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OBSERVATIONS ON AESTIVATION,DISPERSAL AND BREEDING SEASON OF THE GLASSY CLOVER SNAIL *Monacha cartusiana* MULLER AT SHARKIA GOVERNORATE

Mahrous, M.E.[1]; A.E. Basha[1]; Mervat H. Ibrahim[1]; Sh.A. Ismail[2] and M.H. Lokma[2]

[1] Plant Protection Dept., Fac. Agric., Zagazig Univ.

[2] Plant Protection Research Institute, Dokki , Giza.

ABSTRACT

Aestivation, dispersal and breeding season of the glassy clover snail *M.cartusiana* were studied in Egyptian clovers fields at Sharkia Governorate during the period from April 2001 to June 2002. It was found that, snails aestivate during summer months under plants grown in the irrigation canals. Sugarcane was the most preferable one followed by elephant grass, while bermuda grass was the least one in this respect. General means of aestivated snails in 50 x 50 cm. under the aforementioned plants were 207.57, 168.62 and 70.67 snails, respectively. In April, a relatively low numbers enter aestivation. These numbers were gradually increased to reach the maximum values during June or July depending on aestivation site. However, in September and October numbers of aestivated snails were sharply decreased. The majority of aestivated snails were seen with epiphragm during June, July and August. Moreover, in October, high numbers of epiphragms were observed on soil surface at or near aestivation sites.

In December all aestivated snails became active and moved from aestivation sites under bunches of elephant grass grown in irrigation canal to the adjacent clover field and few of them reached a distance of 15 m far from irrigation canal. As the distance increased numbers of recovered snails were obviously decreased. Starting from January numbers of counted snails were increased to reach the peak during March or April with values of 37.0 (52.7), 33.3 (26.1), 23.7 (16) and 17.6 (12.7) individuals in 50x50 cm. at 1.5, 5, 10 and 15 m far from irrigation canal, respectively. In May these figures were sharply decreased, while in June snails were not detected in the field. They were aggregated under bunches of elephant grass. All snails counted during November and December were found in adult stage, while most of those counted during January, February and March were found in juvenile stage.

The breeding season of *M.cartusiana* in Egyptian clover fields lasted three months starting from mid-November to mid-February. Numbers of clutches and eggs were changed during the breeding season according to time of sampling and distance from aestivation sites. More clutches were laid during November and December as compared to those in low numbers which laid during January and February. On the other hand, the highest numbers of egg clutches were deposited in the adjacent five meters near the aestivation sites, while at 10 and 15 m low numbers of egg clutches were laid. Clutch size tended to increase in the beginning of egg-laying period, but showed a noticeable decrease in its second half. It ranged between 8 to 41 eggs/clutch with grand mean of 22.31 eggs / clutch.

Keywords: Glassy clover snail, aestivation, dispersal, breeding season, Egyptian clover, clutch size and epiphragms.

INTRODUCTION

In recent years, terrestrial snails have increased greatly in economic importance in Egypt. They cause considerable damage to field and vegetable crops, fruit trees and ornamental plants. Among these pests, the glassy

clover snail *Monacha cartusiana* (Muller) is the most predominant species attacking the majority of economic crops especially Egyptian clover (Ismail, 1997; Mahrous *et al.*, 2002a and Shetaia, 2005).

Land snails aestivate during summer months where temperature and relative humidity are not suitable for their growth and development (Block, 1971; Patterson, 1973; Solem, 1985; Ali & Suleman, 1992; Chang & Emelen, 1993 and Mortada, 2002). Moreover, Mahrous *et al.* (2002b) determined aestivation sites of *M.cartusiana* in navel orange orchard at Sharkia Governorate. They showed that in the beginning of April a relatively low numbers entered aestivation, while the maximum numbers were detected during June or July. Thereafter, numbers remained stationary during August. However, in Septemper, numbers of aestivated snails gradually decreased, as temperature and relatively humidity were suitable for their activites.

