International Journal of Agricultural Technology 2013 Vol. 9(3): 541-551
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

Efficacy of some biopesticides for the control of the onion maggot, *Delia alliaria* Fonseca (Anthomyiidae:Diptera) on onion under field conditions in Iraq

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Hameed H. Al-Karboli and Feryal B. Hermize (2013). Efficacy of some biopesticides for the control of the onion maggot, *Delia alliaria* Fonseca (Anthomyiidae:Diptera) on onion under field conditions in Iraq. International Journal of Agricultural Technology 9(3):541-551.

Abstract Onion maggot, *Delia alliaria* Fonseca are considered to be a key pest of Alliaceous crops in many part of the World. There were no previous studies about this newly recorded pest in Iraq. Filed studies were conducted to evaluate the effectiveness of two biopesticides and their effects on yield and quality of bulbs. The insecticide Dozer was applied for comparison. Results showed the superiority of *Beauveria bassiana* isolate BSA3 when sprayed after two and four weeks of emergence in the nursery, where infestation level were (12.66, 13.8 and 19.53) % and (14.00, 15.06 and 17.86) %after 2 and 4 weeks of application respectively. Results also indicated that spraying onion plants in the field with 2 isolates of *B. bassiana* resulted in significant reduction of infestation with the superiority of BSA3 isolate. Infestation rates were 14.57%, 16.88% and 25.49% for the treatment of BSA3, BSA1 and the control treatment. The relative efficiency of these isolates was 68.71 %, 62.16%. Yield increase was also reported for treated plots as (267.60, 256.20)g/plant compared with 216.20g/plant in the control treatment . Percentage of the first class bulbs was increased from 65.10 % in the control treatment to 78.60% and 71.70% for the 2 isolates BSA3 and BSA1 treatments respectively. The relative efficiency of the biopesticides was superior on Trigard and Dozer reaching 83.41 %, 66.06 % and 81.10% for the 3 treatment respectively. These treatments caused significant increase in plant yield, reached to (296.20, 252.50, and 285.60) gm / plant respectively compared with 239.50 gm / plant in the control treatment. A significant increase in the percentage of the first class bulbs of 79.66, 65.97, 76.54 % for the 3 treatment respectively. Compared to 62.45% for the control treatment. The possibility of using these Biopsticides in the control program for the onion maggot was also discussed.

Key words: onion maggot, *Delia alliaria,* Spinosad, *Beauveria bassiana* , onion, Iraq .

Introduction

Onions, *Allium cepa* L. is a winter crop which is cultivated in a wide areas of central and Northern regions of Iraq, Particularly the provinces of

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Nennawa, Al-anbar, Bagdad, Diyala and Babil, Where an estimated cultivated area were about 91961acres and average production of 1899kg /dunum .Onion crop is attakedby many insect pests, the key pest onion maggot *Delia spp.* which cause yield losses ranging between 20-60%(Hermize, 2012; Taylor et al., 2000) .

This pest feed on numbers of plants including onion, garlic and Leeks. Larvae feed and burrow inside bulbs leading to a wilting and dead heart of seedlings, one larva may feed on many seedlings before its pupation (Klass and Snover, 2000). Feeding sites and the wounds caused by the larvae to bulbs, this led to easy hit by bacteria and fungi in the soil. Intensive use of Insecticides is considered as the main control methods for the onion fly where it can be applied as seed treatments , or foliar application such as Chlorprifos , Cruiser , Trigard and others insecticides , had led to emergence of Insecticide resistance (Nault et al., 2006). Recently Spinosad (a bioinsecticide) was registered by the Environmental Protection Agency (EPA) for the control of many insect pests such as Lepidopteran pests on cotton (Sparks et al. ,1998), grasshoppers (Amarasekare and Edelson ,2004) , *Thrips tabaci* and onion maggot , *Delia antiqua* in the united states (Nault et al., 2006 ; Crouse and Sparks, 1998). In Iraq the first record of infection by the entomopathogenic fungi , *Beauveria bassiana* was on palm stem borer , *Jebusaea hammerschmidti* Reiche , in 1975 (Twaeeg,2002), then local isolates of fungi isolates were used against many insects such as fig moth , *Ephestia cautella* (walk) (Jassim,et al. 1998), cotton leaf worm , *Spodoptera littoralis* (Obeiidi,2006) , Dubas bug , *Ommatissus bionotatus lybicus* De bergerin, (Jassim, 2007) , potato tuber moth, *Phthorimaea operculella* (Naddawi, 2009) and corn stem borer , *Sesamia cretica* Led. . (Amin, 2002; Ameri, 2009). The emergence of insecticides resistance ,and since the recent trends are directed toward organic agriculture what aimed find alternative control method safe to humans , environment and natural enemies ,Therefore, this study was conducted to evaluate Spinosad and some local isolates of *B.bassiana* for the control of onion maggot , *Delia alliaria* in Iraq .

