L.

Stock culture of *G. melonella* contained larvae and pupae were obtained from honeycomb or honeybee hives that damaged. The insects were kept in glass jars of 5 kg capacity on old wax as a source of food. Pupae were collected and put in uncovered Petri dishes placed in large glass jars covered with muslin and secured with a rubber band. Each jar was provided with a tissue paper as a physical surface for the moths to lay their eggs. The masses of eggs were transferred frequently to new glass jars containing an old wax as a source of food.

Mass culturing of steinernematid nematodes

Source of nematode inoculum

Species and strain of *Steinernema* used in this work was *S. carpocapsae* (Weiser) that obtained from Dr. Ramadan El-Ashry, Faculty of Agriculture, Zagazig University.

Mass culturing of nematodes

The sixth instar larvae of the cotton leafworm, *S. littoralis* (Boisd.) and the greater wax moth, *G. mellonella L.* were used for mass culturing of steinernematid nematodes. They were starved for 2 hours or more before being infected with nematodes. Groups of 10 healthy

Table 1. Different combinations of NPK fertilization rates added in cotton field

Number of treatments	N	P_2O_5	K_2O
1	0	0	0
2	60	15	0
3	75	15	0
4	90	15	0
5	60	25	0
6	75	25	0
7	90	25	0
8	60	15	24
9	75	15	24
10	90	15	24

larvae were placed on two moist filter papers in plastic boxes, where 2000 of infective stage juveniles in 2 ml sterilized distilled water was added. The boxes closed and kept at 26±2°C in an incubator. Two days after iNoculation, dead larvae were removed and immersed in distilled water for several times to prevent propagation of parasites or saprophytes. To collect infective juveniles, cadavers were transferred to extraction dishes according to the technique of White (1927). Extracted juveniles were concentrated and washed several times with distilled water until clearing prior storage in 0.01% formalin in refrigerator at 9 - 10°C until needed.

Tested insecticide

Commercial formulations of methomyl 90% SP (Lannate) was used in this study.

Laboratory bioassay

The tested insecticide formulation was prepared to obtain the proper concentrations using tap water. Series of six concentrations ranging from 10 to 500 ppm of insecticide were used so that LC_{50} and LC_{90} values could be calculated. The concentrations studied were prepared originally from a stock solution of the tested insecticide which was further diluted with tap water to get the desired concentrations. The 6^{th} larval instars of the susceptible colony were used for laboratory bioassays. Fresh castor leaves dipped for 10 seconds in each concentration. After dipping, disks were dried for about 30 min in the air under room temperature. Treated disks were transferred to 16 oz clear plastic cups with perforated snap-fit caps and 10 larvae were used for each replicate Every concentration was replicated four times. All replicates were kept at 25±2°C and 65±5% R.H. The larvae were allowed to feed on treated leaves for 24 h, then for 2 days on fresh untreated leaves. Ten larvae of the same instar were kept on untreated cotton leaves for the control and replicated four times. Thereafter, mortality counts were started 24 h after treatment and observed at 24 h intervals for up to 2 days. Mortalities were corrected using the formula of Abbott's formula (1925) at the end of 2 days after treatment. Concentration mortality regression lines were fitted using the method adopted by Finney (1971).

Entomopathogenic nematodes - methomyl interaction

Sandy soil used in this experiment was obtained from a field in newly reclaimed sandy area of El-Khattara region, Sharkia GoverNorate. The mechanical analysis of the soil was sand (95.7%), silt (1.2%) and clay (3.1%). The soil was autoclaved and left for 24 hours before use. Plastic pots of 8 cm diameter and 10 cm height were used. In each pot 100 g of the soil were added. The pots were divided into 4 groups. Levels of soil moisture *i.e.* 32% were obtained by adding 31 ml distilled water + 1 ml of nematode suspension. The distilled water was added to soil and 1 ml nematode suspension contained 1000 infective juveniles was placed on the surface of each pot. Insecticide concentrations of 10, 20 and 30% divided from LC_{50} and LC_{90} after 2 days were prepared with tap water as previously described and the same procedure previously mentioned was used for preparing fresh castor leaves disks treated at the tested concentrations. Pots were warped tightly with muslin to prevent escape of larvae. One day later dead larvae, pupae in each pot were counted and alive ones were transferred to Petri dish and provided with castor leaves as a source of food. The dead larvae, pupae were incubated at 25±2°C to insure that they were killed by nematodes. Percent mortality was corrected according to Abbott's formula (1925).

RESULTS AND DISCUSSION

Effect of Imidacloprid on the Emergence Rate of Cotton Seedlings

Data presented in Table 2 regarding early and late sowing dates show better growth of the plants of imidacloprid 70 WS treated cotton seeds, The average numbers of cotton seedlings per hill in treated treatments were 2.60 , 6.10 and 2.60 , 9.10 after 2 weeks from sowing in 2009 and 2010, for early and late sowing dates, respectively. The respective values in the untreated control plots were lower being 1.10, 3.60 and 1.80, 6.10.

After three weeks from sowing the average numbers of seedlings increased to be 2.63, 6.36 and 2.70, 9.30 for treated samples, while in the untreated control ones they were 1.60 , 5.03 and 2.05, 6.23 in 2009 and 2010 for early and late sowing dates, respectively.

The same general trend of data was obtained after 4 weeks from sowing. Accordingly, imidacloprid seemed to enhance and increase the emergence of cotton seedlings. Cotton seedlings grown from imidacloprid treated seeds were generally taller and more healthy than those of the untreated control. Average values for the two seasons of cotton seedlings emergened from imidacloprid treated seeds were higher than those of untreated ones and valued 4.35, 4.49, 4.68 and 5.85, 6.00, 6.10 seedlings compared to 2.35, 3.31, 3.21 and 3.95, 4.14, 4.06 after 2, 3, 4 weeks from sowing for early and late sowing dates, respectively.

These results are in agreement with those obtained by Selim and Emam (1993) and Murugesan and Kavitha (2009).

Drinkwater (1997) found that imidacloprid delayed the emergence of certain maize hybrid grains.

Effect of Imidacloprid on Some Pests Attacking Cotton Seedlings

Data in Tables 3, 4, 5 and 6 show the efficiency of imidacloprid against the aphids, jassid, mites, whitefly, thrips and green bug (adults and immature stage). The mean of the overall reduction of aphids of early sowing in 2009 and 2010 seasons. were 72.02 and 55.66%, respectively, but it reduced in late sowing dates to 50.50, 49.72 with specific resistance in the 2nd season to be 55.66 and 49.72% in early and late sowing dates, respectively compared to the first season being 72.02, 50.50 in early and late 2009 season respectively. In early sowing date of 2009 and 2010, the means of the overall reduction of jassids were 45.49, 45.36%, respectively compared to late sowing date of 2009, 2010 where the values were 42.77, 15.35%, In case of mites, the means of the overall reduction were 25.44, 21.97% in early and late sowing dates, 2010 respectively.