Dispersal of terrestrial gastropods from aestivation sites to the adjacent crops was reported by many investigators (Baker, 1988,a,b; Baker & Vogelzang, 1988; Staikou *et al.*, 1988 and Staikou & Lazaridou Dimitriadou, 1990. On the other hand, the breeding season of *M.cartusiana* as determined by the presence of egg clutches in the field of Egyptian clover which was detected by many authors. For instances, it lasted 3 months from mid-November to mid-February (Ismail, 1997), snails laid their eggs during about three months started from the beginning of December to mid-February (Mahrous *et al.*, 2002b) and the breeding season started from the beginning of November to mid-March (Mortada, 2002). Therefore, the objectives of the present study are to throw light on aestivation, dispersal and oviposition of *M. cartusiana* inhabiting Egyptian clover fields at Sharkia Governorate.

MATERIAL AND METHODS

A- Study area and experimental design:

The experimental area was located in Mashtool El-kady village, Zagazig district, Sharkia Govemorate. Within this area, two adjacent Egyptian clover fields, each of about one feddan, were defined as experimental sites. In the north border of the two sites, there were walkway and small irrigation canal, while other borders were surrounded with Egyptian clover fields. In the first field, bunches of elephant grass *Pennisetum purpureum* L. and sugarcane, *Saccarrum officinarum* L. as well as bermuda grass, *Cynodon daclylon* L. were irrigulary grown on the inner belt of the irrigation canal, while in the second field, bunches of elephant grass were grown on the inner belt of the irrigation canal also. The two sites were infested with the glassy clover snail *M.cartusiana*. They were characterized by clay soil and rice was the previous crop. Generally, the first experimental site was selected to study aestivation, while the second one was chosen to study dispersal and oviposition.

Five strips, each of 1.5m wide and 20m length were designed parallel to the irrigation canal in each experimental site. The first strip was adjacent to the irrigation canal, while middle of second, third and fourth onces was at distance of 5, 10, 15m far from irrigation canal, respectively.

B- Aestivation, dispersal and oviposition of *M. cartusiana*:

Observations on aestivation of *M.cartusiana* were undertaken in the first experimental site.Five samples each of 50x50 cm were randomly chosen under bunches of elephant grass and sugarcane as well as plants of bermuda grass grown on the inner belt of the irrigation canal. Each sample was marked by placing red plastic tubes of 2 cm diameter in the borders of each quadrant. Numbers of aestivated snail in each quadrant were counted at monthly intervals during the period from April to November 2001. Moreover, percent of epiphragmed snails in each sample was detected also. Examination was undertaken in early morning before sunshine. Data concerning temperature and relative humidity during the period of study were obtained from metreological station of Abou-Kapper. The obtained data were subjected to statistical analysis using (F) test and general means were compared by Duncan's multiple range test. Moreover, correlation coefficient between percent of epiphragmed snails and each of temperature and relative humidity was also calculated.

Dispersal of *M. cartusiana* from aestivation places under bunches of elephant grass to inside the field was investigated during the period from November 2001 to June 2002 in the second experimental site. Five replicates each of 0.25m^2 were randomly examined under bunches of elephant grass where snails were aestivated and inside the field at the indicated distances of 1.5, 5, 10 and 15 m far from the irrigation canal. Sampling was carried out at monthly intervals in the early morning before sunshine. All juvenile and adult snails found on plants or on soil surface in the quadrate were counted and left in their initial places. Percent of juveniles and adults in the counted snails were also calculated.

The experiment of oviposition for *M. cartusiana* was conducted in the same experimental site also during the period from November 2001 to. February 2002. Five replicates of quadrate sample size 50x50 cm were randomly chosen under elephant grass and at distances of 1.5,5,10 and 15m far from irrigation canal. Number of clutches and number of eggs in each clutch were counted biweekly intervals and carefully returned back to their initial places. Mean ± S.E. was calculated for number of clutches and eggs as well as clutch size. Data were statistically analyzed using (F) test and the least significant differences were calculated at 5% level.

