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INFESTATION OF ONION BULBS WITH *Eumerus amoenus* LOEW. (DIPTERA: SYRPHIDAE) DURING STORAGE

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ABSTRACT

Onion (*Allium cepa* L.) is subjected to the attacks of certain insect pests during storage period, which extends from early June until early November; including those belonging to the genus *Eumerus* particularly the onion bulb fly *Eumerus amoenus* Loew. (Diptera: Syrphidae) .This investigation aimed at evaluating the efficacy of six different storage methods; three outdoor (bulbs on the soil, bulbs on the soil covered with hay and bulbs in perforated plastic sacks) and three indoor (bulbs on the floor, bulbs on shelves and bulbs in perforated plastic sacks) on onion bulbs infestation with *E. amoenus* throughout the three successive storage seasons of 2003- 2005 at Assuit Governorate using the variety "Giza 6 Mohassan" .The effect of frequent discarding of bulbs infested with *E. amoenus* on the % infested bulbs and yield loss was also investigated.

Storing bulbs indoor decreased infestation than their storage outdoor. Onion bulbs stored outdoor on the soil received the highest infestation (23.0- 36.5 %) while storing them in sacks either outdoor or indoor recorded the least infestation (10.0-19.0% and 11.0-14.5%, respectively). Discarding infested bulbs decreased infestation percentage by about 6-14%.The relationship between % bulb infestation and yield loss was highly significant (r = 0.994-0.999and b = 0.63-0.77). A change of 10 % in the % infested bulbs alters yield loss by approximately 6 - 8 %.

Key words: *Allium cepa ,Eumerus amoenus, , infestation ,onion, onion bulb fly .*

1. INTRODUCTION

In Egypt, onion (*Allium cepa* L.) is an important field crop. According to the Department of Statistics of the Ministry of Agriculture and Land Reclamation, the total area cultivated with onion in 2005 exceeded one hundred thousand feddans that produced over 1.3 million tons of bulbs which cover the requirements for both local consumption and exportation. Onion is cultivated in several governorates especially in Upper Egypt and different methods are practiced to store its bulbs .Stored onion bulbs are subjected to the attacks of certain insect pests, the most prominent of which is the onion bulb fly, *Eumerus amoenus* Loew. (Diptera: Syrphidae) and *Eumerus vestitus* Bezzi which is less economically important (El-Shabrawy, 1996). Onion is seeded in August and September, transplanted in October and November and harvested in April and May. Farmers and stock sellers usually store harvested bulbs from June until October. Bulbs are stored either outdoor in the open or indoor in stores. In the field, onions are stored in heaps on the soil, heaps on the soil covered with wheat or rice hay or in sacks .In stores, storage takes place in heaps on the floor, on shelves or in perforated plastic sacks.

Due to the frequently noticed damage caused by *E. amoenus* to onion bulbs, particularly during the storage period, the current investigation was suggested .It concentrated on evaluating the efficacy of six different storage methods (three indoor and three outdoor) for protecting onion bulbs from *E. amoenus* damage as well as the effect of frequent discarding of infested bulbs on infestation rate and yield losses.

Literature on *E. amoenus* and its infestation to onion bulbs during storage is apparently few. Most of the work done in this respect was carried

out in Egypt by El-Sherif (1971) and Abd-El-Fattah (1980) who reported reasonable protection against *E. amoenus* by storing bulbs at 0–2 C^0 and 90 % R. H. Mohamad (1973) and Mikhael (1978) reported that infestation with *E. amoenus* reaches its peak by the beginning of July while El-Shabrawy (1990) recorded two peaks of *E. amoenus* ; one in July and the other by mid-August , Massry (2002) mentioned that, during storage, bulb infestation with *E. amoenus* reaches 5-30 %. Scattered studies were also conducted abroad on other species of the genus *Eumerus* .Zabirov (1963), in USSR, observed that onion bulbs are infested with *E. strigatus* and *E. tuberculatus*. Mulin (1990) and Marcos *et al.*(1999) in USSR and Spain, estimated the loss in onion bulbs infested with *E. strigatus* at 25-30 % and 45-85 %, respectively .

2. MATERIAL AND METHODS

Experiments on the effect of *E. amoenus* infestation on onion bulbs during the storage period were conducted at Assuit Governorate throughout the three successive years 2003-2005 using the commonly cultivated onion variety "Giza 6 Mohassan ".

