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Densities of the red flour beetle *Tribolium castaneum* (Coleoptera: Tenebrionidae) in the presence of the salticid spider *Plexippus paykulli* (Araneae: Salticidae)

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Abstract

Despite the many field applications that have been conducted for controlling pests of stored products; using biological control agents, the matter has not reached a sufficient extent to introduce these techniques into Integrated Pest Management (IPM). This laboratory study came as an initial measurement of the possibility of benefiting from spiders in combating the red flour beetle *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae); The prey was chosen Based on its exploitable behavior that facilitates predation on stored materials, results under long-term laboratory conditions - 35 °C and the relative humidity on 75 RH. were successful in reducing pest density; recording 86.3% reduction percentages of the red flour beetle larvae and 77.7% for the adult stages; the salticid spider *Plexippus paykulli* (Audouin) (Araneae: Salticidae) does not attack the adult individuals; was not recorded in current study; however, the reduction rates were a direct outcome of the fluctuations in the number of larvae when the predator was present.

Introduction

1. Applying biological control agents of stored product insects:

During the last century the biological control methods of the stored product insects had been studied within a lot of laboratories over thirty years (Franz and Krieg, 1972) that have been supporting the roles of the integrated pest management (IPM) to reduce the impacts of chemical' applications of insecticides. About 40 years later during the current century (Schöller, 2010) proved, the biological control methods have not yet been properly exploited to curb warehouse insects that infect stored products. This is due to application methods that do not meet the required standards at the appropriate times and conditions. Some reports mentioned that it is possible to control the use of predators in open warehouses; techniques are approved in many countries. Moreover; some of techniques is hard and costs (using of gases, or the use of special temperature degrees) it is not suitable for developing countries special for small farmers according to their economic causes (Niedermayer and Steidle, 2013), During this time, the European Science Cooperation Commission (European Cooperation in Science and Technology) Recommended the possibility of using biological control and its future; using (predatory mites, parasitic wasps and fungi); predators can reach places of insects and larvae easily without using disinfectants and chemicals. In addition, they can be used in the preventative preparing of bulk commodities, in particular grain, as like using parasitic wasps and predatory mites. On the other hand, egg-parasitoids applied of *Trichogramma* spp. have been produced for protection of packaged products which recorded highly reduction of some stored product insects densities (Schöller and Prozell, 2006). Moreover using of the predatory insects, warehouse pirate bug *Xylocoris flavipes* considered one of the most predatory insects; its roles has been confirmed by Lattin (2000) who proved that it can fed on any small arthropods; probably it is the most species that had been subjected to many studies (biological, economic, ethological and ecological); Uses of this important species has been proven to be highly efficient when release to control bean weevil *Acanthoscelides obtectus* by adding before storing legumes; it recorded 50% reduction percentages where released before attacking of the bean weevil *A. obtectus* that mean the initial time of the treatment was zero (Sharlene and Richard, 2008). In what regarding the red flour beetle *T. castaneum* controlling; the predator *X. flavipes* at all conditions of the experiments; consumed mostly all the immature stages of the red flour beetle (Eggs, larvae, pupae) .One individual of the predator within its life cycle it kills about 539 eggs moreover 34 larvae and 14 pupa; which led to using in the commercial field; that described as a generalist predatory insect that can be used for insect pests found in-grain storage areas with low alert of human health against (A dark brown bug. Both adults and nymphs feed on any life stage of pests that can be subdued. Does not affect grain quality) under site *X. flavipes* (Herts.ac.uk). Same predator listed have been listed as an application in many places when recommended for (Farms, retail businesses, private households and for grain on farms prior to storage) (Christos and Frank, 2017). In addition to using the parasitoid *Anisopteromalus calandrae* which descripted as a biological control method for controlling larvae and pupae of coleopteran insects which attack warehouse; the biological benefits are achieved during warehouse settings. Thus became a recommended agent with others IPM; that is essential to determine economic agriculture systems to control; according to study its life cycle and its hosts; for achieve sustainable mass-rearing system (Bellows *et al*., 1992). Regarding to control the red flour beetle *T. castaneum* ; some of used strategies as phosphine using led to resistance creating what caused increasing the doses of the phosphine; that what be a reason to use the *A. calandrae* for getting the venom components leading to paralyze for host tissue of the pest by the venom of the parasite females; to deal with the resistance to this pest L Perkin research summaries : USDA ARS. Moreover, that released against the wheat weevil *Sitophilus granarius* L. in pasta companies (Schöller *et al*. 2006). The mean results of using this kind of control have been supported by Savoldelli *et al*. (2015) proved that when using *A. calandrae* to control *Stegobium paniceum* and using of *X. flavipes* against *Tribolium confusum,* and *Oryzaephilus surinamensis* there were no result in increased numbers of insect fragments in flour or semolina milled from wheat. On the other hand, the endoparasitics under genus *Trichogramma* is a polyphagous genus; is considered an endoparasitoids infecting insects and their eggs (Flanders and Quednau, 1960). On the other hand, some research papers have been included by (Flinn and Hagstrum, 2001) tabulated 212 reports under 40 research papers discussed of the reduction percentages and predation and parasitization against 19 species of stored-product insect pest. Regarding to the capable of the *Trichogramma* when reduce of damages which caused by stored product insects; Mathias Schöller and Sabine during June 1968 a company of biological control activities founded where the consultants selling parasitoids to organic food trade, food processing, and farmers, wholesale retail, industry and mills. In same context the ectoparasitic *Lariophagus distinguendus* which infect the larvae of the small beetles that live in the seeds and consume the pupae moreover prepupae in the cocoons; there are about 11 companies in Europe produce it to combat many storehouse mites to protect stored grains, especially in Central Europe (Niedermayer *et al*., 2016), other sources report that it has already been successfully registered against four warehouse pests (*S. paniceum*, *Lasioderma serricorne*, *Niptus hololeucus* and *Gibbium psylloides*) (Kaschef, 1955; Steidle *et al.*, 2006; Kassel, 2008 and Kaschef, 1961). It is important to mention the parasitic wasp *Holepyris silvanidis* (Brèthes, 1913) that have been using in biological control applications of the beetle *Tribolium* spp.: In the past, the parasitic wasp *H. silvanidis* that described as an alternative that could be raised to get control of the red flour beetle *T. confusum.* This parasite succeeded in finding the larvae at a depth of four cm of flour. This is the maximum depth the parasite reached while it was able to capture the larvae that had completely emerged from the food materials (Lorenz *et al*., 2010). This parasite *H. silvanidis* succeeds when capturing larvae and transform them far from the flour for depositing the eggs on the larvae. In applied case to control members of family Anobiidae; that known small beetles are considered one of the most important pests that hide in small places in cracks, they have a wide hosts such as skins of animals, beans, books, dried fruits, dead insects, dates and corn mail. Nowadays *L. distinguendus* the female of the parasite ovulates one egg for one host. Then the meeting often occurred after hatching. The behavior of parasitic females of this species have been using for killing the golden spider beetle *N. hololeucus* and the hump beetle *G. psylloides* in Germany where a company devised successful control and release techniques (Kassel, 2008); same results had been provided by Steidle *et al.* (2006).