RESULTS AND DISCUSSION

A. Notes on aestivation of *Monacha cartusiana*:

Data in Table 1 illustrate numbers of aestivated snails and percent of epiphragmed onces in certain selected aestivation sites during the period from April to November 2001. It was found that in the highest numbers of aestivated snails were detected under sugarcane followed by elephant grass, whereas a relatively lower numbers were counted under bermuda grass. General mean of aestivated snails per 50 x 50cm. under the aforementioned plants were 207. 57, 168.62 and 70.67, respectively. In April a relatively low numbers of *M. cartusiana* entered aestivation under elephant

grass(75.7 snails), sugarcane (103.3 snails) and bermuda grass (29 snails). These values were gradually increased to reach the maximum values during June or July months depending on aestivation site. The maximum numbers of aestivated snails under elephant grass and bermuda grass were counted in June with 302.3 and 147.7 snails per 50x50 cm. , respectively. While, the respective figure under sugarcane was counted in July with 348.3 snails per sample. On the other hand in September and October numbers of aestivated snails were sharply decreased under elephantgrass, sugarcane and bermuda grass with values 133,7 (74.6), 125.7 (86) and 37.7(14) snails per 50x50 cm, respectively. Whereas, in November low numbers were counted under sugancane (21), while none aestivated snails were observed under elephant grass and bermuda grass. It is worthy to mention here that, general mean of aestivated snails under the three plants was insignificantly different during summer months (June,- July and August) with values of 267.56, 264.10 and 259.67 snails per sample , respectively.

Most stylommatophoran snails are able to aestivate over periods of unfavourable conditions, with the animal retracted into the shell and the shell aperture sealed with one or more epiphragms (Riddle, 1983). Therefore, percent of epiphragmed snails within aestivated onces were calculated during the study months. It was found that none epiphragmed snails were detected in April. However, in May percent of epiphragmed onces under elephant grass, sugarcane and bermuda grass were 56.6, 35.1 and 84.8%, respectively. These values were markedly increased to reach 94.5, 97.8 and 89.5% in June and remained high during July, August and September. However, in October percent of epiphragmed snails were decreased to 32.9, 78.0 and 80%, respectively. Moreover, it was found that, in October, high numbers of epiphragms were observed on soil surface at or near aestivation sites.

Correlation coefficient between percent of epiphragmed snails and temperature was highly significant under elephant grass (r=0.909), sugarcane (r= 0. 939) and bermuda grass (r=0.934).However , no significant correlation was found between the same parameter and relative humidity under elephant grass (r=-0.184), sugarcane (r=- 0.305) and bermuda grass (r = - 0.350).

The obtained results are in harmony with these reported by Farag and El-Sherief (1990), El-Masry (1997), Ismail (1997), Mahrous *et al.*, (2002b) and Mortada (2002). They reported that land snails aestivate during summer months where temperature and relative humidity are not suitable for their growth and development. On the other hand, our results are in conflect with findings of Kassab & Daoud (1964). Since they showed that from the end of November to the end of February the openings of snails shell remain close with a white liquid secreted from the mantle, this liquid forms a mucus sheet, which soon hardens to the epiphragm.

Table 1: Number of aestivated snails of *M. cartusiana* per 50 x 50cm and percent of epiphragmed onces in certain aestivation sites during the period from April to November 2001.

Aestivation sites	Variables	Sampling time								General mean
		Apr.	May	Jun.	Jul.	Agu.	Sep.	Oct.	Nov.	
Elephant grass	1	75.66	175.33	302.33	298.66	288.66	133.66	74	0	169.70 b
	2	0%	56.57%	94.46%	94.92%	95.09%	91.53%	82.86%	0%	64.44 %A
Sugar -cane	1	103.33	278.33	352.66	348.33	345.33	125.66	86	21	207.58 a
	2	0%	35.08%	97.79%	98.18%	98.78%	94.49%	77.95%	13.8%	64.51% A
Bremuda grass	1	29	46.66	147.66	145.33	145	37.66	14	0	70.66 c
	2	0%	84.75%	89.52%	93.52%	94.58%	95.93%	80%	0%	67.37% A
General mean	1	69.33C	166.77b	267.55a	264.11a	259.66a	99c	58cd	10.11d	
	2	0%D	58.88%C	93.92%A	95.54%A	96.15%A	93.98%A	80.27%B	4.6%D	

1- Number of aestivated snail per 50 x 50 cm^2 2- Percent of epiphragmed snails.