Materials and methods

Nursery

The experimental field was located at the college of Agriculture, Abu-Ghraib, Baghdad .Seeds of Texas Early Grano cultivar were planted in nursery and seedlings were raised for 8 weeks before transplanting. Nursery was divided to equal plots of 1×2 m, each plot was sub-divided into rows of 20 cm a part with an isolation area of 1 m was left between treatments and replicates.

The experiment was laid out according to complete randomized block design (CRBD) with three replication for each treatment. The seedlings were received normal agricultural practices (Dawood, 2006). Two local isolates of *B.bassiana* (BSA1, BSA3) was obtained from the center of Organic Agriculture, Ministry of Agriculture. To identify the appropriate date for spraying these isolates, the experiment was divided in two parts: The first was sprayed at a concentration of 1×10^8 of *B.bassiana* suspension after two weeks from emergence, while the second part was treated after 4 weeks. Control treatment was sprayed with distilled water alone. Onion maggot sampling was carried out weekly until transplanting of seedling to the field. A seedling row of 15 cm long for each treatment were carefully pulled from the ground, and were placed in labeled polyethylene bags for examination in the laboratory and calculate the percentage of infestation.

Field studies

Field was divided into rows of 5 m long in spacing of 75 cm between rows and 10 cm between plants. Each treatment was consisted from five rows, Experiments were set up as Randomize Complete Block Design (RCBD) with 3 replication, A 1m of non treated area was left as separating zone between replicates. Plant received the same normal agricultural practice as above. Seedlings were transplanted to this field 8 weeks from emergence. Treatments application included:

Spinosad (a.I 12.5%) of Dow Agro Science used at rate 0.25 ml / 1 liter of water.

Trigard (Cyromazine) 100 SL of Syngenta was applied at rate of 1 ml / 1 litter of water .

Dozer (a.i Carbosulfan 12.5%) of Astra (Saudi Arabia) was applied at rate of 2 ml / litter of water.

B.bassiana isolates (BSA1, BSA3) were as used in the Nursery.

All treatments were compared to an untreated control.

Applications of these insecticides were made after two weeks of transplanting. Treatments were evaluated by randomly lifting 15 plants from the middle rows of each treatment after two weeks from transplanting at the following dates: 1 day before treatment, 3, 7, 14, 21, 28 days after insecticides application. Samples for *B.bassiana* treatment were taken at: 1 day before treatment 4, 7, 14, and 21 days after treatment. Samples were placed in labeled polythelyne bags and transported to the laboratory to estimate:

1. The percentage of onion maggot infestation
2. Insecticides and *B.bassiana* isolates efficacy according to Henderson – Tiltons formula (1955).
3. Yield and bulb quality of bulbs were calculated using a vernier , and categorized to 3 classes according to Nguthi, et al .(1994) as below : -
Grade 1: Bulb diameter > 7 cm
Grade 2: Bulb diameter = 4 > 7 cm
Grade 3: Bulb diameter < 4 cm

Data were analyzed by analysis of Variance and the means were separated according to least significance differences test(LSD). At the P= 0.05 level of significance (SAS, 2001).

