Mass Production and release of trichogramma spp to control pectiophoragosspiella-saunders and earias in sulana

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Laboratory studies were conducted to determine the Influence of temperature on some biological aspects and production of Trichogramma evanescens, T embryophagum T. brassicae and Trichogrammatoidea bactrae when reared on eggs of P. gossypiella. Studies were also carried out to determine the effects of some insecticides recommended for controlling the pink and spiny bollworms on different biological aspects and life-table of each of the 4 trichogrammatid species. The 4 parasitoid species were mass produced on eggs of Sitotroga cerealella and the parasitized eggs were released in cotton fields during 2000 and 2001 seasons at Moshtohor (Qalubyia governorate) and El-Ebrahimyia (Sharkyia Governorate) to find out the efficacy of these parasitoid species in controlling the pink & spiny bollworms in cotton fields. The obtained data may be summarized as follows:I- Influence of temperature on the production of Trichogramma:1. Development period:The mean total developmental period (from sting to 50% of adults' emergence) was negatively correlated to temperature for the four trichogrammatid species The duration period differed significantly according to the rearing temperature and the parasitoid species. The longest developmental period was obtained at 15°C, while the shortest was at 30°C. When the281rearing temperature was 15°C, duration times for T. evanescens (34.33 days), T bactrae (34.0 days) and T. brassicae (33.68 days) varied insignificantly, while significant differences were obtained between these values and that of T embryophagum (35.83 days). The developmental rates for the 4 species at 15°C were, 2.91, 2.94, 2.97 and 2.79%/ day, respectively. As the rearing temperature was increased to 20°C, development became faster and the developmental rates were estimated by 6.35, 6.67, 7.02 and 6.82%/ days, for T evanescens, T. bactrae, T. embryophagum, and T. brassicae, respectively. That was a normal result due to the shortening in the developmental period, which reached 15.75, 15.00, 14.25 and 14.67 days, respectively. More increasing in the developmental rate was achieved at 25°C, as it averaged 11.53%/ day for T. bactrae and 10%/day for the other three parasitoid species. The increase of rearing temperature to 30°C resulted in shortest duration time, as it decreased significantly to 8 days for T embryophagum & T. brassicae and 7.25, 7.33 days for T. evanescens and T. bactrae, respectively. Thus, the fastest development was obtained by rearing at 30°C as the developmental rate was 12.5%/ day for the former two species and 13.79& 13.64%/ day for the latter two species, respectively.2- Lower threshold, upper threshold and thermal requirements:from the relation between the rate of development (dependent variable) and temperature (independent variable), the lower thresholds of development (LTRS) of T. evanescens, T.282bactrae, T embryophagum and T brassicae were estimated as 11.11, 10.75, 9.92 and 9.80 °C, respectively. The degree-days Celsius (DDC) were estimated by 137.78, 135.32, 155.71 and 157.36 degree-days, respectively. On the other hand, the relation between development period (dependent variable) and temperature (independent variable), provided an upper temperature threshold (UTRS) of 32.12, 31.91, 32.2 and 32.65°C for the aforementioned parasitoid species, respectively. Statistically, no significant difference was found between the three former species but they differed significantly than the last one.3-Survivorship:No adverse effect on parasitoid survivorship occurred on all the tested species when reared at 20 or 25°C. Adults' emergence

ranged between 93.07-96.36% at 20°C and 94.8-96.21% at 25°C, but survivorship tended to be lower when reared at 15 or 30°C (except for T embryophagum which showed 97.2% emergence when reared at 30°C).4-Females' longevity:Longevity of Trichogramma females differed significantly according to the rearing species and temperature. Regardless of the rearing temperature, females' longevity of the four parasitoid species differed significantly and could be arranged descendingly according to their mean longevities as: T evanescens (8.01 days)>T. brassicae (6.62 days) > T bactrae (5.65 days) > T embryophagum (3.98 days). Longevity of T evanescens, T283bactrae and T brassicae female is negatively correlated with temperature; correlation values were —0.997, -0.9518 and —0.9342, respectively. where as T. embryophagum, adults were more sensitive to low as well as to high temperature, since most of females died after one day of emergence when reared at 15°C or 30°C. The longevity of T embryophagum females averaged 1.05 and 1.08 days when reared at 15°C and 30°Ccompared with 13.92, 10.42 & 8.41 and 1.88, 2.32 & 2.86 days for the other three species, respectively.5-Effect on fecundity:The average number of progeny per female differed significantly according to the rearing temperature. Moreover, there were significant differences