* General means for number of aestivated snails with the same lowercase letter (s) indicate no significant differences. according to Duncan's multiple range test at 0.05%

** General means for percent of epiphragmed snails with the same uppercase letter(s) indicate on significant differences according to Duncan's multiple rang test at 0.05%

B- Dispersal of *M. cartusiana* from aestivation sites to adjacent clover field.

Data in Fig.1 showed that in November 2001, numbers of active snails were relatively higher at site of aestivation (5 individuals per 0.25 m^2). However, as the distance from aestivation sites increased numbers of recovered snails were obviously decreased. Since numbers at distances of 1.5, 5,10 and 15m were 4.5, 3, 1 and 0.2 individuals per sample, respectively. On the other hand, in December none of active snails were detected at aestivation sites. It means that all aestivated snails moved from aestivation sites to the adjacent field and reached a distance of 15 m far from aestivation sites . However, starting from January, numbers of counted snails were obviously increased, at all distances to reach the maximum values during March and April months with values of 37.0 (52.7), 33.3 (26.1), 23.7 (16) and 17.6 (12.7)snails/ per sample at 1.5, 5. 10 and 15m, respectively. In May, these values were markedly decrease at all distances, whereas, in June snails were not detected in the field. They were aggregated at aestivation sites under bunches of elephant grass, with mean value of 85.2 snails per sample. It is necessary to mention here that all snails counted during November and December were found in adult stage. It means that juveniles were not detected during this period. On the other hand, during January, February and March months most of the counted snails were found in juvenile stage. Since, percent of juvenile snails in the total counted onces during these months were 86.0, 95.7 and 92.4% respectively. However, in April percent of adult snails started to increased and reached 84.2% during June.

Our results are in agreement to certain extent with many author, who studied dispersal of terrestrial snails.For instances, Baker (1988a,b) indicated that *Theba pisana* and *Cernuella.virgata* may invade the edges of crops from adjacent habitats in which numbers were high. Snails moved out of a well-grazed permanent pasture to adjacent weedy roadside vegetation in early summer. They returned to the pasture in autumn. Moreover, Baker and Hawke. (1991) assured that *Cochlicella acuta* snails were most abundant in spring and summer seasons especially near the edges of the fields. Finally, Ali & Suleman (1992) indicated that maximum population densities of *M. obstructa* immatures were observed during late spring (April- early May), and it was followed by peak density of adults in October to November.

C- Breeding season of *M.cartusiana* under field conditions:

The breeding season of *M.cartusiana* was determined by the presence of egg clutches in the Egyptian clover field. Data in Table 2 showed that *M.cartusiana* laid its eggs during three months started from mid- November, 2001 to mid- February 2002. Eggs were not detected before or after this period. Snails deposited their egg clutches in humid shady places in small holes dug by the parent snail in the soil. In some cases egg clutches were found under stones or dead vegetations. Numbers of clutches and eggs per 50 x 50 cm were changed during the breeding season according to distance from aestivation sites and time of sampling.