Whitefly and green bug infestation were very low especially in 2009 season. The data concerning the efficiency of imidacloprid gave No realistic picture for the spider mite, the overall reduction were 59.75 and 48.33% in early and late sowing dates in season 2009, respectively. For thrips the percent reduction in infestation ranged between 56.62 and 64.48 in the early and late sowing dates in season 2009, while they were 56.13 and 58.77 in the early and late sowing dates in season 2010, respectively.

These findings agreed with those obtained by Elbert *et al.* (1990), who found that imidacloprid is a highly effective insecticide for control of sucking insects such as aphids, leafhoppers, plant hoppers, thrips and whiteflies including resistant strains. Also, Burris *et al.,* 1995; Graham *et al.*, 1995; Hopkins and Donaldson 1996 and Cook *et al.,* 1997 recorded that imidacloprid significantly decreased immature thrips population compared to untreated control. Duyn *et al.,* 1998 and Gencsoulu (2005) reported that seed treatment with imidacloprid against *Thrips tabaci* was very effective and reduced the populatin throughout 30-37 days after planting. Murugesan and Kavitha (2009) found that imidacloprid was the most effective pesticides recording the least mean population of leafhoppers.

Table 2. Mean numbers of cotton seedlings per hill sown with imidacloprid treated cotton seeds during 2009 and 2010 on early and late sowing dates

Sowing date		Early			Late		
Weeks after planting	Treatments	Mean number		Average	Mean number		Average
		2009	2010		2009	2010	
2 Weeks	Treated	2.60 E (236.36)	6.10 B (169.44)	4.35 (202.9)	2.60 a (144.44)	9.10 a (149.18)	5.85 (146.81)
	Control	1.10 G	3.60 D	2.35	1.80 b	6.10 b	3.95
3 Weeks	Treated	2.63 E (164.37)	6.36 AB (126.44)	4.49 (145.40)	2.70 a (131.70)	9.30 a (149.27)	6.00 (140.48)
	Control	1.60 F	5.03 C	3.31	2.05 b	6.23 b	4.14
4 Weeks	Treated	2.66 E (177.33)	6.70 A (135.90)	4.68 (156.61)	2.90 a (152.63)	9.30 a (149.27)	6.10 (150.95)
	Control	1.50 FG	4.93 C	3.21	1.90 b	6.23 b	4.06
Statistical analysis		HSD=0.4115			LSD= 0.1225		

Values between brackets are the percent values of germinated seedlings in treatment relative to that of untreated control.
Means with the same letter are not significantly different.
HSD and LSD indicate honestly and least significant difference, respectively.

Table 3. Mean numbers and mean of percent reduction of some pests attacking cotton seedlings grown from imidacloprid treated cotton seeds (early sowing, 2009)

Pests	Treatments	Weeks after sowing								Mean of percent reduction
		3	4	5	6	7	8	9	10	
Aphids	Treated	0.02	0.05	0.02	1.56	0.29	0.13	0.45	0.42	72.02
	Control	0.40	0.44	0.17	11.56	1.37	0.16	0.80	0.70	
Jassid	Treated	0.01	0.61	0.59	1.26	1.72	1.72	0.13	8.46	45.49
	Control	0.12	2.02	1.40	2.60	2.45	2.45	0.16	9.09	
Whitefly	Treated	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	87.5
	Control	0.00	0.00	0.00	0.00	0.03	0.04	0.00	0.00	
Thrips	Treated	0.14	0.08	0.15	1.98	0.30	5.33	0.21	0.80	56.62
	Control	9.84	1.32	0.92	8.16	0.44	7.21	0.28	1.00	
Green bug	Treated	0.00	0.00	0.00	0.00	0.00	0.01	0.21	0.05	37.68
	Control	0.00	0.00	0.00	0.00	0.00	0.04	0.28	0.06	
Mite	Treated	0.50	0.75	1.95	2.30	1.35	3.43	2.70	0.40	59.75
	Control	5.30	4.15	9.85	7.70	4.10	3.80	4.35	0.60	

Table 4. Mean numbers and mean of percent reduction of some pests attacking cotton seedlings grown from imidacloprid treated cotton seeds (early sowing, 2010)

Pests	Treatments	Weeks after sowing								Mean of percent reduction
		3	4	5	6	7	8	9	10	
Aphids	Treated	0.29	0.03	0.14	0.01	0.04	0.56	0.16	0.13	55.66
	Control	1.37	0.12	0.55	0.03	0.1	1.08	0.21	0.16	
Jassid	Treated	0.59	0.32	0.36	1.73	1.07	0.42	1.52	1.72	45.36
	Control	1.40	0.75	0.71	3.12	1.90	0.71	2.55	2.45	
Whitefly	Treated	0.00	0.03	0.05	0.01	0.01	0.03	0.02	0.03	72.15
	Control	0.03	0.15	0.20	0.04	0.03	0.08	0.03	0.04	
Thrips	Treated	0.15	0.08	1.45	1.87	0.53	0.07	0.54	0.30	56.13
	Control	0.92	0.19	3.39	4.32	1.22	0.15	1.12	0.44	
Green bug	Treated	0.00	0.00	0.00	0.01	0.05	0.20	0.20	0.05	46.69
	Control	0.00	0.00	0.01	0.04	0.09	0.29	0.23	0.06	
Mite	Treated	3.43	5.50	3.96	2.26	3.36	1.80	0.93	0.40	25.44
	Control	3.80	6.90	4.96	3.80	4.36	2.40	1.36	0.60	

Table 5. Mean numbers and mean of percent reduction of some pests attacking cotton seedlings grown from imidacloprid treated cotton seeds (late sowing, 2009)

Pests	Treatments	Weeks after sowing								Mean of percent reduction
		3	4	5	6	7	8	9	10	
Aphids	Treated	0.33	0.12	0.18	0.14	0.20	0.26	0.98	0.00	50.50
	Control	2.26	0.80	0.33	0.25	0.34	0.34	1.24	0.00	
Jassid	Treated	0.90	2.65	0.38	0.22	1.64	0.68	8.42	2.91	42.77
	Control	2.72	7.92	0.96	0.48	2.66	1.04	10.30	3.00	
Whitefly	Treated	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.00	57.00
	Control	0.00	0.00	0.00	0.01	0.05	0.05	0.04	0.00	
Thrips	Treated	0.05	0.25	0.76	0.77	0.30	0.12	0.43	1.61	64.48
	Control	1.48	2.16	4.73	3.21	1.18	0.41	0.56	1.65	
Green bug	Treated	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.27	62.55
	Control	0.00	0.00	0.00	0.00	0.12	0.10	0.06	0.28	
Mite	Treated	2.85	0.16	23.00	4.15	0.95	0.15	0.10	1.00	48.33
	Control	6.45	0.33	31.55	13.9	1.40	0.45	0.60	1.00	

