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A study of population abundance, development of the southern cowpea beetle *Callosobruchus maculatus*, (Coleoptera:Bruchidae) in Wasit Province

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Abstract:

The cowpea beetle is a widespread insect and a major pest of legumes, both in the field and in storage, particularly in tropical and subtropical regions, and indeed wherever legumes are grown or stored. The aim of study was estimate of population abundance, development of the southern cowpea beetle *Callosobruchus maculatus*, in Wasit Province. The percentage of infestation varied according to weather conditions. Different types of insect pests were found. It was found that population of insects increase with increasing humidity and decreasing temperatures, while multiple infestations were found, including (*Bruchus rufimanus* Boh, *Liriomyza trifolii*.

Keywords: *population abundance, southern cowpea beetle, Callosobruchus maculatus*.

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دراسة اعداد و تطور خنفساء اللوبيا الجنوبية *Callosobruchus maculatus* (Coleoptera:Bruchidae) في محافظة واسط

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الخلاصة

خنفساء اللوبيا حشرة واسعة الانتشار وآفة رئيسية تصيب البقوليات، سواء في الحقول أو المخازن، لا سيما في المناطق الاستوائية وشبه الاستوائية، بل وفي أي مكان تُزرع أو تُخزن فيه البقوليات .هدفت هذه الدراسة إلى تقدير كثافة وتطور خنفساء اللوبيا الجنوبية (*Callosobruchus maculatus*) في محافظة واسط .تفاوتت نسبة الإصابة تبعًا للظروف الجوية .وتم رصد أنواع مختلفة من الآفات الحشرية .وتبين أن أعداد الحشرات تزداد مع ارتفاع الرطوبة وانخفاض درجات الحرارة، كما لوحظت إصابات متعددة، بما في ذلك (*Bruchus rufimanus* Boh) و(*Liriomyza trifolii*).

الكلمات المفتاحية: تطور الحشرة، خنفساء اللوبيا الجنوبية، *Callosobruchus maculatus*

1. Introduction

The southern cowpea beetle *Callosobruchus maculates* of the order Coleoptera, belonging to the family Bruchidae, is a widespread insect and a major pest in the field and storage. It infests many types of legume seeds (Vigna), and its main hosts are beans (*Vigna nilotca*), cowpeas (Sneninsis), peas (*Pisium sativum*), chickpeas (*Cicer arietinum*), and stored grains (Vigna nilotca). Stored grains are those grains that are collected after harvesting and then stored for several months under suitable conditions, including their products and the foods made from them (Seidu, 2019).

The *C. maculatus* causes significant damage and losses, estimated at around 51%, feeding on the contents of the seed, which loses a large portion of its weight. The most important sign of infestation is the observation of live adult beetles crawling on the seeds, as well as eggs attached to the seeds or feeding chambers and their circular openings. Each seed may contain 1-4 beetles (Hajam & Kumar, 2022). The cowpea beetle is a widespread insect and a major pest of legumes, both in the field and in storage, particularly in tropical and subtropical regions, and indeed wherever legumes are grown or stored (Abdelfattah & Zinhoum, 2024). The larvae of this beetle develop on 35 types of legume seeds, but its main hosts are cowpeas, chickpeas, mung beans, and peas. These types of seeds are susceptible to infestation by this insect, particularly in Africa, India, and throughout the Middle East. This insect causes significant losses to the seeds it infests, with losses reaching up to 63% (Jassim et al., 2020).

Recent studied have shown that a single cowpea beetle larva consumes approximately 5% of the weight of a single seed. Based on this, the loss resulting from infestation can be estimated by counting the number of exit holes of adult beetles on the seed surface, with each hole representing a single emerging beetle (Ali et al., 2024). Experiments have also shown that a single pair of cowpea beetles caused a weight loss of approximately 62.1% in mung beetles over a four-week period. Other study has been found that seeds with moisture content between 17.1% and 23.4% promote the emergence of the active form. This effect was not observed in stored seeds, which have a lower moisture content ranging from 7.7% to 13.5% (Wasserman & Futuyma, 1981). Therefore, the aim of study was to estimate of population abundance, development of the southern cowpea beetle Callosobruchus maculatus, (Coleoptera:Bruchidae) in Wasit Province.

2. Materials and methods

Survey of insect population

A field survey of the cowpea beetle was conducted in several different areas of Wasit Province including (Al-Numaniyah, Al-Kut and Al-Hayy). The survey lasted for three months and repeated two times. The survey is started 3/2/2024 until 3/5/2024. Samples were taken randomly from warehouses using plastic containers and transported to the laboratory for testing the presence of the southern cowpea beetle.