The red flour beetles *T. castaneum* as a pattern pest for biological, ecological and control studies: that it's one of the common pests attacks the stored product, there are about 150 countries reported about the distribution of this insect. In addition to it can live in the dry weather what personable with its ecosystem that it lives inside dry grains. It can also be present in 215 products, which makes it a major pest that threatens the economy in an effective way, but it is easy for studies due to its relatively short life cycle; these reasons led to make it a model insect for fundamental and applied research (Campbell *et al*., 2022). the insects which belong to genus *Tribolium* have been used for a long time in many biological fields; the insects which belong to genus

Tribolium have been used for a long time in many biological and ecological fields as like it was studied in the population dynamics and evolution experimenting; that what also confirmed by Pointer (2021). Some salticid species of spiders usually move continuously, before stopping periodically to look around for prey. Searching for prey begins first in the place near it (Richman and Jackson, 1992). It should be noted that spiders require protein and nutrients if the diet they are exposed to is not diverse, and if the prey is not rich in nutrients for the spider, this will affect its activity and ability to capture prey, as well as movement, and daily habituation to low-nutrient prey may become a factor that leads to the death of individuals (Toft, 2013).

There has been no reports studied the behavior of spiders as predators inside foodstuffs and monitored their behavior except what did Taha and Abd-Elhalim (2023) when they concluded that the salticid spider *P. paykulli* could not reach the larvae of the flour beetle *T. castaneum* under the flour, but it was successfully capturing them outside the food item, and in this way it differs from the parasitic wasp *H. silvanidis* that penetrates deep into the flour, unlike the spider that did not stay away from the flour because it was difficult to walk on. Because jumping types of spiders need a solid ground to jump, they can eat many larvae during their life cycle; this result agree with what (Konishi *et al.*, 2020) informed that the females of the salticid spider *Hasarius adansoni* (Araneae: Salticidae) have ability to attack the adults of the red flour beetles *T. castaneum* and fed on it. But it was recorded after starving spiders, which was met with the phenomenon of pretending to be dead by the adult beetles. On the other hand; the larvae of the red beetles *T. castaneum* was considering a favorite prey of the *P. paykulli* As a result of some larval behaviors, such as the slow movement of the larvae and their being exposed to the predatory spider, which means that the predator does not bother to search for prey: which can be easily used to multiply spiders with the aim of releasing them and using them to combat other pests; the feeding method was based on placing food items inside plastic boxes containing tunnels at the bottom through which the larvae fall away from the flour (Taha and Abd-Elhalim, 2023). In addition to what (Powell *et al*., 2020) when they proved ability of spiders venom as a new novel biopesticide that is toxic to against small hive beetle (*Aethina tumida*) but harmless to honeybees. Where spider venom neurotoxin ω-hexatoxin-Hv1a (Hv1a) linked to the N- or C-terminus of snowdrop lectin (GNA) were used to produce recombinant Hv1a/GNA and GNA/Hv1a fusion proteins; when the concentrations were by injection (respective LD_{50}s 1.5 and 0.9 nmoles/g larvae) caused; Destruction of larvae with very high mortality rates without any effect on the product; thus, this kind of studies under development. Note: Spiders are very successful in suppressing insect pests under special conditions such as greenhouses. They can eat cotton leaf-worm larvae within days, depending on the intensity of release and the density of the pest according to Taha *et al*. (2017). While to date, there have been no direct reports discussed the possibility of using spiders to control stored product insects, although they are widespread and tolerate different environments. It is possible to release them massively into open grain stores as an alternative to chemical practices if conditions permit in the empty rooms, as like predatory mites, parasitic wasps, and fungi; with the agents which what tested by European Cooperation in Science and

Technology, in the previous report. It is worth mentioning that the spider's voracious feeding on larvae of the insects which attack the stored product grains can be exploited in a correct way to reduce chemicals and spread predators into the environment. Moreover, the salticid species have what distinguishes comparing other families; that they do not build an any bother web; but rather build a weed-like fabric and stays away until it jumps to capture the prey that what provided by Taha and Abd-Elhalim (2023).