Table 6. Mean numbers and mean of percent reduction of some pests attacking cotton seedlings grown from imidacloprid treated cotton seeds (late sowing, 2010)

Pests	Treatments	Weeks after sowing								Mean of percent reduction
		3	4	5	6	7	8	9	10	
Aphids	Treated	0.12	0.18	0.10	0.17	0.18	0.14	0.13	0.07	49.72
	Control	0.80	0.56	0.25	0.38	0.33	0.25	0.18	0.08	
Jassid	Treated	0.68	1.04	1.08	0.90	1.67	1.26	0.79	2.91	15.35
	Control	1.04	1.39	1.36	1.08	1.87	1.36	0.83	3.00	
Whitefly	Treated	0.00	0.04	0.05	0.01	0.04	0.24	0.03	0.03	61.88
	Control	0.05	0.42	0.35	0.05	0.09	0.36	0.04	0.04	
Thrips	Treated	0.12	0.10	0.35	0.24	0.09	1.64	0.24	0.43	58.77
	Control	0.41	0.34	1.18	0.68	0.25	3.98	0.46	0.56	
Green bug	Treated	0.00	0.00	0.01	0.01	0.04	0.05	0.32	0.27	57.93
	Control	0.01	0.02	0.06	0.04	0.14	0.06	0.37	0.28	
Mite	Treated	0.16	0.13	1.63	1.80	0.36	3.43	0.40	1.00	21.97
	Control	0.33	0.26	2.40	2.13	0.40	3.80	0.43	1.00	

Relation between NPK Fertilization and the Levels of Aphids, Mites, Thrips and Jassid Infestation of Cotton Plants

Effect on aphid infestation

Results in Tables 7, 8, 9 and 10 showed that the increase in nitrogen fertilization leads to increase in aphid counts per 100 leaves at any period after the addition of the nitrogen fertilizer. Aphid numbers were 9.58/100 leaves in the unfertilized plots but increased to 9.91 aphids /100 leaves following the addition of 60 kg N plus 15 kg P fertilizer and reached 10.91 aphids under the treatment of 90 kg N/faddan. Phosphorus fertilization indicated the same trend as nitrogen. In other words, the number of aphids infesting cotton plants related directly to the quantities of N and P fertilizers. This general trend was true till 10 weeks after sowing *i.e.* the experiment end time. The contrary was shown with potassium (K) fertilization. K addition decreased the numbers of aphids infesting cotton plants.

Effect on thrips infestation

Data presented in Tables 11, 12, 13 and 14 indicated that N and P fertilization increased the numbers of thrips infesting cotton plants considering the average values in the early planting date in first seasons. The intensity of thrips was 3.62 insects /100 leaves on the untreated cotton plants increased to 7.78 individuals after addition of N at 60 kg / fad., and P at 15 kg/fad.This value was increased to be 9.95 insects /100 leaves at N = 90 kg/fad. The same trend was observed with P fertilization.

The increase in N and P fertilization caused increases in thrips infestation on cotton plants.

Table 7. Mean numbers of aphids per 100 cotton leaves under different rates of NPK fertilization (early sowing date, 2009)

Treatments	Units/fad.			Weeks after sowing								Average
	N	P_2O_5	K_2O	3**	4	5*	6	7*	8	9	10	
1	0	0	0	10.00	13.33	15.00	8.33	10.00	10.00	6.66	3.33	9.58
2	60	15	0	10.00	11.66	13.33	10.00	11.66	10.00	8.33	4.33	9.91
3	75	15	0	11.66	13.33	15.00	8.33	11.66	11.66	6.66	2.33	10.07
4	90	15	0	15.00	15.00	16.66	10.00	8.33	13.33	6.66	2.33	10.91
5	60	25	0	15.00	16.66	20.00	11.66	15.00	18.33	8.33	8.33	14.16
6	75	25	0	15.00	21.33	23.33	16.66	18.33	20.00	10.00	8.33	16.62
7	90	25	0	20.00	23.33	25.00	18.33	20.00	30.00	13.33	13.33	20.41
8	60	15	24	6.66	6.66	8.33	5.00	3.33	3.33	1.66	0.00	4.37
9	75	15	24	8.33	8.33	10.00	5.00	5.00	6.66	1.66	1.66	5.83
10	90	15	24	10.00	8.33	10.00	5.00	6.66	8.33	2.33	2.33	6.62
Average				12.16 B	13.79 A	15.66 A	9.83 D	10.99 C	13.16 AB	6.56 E	4.63F	HSD 0.0105

Table 8. Mean numbers of aphids per 100 cotton leaves under different rates of NPK fertilization (late sowing date, 2009)

Treatments	Units/fad.			Weeks after sowing								Average
	N	P_2O_5	K_2O	3**	4	5*	6	7*	8	9	10	
1	0	0	0	2.33	1.66	3.33	2.66	1.66	1.66	2.33	1.66	2.16
2	60	15	0	3.33	2.66	5.00	3.33	2.66	1.66	1.66	0.00	2.53
3	75	15	0	3.33	2.66	5.00	3.33	2.66	1.66	2.33	1.66	2.82
4	90	15	0	2.33	1.66	5.00	3.33	3.33	2.33	3.33	3.33	3.08
5	60	25	0	3.33	2.66	6.66	3.33	3.33	2.33	3.33	2.33	3.41
6	75	25	0	5.00	3.33	8.33	6.66	5.00	3.33	5.00	5.00	5.20
7	90	25	0	2.33	6.66	5.00	3.33	3.33	8.33	5.00	8.33	5.28
8	60	15	24	2.33	1.66	2.66	1.66	0.00	0.00	1.66	0.00	1.24
9	75	15	24	2.33	1.66	3.33	1.66	0.00	0.00	1.66	1.66	1.53
10	90	15	24	2.33	1.66	3.33	1.66	0.00	1.66	1.66	1.66	1.74
Average				2.89 B	2.62 BCD	4.76 A	3.09 B	2.19 D	2.29 CD	2.79BCD	2.56BCD	HSD 0.0056

Table 9. Mean numbers of aphids per 100 cotton leaves under different rates of NPK fertilization (early sowing date, 2010)

