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Influence of parent age and some plant extracts on certain biological aspects of pulse beetle, *Callosobruchus chinensis* L. (Coleoptera: Bruchidae)

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Abstract

The present work was carried out to study the effect of age of parents and some plant extracts against pulse beetle, *Callosobruchus chinensis* L. on chickpea seeds. The results generally showed that, fecundity of *C. chinensis* increased in the females with younger ages and reduced in those with progress age females, while the time of development increased significantly with the increase in age of parents of either sexes. Also, leaves of castor (*Ricinus communis* L.), datura (*Datura stramonium* L.), Jatropha (*Jatropha curcas* L.) and neem (*Azadirachta indica* A. Juss) were used in acetone and aqueous extracts. The results indicated that among all the tested plant extracts, neem leaf extract was significantly affect oviposition deterrent, reduction of the adult emergence of *C. chinensis* and antifeedant as compared to other extracts. In general, acetone extract of leaf of the tested plants were more effective than those of aqueous extract.

Keywords: pulse beetle, parent age, plant extracts, oviposition, adult emergence.

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1. Introduction

Chickpea, *Cicer arietinum* (L.) is one of the major pulse crops extensively grown worldwide. It works as a source of fats (4-10 %), vitamins, minerals such as iron, calcium, and phosphorus and energy (416 kcal / 100 g), and also helps to lower the cholesterol levels (Ali and Rabi, 2002). Pulse beetle *Callosobruchus chinensis* L. (Coleoptera: Bruchidae) attacks all pulses and also damages other stored grains and their products (Tesfu and Emana, 2013). It is responsible for an average of 32–64% loss under storage in different parts of Asia and Africa (Raja *et al*., 2007). Chickpea seeds is significantly affected both qualitatively and quantitatively and these seeds lose their germinating capacity completely (Ahmed *et al*., 2003; Ahmed and Din, 2009). The female lays eggs that are glued to the seed surface and the larvae bore into the pulse grain and feed on the entire material. The adults emerge out leaving behind holed grains, which are unsuitable for human consumption (Ajayi and Lale, 2001). Certain features of adult insects change with age as a natural phenomenon. Delayed mating of adults has been shown to have a major impact on egg fertility. The number of eggs decreases with the age increase of the maternal in many insects, including Coleoptera. A decrease in the number of eggs with a maternal age was observed in *Callosobruchus maculatus* F. (Fox, 1993). Studies have shown that the progeny of older mothers is much smaller when adults emergence compared to the progeny of younger mothers (Mousseau and Dingle, 1991). Maternal influences can affect population dynamics and fertility (Hunter, 2002). Offspring that is emerging out from the eggs laid by the older maternal has less success in hatching, higher mortality and slower growth than that in the eggs laid by the younger maternal (Fox and Dingle, 1994). The control of stored products insects like *C. chinensis* has centered mainly on the use of synthetic insecticides (Asawalam *et al*., 2007). However, disadvantages associated with the use of conventional control strategies (synthetic insecticides) are affecting non-target organisms (Rajendran and Sriranjini, 2008), human health (Isman, 2006), environmental pollution (Ogendo *et al*., 2003) and the development of insect resistance and the emergence of pests (Sousa *et al*., 2009). Being an internal feeder, it is very difficult to control the larval stage of *C. chinensis* with insecticides. It is required biodegradable, safe, and environmentally friendly pesticides. Plant insecticides are biodegradable, relatively specific in their working method, and easy to use (Das, 1986). More than 2000 plant species contain biologically active substances. Plant chemicals have some properties inhibitors of hatching of eggs, reproductive of insects (Pushpanathan *et al*., 2006). Plant insecticides have been traditionally used in developing countries to control stored grain pests, such as Coleoptera (De Oliveira, 2003). Thus, many plants were explored for their insecticidal properties (Kamakshi *et al*., 2000). Plant extracts are among many plant-derived materials and have different effects on insect pests, including insects of stored products (Shaaya *et al*., 1991). Castor, datura, Jatropha and neem plant leave extracts have also been used by several researchers (Abbasipour *et al*., 2011b; Bhuiyah *et al*., 2003; Hossain and Haque, 2010; Khatun *et al*., 2014; Mollah and Islam, 2002; Patel, 2011; Upasani *et al*., 2003; Zia *et al*., 2011) to combat *C. chinensis* seed invasion. Oviposition inhibition is caused either by the death of the female before eggs are laid in contact with plant products or because the alive female fails to lay many eggs (Shukla *et al*., 2011). Painting plant products on the seeds prevents eggs from sticking firmly to the seed layer and thus prevents the penetration of the larvae into the seeds (Adebowale and Adedire, 2006). The significant decrease in the emergence of adults can also be due to low hatching eggs. Hatching failure can be due to the death of eggs due to the different components of botanicals as well as to the physical properties that cause changes in surface tension and oxygen tension within the eggs (Abdullahi *et al*., 2011). The study was intended to clarify the changes in reproductive behavior due to the age progress of *C. chinensis*. Also, effect of plant extracts on oviposition, adult emergence of *C. chinensis* and as antifeedant of the pest.