Materials and methods

1. Rearing of the red flour beetle *Tribolium castaneum*:

The red flour *beetle T. castaneum* had been rearing in glass jars (250ml) where the materials for food of the insect was wheat flour; the nozzle of the jars was closed from the top by fine cloth for ventilation. After the adult individuals were brought from the Plant Protection Dept. Faculty of Agric., Benha University, Egypt. The age of the adults which are used in the start of rearing were brought after 2-4 days old from the molting. In the start of the rearing fifty adults were placed in each jar. It should be noted that the diet was monitored every three or four days, and the incubator was set at a temperature of 35 °C, and 75 % RH. This method of rearing is consistent with (Beeman *et al*., 2022).

2. Rearing of the salticid spider *Plexippus paykulli*:

This species had been rearing at Department of Cotton and Field Crops Mites, Plant Protection Research Institute, ARC, Dokki, Giza, Egypt. That was placed in plastic boxes 10 diameter × 20 height and was fed with red flour beetle larvae of all stages; this method used by Taha and Abd-Elhalim (2023). Large agricultures of the red flour beetle were provided to begin the experiments; the biological control was conducted in same plastic boxes as an artificial feeding environment as mentioned by the previous reference. At the beginning of the experiment with artificial biological control, flour containing 100 eggs was placed, then only the adult stages of spiders were introduced into plastic containers after four days of incubation of the eggs - before hatching, so that the spiders could experiment with their nutrition and know its effect on the growth rate of the two insects. It was considered to provide the experiment with adult spiders of the same age in case the life cycle of the predator within the experiment ended. 10 replicates were made for each treatment, and each replicate contained an equal weight of flour, weighing 500 grams, and the weight was adjusted equally to replenish the replicates in case of weight loss. Accordingly, the density was calculated per 100 grams.

3. Statistical analysis:

The Reduction percentages of the insects had been calculating by Henderson and tilton's formula (Henderson and Tilton, 1955):

$$\textbf{Corrected}\ \% = \mathbf{1} - \frac{\textbf{n in Co before treatment} * \textbf{n in T after treatment}}{\textbf{n in Co after treatment} * \textbf{n in T before treatment}} * \mathbf{100}$$

Where: n = Insect population, T = treated, Co = control.

Noticed that the reduction percentages; it was not calculated because the initial number included only eggs - so the numbers were recorded without calculating the percentages of reduction While the complete reduction rates began to be calculated 40 days after the starting of the experiment, when the rest of the stages interfering with the predator emerged.

Results and discussion

1. Densities of the red flour beetle *Tribolium castaneum* in the presence of the salticid spider *Plexippus*

***paykulli* under laboratory conditions:**

Behavior notes, there were some of differentiation between the predator wasp *H. silvanidis* which released in same treatment conditions, wasp has capable to find larvae of *T. confusum* under of depth 4 cm in the soft flour; that noted by Lorenz *et al*. (2010) while in this study noted that the larvae were easily to be captured out the soft material- it a recorded behavior. The spider initially relies on visual vision when capturing prey. It was observed that he quickly jumped once on the larvae and tied it from a fixed place that would not change until the predation process was complete. It was also noted that it didn't approach to walk on soft flour, and when forced it stumbles when walking, and it remain at the top of the bottles except when feeding; noted it didn't produce much web. Regardless of the spider's ability to coexist in rugged environments, the aforementioned insect predator also gains a strength if it is used in open houses that contain this type of pest in the case of flour residue, as it can penetrate soft products unlike the spider predator; that may possibility of multiple releasing of predators. On the other hand data that inserted in Table (1) and Chart (1) showed the effect of the predation of the salticid spider *P. paykulli* after 30 days; where the predator could just fed on the larvae as it reported by Taha and Abd-Elhalim (2023), while other species belong to the salticid family could fed on the adult under starving; but this is not taken into account; these results make us think that this type of predator is required in all agricultural environments for its dense distribution. The more positively results as a clear in the Chart (1) that after 30 days the jars just contain about 8 larvae that were contain about 100 eggs when 20 predators had been living with the prey; meanwhile the normal number without predation reached about 88 larvae as inserted in the control group.