Treatments.	Units/fad.			Weeks after sowing								Average
	N	P_2O_5	K_2O	3**	4	5*	6	7*	8	9	10	
1	0	0	0	10.00	20.00	3.33	5.00	11.66	6.66	3.33	4.33	8.03
2	60	15	0	10.00	15.00	8.33	10.00	11.66	6.66	1.66	3.33	8.33
3	75	15	0	11.66	20.00	5.00	8.33	16.66	5.00	1.66	2.33	8.83
4	90	15	0	15.00	20.00	10.00	11.66	13.33	3.33	1.66	2.33	9.66
5	60	25	0	15.00	33.00	6.66	13.33	20.00	8.33	2.33	8.33	13.37
6	75	25	0	20.00	33.33	11.33	13.33	30.00	8.33	5.00	8.33	16.20
7	90	25	0	15.00	45.00	8.33	6.66	30.00	13.33	10.00	13.33	17.70
8	60	15	24	6.66	13.33	1.66	3.33	11.66	3.33	1.66	2.33	5.49
9	75	15	24	8.33	11.66	4.33	6.66	8.33	2.33	1.66	2.33	5.70
10	90	15	24	15.00	20.00	15.00	10.00	10.00	2.33	1.66	2.33	9.54
Average				12.66 C	23.13 A	7.39 DE	8.83 D	16.33 B	5.96 EF	3.06 G	4.93 F	HSD 0.0161

*indicates nitrogen addition time . **indicates potassium addition time .

Table 10. Mean numbers of aphids per 100 cotton leaves under different rates of NPK fertilization (late sowing date, 2010)

Treatments	Units/fad.			Weeks after sowing								Average
	N	P_2O_5	K_2O	3**	4	5*	6	7*	8	9	10	
1	0	0	0	20.00	5.00	10.00	5.00	1.66	5.00	5.00	3.33	6.87
2	60	15	0	16.66	3.33	20.00	3.33	1.66	5.00	3.33	2.33	6.95
3	75	15	0	20.00	6.66	8.33	5.00	2.33	6.66	6.66	5.00	7.58
4	90	15	0	20.00	6.66	20.00	6.66	2.33	6.66	6.66	8.33	9.66
5	60	25	0	16.66	8.33	21.33	6.66	2.33	10.00	8.33	6.66	10.03
6	75	25	0	20.00	10.00	30.00	8.33	3.33	11.66	10.00	8.33	12.70
7	90	25	0	21.33	11.66	31.66	10.00	8.33	13.33	11.66	8.33	14.53
8	60	15	24	15.00	2.33	8.33	2.33	0.00	2.33	1.66	0.00	3.99
9	75	15	24	16,66	3.33	20.00	3.33	1.66	5.00	3.33	1.66	5.47
10	90	15	24	15.00	3.33	15.00	3.33	1.66	6.66	5.00	3.33	6.66
Average				18.29 A	6.06 D	18.46 B	5.39 DE	2.52 F	7.23 C	6.16 D	4.73E	HSD 0.0089

Table 11. Mean numbers of thrips per 100 cotton leaves under different rates of NPK fertilization (early sowing date, 2009)

Treatments.	Units/fad.			Weeks after sowing								Average
	N	P_2O_5	K_2O	3**	4	5*	6	7*	8	9	10	
1	0	0	0	8.33	5.00	8.33	2.33	1.66	1.66	0.00	1.66	3.62
2	60	15	0	15.00	8.33	13.33	5.00	8.33	3.33	6.66	2.33	7.78
3	75	15	0	11.66	10.00	11.33	6.66	10.00	6.66	8.33	3.33	8.49
4	90	15	0	15.00	11.33	15.00	8.33	10.00	5.00	8.33	6.66	9.95
5	60	25	0	21.66	13.33	10.00	6.66	8.33	8.33	10.00	6.66	10.62
6	75	25	0	23.33	15.00	13.33	8.33	10.00	6.66	10.00	6.66	11.66
7	90	25	0	21.66	13.33	16.66	10.00	11.33	8.33	10.00	6.66	12.24
8	60	15	24	13.33	5.00	8.33	3.33	3.33	2.33	3.33	3.33	5.28
9	75	15	24	10.00	6.66	10.00	6.66	8.33	3.33	5.00	2.66	6.58
10	90	15	24	11.66	10.00	11.66	6.66	5.00	2.33	3.33	2.66	6.66
Average				15.163 A	9.79 C	11.797 B	6.39E	7.63D	4.79 F	6.49 E	4.26 F	HSD 0.011

Table 12. Mean numbers of thrips per 100 cotton leaves under different rates of NPK fertilization (late sowing date, 2009)

Treatments	Units/fad.			Weeks after sowing								Average
	N	P_2O_5	K_2O	3**	4	5*	6	7*	8	9	10	
1	0	0	0	2.33	1.66	3.33	3.33	2.33	1.66	1.66	0.00	2.03
2	60	15	0	8.33	5.00	6.66	4.33	3.33	2.33	3.33	1.66	4.37
3	75	15	0	8.33	5.00	13.33	3.33	2.33	1.66	3.33	1.66	4.87
4	90	15	0	11.66	8.33	10.00	6.66	3.33	3.33	5.00	3.33	6.45
5	60	25	0	15.00	10.00	21.66	6.66	5.00	2.33	8.33	2.66	8.95
6	75	25	0	10.00	8.33	23.33	6.66	10.00	5.00	8.33	3.33	9.37
7	90	25	0	16.66	15.00	16.66	13.33	8.33	3.33	10.00	5.00	11.03
8	60	15	24	5.00	1.66	3.33	4.33	1.66	0.00	1.66	0.00	2.20
9	75	15	24	3.33	1.66	3.33	3.33	2.33	1.66	3.33	2.66	2.70
10	90	15	24	3.33	2.33	8.33	3.33	2.33	1.66	1.66	0.00	2.87
Average				8.39 B	5.89 C	10.99 A	5.52 CD	4.09 E	2.29 F	4.66DE	2.03 F	HSD 0.094

*indicates nitrogen addition time. **indicates potassium addition time .

Table 13. Mean numbers of thrips per 100 cotton leaves under different rates of NPK fertilization (early sowing date, 2010)

Treatments	Units/fad.			Weeks after sowing								Average
	N	P_2O_5	K_2O	3**	4	5*	6	7*	8	9	10	
1	0	0	0	13.33	11.33	10.00	3.33	1.66	1.66	2.66	2.66	5.82
2	60	15	0	25.00	26.66	10.00	2.66	3.33	1.66	2.66	3.33	9.41
3	75	15	0	35.00	15.00	10.00	2.66	6.66	1.66	3.33	2.66	9.62
4	90	15	0	25.00	35.00	15.00	5.00	3.33	2.66	1.66	1.66	11.16
5	60	25	0	25.00	30.00	15.00	6.66	6.66	1.66	5.00	1.66	11.45
6	75	25	0	25.00	30.00	15.00	8.33	6.66	1.66	3.33	2.66	11.58
7	90	25	0	35.00	20.00	13.33	6.66	8.33	5.00	6.66	2.66	12.20
8	60	15	24	16.66	18.33	10.00	3.33	8.33	1.66	5.00	2.66	8.24
9	75	15	24	15.00	30.00	10.00	3.33	2.66	2.66	5.00	2.33	8.87
10	90	15	24	20.00	18.33	15.00	6.66	5.00	2.66	1.66	3.33	9.08
Average				23.49 A	23.46 A	12.33 B	4.86 C	5.26 C	2.294 C	3.69 C	2.56 C	HSD 0.0297