2.1.Effect of storage method on bulb infestation

Six quantities of onion bulbs, each weighing 100 kg., were collected from the field at the beginning of the storage season (early June) for each of the three years of investigation. One of these quantities was stored under one of the following six different storage methods: A) outdoor methods: bulbs stored on the soil, bulbs stored on the soil and covered with wheat hay, and bulbs stored in perforated plastic sacks. B) indoor methods in clean stores: bulbs stored on the floor, bulbs stored on shelves at what height, and bulbs stored in perforated plastic sacks. The bulbs of each quantity were then divided into four equal subquantities of 25 kg. each and regarded as replicates. Monthly samples of 10 bulbs / replicate were collected at random and inspected for infestation with *E. amoenus*. Sampling continued from late June until late October and thus a total of 5 samples / treatment was taken. Comparison between tested storage treatments was based on the analysis of variance, F test and L.S.D.

2.2.Effect of frequent discarding of infested bulbs on infestation

For every considered year, onion bulbs were randomly collected from the field by early June. Three random quantities (treatments) of bulbs each weighing 40 kg. were piled and every pile was divided into four subquantities of 10 kg. each (replicates). All subquantities were then stored on the floor of a clean store until the end of the season by late October. The bulbs (4 replicates) of each of the three piles were subjected to one of the following three treatments: A) bulbs inspected and infested ones discarded, B) bulbs inspected without discarding infested ones. C) bulbs totally protected from infestation using Furan 10 % granules at a rate of 50 gm. / replicate added at the beginning of the experiment and again every 15 days. Examining bulbs for *E. amoenus* infestation was practiced twice: once by late August (2-months after storage) and again by late October (4-months after storage). At every inspection date, the sound and infested bulbs in treatments A (bulbs inspected and infested ones discarded) and B (bulbs inspected without discarding infested ones) were counted and weighed. The bulbs of treatment C (control) were also weighed at every inspection date.

The percentage of infested bulbs, percentage of actual weight loss, percentage of humidity loss and percentage corrected weight loss for each tested treatment were then calculated by applying the following set of formulae:

$$\textbf{\% infested bulbs} = \frac{\text{No. of infested bulbs}}{\text{Total no. of bulbs}} \times 100$$

% actual weight loss =

$$\frac{\text{Weight at the beginning of the storage period - weight at inspection date}}{\text{Weight at the beginning of the storage period}} X100$$

% humidity loss =

$$\frac{\text{Weight of bulbs in the control treatment at the beginning of the storage period – weight of bulbs in the control treatment at inspection date}}{\text{Weight of bulbs in the control treatment at the beginning of the storage period}} X100$$

% corrected weight loss = % actual weight loss - % humidity loss

2.3.Loss assessment

Suitable quantities of onion bulbs, more or less of similar size, were stored into a clean store at the beginning of each considered storage season *i.e.*,early June. One month later, all bulbs were examined for *E. amoenus* infestation to separate infested ones. Separated infested bulbs were then used for inducing different levels of infestation with the fly through mixing uninfested and infested bulbs at certain specified infestation rates (percentages). Eleven induced infestation levels were tested to represent ; 0 , 10 , 20 , 30 , 40 , 50 , 60 , 70 , 80 , 90 and 100 % infestation . Fourty bulbs were devoted for each tested infestation level. Bulbs were divided into 4 equal groups of 10 bulbs each (replicates). Zero infestation level consisted of 10 sound bulbs / replicate and 100 % infestation level consisted of 10 infested bulbs /

replicate. Intermediate infestation levels were induced by adjusting the proportions of sound and infested bulbs for each replicate. For example, to induce 30 % infestation, each replicate for this particular level consisted of 7 sound bulbs and 3 infested ones. The bulbs of each replicate were packed in a tightly tied perforated cloth bag and stored in a clean store. The bags were inspected and weighed three times by early July, early September and early November (1, 3 and 5 months after the beginning of storage, respectively) . To maintain the percentage of bulb infestation constant at the specified infestation level, the percentage of infestation was regularly adjusted at every examination date by discarding the excessive infested bulbs and replacing them with sound ones of (nearly) similar size. Loss assessment was then estimated by applying the following formula:

$$\% \text{ Weight loss} = \frac{\text{Weight of control treatment - Weight of treatment}}{\text{Weight of control treatment}} \times 100$$

To determine the effect of infestation rate on weight loss, the simple correlation and regression coefficients for % weight loss on % infestation were calculated.

3. RESULTS AND DISCUSSION

3.1.Effect of storage method on bulb infestation

The effect of storage method on the monthly mean numbers of onion bulbs infested with the onion bulb fly *E. amoenus* throughout the three successive years 2003-2005 is summarized in Table (1). Table (2) shows the mean percentages of infested bulbs for 2003-2005 under the different tested storage methods. Bulbs stored outdoor were subjected to a relatively higher infestation than those stored indoor (2.3-18.7 / 40 bulbs & 10.0-36.5 % infested bulbs and 2.3-8.7 / 40 bulbs & 12.0-17.5 % infested bulbs, respectively).