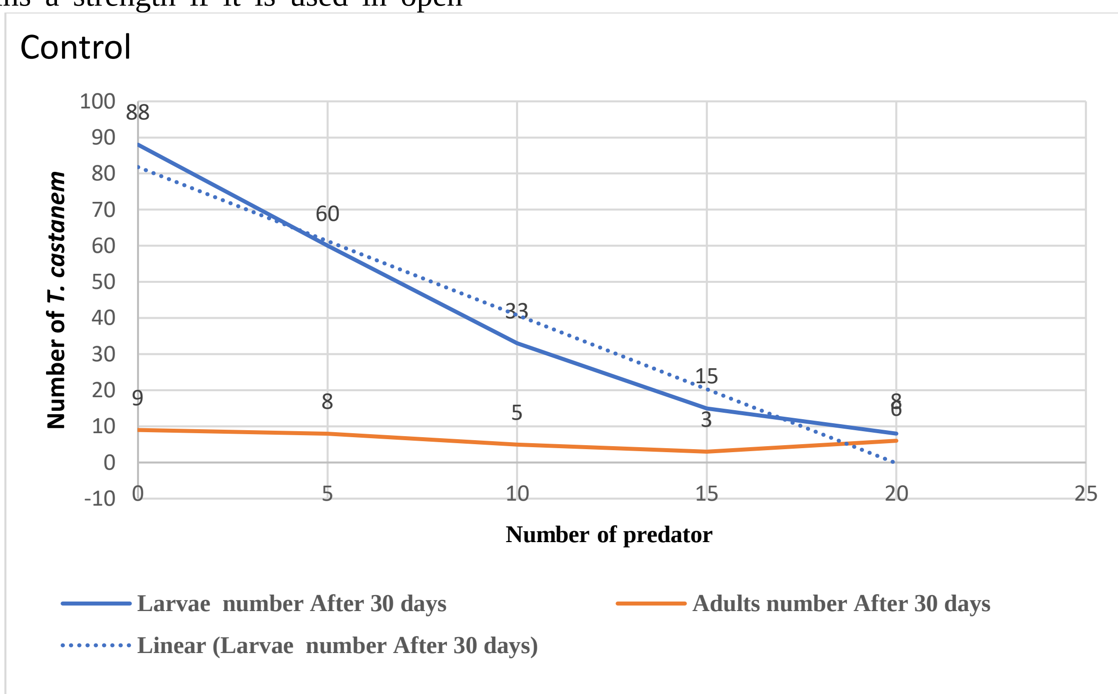

Chart (1): Densities of the red flour beetle *Tribolium castaneum* in the presence of the salticid spider *Plexippus paykulli* under laboratory conditions.

In total, the averages of density of larvae after 30 days recorded about 88 in the control group while it reached about (60, 33, 15 and 8) individuals; when the levels of the predator were (5, 10, 15 and 20) individuals, respectively. Therefore, the rate numbers of the adults after 30 days were about 9 in the control group while had reached about (8, 5, 3 and 6) individuals where the levels of the predator (5, 10, 15 and 20) individuals respectively. While the inserted information in Chart (2) and Table (1), showed that the population growth rate had been affected under the predation condition; the rate of larvae in the control had been increasing a result of adult existence; which caused a slight decrease where the same number at 5 predator level after 30 days was about 60 while after 30 days later recorded 65.

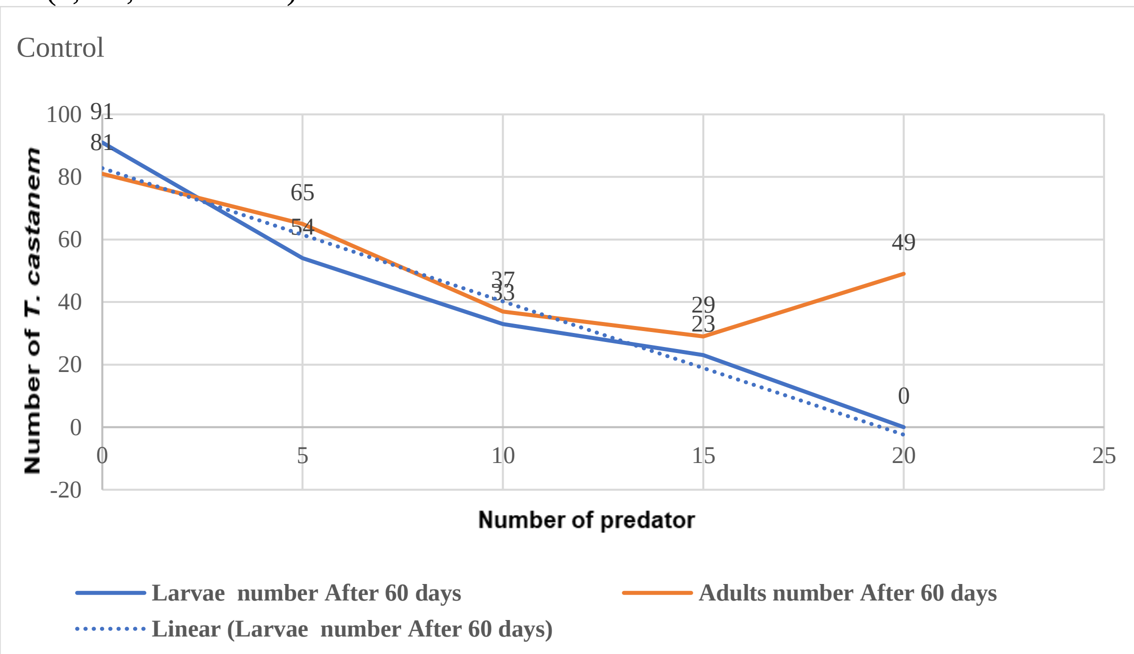

Chart (2): Densities of the red flour beetle *Tribolium castaneum* in the presence of the salticid spider *Plexippus paykulli* under laboratory conditions.

While at same level the rate of the adult number reached 65 individuals after 30 days which recorded 60 individuals as direct reason of rabidly development of the insect stages under the condition of the treatment 35 °C and 75% RH., these rates of the insect duration did not differ significantly from biological studies which proved that the larvae stages became complete during about 41 days on wheat flour. The very important observation is that the larvae completely disappeared 60 days after the start of the experiment as a result of predation, while an insignificant number of complete stages of the insect were present, about 49 individuals, as is clear from the curve of the graph. The numbers listed are in general were about of the larvae after 60 days recorded about 91 in the control group while had been reached about (54, 33, 23 and 0) larvae when the levels of the predator were (5, 10, 15 and 20) spider respectively. At the same time the rate number of the adults after 60 days recorded about 81 in the control group while had been reached about (65, 37, 29 and 49) when the levels of the predator were (5, 10, 15, 20) respectively.