Table 14. Mean numbers of thrips per 100 cotton leaves under different rates of NPK fertilization (late sowing date, 2010)

Treatments	Units/fad.			Weeks after sowing								Average
	N	P_2O_5	K_2O	3**	4	5*	6	7*	8	9	10	
1	0	0	0	5.00	2.66	5.00	1.66	1.66	1.66	2.66	0.00	2.53
2	60	15	0	10.00	5.00	6.66	2.66	3.33	6.66	3.33	1.66	4.91
3	75	15	0	8.33	3.33	8.33	5.00	6.66	10.00	4.33	2.66	6.08
4	90	15	0	10.00	5.00	11.33	6.66	8.33	10.00	6.66	3.33	7.66
5	60	25	0	15.00	10.00	16.66	6.66	5.00	5.00	3.33	2.66	8.03
6	75	25	0	10.00	6.66	10.00	2.66	3.33	21.66	6.66	5.00	8.24
7	90	25	0	20.00	8.33	8.33	3.33	6.66	25.00	10.00	3.33	10.62
8	60	15	24	2.33	1.66	3.33	2.33	6.66	5.00	3.33	2.66	3.41
9	75	15	24	10.00	3.33	5.00	1.66	3.33	8.33	3.33	1.66	4.58
10	90	15	24	11.33	5.00	6.66	1.66	3.33	5.00	2.66	1.66	4.66
Average				10.19 A	5.09 C	8.13 B	3.42 DE	4.82 C	9.83A	4.62 CD	2.46 E	HSD 0.0117

*indicates nitrogen addition time. **indicates potassium addition time.

On the contrary, K fertilization reduced the numbers of thrips counts that were 7.78 insects /100 leaves under the fertilization levels of 60 kg N plus 15 kg P, but lowered to be 5.28 insects\100 leaves in case of K addition at 24 kg /faddan (early sowing date, 2009). The same negative trend was Noted for other treatments and was correct during the both seasons.

Effect on jassid infestation

The population density of *Empoasca* spp. was higher in 2009 than that in 2010 cotton season. From data shown in Tables 15, 16, 17 and 18, it is obvious that, the fertilization treatments significantly affected the population densities of *Empoasca* spp. Cotton plants fertilized with K and N at 60 kg / fad., were infested with the highest mean of *Empoasca* spp. population densities of 24.58 and 6.24 insects/100 cotton leaves in 2009 and 2010 seasons under early sowing dates, respectively.

On the contrary, plants fertilized with 25 kg P_2O_5 and N at 60 kg/fad. were infested with the highest mean of 57.28 and 13.12 insects /100 leaves during late sowing dates in 2009 and 2010 seasons, respectively. The population density of *Empoasca* spp. in untreated cotton plants was lower then that in fertilizer cotton plants in any cases.

Effect on mite infestation

Nitrogen (N) effect

Data presented in Tables 19, 20, 21 and 22 demonstrated that nitrogen fertilizer treatments significantly increased densities of both adults and immatures of *T. urticae* on cotton plants in the field indicating a positive response between

Table 15. Mean numbers of jassid per 100 cotton leaves under different rates of NPK fertilization (early sowing date, 2009)

Treatments	Units/fad.			Weeks after sowing								Average
	N	P_2O_5	K_2O	3**	4	5*	6	7*	8	9	10	
1	0	0	0	13.33	30.00	30.00	15.00	15.00	15.00	40.00	16.66	21.87
2	60	15	0	15.00	40.00	10.00	30.00	30.00	40.00	40.00	21.66	28.33
3	75	15	0	15.00	30.00	30.00	30.00	30.00	40.00	30.00	15.00	27.5
4	90	15	0	8.33	11.66	50.00	21.33	11.66	30.00	50.00	16.66	24.95
5	60	25	0	13.33	60.00	30.00	30 .00	45.00	93.33	40.00	11.66	40.41
6	75	25	0	15.00	20.00	80.00	70.00	30.00	20 .00	40.00	20.00	39.28
7	90	25	0	16.66	50.00	10.00	30.00	45.00	15.00	50.00	13.33	28.74
8	60	15	24	11.66	20.00	40.00	30.00	40.00	10.00	30.00	15.00	24.58
9	75	15	24	8.33	11.66	15.00	30.00	30.00	30.00	50.00	11.66	23.33
10	90	15	24	6.66	13.33	30.00	13.33	11.33	30.00	50.00	21.66	22.03
Average				12.33 D	28.66 B	32.5 B	29.96 B	28.79 B	33.70 B	42.00 A	16.32 C	HSD 0.0388

Table 16. Mean numbers of jassid per 100 cotton leaves under different rates of NPK fertilization (late sowing date, 2009)

Treatments	Units/fad.			Weeks after sowing								Average
	N	P_2O_5	K_2O	3**	4	5*	6	7*	8	9	10	
1	0	0	0	13.33	50.00	15.00	20.00	10.00	8.33	3.33	1.66	15.20
2	60	15	0	6.66	10.00	60.00	93.33	75.00	50.00	20.00	8.33	40.41
3	75	15	0	10.00	20.00	90.00	75.00	41.66	15.00	25.00	11.66	36.04
4	90	15	0	10.00	30.00	90.00	93.33	30.00	16.66	8.33	2.66	35.12
5	60	25	0	21.66	70.00	35.00	30.00	93.33	93.33	93.33	21.66	57.28
6	75	25	0	11.66	20.00	50.00	70.00	25.00	93.33	75.00	11.66	44.58
7	90	25	0	10.00	30.00	75.00	75.00	.00 30	15.00	75.00	13.33	41.90
8	60	15	24	16.66	30.00	45.00	30.00	30.00	20.00	10.00	2.66	23.04
9	75	15	24	13.33	10.00	35.00	20.00	35.00	25.00	10.00	11.66	19.99
10	90	15	24	11.66	10.00	15.00	35.00	25.00	10.00	15.00	3.33	15.62
Average				12.49 E	28.00 D	51.00 A	54.16 A	40.55 B	34.66 C	33.49C	8.86E	HSD 0.0465

Table 17. Mean numbers of jassid per 100 cotton leaves under different rates of NPK fertilization (early sowing date, 2010)