Insect rearing

The cowpea beetle was obtained from infested cowpea seeds collected from grain stores in January, 2024. Males and females were distinguished as cowpea beetles and identified. Subsequently, healthy red cowpea seeds were obtained from local markets and placed in a freezer at ±18°C for one week to ensure they were free of any insect or fungal infestation, thus enabling the beetle to be reared. The insect colony was maintained by placing a kilo of healthy cowpeas in glass bottles. Ten pairs of cowpea beetles were added to them, and their openings were covered with a cloth lid. The lid was tied with a rubber band and placed in the incubator at a temperature of 34 ± 2 C° and a relative humidity of 55 ± 3%. The colony was renewed every month to ensure its maintenance after each generation according to (Loganathan et al., 2011).

Determination of population abundance of *C. maculatus*

The population abundance of *C. maculatus* were determined in the laboratory on the data obtained from the semi-monthly surveys conducted from January to May 2024 in the of Wasit Province of Iraq. In addition, the key factor (Kf), which represents the sum of the logarithms of mortality for each age group, is calculated according to the following equation.

$$Key\ factor(kf) = Log10(nx) - Log10(nx+1)$$

Where, kx = age-specific mortality (x), nx = number of individuals at the given age, nx + 1 = number of individuals at the subsequent age, and the total generation mortality, represented by the value K was calculated by summing the K values of all age groups i.e., K = K1 + K2 + K3 ... + KN (Badii et al., 2013).

Statistical analysis

The statistical SPSS software (Version 22.0) has used for statistical analysis of our data. The results regarding the *C. maculatus* captures, mortality, and life table parameters were analyzed using an analysis of variance according to the design used, and the mean values were compared using the least significant difference (LSD) at a probability level of 0.05.

Results and Discussion

Stored grain Survey

The results of the study survey have indicated that the presence of the cowpea beetle and several other insects including the red flour beetle *Tribolium castaneum* and the grain beetle *Typhaea stercorea*. The results showed that Alkut region recorded highest number of *C. maculatus* and the lowest was at Al-Hay region (Figure 1).