Meanwhile the tabulated in both Table (1) and figured in Chart (3), supported the abilities of the mentioned spider as a predator can attack a new prey and could complete its life cycle with one feeding; that there were just about three

T. castaneum larvae 90 days after; at level 20 individuals of the spider; the adults at this point recorded about 69 individuals. It is striking that when there are five individuals of the predator, after 90 days, many of the nymphs have passed to the full stage without predation as a result of internal predation among spiders (Cannibalism), which led to the emergence of adult stages, while the required number of predators was completed from cultures equipped with each individual individually. It increases the efficiency of predation, and this may make outdoor experiments more successful than laboratory experiments. It has not been found in research papers on the predator under study that the efficiency of predation increases with an increase in the diversity of prey. Noted that checked the predation of the linyphiid spider *Mermessus denticulatus* when the spider had been feeding on *Rhopalosiphum padi* L. which belongs to the family Aphididae; the study reported that the predator consumed more aphids than did the theridiid spider *Enoplognatha gemina* and the linyphiid spider *Bathyphantes extricates*. the species *M. denticulatus* which preys on the pest extensively; spread over vegetation to a greater extent than the other two species do; this in turn enhances the ability of the spider *M. denticulatus* can capture larger numbers of diverse pests, so diversification of nutrition for this species was experimented. The laboratory study resulted that the linyphiid spider *M. denticulatus* devours larger insects than aphids when Collembola is first introduced. This reinforces that prey diversity increases the predator's ability to combat the aphid pest.

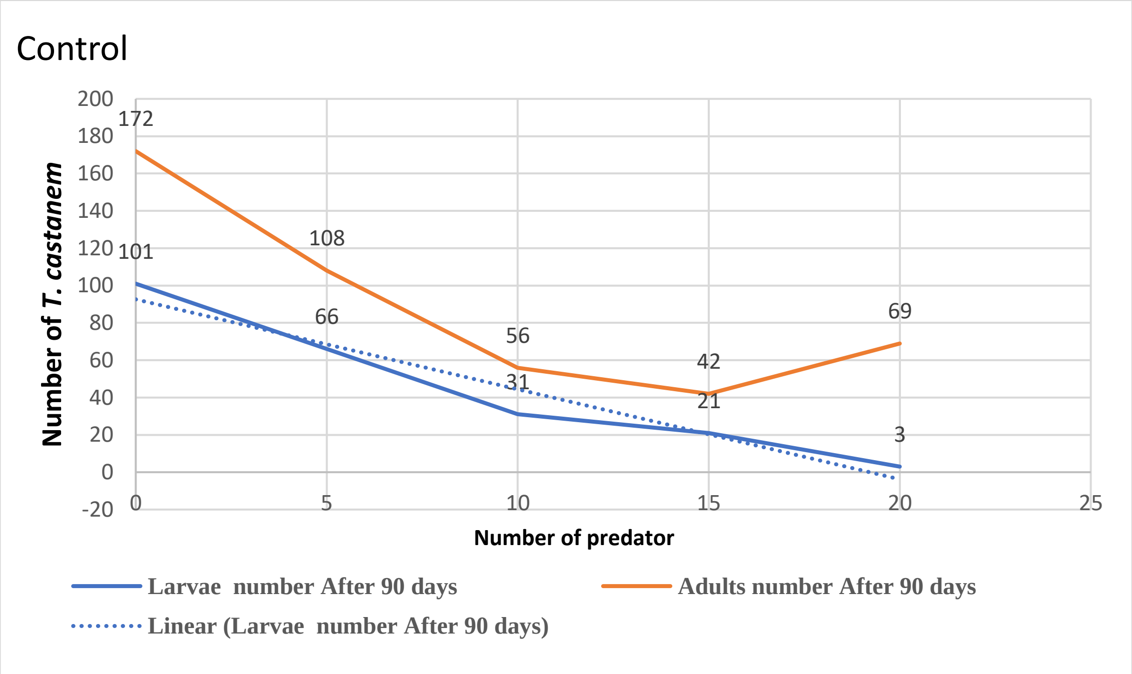

Chart (3): Densities of the red flour beetle *Tribolium castaneum* in the presence of the salticid spider *Plexippus paykulli* under laboratory conditions.

Mentioned that the averages of number of the larvae after 90 days recorded about 101 in the control group while had been reached about (66, 31, 21 and 3) when the levels of the predator were (5, 10, 15, 20) respectively on the other hand the rate number of the adults after 90 days recorded about 172 in the control group while had been reached about (108, 56, 42 and 69) when the levels of the predator were (5, 10, 15, 20) individuals, respectively.

After 120 days, Table (1) and illustrated data in Chart (4); showed the higher effect of the predation in the last of the generation the experimentation periods were chosen over 120 days because, on average, it is considered a number close to the generation period according to biological studies conducted under close laboratory conditions; Inserted a research paper contains numbers close to the development periods in this experiment; while in this work; the aim was not measurement the periods of development as much as it was to measure the predator's effect on growth rate; the existence of larvae were slightly absent during the treatment and it reappeared again as a result of the intensity of egg laying and also the inability of the predator to deal with adult individuals as indicated that the growth rate of eggs is different at temperature.