Treatments	Units/fad.			Weeks after sowing								Average
	N	P_2O_5	K_2O	3**	4	5*	6	7*	8	9	10	
1	0	0	0	1.66	2.33	2.33	3.33	8.33	3.33	3.33	0.00	3.08
2	60	15	0	5.00	3.33	5.00	13.33	10.00	10.00	5.00	1.66	6.66
3	75	15	0	3.33	5.00	10.00	8.33	8.33	10.00	5.00	1.66	6.45
4	90	15	0	5.00	10.00	15.00	10.00	5.00	2.66	1.66	1.66	6.37
5	60	25	0	8.33	5.00	6.66	5.00	11.66	11.66	6.66	2.66	7.20
6	75	25	0	5.00	5.00	5.00	16.66	10.00	6.66	5.00	2.66	6.99
7	90	25	0	6.66	8.33	5.00	16.6 6	20.00	5.00	2.66	0.00	6.80
8	60	15	24	5.00	5.00	6.66	5.00	15.00	6.66	5.00	1.66	6.24
9	75	15	24	2.33	5.00	5.00	13.33	5.00	3.33	1.66	0.00	4.45
10	90	15	24	3.33	6.66	3.33	5.00	6.66	1.66	5.00	1.66	4.16
Average				4.56 D	5.56 C	6.39 B	8.88 A	9.99 A	6.09 BC	4.09D	1.36E	HSD 0.0077

*indicates nitrogen addition time. **indicates potassium addition time .

Table 18. Mean numbers of jassid per 100 cotton leaves under different rates of NPK fertilization (late sowing date, 2010)

Treatments	Units/fad.			Weeks after sowing								Average
	N	P_2O_5	K_2O	3**	4	5*	6	7*	8	9	10	
1	0	0	0	2.66	5.00	21.66	8.33	3.33	1.66	1.66	0.00	5.53
2	60	15	0	6.66	10.00	30.00	10.00	10.00	8.33	5.00	1.66	10.20
3	75	15	0	3.33	10.00	30.00	13.33	6.66	3.33	3.33	1.66	8.95
4	90	15	0	5.00	10.00	15.00	8.33	11.66	8.33	5.00	2.33	8.20
5	60	25	0	13.33	16.66	30.00	13.33	15.00	10.00	5.00	1.66	13.12
6	75	25	0	10.00	15.00	30.00	16.66	6.66	5.00	3.33	1.66	11.03
7	90	25	0	10.00	15.00	20.00	16.66	10.00	8.33	3.33	2.66	10.74
8	60	15	24	2.66	5.00	20.00	11.66	11.66	6.66	2.66	1.66	7.74
9	75	15	24	6.66	5.00	15.00	10.00	11.66	6.66	2.66	1.66	7.41
10	90	15	24	1.66	5.00	15.00	6.66	8.33	5.00	3.33	2.33	5.91
Average				6.19 D	9.66 C	22.66 A	11.49 B	9.49 C	6.33 D	3.53 E	1.72F	HSD 0.0066

Table 19. Mean numbers of mite per 100 cotton leaves under different rates of NPK fertilization (early sowing date, 2009)

Treatments	Units/fad.			Weeks after sowing								Average
	N	P_2O_5	K_2O	3**	4	5*	6	7*	8	9	10	
1	0	0	0	161.66	362.5	365	115	195	135	50.00	35.00	177.39
2	60	15	0	135	290	591.66	457.5	457.5	146.66	140	66.66	285.62
3	75	15	0	645	675	510	260	190	198.33	123.33	100	337.70
4	90	15	0	590	770	690	501.66	260	110	50.00	40.00	376.45
5	60	25	0	230	260	290	138.33	230	210	100	90.00	193.54
6	75	25	0	260	270	340	362.5	195	188.33	100	75.00	223.85
7	90	25	0	115	230	420	260	501.66	233.33	113.33	93.33	245.83
8	60	15	24	630	780	610	457.5	290	113.33	75.00	70.00	378.22
9	75	15	24	457.5	600	630	610	457.5	221.66	146.66	50.00	396.66
10	90	15	24	585	720	510	362.5	590	231.66	161.66	63.33	403.01
Average				380.91 B	495.75 A	495.66 A	352.49 B	336.66 B	178.83 C	105.99 D	68.33 D	HSD 0.6087

Table 20. Mean numbers of mite per 100 cotton leaves under different rates of NPK fertilization (late sowing date, 2009)

Treatments.	Units/fad.			Weeks after sowing								Average
	N	P_2O_5	K_2O	3**	4	5*	6	7*	8	9	10	
1	0	0	0	161.66	210	288.33	100	250	286.66	120	61.66	184.78
2	60	15	0	585	350	365	138.33	420	411.66	151.66	93.33	314.37
3	75	15	0	585	660	440	293.33	361.66	126.66	113.33	70.00	331.24
4	90	15	0	580	730	455	258.33	288.33	280.0	146.66	61.66	349.99
5	60	25	0	605	359	395	231.66	250	188.33	131.66	110	283.83
6	75	25	0	420	595	410	221.66	623.33	80.00	83.33	50.00	310.41
7	90	25	0	645	435	510	310	190	198.33	123.33	100	313.95
8	60	15	24	590	770	450	501.66	310	233.33	70.00	56.66	372.70
9	75	15	24	730	641.5	675	431.66	283.33	155.0	75.00	35.00	378.31
10	90	15	24	630	675	470	330.83	591.66	268.33	120	53.33	392.39
Average				553.16A	542.55A	445.83B	281.74D	356.83C	222.83E	113.49F	69.16G	HSD 0.4187

*indicates nitrogen addition time. **indicates potassium addition time.

Table 21. Mean numbers of mite per 100 cotton leaves under different rates of NPK fertilization (early sowing date, 2010)

Treatments	Units/fad.			Weeks after sowing								Average
	N	P_2O_5	K_2O	3**	4	5*	6	7*	8	9	10	
1	0	0	0	90.00	90.00	100	50.00	35.00	11.66	5.00	1.66	47.915
2	60	15	0	230	350.00	140.00	55.00	21.33	20.00	6.66	2.66	103.20
3	75	15	0	275	226.07	138.33	54.81	43.33	90.00	35.00	11.66	109.27
4	90	15	0	245	365.00	155.00	45.36	30.00	40.00	10.00	5.00	111.92
5	60	25	0	90.00	288.09	80.43	60.00	17.57	10.00	2.33	1.66	68.76
6	75	25	0	250	211.00	115.0	27.69	50.86	20.00	6.66	5.00	85.77
7	90	25	0	225	215.00	177.88	32.88	30.00	23.33	20.00	13.33	92.17
8	60	15	24	280	361.66	155.00	45.36	30.00	50.00	23.71	16.66	120.29
9	75	15	24	305	395.62	146.66	65.77	14.62	10.00	20.00	11.66	121.16
10	90	15	24	275	362.5	225.60	195	71. 1	30.00	8.73	3.33	157.16
Average				226.5 A	286.49 A	143.39 B	63.18 C	30.30 C	30.49 CD	13.80 CD	7.26D	HSD 0.5079