Results and discussions

Efficacy of foliar application of B.bassiana isolates

Results in table (1) showed incidence of onion maggot infestation on two weeks old onion seedlings' after spraying with *B.bassiana* in the nursery. A significant difference were observed between the two isolates in infestation , The isolate BSA3 was superior in reducing infestation rates to 6.67%, followed by 7.33% for BSA1 compared with 13% in the control treatment. Then infestation rates began to increase gradually with the presence of significant differences between treatments after 4 weeks from seedling emergence reached to (18.67, 19.67 and 26.33) % for isolates BSA3, BSA1 and the control treatment respectively. The general rates of infestation during the period of nursery were 12.66, 13.8 and 19.53 % respectively and this means that isolates BSA3 and BSA1 have reduced infestation rates by 35.18% and 29.34%.

Treatment of onion seedlings after 4 weeks of emergence resulted in a superiority of BSA3 isolate too. Onion maggot infestation was 7 % compared with 9.33% for BSA1 and 12% for the control treatment. Then, infestation rates began to increase gradually with presence of a significant differences between treatments reaching 19, 21.33 , 25.33 % for BSA3 , BSA1 and control treatment respectively , Overall infestation rates was reduced by 22.62% and 15.66% for isolates BSA3 and BSA1 respectively . Results also indicated superiority of spraying after 2 weeks over 4 weeks from emergence. Based on these results it seems that the use of BSA3 isolate is the best and that the timing of the spraying should be two weeks from emergence to reduce the incidence of onion maggot infestation in the nursery. In a field study Amin et al (2000) found that spraying corn plants with *B.bassiana* led to a reduction in the incidence of corn

borer, *Sesamia cretica* Led. to 21.30% and 28% for Iraqi and Chinese isolates respectively compared with 53.80% in the control treatment. in another study Al – Ameri(2009) also found that spraying corn plants resulted in a reduction in the infestation rates by the corn borer, *Sesamia cretica* Led. to 10% compared with 58.5% in the control treatment .

Table 1. Effect of two isolates of *B. bassiana* sprayed at two different times on infestation by onion maggot, *Delia alliaria* in Nursery

Sampling date	**Percentage of infestation by the onion maggot *D. alliaria***							
	After 2 weeks from seeding emergence				After 4 weeks from seeding emergence			
	BSA3	BSA1	Control	Mean	BSA3	BSA1	Control	Mean
9/11	6.67 a	7.33 b	13.00c	9.00a	7.00 a	9.33b	12.00 c	9.44a
15/11	8.33a	10.00 b	15.00 c	11.11b	9.67 a	11.00b	14.33 c	11.66b
23/11	12.67a	13.67b	19.67 c	15.33c	13.67a	14.33b	16.00 c	14.66c
30/11	17.00a	18.33b	23.67 c	19.66d	17.67a	19.33b	21.67 c	19.55d
6/12	18.67a	19.67b	26.33 c	21.55e	19.00a	21.33b	25.33 c	21.88e
Mean	12.66 a	13.8 b	19.53 c		14.00 a	15.06b	17.86 c	
LSD 0.05 after 2 weeks		isolates=0.32		weeks=0.59		isolates x weeks=1.02		
LSD 0.05 after 4 weeks		isolates=0.42		weeks=0.77		isolates x weeks =1.34		

Effect of foliar application with B. bassiana in field

Result in table 2 also showed the superiority of BSA3 treatment on infestation with onion maggot, *D. alliaria* . The relative efficiency of the two isolates after 4 days from treatment were 36.18% and 28.13 % and reached to91.61% and 85.63% for BSA3 and BSA1 after 28 days from application .,The general efficiency rates for the two isolates were 68.71% and 62.16% respectively.

Table 2. Relative efficiency of *B. bassiana* isolates on mortality rates of onion maggot, *D. alliaria*

Treatment	**Corrected mortality after%**					
	4 days	7days	14 days	21 days	28 days	Mean
BSA3	36.18 a	55.92 a	73.46 a	86.41a	91.61a	68.71a
BSA1	28.13 b	46.30b	69.27 b	81.47b	85.63b	62.16b
Mean	32.15a	51.11b	71.36c	83.94d	88.63e	
LSD 0.05	treatments=1.71		days=2.42		treatments x days=3.42	

Result in Fig.1 indicate the effect of the two isolates on the infestation with the onion maggot, The isolate BSA3 significantly reduced infestation rates after 4 days from treatment , to 18.35% compared with 20.11 % and 21.07 % for BSA1 and control respectively, So this isolate can be used in the

integrated pest management program for onion maggot . The effects of these isolate began to be observed after a week , because the fungus needs time to grow and multiply within the plant tissue as the hyphae of the fungus *B.bassiana* enter the leaves and make a symbiotic relationship , hyphal filament penetrated plant , enter and move through the wood cells. They are associated with cells, Therefore, they made a vascular colonization inside host cells, this explains how transmission of *B.bassiana* inside the plant is happen and gives it protection to the host plant from attacking insects (Wagner and Leslie, 2000).