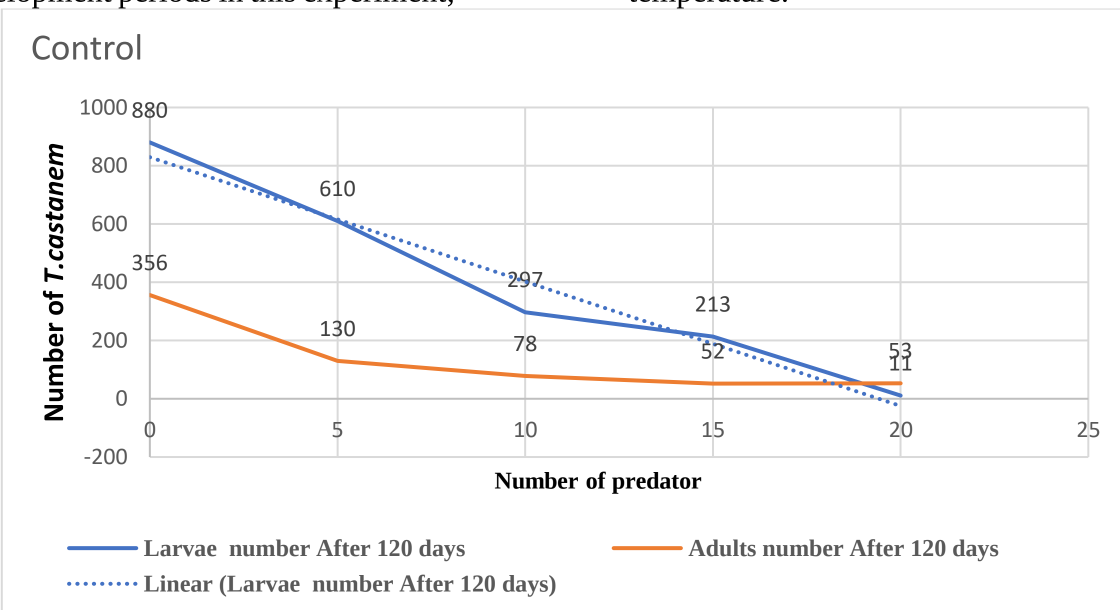

Chart (4): Densities of the red flour beetle *Tribolium castaneum* in the presence of the salticid spider *Plexippus paykulli* under laboratory conditions.

Above all, the larvae after 120 days recorded about 880 in the control group while had been reached about (610, 297, 213 and 11) when the levels of the predator were (5, 10, 15, 20) respectively. While the same of the adult of the insect recorded about 356 individuals in the control group on the other hand the rest of the individuals had been reached about (130, 78, 52 and 53) when the levels of the predator were (5, 10, 15 and 20) individuals, respectively.

Table (1): Densities of the red flour beetle *Tribolium castaneum* in the presence of the salticid spider *Plexippus paykulli* under laboratory conditions.

Time		**After 30 days**		**After 60 days**		**After 90 days**		**After 120 days**	
Duration of *Tribolium castaneum*	**Initial of eggs**	**Rates of Larvae**	**Rates of Adults**	**Rates of Larvae**	**Rates of Adults**	**Rates of Larvae**	**Rates of Adults**	**Rates of Larvae**	**Rates of Adults**
Control	100	88±10.6	9±0.2	91±3	81±5.4	101±9.1	172±8	880±25.1	356±16.1
5 individuals of *Plexippus paykulli*	100	60±1.1	8±2.3	54±2.1	65±1.6	66± 6.4	108±4.8	610±16.4	130±7.8
10 individuals of *Plexippus paykulli*	100	33±2.1	5±5.4	33±1.5	37±4.8	31±5.6	56±2.1	297±6.8	78±3.1
15 individuals of *Plexippus paykulli*	100	15±3.4	3±0.5	23±3.4	29±4.1	21±3.1	42±3.1	213±12.4	52±5.1
20 individuals of *Plexippus paykulli*	100	8±0.3	6±0.1	0	49±0.7	3±0	69±3.8	11±1.1	53±2.6

2. Reduction percentages of the red flour beetle *Tribolium castaneum* in the presence of the salticid spider *Plexippus paykulli* under laboratory condition:

Inserted data in Table (2) that figured in Chart (5) which showed the reduction percentages of the adults and larvae of the red flour beetle *T. castaneum* under predation of the salticid spider *P. paykulli* when the temperature stabilized on 35 °C and the relative humidity on 75 RH.; that after 60 days; the percentages of larvae were reduced about 12.9 %, when the number of the predator was 5 individuals; that led to the predation and the behavior of the predation in at that time does not enough to achieve the required hypothesis; the spiders; the oviposition capable of the red flour beetle was a stronger than the predator's ability at this point. This is clearly shows with the reduction of the adults which recoded no reduction; means that the growth rate of the adult had not been affected; similar results also occurred at same time when the number of the predator was 10 individuals, just 3.3% reduction. The result that is considered that when the individuals of spiders were 15 the reduction reached 56.4% for the larvae. the liner that indicates the reduction level when the number of the predator was 10 individuals recorded 87.3 % against the adult that caused by predation larvae of the insect by the predator, where that spider does not want to prey on individuals except in special cases. The percentages increased to 91.1% when the predators were 15 individuals. The percentages of reduction of complete individuals increased in this period based on the decrease in larvae during the first month, because this fluctuation depends on the quantities of adult individuals and larvae sequentially. These rates in total what (Schöller, 2010).