Table 22. Mean numbers of mite per 100 cotton leaves under different rates of NPK fertilization (late sowing date, 2010)

Treatments	Units/fad.			Weeks after sowing								
	N	P_2O_5	K_2O	3**	4	5*	6	7*	8	9	10	Average
1	0	0	0	90.00	100	115	61.66	15.00	3.33	1.66	1.66	48.53
2	60	15	0	250	115	215	36.66	63.33	36.66	28.33	10.00	94.37
3	75	15	0	275	250	140	93.33	40.00	15.00	8.33	3.33	103.12
4	90	15	0	275	130	235	76.66	55.00	46.66	26.66	11.66	107.08
5	60	25	0	90.00	130	50.00	33.00	13.33	6.66	1.66	1.66	40.78
6	75	25	0	225	155	110	43.33	16.66	20.00	5.00	3.33	72.29
7	90	25	0	230	235	215	16.66	23.33	5.00	1.66	1.66	91.03
8	60	15	24	245	300	300	60.00	16.66	30.00	10.00	5.00	120.83
9	75	15	24	305	210	365	86.66	83.33	16.66	5.00	2.66	134.28
10	90	15	24	280	460	335	63.33	38.33	34.16	21.66	16.66	156.14
Average				226.5 A	208.5 A	208 A	57.12 A	36.49 A	21.41 A	10.99 A	5.76 A	HSD 15.515

*indicates nitrogen addition time. **indicates potassium addition time.

nitrogen treatments and numbers of adult or immature stages of two spotted spider mite in most sowing dates. The intensity of mite on the early sowing were 177.39 and 47.91 mites /100 leaves on the untreated cotton plants increased to 285.62 and 103.20 individuals after addition of N at 60 kg / fad. and increased to 376.45 and 111.92 after addition of N at 90 kg/fad. and P at 15 kg/fad. in 2009 and 2010 seasons, respectively. The increment of nitrogen level in the range of 0 to 90 kg/fad., enhanced mite population on cotton plants in the field. The same previously cases were found in the second season.

Phosphorus (P) effect

Data in Tables 19, 20, 21 and 22 indicated that phosphorus treatments at high levels decreased the numbers of adult or immature stages of two spotted spider mite.

The average numbers of mite population in the treatment No. 2 was 285.62 (N=60kg P=15kg), decreased to 193.54 mites/100 levels at treatment No. 5 (N = 60 kg and P = 25 kg) in early sowing date, 2009 (Table 19).

Potassium (K) effect

The mean number of mite population, 8 weeks after sowing, was 285.62 mites /100 leaves at 15 kg P / fed., (Table 19) and 60 kg N /fad. increased to 378.22 mites/100 leaves after addition of K at 24 kg/fad. The population density of mites were increased by increasing N fertilizer rates in NPK.

These results are in agreement with those obtained by Beckham (1969), Villamayor (1976), Ibraheem (1993), Megahed (1994), Gomaa (1994), Helaly *et al.* (1994), Atakan and Ozgur (1995), Slosser *et al.* (1997), Bauer and Roof (2004), Chen and Ruberson (2008) found that the population densities of aphids, leafminers, whitefly and thrips were increased significantly due to the increase of nitrogen level individually and in combination with P and K. Mohamed (1984), Helaly *et al.* (1990), Megahed (1994), Rosseto *et al.* (1997) found that phosphorous fertilizers had an insignificant effect on numbers of immature stages (Larvae and pupae) of *B. tabaci* during 1988. The highest infestation was recorded in the treatment, which received P_2O_5 while that received No P_2O_5 was the least infested one. The addition of potassium fertilizer to any combination of nitrogen and phosphorus fertilizers decreased significantly the population density of aphids and whitefly. In case of whitefly, leafminers and thrips, the population densities of these insects were decreased significantly in most cases. Chen *et al.* (2007) showed that there was No difference in the number of mites per host plant. Phosphorus had No effect on the mite population levels until week 8 of the study. Phosphorus on ivy geranium can therefore have a positive effect on tetranychid mites within a certain concentration range and perhaps N or K with further exploration, Geddes (2010) showed that mite density peaked highest in the potassium treatment and had a second high peak in the nitrogen treatment. In addition, egg density peaked highest in the potassium treatment. Ai *et al.* (2011) stated that the occurrence of insect herbivores is closely related to the nutrient their status in plant tissues supplied by soil fertility. Our results revealed the vital role of fertilizer element either applied alone or in combinations on the population densities of sucking pests. They also found that cotton plants treated with potassium and/or nitrogen fertilizers were less preferable to *Empoasca* spp. infestation, while that treated with phosphorus fertilization were highly infested with *Empoasca* spp. Najafabadi *et al.* (2011) indicated that increasing nitrogen level in the range of 0 to 69 kg ha enhanced mite population on bean leaves in field.

Compatibility of the Entomopathogenic Nematode, *Steinernema carpocapsae* with Methomyl on *Spodoptera littoralis* Under Laboratory Conditions

Results in Table 23 showed that the treatment of the cotton leafworm with 100 infective juveniles /ml killed 25-37% larvae within 48 and 96 h from treatment with *S. carpocapsae*, respectively. Percent mortalities after feeding the 6[th] instar larvae on treated leaves for 1, 2 and 4 days until pupation, indicated that the methomyl LC_{50} with *S. carpocapsae* was the most effective on the 6[th] instar which caused 50.00 , 87.5 and 100% mortalities compared to 25.00, 50.00 and 91.66% mortalities percent by methomyl LC_{50} (30%) with *S. carpocapsae*, respectively. On the other hand, the average of percent mortalities after treatment with *S. carpocapsae* alone was 20.66 increased to 27.16, 43.75, 43.75, 55.55 and 79.16 after treatment with *S. carpocapsae* suspension mixed with 10%, 20%, 30% LC_{50} and LC_{50} of methomyl, respectively. However, nematode treatment alone decreased the percent pupation of larvae and percent emergence of insects compared to the addition of methomyl at different concentrations that indicate that *S. carpocapsae* prevent progress to pupation and adult insect , showing 12.50% for pupation and 6.25% for emergence and increased to 31.25% and 18.75% in any methomyl treatment, respectively. Perhaps it's occurring due to killed infective juveniles of entomopathogenic nematode by gradation in methomyl concentration. *S. carpocapsae* was quite tolerant to methomyl. Percent mortalities of infective juveniles varied from 11.11% to 66.66% within 96 hours.