As seen in Table (1), for outdoor storage, infestation tended to increase from June until September (from 2.3 to 16.0 / 40 bulbs). During October, infestation continued to increase among the bulbs stored on the soil (18.7 / 40 bulbs) whereas it decreased among those covered with hay (7.0 / 40 bulbs) or stored in perforated plastic sacks (6.3 / 40 bulbs). During the three considered years, the peak of infestation with *E. amoenus* under outdoor storage took place by the end of September for bulbs covered with hay or stored in perforated plastic sacks (13.7 and 9.0 / 40 bulbs, respectively) and about a month later for the bulbs stored on the soil (18.7 / 40 bulbs) . For indoor storage , infestation increased between June and August to reach peaks of 8.3 , 8.7 and 7.0 bulbs / 40 bulbs for storage on the floor, shelves and in perforated plastic sacks, respectively, by the end of August. Infestation declined throughout September and October for the three tested indoor storage methods (6.7, 5.3 and 6.7 bulbs / 40 bulbs for storage on the floor, shelves and in perforated plastic sacks, respectively). El-Shabrawy (1990) reported that, in Giza Governorate, *E. amoenus* has two peaks; one during the first week of July and the other in mid August. Massry (2002) mentioned that, in Alexandria Governorate, infestation with *E. amoenus* reaches its maximum between late July and early August.

The analysis of variance indicated that the differences between the six tested storage methods in respect of onion bulb infestation with *E. amoenus* were highly significant. Storage of bulbs outdoor either on the soil or covered with hay recorded the maximum infestation (11.7 and 9.4 bulbs / 40 bulbs, respectively) and both storage methods were statistically insignificant from each other. Storage in perforated plastic sacks outdoor as well as all tested indoor storage methods were less susceptible to infestation and insignificantly different from each other (5.4, 6.3, 5.5 & 5.1 bulbs / 40 bulbs and 13.6, 15.8, 13.7 and 12.7 % infested bulbs for storage outdoor in perforated plastic sacks and storage indoor on the floor, on shelves or in perforated plastic sacks, respectively, Tables (1&2).

The above data lead to the general conclusion that the storage of onion bulbs in stores protects them from *E. amoenus* infestation. However, storage of bulbs in perforated plastic sacks outdoor provides an almost similar protection. For indoor storage, keeping bulbs on shelves seems to provide a better protection against *E. amoenus* than keeping them on the floor while storage in sacks provides a relatively better protection. It is recommended, therefore, to store onion bulbs indoor in perforated plastic sacks rather than outdoor under any storage conditions to minimize their infestation with *E. amoenus* throughout the storage season.

Table (1): Monthly mean numbers of infested bulbs / 40 bulbs under six different storage methods (means for three successive years, 2003-2005).

Month	Storage method					
	Outdoor			Indoor		
	On the soil	On the soil covered with hay	Sacked	On the floor	On shelves	Sacked
June	5.0	6.3	2.3	4.0	2.3	2.3
July	6.0	8.7	3.3	5.3	4.3	2.7
August	13.0	11.3	6.3	8.3	8.7	7.0
September	16.0	13.7	9.0	7.3	6.7	6.7
October	18.7	7.0	6.3	6.7	5.3	6.7
Mean	11.7 [a]	9.4 [ab]	5.4 [b]	6.3 [b]	5.5 [b]	5.1 [b]
$F_{Cal.(0.05)}$	3.27					
$F_{Tab.(0.05)}$	2.62					
L.S.D. (0.05)	4.380					

Table (2): Mean % of infested bulbs for 2003-2005 under six different storage methods.

Storage method		Mean % infested bulbs		
		2003	2004	2005
Outdoor	On the soil	23.0	28.5	36.5
	On the soil covered with hay	17.5	21.5	31.5
	Sacked	19.0	10.0	12.0
Indoor	On the floor	17.5	13.0	17.0
	On shelves	12.0	13.5	15.5
	Sacked	14.5	11.0	12.5

3.2. Effect of frequent discarding of infested bulbs on infestation

Usually, onion growers and stock sellers practice discarding the bulbs infested with *E. amoenus* during the storage season. Such discarding is oftenly practiced once or twice during the storage period almost every2 months.The practicability of such practice and its effect on the percentage of infested bulbs and yield loss was investigated (Table3). For the three considered years, discarding infested bulbs twice throughout the storage season decreased the percentage of infested bulbs at the end of the storage season by 5.8-7.0 %, with a grand mean of 6.3 % compared to mean infestation percentages of 12.6-15.0 %, with a grand mean of 13.8 % when infested bulbs were not discarded .