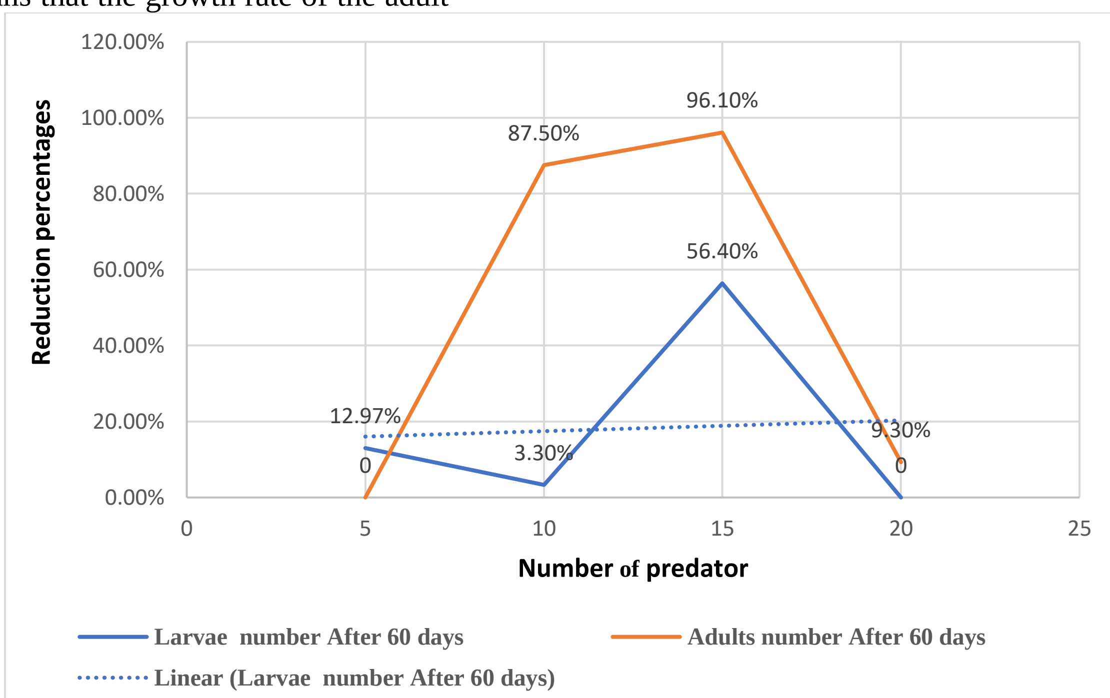

Chart (5): Reduction percentages of the red flour beetle *Tribolium castaneum* in the presence of the salticid spider *Plexippus paykulli* under laboratory conditions.

Mentioned; when called that this field need much more research, in this field experimenting than my necessary to find the potential of natural enemies for biological control of stored-product pests. Noted that reductions percentages indicate that the effects were significantly positive on the adults; this may be due to the predator attacking the larvae without killing them completely or being affected by its toxicity, so they remain alive and are included in the calculations of the lineage of the living, and then die later before completing their life cycle; this hypothesis is consistent with some behaviors of (Web-based hunters). While no reference has been found confirming that it occurs in jumping spiders; some literature confirmed that the behaviors of jumping spiders vary according to visual ability, the space in which the spider is located, and the conditions for capturing prey (Taylor *et al*., 1998).

The tabulated data in Table (2) that figured in Chart (6), which showed the reduction percentages of the adults and larvae of the red flour beetle *T. castaneum* under predation of the salticid spider *P. paykulli* when the temperature stabilized on 35 °C and the relative humidity on 75 RH., that after 90 days; indicates that the effects were significantly positive on the adults when the predators were 5 individuals; The fluctuation between the number of individuals and predation capacity generally indicates that an increase in predators leads to a decrease in prey. This may lead to stronger results in open spaces with the largest amount of spider predators; especially that the daily rate of prey devouring -same spider and pest is fluctuates (Taha and Abd-Elhalim, 2023).

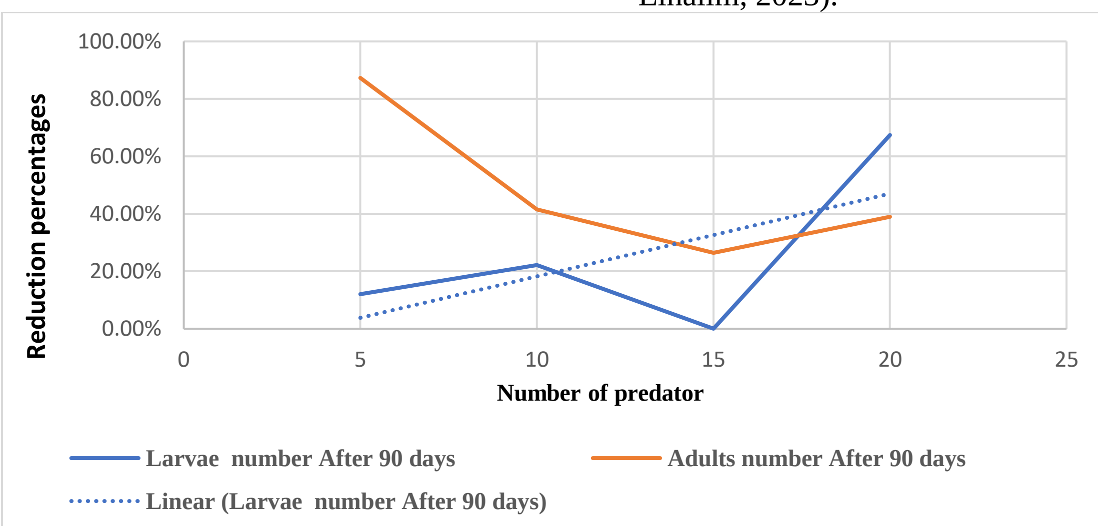

Chart (6): Reduction percentages of the red flour beetle *Tribolium castaneum* in the presence of the salticid spider *Plexippus paykulli* under laboratory conditions.