These results agreed with those obtained by some investigators such as Glazer *et al.* (1992), who defined ways to reduce larval populations of the cotton pests using the entomopathogenic nematode *Steinernema carpocapsae.* Application to the foliage of 500 and 1000 IJs \ ml in water was required to attain > 85% control of *Earies insulana* and *S. littoralis*, respectively. Application of *S. carpocapsae* (Mexican strain) (250 IJs\ml) mixed with Folicote (6% wt\wt) resulted in a 61% reduction in the persistence of *S. littoralis* larvae on cotton plants. Addition of Folicote (6% wt\wt) to the nematode suspension had a similar effect on insect mortality, with lower nematode concentrations (125 and 250 IJs\ml for *E. insulana* and *S. littoralis*, respectively. Zhang *et al.* (1994) studied the effect of insecticides on the entomopathogenic nematode *S. carpocapsae* by checking the mortality of infective juveniles (IJs) in insecticide solutions. The IJs were incubated in insecticide solutions (100 mg/ml) for 24 h and then

Table 23. Effect of different methomyl concentrations and pathogenicity of *Steinernema carpocapsae* (Weiser) against the sixth instar larvae of *Spodoptera littoralis* (Boisd.)

% concentration of LC_{50} (48 h)	% larval mortality at indicated days after treatment			Average	% pupation	% emergence	% mortality of infective juveniles in Petri dish
	1	2	4				
-	0.00	25.00	37.00	20.66	12.5	6.25	
10% LC_{50}	0.00	31.5	50.00	27.16	31.25	18.75	11.11
20% LC_{50}	18.75	37.5	75.00	43.75	31.25	18.75	33.33
30% LC_{50}	25.00	50.00	91.66	55.55	31.25	18.75	50.00
LC_{50}	50.00	87.5	100	79.16	37. 5	6.25	66.66

used newly molting instar *Spodoptera litura* larvae. OrgaNo Phosphorus (except acephate, malathion and temephos), 1 carbamate (methomyl), 2 pyrothroids (permethrin and ethofeNoprox) and cartap apparently inhibited infectivities of IJs, only cartap (≥10 mg\ml) and profeNofos (100 mg\ml) left a detrimental effect on the IJ infectivity. The same authors proved also that methomyl (100 µg\ml) had slight effects which led to insect mortality and nematode infectivity of ca. 80%.

Abdel-Razek (2006) studied the infectivity prospects of both nematodes and bacterial symbionts against cotton leafworm, *S. littoralis*, each nematode species was used (75, 150, and 300 infective juveniles) and found that *S. carpocapsae* (*XeNorhabdu nematophilus.*) gave 100% mortality 120, 90, and 56 h post-treatment, respectively.

Salem *et al.* (2007) evaluated entomopathogenic nematodes in controlling some cabbage pests. *S. carpocapase* (All) and *S. caprocapsae* S2 were more virulent to the 2nd larval instar than 5th one. As for *S. littorals, S.carpocapsae* (All) and *S.carpocapsae* S2 were the most virulent and fastest in action especially against the younger instars larvae.

Campos and Gutierrez (2009) studied the effect of *Steinernema feltiae* on *S. littoralis* (LC_{50} = 0.69 IJs/cm²) and reported that, it was considered the most suitable for development of the Rioja strain as a biocontrol agent for soil application.

In conclusion, imidacloprid increased the germination of cotton seeds, delayed the emergence of cotton seedlings and sowing date as a limited factor for imidacloprid activity. imidacloprid is a highly effective insecticide for control aphids, leafhoppers, plant hoppers, thrips, whiteflies, mites and green bug including resistant strains. Imidacloprid was very effective and reduced the population of aphids, thrips, green bug and whitefly invasion for minimum 10 weeks; showing very poor protection from jassids and mites. There are relationships between low pest infestation and level of pest control, this link by time of planting (*i.e.* early and late sowing), for example the highest effective of imidacloprid in early sowing was on aphids, jassid and whitefly, although the highest effectiveness in late sowing on thrips and green bug. Mites were the most resistance for imidacloprid. Excessive applications of fertilizers in cotton fields, especially nitrogen fertilizers lead to increase pest population and the control is generally adverse. Majority of Egyptian farmers fertilized cotton plants using nitrogen and phosphorus fertilizers only. Positive relation was found between N and P fertilization from one side and the numbers of aphids and thrips. Increased N amount decreased jassid population infesting cotton plants. Whereas, the relationship was positive between N and K fertilization in mites cases. The entomopathogenic nematode, *Steinernema carpocapsae* mixed with methomyl was potential to kill *S. littoralis* larvae and more efficient than *Steinernema carpocapsae* alone.

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تـأثير المكافحة الكيماوية ومعدلات التسميد المختلفة والنيماتودا الحشرية المتطفلة على بعض الآفـــات التي تصيب نبـاتـــات القطن

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أجريت التجارب الحقلية خلال موسمى ٢٠٠٩ و ٢٠١٠ في قرية طوخ طنبشا مركز بركة السبع بمحافظة المنوفية. أوضحت النتائج المتحصل عليها أن معاملة بذور القطن بمبيد الإميداكلوبريد قد أدى لتحسين نسبة الإنبات وزيادة معدلات ظهور البادرات كذلك أدى إلى زيادة طول البادرات. وأيضا أعطى هذا المبيد (اميداكلوبريد) حماية للبادرات من الحشرات الثاقبة الماصة مثل المن والتربس ونطاط الأوراق (الجاسيد) والذبابة البيضاء والبقة الخضراء. تم دراسة تاثير التسميد النيتروجيني والفوسفاتي والبوتاسي على مستويات الإصابة بالمن والتربس والجاسيد وأكاروس العنكبوت الأحمر وأوضحت النتائج أن زيادة التسميد الأزوتي من ٦٠- ٩٠ كجم/فدان وكذلك الفوسفاتي أدى الى زيادة الإصابة بالمن والتربس وعلى العكس من ذلك فإن التسميد البوتاسي أدى إلى خفض الإصابة بالمن والتربس بينما إنخفضت الإصابة بالجاسيد مع زيادة النيتروجين وزادت الإصابة بأكاروس العنكبوت الأحمر بزيادة التسميد البوتاسي. في الدراسات المعملية على النيماتودا المتطفلة على الحشرات من النوع *Steinernema carpocapsae* على يرقات دودة ورق القطن إتضح أن النيماتودا المتطفلة تسببت في موت اليرقات بنسبة ٢٥- ٣٧ ٪ بعد ٤٨-٩٦ ساعة من المعاملة، كما أنها قد قللت من معدلات التعذير وخروج الحشرات الكاملة . ولقد أثبتت النتائج إمكانية خلط النيماتودا بمبيد الميثوميل حيث زادت نسبة الموت في اليرقات من ١١,١١ – ٦٦,٦٦ ٪ خلال ٩٦ ساعة من المعاملة.

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