Table (3) shows also that yield reduction ranged between 7.7-9.7 % , with a grand mean of 8.7 % in the case of discarding infested bulbs twice whereas non – discarding of the infested bulbs resulted in a yield loss of 11.2-17.0 % with a grand mean of 13.5 % . Results emphasize that the process of discarding infested bulbs once two months after the beginning of the storage season and again two months later decreases infestation percentage approximately from about 14 % to 6 % and yield loss from about 14%to 9%.In conclusion , it might be recommended to inspect stored onion bulbs as much as possible throughout the storage season and discard infested bulbs to help decreasing both % infested bulbs and yield loss .

3.3. Loss assessment

Table (4) shows the effect of % bulb infestation with *E. amoenus* on yield loss based on the annual grand means of infestation for the three successive onion storage years 2003-2005. Results confirm a highly significant positive correlation between % bulb infestation and yield loss (r = 0.994 – 0.999). The simple regression coefficient for such relationship ranged 0.63-0.77. In other words, an increase or decrease of 10 % in % bulb infestation alters % yield loss by approximately 6-8 %.

Table (3): Effect of discarding onion bulbs infested with *E. amoenus* on the mean percentage of infested bulbs and yield loss.

Year	% infested bulbs		% yield loss	
	Infested bulbs discarded	Infested bulbs undiscarded	Infested bulbs discarded	Infested bulbs undiscarded
2003	6.0	13.9	8.7	17.0
2004	7.0	12.6	9.7	11.2
2005	5.8	15.0	7.7	12.3
Grand mean	6.3	13.8	8.7	13.5

Table (4) : Effect of % bulb infestation on yield loss . (Grand means for the three successive years 2003-2005).

% infested bulbs	Months after storage		
	1 (early July)	3 (early September)	5 (early November)
10	5.9	6.8	4.5
20	10.9	13.0	14.6
30	17.2	21.3	21.6
40	21.3	29.5	30.6
50	28.3	36.6	37.3
60	34.3	42.5	42.9
70	39.2	49.5	52.2
80	48.5	56.7	59.9
90	54.9	64.6	66.3
100	62.5	72.1	76.5
r	0.994	0.999	0.997
$b_{y.x}$	0.63	0.72	0.77

r : Simple correlation coefficient. $b_{y.x}$: Simple regression coefficient.

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إصابة الأبصال المخزنة بذبابة البصل الكبيرة*Eumerus amoenus* Loew. (Diptera: Syrphidae)

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ملخص

تصاب نباتات البصل .*Allium cepa* L في مصر بنوعين من الذباب هما ذبابة البصل الكبيرة *Eumerus amoenus* وذبابة البصل الكبيرة المتشابهة *Eumerus vestitus* من عائلة Syrphidae ورتبة ذات الجناحين . والنوع الأول هو الأكثر شيوعاً وضرراً للأبصال خاصة في فترة التخزين التي تمتد من أوائل يونية حتى أوائل نوفمبر. وقد استهدفت الدراسة الحالية تقويم أثر ستة طرق مختلفة لتخزين الأبصال ثلاثة منها في العراء (بصل على الأرض مفرط، و بصل على الأرض مغطى بطبقة من القش، و بصل معبأ في أجولة من البلاستيك المثقب) و ثلاثة في المخزن (بصل على الأرض مفرط، و بصل علي رفوف، و بصل معبأ في أجولة من البلاستيك المثقب) علي الإصابة بذبابة البصل الكبيرة *Eumerus amoenus* خلال ثلاثة مواسم تخزين متتالية (2003-2005) بمحافظة أسيوط باستخدام الصنف "جيزة 6 محسن" . تناولت الدراسة أيضا أثر فرز الأبصال أثناء فترة التخزين واستبعاد المصاب منها على نسبة الإصابة وكذلك الفقد في المحصول تحت كل طريقة من طرق التخزين المختبرة.

بينت النتائج أن حفظ الأبصال داخل المخزن يقلل من إصابتها بذبابة البصل عن حفظها في العراء ، وأن تعبئة الأبصال داخل أجولة من البلاستيك المثقب وتخزينها سواء في العراء أو في المخزن يقلل من الإصابة بالحشرة عنه في طرق التخزين المختبرة الأخرى. وأدى فرز الأبصال واستبعاد المصاب منها مرة كل شهرين بعد شهر من بداية فترة التخزين إلى خفض نسبة الإصابة بالذبابة بحوالى 6- 14 ٪. وأشارت التحاليل الإحصائية إلى وجود علاقة ارتباط وانحدار موجبة ومعنوية جدا بين النسبة المئوية للإصابة والفقد في وزن الأبصال أثناء فترة التخزين حيث يؤدى كل تغير قدره 10٪ في النسبة المئوية للإصابة إلي تغير الفقد في الوزن بمعدل 6– 8٪ .

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