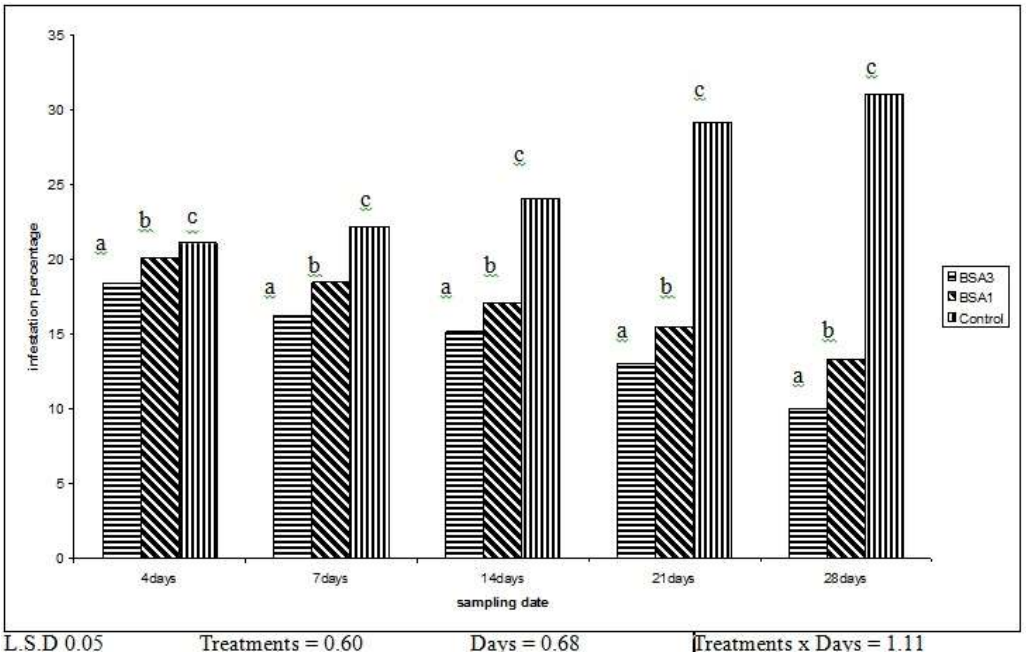


Fig. 1. Effect of spraying *B. bassiana* isolates on the percentage of infestation by the onion maggot, *D. alliaria* in the field.

The impact of B .bassiana spraying on yield and quality of bulbs

Results in table 3 showed a significant differences between treatment and the superiority of BSA3 in the reducing of percentage of infestation by the onion maggot which a rounded to 14.57%, 16.88% and 25.49 %for BSA3, BSA1 and control treatment respectively. The total weights of 3 meter row of onion plants were 4.35, 3.84 and 2.74 kg for BSA3, BSA1 and control treatment. The average weight of the bulbs reached 267.60, 256.20 and 216.20 g / plant respectively. A significant difference was observed in quality of bulbs,

as the percentage of first class bulbs (Grade1) were 78.60 %, 71.70% and 65.10% for the treatment of BSA3, BSA1 and control respectively. These results indicating that using of these isolates showed an obvious increased in yield and quality of bulbs. A similar previous studies (Soundararajan and Chitra,2011) on legumes found that spraying with *B.bassiana* has increased yield from 513 kg in the control treatment to 740.5 kg/ha.