The rest of the reduction percentages of the larvae 90 days after starting the experimental recorded (12 %, 22.18 %, negative and 67.4 %) when the predator numbers were (5, 10, 15 and 20) meanwhile on the recorded (87.3 %, 41.5 %, 26.4 % and 39 %) when the predator numbers were (5, 10, 15 and 20) respectively. Data of Table (2) which figured in Chart (7), that recorded the reduction percentages of the adults and larvae of the red flour beetle *T. castaneum* under predation of the salticid spider *P.paykulli* when the temperature stabilized on 35 °C and the relative humidity on 75 RH.; that after 90 days; indicates the predation rate increases as a linear determinant.

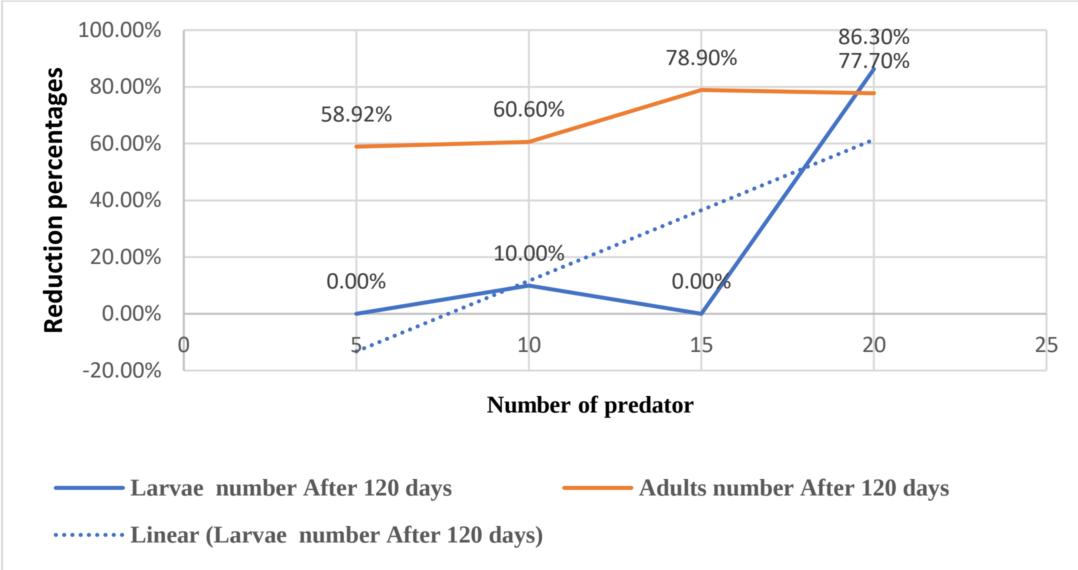

Chart (7): Reduction percentages of the red flour beetle *Tribolium castaneum* in the presence of the salticid spider *Plexippus paykulli* under laboratory conditions.

This means that releasing experiments, if they take place, must begin early; this agreement with **Sharlene and Richar (2008)** when recorded 50% reduction percentages when released the predatory warehouse pirate bug *Xylocoris flavipes* against the bean weevil *Acanthoscelides obtectus*; adding the predator before storing legumes; thus recommended the initial time of adding the predator should be when zero infection. In total the reduction percentages of the larvae; 120 days after experimental starting recorded (Negative, 10 %, negative and 86.3 %) when the predator numbers were (5, 10, 15 and 20). While about the adults reached (58.9 %, 60.6 %, 78.9 % and 77.7%) when the predator numbers were (5, 10, 15 and 20), respectively.

Table (2): Reduction percentages of the red flour beetle *Tribolium castaneum* in the presence of the salticid spider *Plexippus paykulli* under laboratory conditions.

Time		**After 30 days**		**After 60 days**		**After 90 days**		**After 120 days**	
Duration of *Tribolium castaneum*	**Initial of eggs**	Larvae	Adults	Larvae	Adults	Larvae	Adults	Larvae	Adults
Control	100	88±10.6	9±0.2	91±3	81±5.4	101±9.1	172±8	880±25.1	356±16.1
R. P. at 5 *Plexippus paykulli*	100	No result recorded		12.97 %	Negative	12.00 %	87.3 %	Negative	58.92 %
R. P. at 10 *Plexippus paykulli*	100	No result recorded		3.30 %	87.5%	22.18 %	41.5%	10.0 %	60.6%
R. P. at 15 *Plexippus paykulli*	100	No result recorded		56.4%	96.1%	Negative	26.4%	Negative	78.9%
R. P. at 20 *Plexippus paykulli*	100	No result recorded		0	9.3%	67.4%	39%	86.3%	77.7%

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