2. Materials and methods

2.1 Insect Rearing

The beetles used in the current study were obtained from naturally infected chickpea seeds. *C. Chinensis* adult culture were kept in the incubator at a constant temperature of 30 ± 2 °C and 75 ± 5% R.H. in the Laboratory of Plant Protection Department, Faculty of Agriculture, Al-Azhar University, Assiut Governorate, Egypt. Uninfected chickpea seed (variety: Giza 195) was used for the experiment, and it was disinfected in an oven at 60 °C for one hour before it was used as a substrate for insect breeding. Culture was created by 100 pairs of *C. Chinensis* introduced into breeding bottles containing 500 g of seeds. The bottles were covered with a piece of gauze and attached with rubber bands. Parent beetles were screened and removed out 7 days after oviposition. Later, the seeds were kept in the incubator for the emergence of adults, which were used in the experiment.

2.2 Effects of parent age on oviposition and developmental time

To determine the effect of parent age on oviposition and developmental period of *C. chinensis* there were two treatments of mating. A) Newly emerged virgin males (age less than one hr) were paired with 1, 3, and 5 days old virgin females. B) Newly emerged virgin females (age less than one hr) were paired with 1, 3 and 5 days old virgin males. Each treatment was replicated 10 times by introducing a pair of *C. chinensis* in glass jars (10×5 cm) contain 5g of chickpea seeds. The seeds in the jars were covered with a muslin cloth to allow air circulation and then left undisturbed for 7 days to allow mating and laying eggs by females. Laid eggs on the surface of seeds were carefully examined with the aid of a magnifying lens. Eggs were counted and recorded and then returned back into the jars until progeny emergence. The developmental period was determined by counting the days between the oviposition by the released adults and the first adult emergence in each replication (Sadozia *et al*., 2003).

2.3 Plant extracts

2.3.1 Collection of plant materials and preparation of extracts

The plant materials used in this study were castor (*Ricinus communis* L.), datura (*Datura stramonium* L.), Jatropha (*Jatropha curcas* L.) and neem (*Azadirachta indica* A. Juss) leaves. These materials were sourced fresh from the Faculty of Agriculture farm at Al-Azhar University, Assiut, Egypt. Firstly, leaves were cleaned and then air-dried in the laboratory of the Plant Protection Department. The cleaned dried leaves were pulverized into fine powders using a blender. The powders were further sieved to pass through 1 mm^2 mesh. Aqueous and acetone extracts of each experimental material were carried out using a cold extraction method. About 100g of each powder was soaked separately in an extraction bottle containing 300 ml distilled water or acetone. The mixture was stirred occasionally with a glass rod and extraction was terminated after 72 hours. Filtration was carried out using a double layer of Whatman No. 1 filter papers and acetone were evaporated using a rotary evaporator at 30 to 40 ^oC (Udo, 2011). The resulting extract was air-dried to remove traces of solvent. The obtained crude extract was stored in the refrigerator prior to use. From the original stock, a solution of 500 ppm concentration was prepared for each Aqueous and acetone extracts.