Table 3. Effect of *B. bassiana* isolates on infestation by the onion maggot, *D. alliaria*, plant yield and quality of bulbs

Treatment	Plant yield			% Of bulbs size		
	infestation Percentage	Mean treatment Weight(kg)/3 meter row	Mean plant yield(g)	Grade 1	Grade 2	Grade 3
BSA3	14.57a	4.35a	267.60a	78.60a	12.25b	10.20b
BSA1	16.88b	3.84b	256.20b	71.70b	19.58a	8.8b
Control	25.49c	2.74c	216.20c	65.10c	17.58a	17.40a
LSD0.05	0.60	0.42	8.01	4.09	6.86	5.85

Effect of foliar application of Spinosad in the field

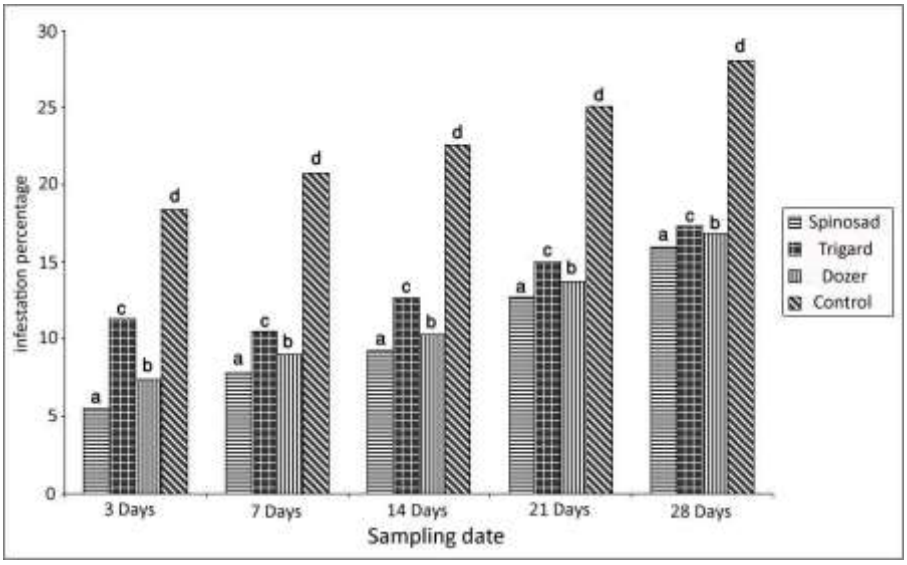
Results presented in table 4 indicated that efficiency of insecticides on onion maggot was varied with superiority of spinosad compared with other insecticides.

The relative efficiency of insecticides reached to 97.78%, 69.89% and 64.02 for spinosad, Dozer and Trigard respectively after 3 days from treatment. Efficiency of these treatments had begun to decreased gradually reached to 56.11 53.76 and 63.57% for spinosad, Dozer and Trigard respectively after 28 days of application. The impact of the bio-insecticide (spinosad) was rapid effect similar to the insecticide Dozer, while the effect of the IGR (Trigard) was slow and not reaches 70% only after 3 weeks. The difference may be attributed to the nature of the IGR, and it takes longer to start acting. For overall relative efficiency to the three treatments, spinosad was showed a significant differences reaching 83.41%, followed by dozer (81.10%) and 66.06% for Trigard.

Table 4. Relative efficiency of insecticides on mortality rates of onion maggot, *D. alliaria*

Treatment	Corrected mortality after%					
	days 3	days 7	days 14	days 21	days 28	Mean
Spinosad	97.78a	93.33a	86.81a	66.44b	56.11b	83.41a
Trigard	64.02b	82.00c	73.78c	70.32a	63.57a	66.06c
Dozer	96.89a	88.47b	83.34b	64.18c	53.76c	81.10b
Mean	86.23	87.93	81.31	66.98	57.81	
LSD0.05	Treatments= 2.40		days=3.52	treatments x days =6.10		