between fecundity of the 4 parasitoid species when reared at the same temperature. Regarding the rearing temperature, all parasitoids produced significantly the lowest progeny/ female (mean= 43.001 8.54 individual/ female) when they were reared at 15°C, as the averages were 46.8, 43.33, 37.00 and 43.00 individuals/ T. evanescens, T. bactrae, T embryophagum and T brassicae female, respectively. On the contrary, all parasitoids produced significantly the greatest progeny (72.07 ± 14.74 individuals/female) when reared at 25°C; the recorded progenies were 77.83, 60.75, 88.38 and 61.33 individuals / female, respectively. While, moderate numbers of progeny/ female (mean of four species = 59.43 individuals/ female & the obtained averages were 56.71, 54.54, 69.13 and 57.33 individuals/ female, respectively) were produced when rearing took place at 20 °C.284On the other hand, lower averages of progenies were also produced when wasps were reared at 30°C; general mean = 46.78 & the averages = 40.04, 54.04, 53.33 and 39.71 individuals/female, respectively.6- Sex ratio:Regardless of temperature or species, female progeny always dominated that of male. Higher percentages of females in progeny were obtained when parasitoids were reared at temperature up to 25°C, while the lower percentages were produced at 30°C.. Percentage of females in T evanescens progeny varied insignificantly when reared at 15, 20 and 25°C, those were 60.47, 57.50 and 59.50%, respectively. While an obvious reduction occurred (51.41%) when rearing took place at 30°C. As for T bactrae progeny, the highest percentage of females (67.75%) was produced at 25°C, while lower percentages were produced at the lower (15°C) and the higher (30°C) rearing temperatures (54.16 and 54.71%, respectively). At 20°C, moderate percentage of females was obtained in T bactrae progeny. On the other hand, the percentage of females in T embryophagum progeny averaged 62.10, 61.00, 59.20 and 57.75% when reared at the four temperatures, respectively. In case of T. brassicae, rearing at 20 and 25°C led to obtain, approximately, the same percentages of females in progeny (66.78 and 67.59% respectively). However, production of females in progeny decreased to 61.02, 54.50% when rearing temperature was changed to 15 or 30°C, respectively.2857- Life table parameters:The life table parameters including the net reproductive rate (110), life cycle, the intrinsic (`m) and finite (exp. I'm) rates of increase and population doubling time [(1n2)rm] were also studied under the studied degrees of temperature, results showed that 25°C is the most favorable temperature for breeding the four species of Trichogramma: At this temperature, the highest values of net reproductive rates were obtained. At this temperature, it was observed that T. bactrae had good qualities, including high intrinsic rate of natural increase NI = 0.3726), a high finite rate of increase (exp. rm = 1.451) and the shortest population doubling time (1.860 days) although it had the least net reproductive rate (36.144 females). Thus this parasitoid is expected to be effective for use in biological control of pink bollworm.II-Effects of some insecticides recommended for controlling bollworms on four trichogrammatids:Laboratory study was conducted to estimate the difference in sensitivities of the various immature stages of four trichogrammatids to insecticides for designing a program including the best time to release the parasitoids and application of insecticides. The insecticides tested were Karate, Kendo, Danitol, Sumi-gold, Larvin and Curacron. The treated trichogrammatids were T bactrae, T. evanescens, T. embryophagum and T brassicae, and the concerned immature stages at

the time of treatment were eggs, larvae, prepupae,’1 I286freshly formed pupae and mature pupae (3 hours & 1, 3, 5 and 7-days from stinging).1. Effects on emergence of treated Parasitoids:Regardless of the treated stage, there were insignificant differences between the four species when treated with water, as the percentages of emergence in control ranged between 94.50-95.92%. While, data revealed that the susceptibility of the parasitoids to the insecticidal effect varied, significantly, according to the wasp species and the tested compound. For example, 7’. embryophagum was significantly more tolerant to the adverse effect of Karate, Larvin and Danitol. However, T. bactrae was more tolerant to Curacron (the most toxic insecticide), T evanescens was more tolerant to Kendo and T brassicae was more tolerant to Sumi-gold. Regardless of parasitoid stage or the tested compound, the 4 parasitoid species could be divided into two groups based on the percentage of adult emergence after treatment. The first group included T embryophagum and T. bactrae, which were more tolerant to the insecticidal effect and had the same average of adult emergence (55.9%). The second group included T evanescens and T brassicae which were less tolerant to the insecticidal effect and varied insignificantly in the overall mean percentage of emergence due to treatments (51.12 and 