2.3.2 Experimental design

Chickpea seeds were cleaned and sterilized at 60 °C for 1 hour to kill the eggs and developing larvae. Weighed amount (25g) of seed was treated with 1 ml of concentration 500 ppm for each treatment. Control was treated with aqueous and acetone alone. The treated seed was kept in air and the solvent (aqueous and acetone) was allowed to evaporate for 10 min. Five pairs of newly emerged (0-24 hours old) *C. Chinensis* were introduced to each plastic container (250 ml) on the treated seed. Containers were kept in an incubator at 30±2 °C and 75±5% R.H., after covering with a cloth to avoid insect escape. Three replicates were made for each treatment. After 7 days, numbers of eggs were laid on control seeds (Cs) and numbers of eggs were laid on treated seeds (Ts) were recorded and the percentage of oviposition deterrence (POD) was calculated according to Vanmathi *et al*. (2010);

$$\text{POD} = \frac{\text{Cs} - \text{Ts}}{\text{Cs}} \times 100$$

After the eggs were counted, the experimental set up was kept undisturbed till the emergence of Fl adults from the treated and untreated seeds. After 4 weeks of treatment, the freshly emerged beetles were counted and removed daily for another one week to avoid the chances of their recounting and to confirm that the total emergence is over. The percentage in F1 adult deterrence (PAD) emergence was calculated according to Vanmathi *et al*. (2010);

$$\mathrm{PAD} = \frac{\mathrm{Ac} - \mathrm{At}}{\mathrm{Ac}} \times 100$$

Where Ac, is the number of emerged insects in the control and At, is the number of emerged insects in the treated. The percentage of feeding deterrence was calculated using the feeding deterrent index (FDI) according to Isman *et al*. (1990).

$$\mathrm{FDI}\ (\%) = \frac{\mathrm{C} - \mathrm{T}}{\mathrm{C}} \times 100$$

Where C, is weight loss in the control seed and T, is weight loss in the treated seed.

2.4 Statistical analysis

Collected data were subjected to the Analysis of Variance (ANOVA) using the Statistical Analysis System (SAS) at a 5% level of significance. The mean differences were separated using Least Significant Difference (LSD) and showed as means ± SE. Shapiro-Wilk's W test was done for the assumption of normality in which the test was in significant.

3. Results

3.1 Effects of parent age on oviposition of C. chinensis

Data in Figure (1) showed the effect of the age of parents on the mean number of laid eggs per female (fecundity) on chickpea seeds. The highest mean number of eggs laid on chickpea seeds (82.66 ± 2.23 eggs) was recorded after pairing the newly emerged females (age less than one hr) with 1-day old males, compared with other pairing combinations. The mean number of eggs laid on seeds were (70.66 ± 1.45 and 58.0 ± 1.15 eggs) recorded after pairing the newly emerged females (age less than one hr) with 3 and 5-day old males, respectively. The mean number of eggs laid on seeds were (76.33 ± 1.76 and 37.0 ± 1.52 eggs) recorded after pairing the newly emerged males (age less than one hr) with 1 and 3-day old females, respectively. While the lowest mean number of eggs laid on seeds (16.33 ± 0.66 eggs) was recorded after pairing the newly emerged males (age less than one hr) with 5-day old females, compared with other treatment combinations.

3.2 Effects of parent age on developmental period of C. chinensis

Data in Figure (2) showed the effect of the parent age on the mean of the developmental period of *C. chinensis* in chickpea seeds. The shortest mean of developmental period (23.66 ± 0.88 days) was recorded after pairing the newly emerged females (age less than one hr) with 1-day old males, compared with other pairing combinations. The mean of developmental periods were (26.0 ± 0.0 and 27.33 ± 0.66 days) after pairing the newly emerged females (age less than one hr) with 3 and 5-day old males, respectively. The mean of developmental periods were (25.0 ± 0.57 and 30.66 ± 1.33 days) after pairing the newly emerged males (age less than one hr) with 1 and 3-day old females, respectively. While, longest mean of the developmental period (34.33 ± 1.45 days) was recorded after pairing the newly emerged males (age less than one hr) with 5-day old females, compared with other treatment combinations.