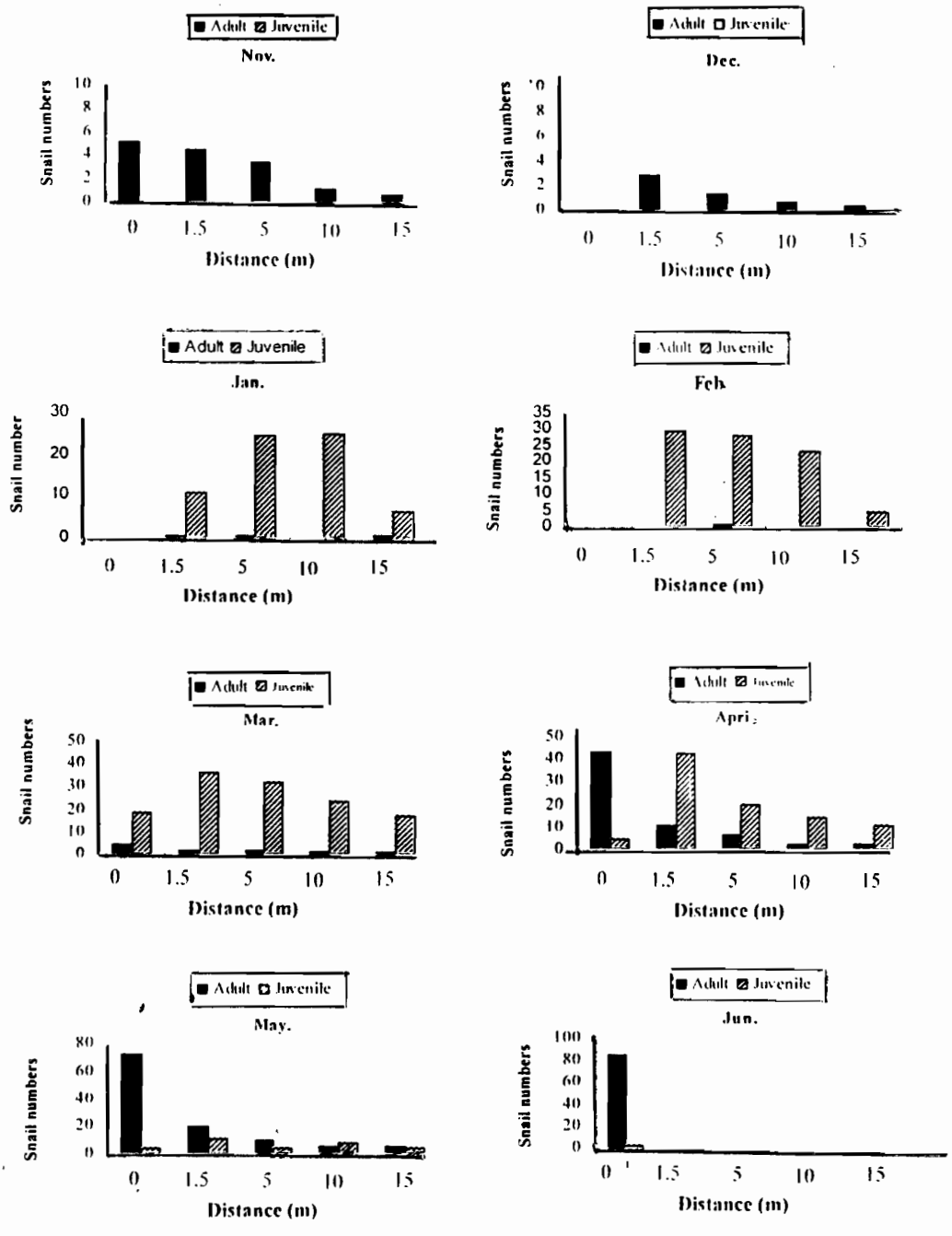

Fig. (1) Numbers of juveniles and adults of *M.cartusiana* in 50 x 50 cm. at different distances from aestivation sites in Egyptian clover field during the period from November 2001 to June 2002.

Table 2: Numbers of clutches and eggs in 50 x 50 cm and clutch size of *M. cartusiana* in Egyptian clover field at different distances from aestivation sites during the period from November 2001 to February 2002.

Varaibles	Distances between samples and aestivation site (m)	Sampling time							General mean ± S.E	L.S.D$_{0.05}$
		15 Nov.	30 Nov.	15 Dec.	30 Dec.	15 Jan.	30 Jan.	15 Feb.		
Eggs	1.5	17.8	49.5	65.5	144	19.2	0	11	43.85±19.66	26.51
	5	181.4	92.5	130.9	30.2	29.4	3	4.4	67.4±30.22	
	10	30.8	73.4	72.3	45.8	12.4	17	6	36.81±16.50	
	15	15.8	29.6	47	34	8.6	11.6	0	20.94±9.39	
	General mean	61.45	61.25	78.92	63.5	17.4	7.9	5.35		
Clutches	1.5	0.6	2.8	3.2	6.4	1.2	0	0.8	2.14±0.95	1.004
	5	6	3.4	3.8	1.8	1.2	0.4	0.4	2.42±1.08	
	10	0.8	2.6	2.4	1.8	1	1	0.4	1.42±0.63	
	15	0.4	0.8	1.4	1	0.4	0.6	0	0.65±0.29	
	General mean	1.95	2.40	2.70	2.75	0.95	0.5	0.4		
Clutch size	1.5	29.66	17.67	20.46	22.50	16	0	13.75	17.14±7.68	6.30
	5	30.23	27.20	34.44	16.77	24.5	7.5	11	21.66±9.71	
	10	39.5	28.23	30.12	27.11	12.4	17	15	24.05±10.78	
	15	3.5	37	33.57	34	21.5	19.33	0	26.41 ±11.83	
	General mean	34.47	27.52	29.64	25.09	18.6	10.95	9.93		