Treatments were reduce the incidence of infestation after 3 days from spraying to 5.51 % , 7.40% , 11.33% and 18.40% for the treatments of Spinosad , Dozer , Trigard compared with 18.40% for the control treatment. However, infestation showed same variation with reached 15.98%, 16.81%, 17.33% and 28% for spinosad, Dozer, Trigard and control treatment respectively after 28 days of spraying Fig. (2). The general mean of the infestation rates may indicate that Spinosad was able to reduce the rate of infestation of onion maggot by 50%, which was significantly different from Dozer. Furthermore the Biopsticides is the preferred choice because it safe to natural enemies and the environment. Sparks et al (1998) found that Spinosad effect many insects species including, Lepidoptera, Diptera such as Mediterranean fruit fly and leaf miners. On these study showed that infection rate of two species of fruit fly, *Ceratitis capitata* and *Anastrepha suspense* were reduced with Spinosad (Burns, et al .2001) .As for the growth regulator Trigard its effect was observed after 3 days and increased after a week and then begun to decrease. Previous studies (Schlapfer and Moore, 1986) showed that Trigard is effective on insects, such as leaf maggot, leaf miners and onion maggot, So that Trigard were used in the integrated pest management (IPM) for the onion pests .



LSD 0.05 treatments=0.98 days=1.17 treatments xdays=2.25

Fig. 2. Effect of spraying insecticides on the percentage of infestation by the onion maggot, *D. alliaria*

Effect of foliar application on yield and quality of bulbs

Data presented in table 5 showed a significant differences between treatments in reducing infestation rates and that did have an obvious effect on the yield . A significant differences were found between treatments in the rates of bulbs weight, , The average weights were 4.83kg , 4.47kg , 3.95kg and 3.13kg / 3 meter of row for the treatments of Spinosad , Dozer , Trigard and control respectively , The higher average of weight per bulb (plant) was recorded for spinosad treatment reached to 296.20 g/bulb , compared to 285.60 , 252.50 and 239.50 g /bulb for Dozer , Trigard and control. Spinosad treatment did also significantly increased the percentage of the first class blubs which reached to 79.66% compared to 76.54 %, 65.97% for Dozer Trigard respectively. These results indicated that Spinosad showed positive effects in favor of the quality and yield of bulbs, Therefore, spinosad can be used within IPM program to the onion maggot. The findings of Tanzubil et al (1999) are similar to results obtained here, when indicated that the use of insecticides on foliage can reduce the incidence of infestation and lead to reducing yield loss.

Table 5. Effect of different treatments on infestation by the onion maggot, *D. alliaria*, plant yield and quality of bulbs

Treatment	Plant yield			Of bulbs size%		
	infestation Percentage	Mean Weight (kg)/3meter row	Mean plant yield(g)	Grade1%	Grade2%	Grade3%
Spinosad	10.41a	4.83a	296.20a	79.66a	12.01b	8.1b
Trigard	13.44c	3.95c	252.50c	65.97c	19.17a	14.90a
Dozer	11.64b	4.47b	285.60b	76.54b	12.78b	10.60b
Control	21.29d	3.13d	239.50d	62.45d	17.39a	20.10a
LSD0.05	0.98	0.16	8.54	3.08	4.68	6.72

References

Amarasekare, K.G. and J.V. Edelson (2004). Effect of temperature on efficacy of Insecticides to differential grasshopper (Orthoptera: Acridide). J. Econ. Entomol. 97:1595-1602.

Ameri , H.S.A. (2009). Identification of the sources of variation for some isolates of *Beauveria bassiana* and evaluate their efficiency to control corn borer, *Sesamia cretica* Led. (Lepidoptera: Noctuidae) under field conditions Ph.D. thesis, College of Agriculture, university of Baghdad, pp. 89.

Amin, A.T., H.H. karboli and H.M. Saleh (2002). Field studies on the effects of entomopathogenic fungi *Beauveria bassiana* on corn borer *Sesamia cretica* Led. (Lepidoptera: Phalaenidae). Iraqi journal of Agricultural Sciences 14 (3):67-73.

Burns, R.E., D.L .Harris, D.S. Moreno and J.E. Eger (2001). Efficacy of Spinosad Bait sprays to control Mediterranean and Caribbean fruit flies (Diptera: Tephritidae) in commercial citrus in Florida. Florida Entomologist 84(4):672-678.

Crouse, G.D. and T.C .Sparks (1998). Naturally Derived Materials as Products and Leads for Insect Control: The Spinosyns .Rev. Toxicol 2:133-146.

Dawood, M.S. (1992). Onion production. Ministry of Agriculture and Irrigation. Research leaflet, pp. 14.