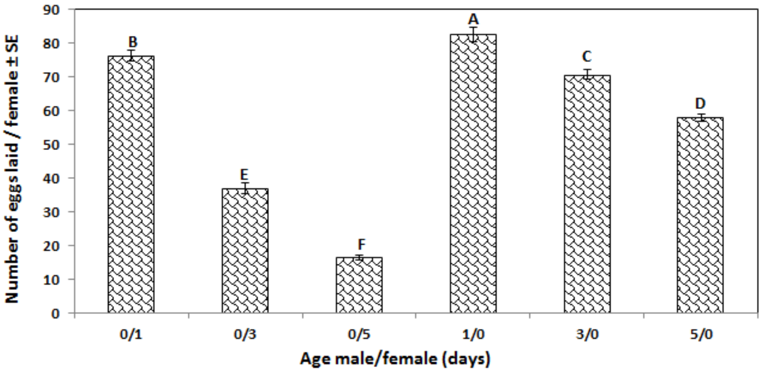

Figure (1): Mean number of laid eggs per female of *C. chinensis* of various age of parents on chickpea seeds. Columns headed by the same letter are not significantly different by the LSD test at $P \leq 0.05$.

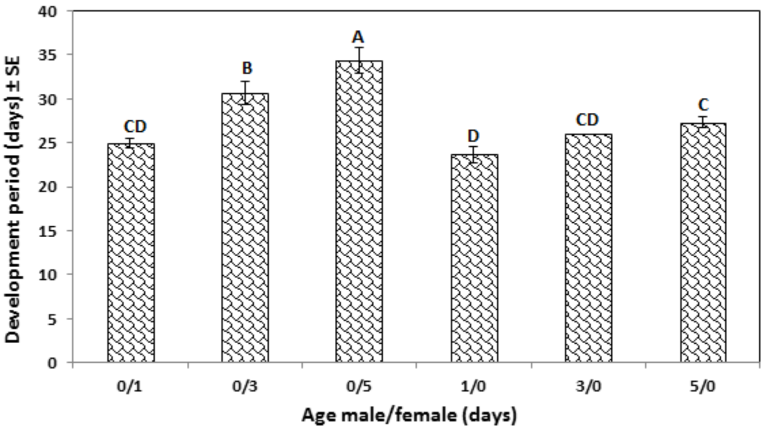

Figure (2): Mean of developmental period of *C. chinensis* of various age of parents in chickpea seeds. Column, headed by the same letter are not significantly different using the LSD test at $P \leq 0.05$.

3.3 Effect of some plant extracts on oviposition deterrent of C. Chinensis

Data in Figure (3) showed the deterrent effect of both acetone and aqueous extracts on oviposition of *C. chinensis* in chickpea seeds. In the case of the acetone extract, the highest mean of the percentage of oviposition deterrence was observed in acetone extract from leaves of neem (74.73 ± 2.65%), followed by the acetone extract from leaves of datura (71.69 ± 1.56%), the acetone extract from leaves of Jatropha (54.47 ± 2.56%), while the acetone extract from leaves of castor gave the lowest percentage of oviposition deterrence (45.80 ± 0.30%), among all acetone extracts. In the case of the aqueous extract, the aqueous extract from the leaves of neem showed the highest mean of the percentage of oviposition deterrent (67.24 ± 0.80%), followed by the aqueous extract from leaves of datura (62.87 ± 0.57%), the aqueous extract from leaves of Jatropha (48.15 ± 0.19%), while the aqueous extract from leaves of castor gave the lowest percentage of oviposition deterrent (34.75 ± 1.14%), among all aqueous extracts.

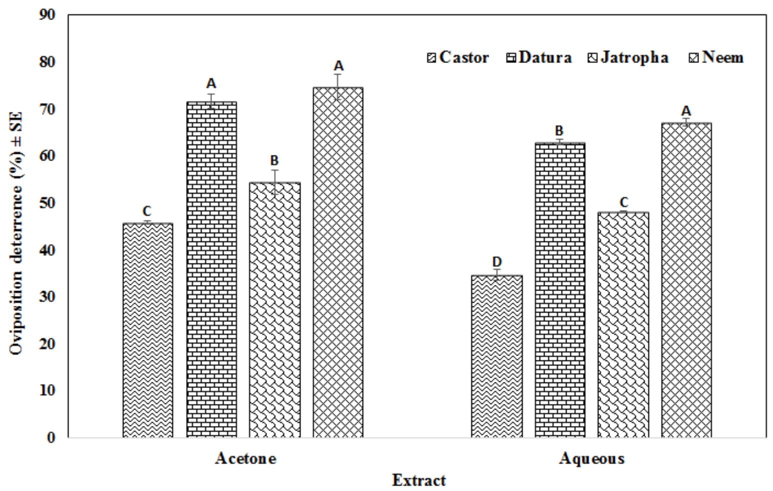

Figure (3): Mean percentage of oviposition deterrence of *C. chinensis* on chickpea seeds treated with different plant extracts. Columns headed by the same letter, in the same group, are not significantly different using the LSD test at $P \leq 0.05$.