General mean of clutches and eggs, at biweekly intervals, was gradually increased to reach its peak during December with values of 2.70 & 2.75 clutches and 78.92 & 63.5 eggs per 0.25m^2 respectively. Thereafter, number of clutches and eggs were sharply decreased to reach relatively lower values at the end of the breeding season, in mid – February with 0.4 clutches and 5.35 eggs. Generally, it could be concluded that the majority of egg clutches were laid during November and December months as compared to lower values during January and February.

Considering general mean of distances far from aestivation sites, it was found that the highest values of clutches and eggs were laid at distance of 5m (2.42 clutches and 67.4 eggs per sample), followed by 1.5m (2.14 clutches and 43.85 eggs). However, as the distance increased to 10 and 15m, numbers of clutches and eggs were significantly decreased to 1.42 (36.81) and 0.65 (20.94) respectively. Generally, the highest numbers of egg clutches were laid in the adjacent 5m near aestivation sites. However, at 10 and 15m a relatively lower number of egg clutches were laid.

The obtained results are confirmed with those reported by many authors who determined the breeding season of *M.cartusiana* under field conditions in Egypt (Ismail, 1997; Mahrous *et al.*, 2002b and Mortada, 2002) Moreover, in Greece Staikou and Lazaridou – Dimitriadou (1990) showed that the reproductive period of *M. cartusiana* started between August and November depending on the year. Also, in Pakistan Ali & Suleman (1992) revealed that spring season recorded higher breeding period, followed by autumn season. Clutches had been observed in winter while no oviposition occurred in summer months.

Clutch size (number of eggs per clutch) during the oviposition period of *M. cartusiana* ranged between 8 to 41 with grand mean of 22.31 eggs/clutch. On the other hand, clutch size was relatively higher in the beginning of egg laying period, but showed a noticeable decrease in its second half. Since, general mean of clutch size in mid- November was 34.47 eggs/clutch, whereas it was 29.65 eggs/clutch in mid- December. However, in the second half it was gradually decreased to reach 13.27 eggs/clutch in the end of the breeding season (mid- February). On the other hand, it was found that, as the distance from aestivation site increased, clutch size was obviously increased also. General mean of clutch size was 17.14, 21.66, 24.05 and 26.41 eggs/clutch at 1.5,5,10 and 15m, respectively.

In Egypt, many authors determined clutch size of *M. cartusiana* in clover field. General mean of clutch size was 22.5 eggs/clutch with range of 5 to 57 eggs/clutch (Ismail, 1997), 26.12 eggs/clutch with range of 6 to 51 eggs/ clutch (Mahrous *et al.* 2002b) and 22 ± 0.53 eggs/clutch (Mortada 2002).

Regarding changes in clutch size during the oviposition period, our results agree to certain extent with those reported by (Mortada 2002). He showed that, clutch size was significantly changes during the breeding season. In the beginning of November, clutch size was 16.1 eggs/clutch. This value was increased to reach the peak (29.5 eggs/clutch)in mid – December. Thereafter, clutch size was gradually decreased to 14.49 eggs/clutch in the end of egg – laying period. Generally, inconstant results concerning changes in clutch size during the breeding season may be attributed to the prevailing

of certain ecological factors such as temperature, relative humidity and soil type or may be due to genetic variations between populations of the same species.