Henderson, C.F. and Tilton, E.W. (1955). Test with acaricides against the brown Wheat mite .J.Econ.Entomol.48:157-161.

Hermize, F.B. (2012). Evaluation of some types of control methods against the Onion maggot, *Delia alliaria* Fonseca (Diptera : Anthomyiidae) , Ph.D. thesis, College of Agriculture, University of Baghdad. pp. 126.

Jassim , H.K., L.M. Abdullah and A.A.Abdullah (1998). Determination of the effect concentration of *Beauveria bassiana* for the control of the dates palm Moth, *Ephestia cautella* (walk) on stored dates in Iraq. Arab J. of plant Protection 6(1):40-45.

Jassim, J.K. (2007). Biological Studies on Dubas palm *Ommatissus lybicus* (Debergevin) Asche & Wilson and control by *Beauveria bassiana* isolates. Ph.D. thesis, College of Agriculture, university of Baghdad. pp. 165.

Klass, C. and K.L. Snover (2000). Onion Maggot; Part 1; Pest Management Around The home, Cultural method. Alternative Control Outreach Research Network (ACORN) at Purdue University. Cornell University.

Naddawi, F.A. (2009). Biological and field studies on potato tuber moth, *Phthorimaea operculella* (zeller) (Lepidoptera: Gelechiidae) . And its control With isolates of *Metarhizium anisopliae* (Metch) and *Beauveria bassiana* in Baghdad. M.Sc. thesis, College of Agriculture, university of Baghdad, pp. 102.

Nault, B.A., A.M. Straub and A.G. Taylor (2006). Performance of novel insecticide Seed treatments for managing onion maggot (Diptera: Anthomyiidae) in onion Fields. Crop Protections .25:58-65.

Nguthi, F.N., J.A. Chweya and P.M. Kimani (1994). Effect of plant density on Growth, yield and quality of bulb onions. In Proc. Eastern Africa Regional Alliums Workshop, Kabete, Kenya. 21-22 Sept. pp. 57-62.

Obeiidi, S.H. (2006). Efficiency of *Beauveria bassiana* and insecticide Avaunt Against cotton leaf worm, *Spodoptera littoralis* Boisd (Lepidoptera: Noctuidae) M.Sc. thesis College of Agriculture, university of Baghdad, pp. 91.

SAS, (2001). SAS/ STAT. Users Guide for personal computers. Release 6.12 SAS Institute Inc., Cary. NC, U.S.A.

Schlapfer, T.C. and J.I. Moore (1986). Cyromazine, a new insect growth Regulator for leaf miner control Proceeding of the 1986 British Crop Protection Conference- Pests and Diseases, 8:123-128.

Soundararajan, R.P. and N. Chitra (2011). Effect of bioinoculants on sucking pests and pod borer complex in Urdbean. Journal of Biopesticides 4(1):7-11.

Sparks, T.C., C.D. Thompson, H.A .Kirst, M.B. Hertlein, L .L .Larson, T. V. Worden and S.T. Thibaut (1998). Biological Activity of the Spinosyns, New Fermentation Derived Insect Control Agents, on Tobacco Budworm Larvae (Lepidoptera: Noctuidae).J. Econ. Entomol. 91: 1277-1283.

Tanzubil, P.B, P. Terbobri and E .Ansoba (1999). Incidence and control of onion fly *Delia antiqua* , at some irrigation sites in the Upper East Region of Ghana. Ghana J. agric .Sci.32:205-211.

Taylor, A.G., C.J. Eckenord and R.W. Straub (2000). Seed coating technologies and Treatments for onion: Challenges and Progress .New York state Agriculture Experiment Station .Cornell University, Geneva, NY 14456, pp. 7.

Twaeeg, N.S. (20020. Production of a bio-pesticide from *Beauveria bassiana* to Control the green peach aphid, *Myzus percicae* . M.Sc. thesis, University of Kufa, pp.76.

Wagner , B.L. and C.L. Leslie (2000). Colonization of corn *zea mays* , by the Entomopathogenic fungus *Beauveria bassiana* . American Society for Microbiology, 66(8):3468-3473.

(Received 7 January 2013; accepted 30 April 2013)