3.4 Effect of some plant extracts on adult emergence of C. Chinensis

Data in Figure (4) showed the effect of both acetone and aqueous extracts on adult emergence of *C. chinensis* in chickpea seeds. In the case of the acetone extract, highest mean of the percentage of adult emergence was observed in acetone extract from leaves of neem

(74.13 ± 1.47%), followed by the acetone extract from leaves of datura (67.59 ± 1.72%), the acetone extract from leaves of Jatropha (47.40 ± 2.60%), while, the acetone extract from leaves of castor gave the lowest percentage of adult emergence (36.18 ± 2.23%), among all acetone extracts.

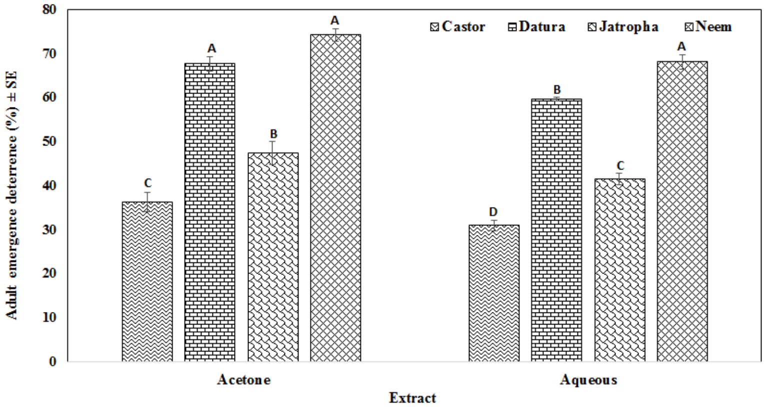

Figure (4): Mean percentage of adult emergence of *C. chinensis* in chickpea seeds treated with different plant extracts. Columns headed by the same letter, in the same group, are not significantly different using the LSD test at P ≤ 0.05.

In the case of the aqueous extract, the aqueous extract from leaves of neem showed the highest mean of the percentage of adult emergence (68.05 ± 1.59%), followed by the aqueous extract from leaves of datura (59.51 ± 0.44%), the aqueous extract from leaves of Jatropha (41.51 ± 1.31%), while the aqueous extract from leaves of castor gave the lowest percentage of adult emergence (30.90 ± 1.22%), among all aqueous extracts.

3.5 Effect of some plant extracts on feeding deterrent of C. Chinensis

Data in Figure (5) showed the deterrent effect of both acetone and aqueous extracts on the feeding of *C. chinensis* in chickpea seeds. In the case of the acetone extract, highest mean of the percentage of feeding deterrence was observed in acetone extract from leaves of neem (94.26 ± 0.67%), followed by the acetone extract from leaves of datura (91.68 ± 0.50%), the acetone extract from leaves of Jatropha (85.41 ± 0.55%), while the acetone extract from leaves of castor gave the lowest percentage of feeding deterrence (76.69 ± 1.04%), among all acetone extracts. In the case of the aqueous extract, the aqueous extract from leaves of neem showed the highest mean of the percentage of feeding deterrent (86.51 ± 0.90%), followed by the aqueous extract from leaves of datura (81.11 ± 0.33%), the aqueous extract from leaves of Jatropha (72.25 ± 1.50%), while the aqueous extract from leaves of castor gave the lowest percentage of feeding deterrent (63.26 ± 2.20%), among all aqueous extracts.