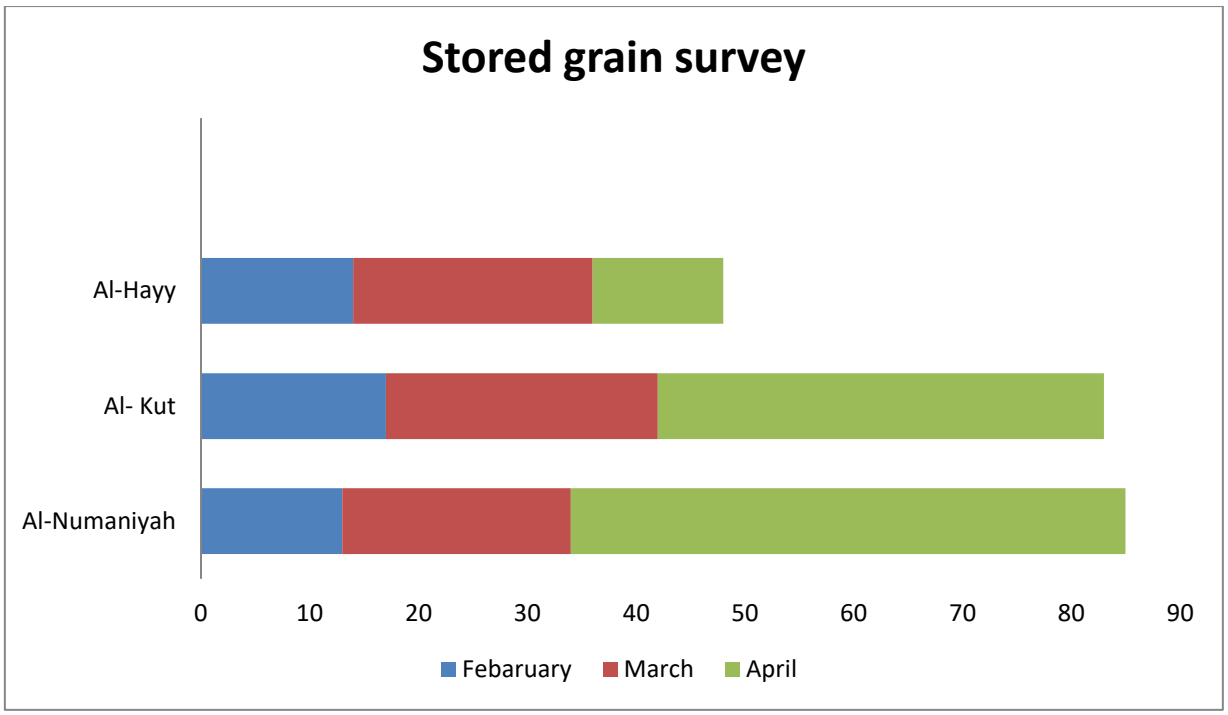

Figure (1) survey regions for the cowpea beetle, *C. maculatus*, in Wasit Province

This study is consistent with the study conducted by (Hajam & Kumar, 2022) regarding the presence of some types of beetles belonging to the order Coleoptera that infest grains of the grass family and their stored products. Environmental conditions such as temperature and humidity directly affect the insect's life cycle, and the hot and humid climate is preferred for its spread in some regions. The results showed the presence of the insect in several regions along with some other insects belonging to other insect orders (Cope & Fox, 2003; Credland & Wright, 1989).

Determination of population abundance of *C. maculatus*

The results have showed that significant on the average number of eggs laid and hatched by the southern cowpea beetle, *C. maculatus*. The average number of eggs laid was 51.3 55.3 and 52.7, respectively at Al-Numaniyah region, compared to 61.7, 50.0 and 44.3 for

Al-Kut region, while Al-Hayy region recorded 55.1, 44.9 and 45.1 in February, March and April months. The hatching rate was 42.6, 44.7 and 58.9, respectively, compared to 55.7, 43.2 and 39.2 in Al-Kut region, But, it was 45.1, 34.7 and 33.9 in Al-Hayy region. The generation time was 34.7, 41.3 and 43.1, respectively at all regions.

Table 1: Monthly mean values of number of eggs, hatching rate (%), and generation period (days) for three regions (Al-Numaniyah, Al-Kut, and Al-Hayy) during February–April. LSD values are provided for each parameter at $P \leq 0.05$.

Months	**Al-Numaniyah region**			**Al-Kut region**			**Al-Hayy region**		
	Number of eggs	Hatching rate	Generation period	Number of eggs	Hatching rate	Generation period	Number of eggs	Hatching rate	Generation period
Feb.	51.3	42.60	33.00	61.70	55.70	34.00	55.10	45.10	32.70
Mar.	55.3	44.70	34.20	50.00	43.20	39.10	44.90	34.70	43.10
Apr.	52.7	58.90	34.70	44.30	39.20	41.30	45.10	33.90	32.40
LSD	1.65	2.44	3.11	3.14	5.6	3.41	3.11	4.12	3.44

The cause may be growth hormone and reproductive hormone stimulants, affecting ovarian maturation or preventing infection, which reduces egg production, damages the ovaries or sex cells, disrupts egg formation, or produces abnormal eggs (Mbata, 1993). The current study agrees with the findings of that many factors can affect egg production due to their content of compounds similar to molting hormone, leading to growth and developmental disorders and reducing egg production in hens. These factors can also cause egg death by entering the egg, potentially leading to rapid embryonic death through direct cytotoxicity and penetration through the outer shell (Akunne et al., 2014).

This results in failure of embryonic development and affects the embryo's muscle tissues. Furthermore, they can damage the outer shell, rendering the embryo unable to hatch. The effects of factors such as temperature, humidity effects eggs with that may be due to the precipitation and accumulation of certain active substances on the eggshell, hindering gas exchange between the embryo inside the egg and the external environment (Cruz et al., 2016). These results are similar to those of, (Mbata et al., 2009) who indicated that increase temperature gave the highest egg-laying inhibition rate, reaching 0.51%, for the southern cowpea beetle.