53.05%,respectively).As overall results, the order of toxicity of the tested compounds may be arranged descendingly as follows: Curacron (Profenofos, 22.90% emergence)> Karate (Lambda-cyhalothrin,28732.66%)> Danitol (Fenpropathrin, 42.64%)> Kendo (53.30%)> Sumi-gold (Esfenvalerate, 56.79%)> Larvin (Thiodicarb, 74.33%). The overall, percentages of adults’ emergence averaged 64.40, 59.80, 57.14, 46.34 and 42.21% after treatment at the egg, larva, prepupa, freshly formed pupa and mature pupal stage, respectively. Generally, the effect of the aforementioned insecticides appeared to be positively related to progressing of development at the time of treatment.2. Effects on the vitality of emerged females:The emerged parasitoid females, which succeeded to complete their development after treatment at different ages with Curacron, Kendo and Larvin, were examined to determine their vitality and efficiencies in parasitizing new pink bollworm eggs.a- Fecundity of the emerged females:Regardless of the parasitoid stage at the time of treatment or the tested insecticide, insignificant differences were observed between treated parasitoid species as their fecundity were 38.95, 38.08, 32.95 and 28.77 progeny/ female for T. bactrae, T brassicae, T. evanescens and T embryophagum, respectively. T embryophagum may be considered more susceptible than the remaining 3 species to the insecticidal effects. Generally, overall means showed that treatment of P. gossypiella eggs parasitized by Trichogramma, led to females of higher fecundity (39.17, 34.98 and 34.65 progeny/ female for egg, prepupae and first instar larvae treated stages, respectively. Fecundity decreased gradually by treatment during the fresh pupa or older pupa288(33.96 and 31.63 progeny/ female, respectively. This could be attributed to the adverse effect of these insecticides on the oocytes differentiation at these stages (Narayana and Babu (1992).b- Longevity of emerged females:from the whole mean longevity data of four trichogrammatid adult females treated as immature stages with the three aforementioned insecticides. It could be noted that emerged females from all treatments lived significantly, shorter periods than control. Females treated as immature stages with Curacron and Larvin lived statistically the shorter time (0.15 and 1.31 days) which differed significantly, than Kendo (3.27 days). In addition, female’s longevity varied insignificantly either between the four parasitoid species (2.25-2.74 days) or between the treated ages (2.16-2.75 days).3. Effects on progeny produced by treated parents: a. Progeny emergence:Data revealed high percentages of progeny emerged in all treatments. Mean percentages of emerged progeny varied insignificantly between the four parasitoids, the five stages and the tested compounds. For unknown reason, the percentage of emergence increased in some treatments than control. For example, it was significantly increased to 97.91% when T embryophagum females were treated as immature stages with Larvin opposed to 95.12% in control and to 98.8%289when T. brassicae was treated with Curacron opposed to 94.70% in control. Furthermore, these percentages increased significantly to 97.06% opposed to 95.72% in control after treatment the four species during egg stage with Curacron. On the contrary, these percentages decreased significantly to 86.2 and 90.04% when treatment was done during larval stage with Curacron and Larvin opposite to 95.58% in control.h. Females’ percentage in produced progeny (Sex-ratio):The whole mean of the sex-ratio among the emerged progeny of the four parasitoid species treated as immature stages with the three aforementioned insecticides,

showed that Curacron was the most harmful compound (21.33%) and Larvin was, approximately, harmless (51.67%), while Kendo had intermediate effect (38.35%). Regardless of the parasitoid species or the insecticide tested, the latent effect of these insecticides on the sex-ratio appeared to be related to the parasitoid stage at the time of treatment. Pupal stage, (freshly formed or mature pupa) was more susceptible to the insecticidal effect than the other stages, as the mean percentage of females in progeny averaged 33.23 and 35.40%, respectively. While, these percentages were 53.09, 47.64 and 46.11% when treatment was done during egg stage, first instarlarvae and prepupae.r01.1290*Life tables for the parasitoids after exposure to insecticides:No observations were recorded at many treatments as a result to the following:i)Mortality of all parasitoids inside the host eggs (treatment of T embryophagum as prepupae or freshly formed pupae).ii)Mortality of all parasitoids immediately after emergence (treatments of T evanescens as prepupae & mature pupae; T. embryophagum as first instar larva, and T brassicae as first instar larvae, prepupae, freshly formed pupae & mature pupae).iii)Females, laid unfertilized eggs inside the host eggs (treatments of T. evanescens and T. bactrae during pupal stage) and consequently these eggs hatched to males (these parasitoids are parthenogenetically