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ملاحظات علي البيات الصيفي والإنتشار وموسم التزاوج لقوقع البرسيم الزجاجي فى محافظة الشرقية

مصطفى النبوي محروس[١] ، عبد العزيز النشرتي باشا[١] ، مرفت حسن إبراهيم[١]، شحاته أحمد على إسماعيل[٢]و محمد حسن عصام لقمه[٢]

[١]- قسم وقاية النباتات – كلية الزراعة – جامعة الزقازيق

[٢]- معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقى – جيزة

تم دراسة البيات الصيفي والإنتشار وموسم التزاوج لقوقع البرسيم الزجاجي في حقول البرسيم بمحافظة الشرقية خلال الفترة من إبريل ٢٠٠١ إلى يونيه ٢٠٠٢، وقد وجد أن لهذا القوقع بيات صيفي خلال أشهر الصيف أسفل النباتات المنزرعة علي قنوات الري وكان قصب السكر أكثرهم تفضيلا يليه علف الفيل بينما كان النجيل أقلهم تفضيلا وكان المتوسط العام لأعداد القواقع في مساحة ٥٠ X٥٠ سم تحت النباتات السابقة هو ٢٠٧,٥٧، ١٦٨,٦٢، ٧٠,٦٧ قوقعاً على الترتيب.

تدخل إعداد قليلة البيات الصيفي في شهر إبريل ثم تزداد تدريجيا حتى تصل ذروتها خلال شهري يونيو ويوليو ويتوقف ذلك علي مكان البيات ثم تقل تدريجيا خلال شهري سبتمبر وأكتوبر، وقد لوحظت الغالبية العظمى من القواقع مكونة لأفراز صلب تغلق به فتحة الصدفة خلال يونيو ويوليو وأغسطس، وظهر بكثافة علي سطح التربة في أماكن البيات أو قريبا منها خلال شهر أكتوبر أما في شهر ديسمبر فقد خرجت جميع القواقع من البيات الصيفي تحت حزم علف الفيل المنزرع علي قناة الري وانتقلت إلي حقل البرسيم المجاور لها، ووصلت أعداد قليلة منها إلي مسافة ١٥ مترا بعيداً عن قناة الري.

وابتدأ من شهر يناير تزداد أعداد القواقع تدريجيا في الحقل حتى تصل إلى الذروة خلال شهري مارس وابريل حيث بلغت الأعداد ٣٧,٠ (٥٢,٧)، ٣٣,٣(٢٦,١) ، ٢٣,٧ (١٦) و ١٧,٦ (١٢,٧) قوقعاً في مساحة ٥٠ X ٥٠ سم عند مسافات ١,٥، ٥، ١٠ و ١٥ متراً من قناة الري على الترتيب ثم تقل هذه الأعداد في شهر مايو بينما لم تتواجد القواقع في الحقل في شهر يونيه ولكن وجدت متجمعة تحت حزم علف الفيل. وكانت جميع القواقع التي تم عدها في شهري نوفمبر وديسمبر في طور البلوغ بينما وجد أن معظم الأفراد التي تم عدها في أشهر يناير وفبراير ومارس لم تصل بعد إلي مرحلة البلوغ.

استمر موسم التزاوج لقوقع البرسيم الزجاجي لمدة ثلاثة أشهر ابتدأ من منتصف نوفمبر حتى منتصف فبراير وقد تغيرت أعداد كل من الكتل والبيض بصورة معنوية خلال موسم التزاوج. وقد وضعت معظم الكتل في شهري نوفمبر وديسمبر بالمقارنة خلال شهري يناير وفبراير . ومن ناحية أخري وضعت أعداد كبيرة من الكتل في الخمسة الأمتار المجاورة لقناة الري في حين انخفض عدد الكتل علي مسافة ١٠ و ١٥ متراً من قناة الري. وقد إزداد حجم الكتلة تدريجيا في بداية فترة وضع البيض بينما لوحظ انخفاض تدريجي في النصف الثاني من فترة وضع البيض وتراوح حجم الكتلة ما بين ٨ إلي ٤١ بيضة/ للكتلة مع متوسط عام ٢٢,٣١ بيضة / للكتلة.