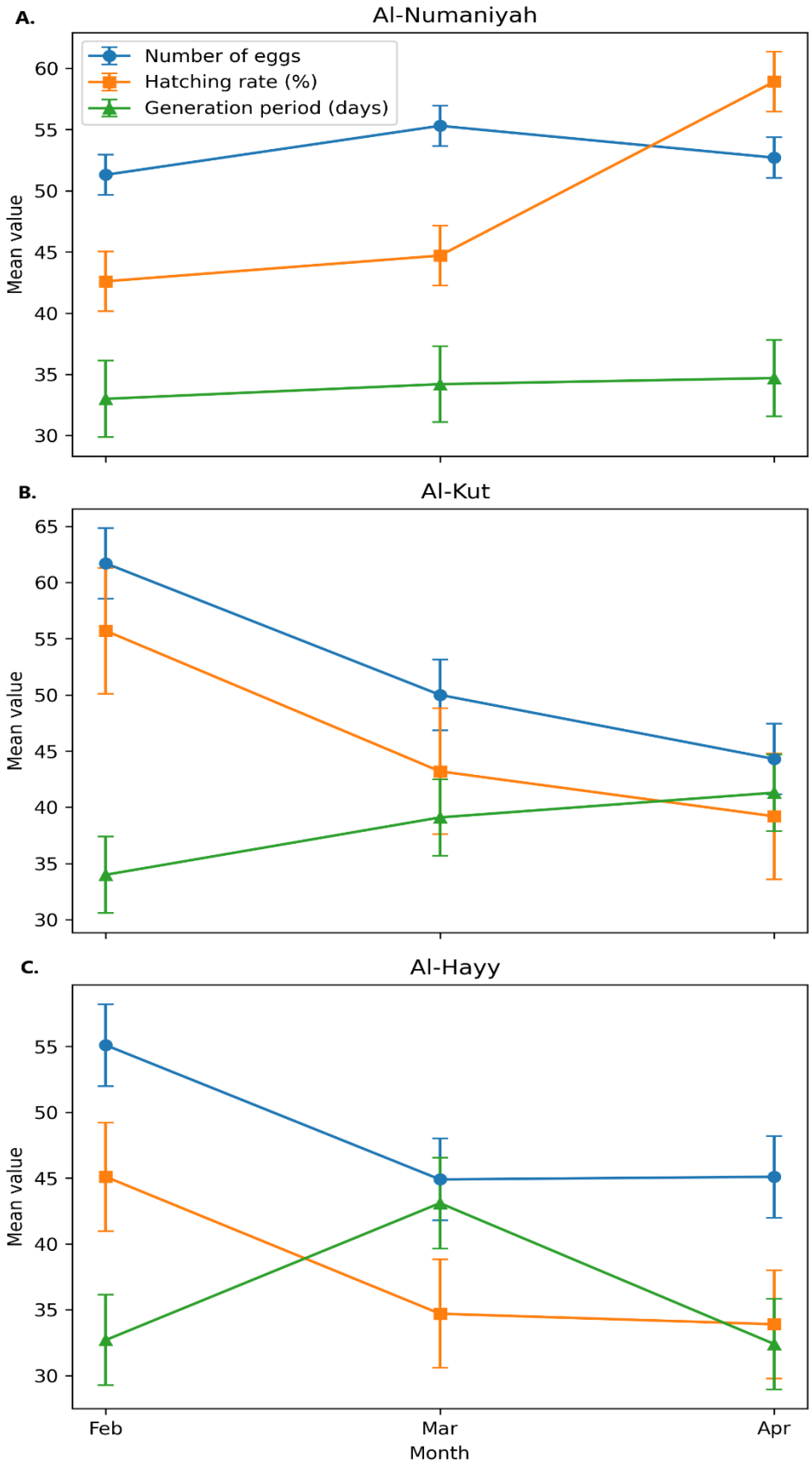

Figure 1. Monthly variation in biological parameters (number of eggs, hatching rate, and generation period) of three regions: A = Al-Numaniyah, B = Al-Kut, C = Al-Hayy during February–April. Vertical bars represent LSD at $P \leq 0.05$.

This is also similar to the study by (Appleby & Credland, 2004) , who indicated that the aqueous extract of harmal seeds negatively affected the productivity of adult cowpea beetles, and that the number of eggs laid was inversely proportional to the extract concentration (Mohammed & Aswd, 2019). However, these results differ from those of in his study on the effect of a concentrated aqueous extract of safflower fruit on some immature stages of the insect. Other study has been used extract was highly toxic one day after treatment and affected the insect's life cycle, shortening the pre-pupal period and lengthening the larval and pupal stages. This extract lost its residual toxicity after the seventh day of treatment (Arotolu et al., 2018).

Conclusions

The study concludes that the survey have indicated that the presence of the cowpea beetle and several other insects including the red flour beetle *Tribolium castaneum* and the grain beetle *Typhaea stercorea*. The results showed that Al-kut region recorded highest number of C. maculatus and the lowest was at Al-Hay region.

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