arrhenotoukous).Therefore, complete life table data and age specific fecundity figures could not be illustrated in cases ofi)Treatments of T. evanescens as first instar larva or prepupa; T bactrae as first instar larva or pupa; T. embryophagum during all immature stages and T brassicae at any stage after hatching with the organophosphorus compound Curacron.ii)Treatments of T. embryophagum as first instar larvae or prepupae and T brassicae as immature pupae with the carbamate compound Larvin.291Generation time, the net reproductive rate (R0), the intrinsic rate (`m), the finite rate (exp. rin) of increase and population doubling time [(In2)/ IA were determined also for the parasitoid speciesunder study when exposed to the tested recommended insecticides.The obtained data indicated that, the organophosphorus compound Curacron was harmful followed by the carbamate compound Larvin, while the pyrethroid compound Kendo was the least harmful to the four parasitoid species. Kendo demonstrated quite good insecticide and could introduce with parasitoids in management program to control pink bollworm in cotton fields. Larvin that had the lowest effect on the survivorship of the immature stages within the pink bollworm eggs could notably reduced the fecundity of the adult parasitoids emerged. It is recommended to avoid using Curacron in any control program including releasing of the four parasitoids. On the other hand, field application of Kendo in the suitable time is important to protect the released parasitoids. However, if Larvin is used in management program, it should be used only as acontrol agent regardless of its adverse effect on the following parasitoid generation.III- Applied control of pink and spiny bollworms in cotton fields by releasing Trichogramma:2921. Releasing T. bactrae for control of pink and spinybollworms in Qalubyia Governorate (2000 & 2001 -cotton seasons).T. bactrae was released on July, 4th, 2000 and July 17th, 2001 at a rate of 80000- 90000 parasitoid/ feddan. The efficacy of this parasitoid in suppressing infestation varied between the two seasons. The overall mean seasonal infestation percentage by both P. gossypiella and E. insulana altogether in T bactrae releasing treatment averaged 15.2 and 10.88% opposed to 35.83% and 31.63% in control in 2000& 2001 season, respectively. This difference may due to the differences in developmental rate of pink bollworm population at the releasing time in the two seasons. In case of P. gossypiella, the seasonal mean infestation percentages with this pest reached 18.98 & 16.0% in control, while those were 11.75 & 7.75% in treatment throughout the two cotton seasons, respectively. Accordingly, the release of parasitoid caused more effective reduction in pink bollworm population at the second season (59.38%) compared with the first one (38.09%). As for the spiny bollworm, the seasonal mean infestation percentages at the two seasons was found to be kept approximately at the same level and accordingly the same reduction percentages (79.51 & 79.97%) occurred. Also, reducing the period between T bactrae applications from 15 days in the first season to 10 days during the second one enhanced the efficacy of this parasitoid in suppressing infestation during the second season.2932.Efficiency of late season releasing of four trichogrammatid species in suppressing infestation with P. gossypiella infesting cotton fields in Sharkyia Governorate:The four trichogrammatid species T bactrae, T evanescens, T embryophagum and T brassicae were released on August26th, 2000 and August27th, 2001 at a rate of 150000- 160000 parasitoid/

feddan, 7 days after the last insecticidal spray against bollworms, aiming to suppress pink bollworm infestation to cotton bolls which grow late in the season.According to the obtained results on the four parasitoid species, seasons those species could be arranged descendingly according to their effectiveness in suppressing P. gossypiella infestation in both seasons as: T embiyophagum> T evanescens > T brassicae > T bactrae.Comparing the results of using T. bactrae as a biocontrol agent against pink bollworm at the beginning of the season (Qalubyia experiments) with those when used late in the season (Sharkyia experiments), it could be noted that the efficacy of this parasitoid was much higher in the later than in the former one. This conclusion may be due to the higher population density of the target pest in the field at the time of releasing T bactrae compared with the first one.Regardless of the parasitoid or bollworm species, it could be, generally, concluded that Trichogramma wasps are effective in controlling bollworms either when used at the beginning or294the end of the season. Thus, Trichogramma releases could be used safely in IPM programs for bollworms control.B. Loss assessment in crop yield:The losses in cotton yield were estimated during 2001 cotton season using the total number of full opened bolls or the total number of healthy locks. The percentages of losses were estimated by 44.82 and 12.3% in control and T. bactrae release areas, respectively.