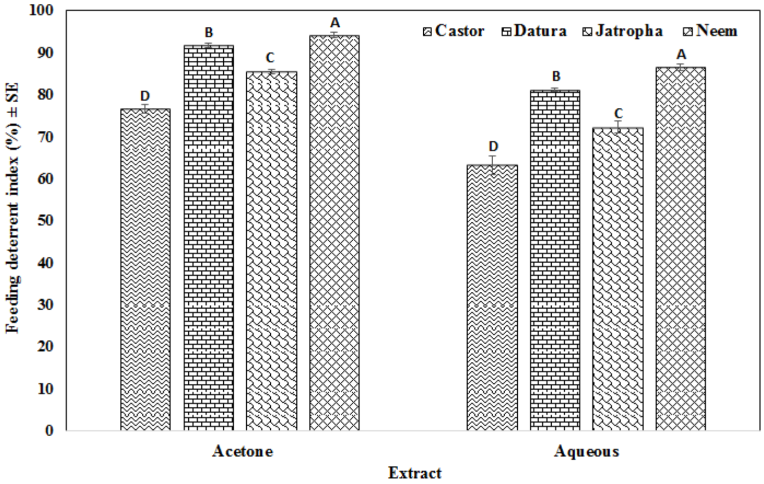

Figure (5): Mean percentage of feeding deterrent index of *C. chinensis* in chickpea seeds treated with different plant extracts. Column headed by the same letter, in the same group, are not significantly different using the LSD test at $P \leq 0.05$.

4. Discussion

The results in the current work revealed that the lowest mean number of eggs laid on seeds was 16.33 ± 0.66 eggs, while, the longest mean of developmental period (34.33 ± 1.45 days) was recorded in pairing newly emerged males (age less than one hr) with 5 days old females, compared with other treatments. Results of the present work are in general accordance with those of Wasserman and Asami (1985) who studied the effect of maternal age upon the fitness of progeny in the southern cowpea weevil, *C. maculatus*. The result showed that the female eggs decline in fitness with increasing maternal age. The developmental periods of offspring increase with maternal age, after 5 and 3 days of oviposition, respectively. Fox (1993) studied the influence of maternal age on offspring performance of the bruchid beetle, *C. maculatus*. Results showed that the developmental time increase with increasing maternal age. Huang and Subramanyam (2003) studied the effect of age at mating on the number of eggs laid (fecundity). Results showed that for each day that mating of virgin female or male of *Plodia interpunctella* (Hubner) was delayed, fecundity decreases by about 25 eggs. When males and females were mated without delay, all females mated successfully. Fecundity was significantly and positively correlated with the number of spermatophores/female. Fox and Dingle (1994) found that the developmental time of an offspring reared from eggs laid at older maternal age was longer than that from eggs laid at a younger age in *C. chinensis*. Hamed *et al*. (2010) determine the effect of delayed mating on the fecundity of *P. interpunctella*. Results showed that fecundity was decreases significantly with the increase in the age of females and males. However, males continue to produce progeny up to the age of 3 days when they were mated with freshly emerged females. No reproduction occurs when 3 days old virgin females were paired with newly emerged males. Egg-laying is continuing up to 8th day when 1-2 days old males and 1-day old females were mated with newly emerged females and males. Significantly high fecundity per day is achieved on 2nd, 3rd, and 4th day after mating in all treatments. Mahyuob *et al*. (2014) studied the effects of maternal age and temperature at 20, 25, and 30 ^{o}C on fecundity and development of *C. maculatus*. Results showed that the effects of maternal age are not consistent at the three tested temperatures. The number of eggs deposited daily is negatively correlated with maternal age for the tested temperatures. There is a significant positive correlation between maternal age and developmental time at 25 ^{o}C. Kostenkoa and Kolot (2018) studied the effects of maternal and/or paternal age on reproductive function parameters in the offspring of *Drosophila melanogaster*. Results showed that the effects of maternal and paternal ages are shown to vary various reproductive function parameters in F1 offspring. The advanced parental age has a negative effect on fertility and viability characteristics in F1 offspring such that the emergence of less adapted and viable offspring in the population is prevented. The results here revealed that the acetone extracts and aqueous extracts from neem leaves gave the highest mean of the percentage of oviposition deterrent, adult emergence and antifeedant were 74.73 ± 2.65 and 67.24 ± 0.80%, 74.13 ± 1.47 and 68.05 ± 1.59%, and 94.26 ± 0.67 and 86.51 ± 0.90%, respectively. Obtained results are in accordance with those of Elhag (2000), who tested extracts from nine plant materials including *A. indica* as oviposition deterrents against *C. maculatus* on chickpea seeds. Also, the progeny production is significantly reduced only11.9% of the eggs deposited reached adulthood. Raja *et al*. (2000) reported that leaf extract of *A. indica* and *J. curcas* show antifeedant, oviposition deterrent and reduction of the adult emergence of *C. maculatus*. Mollah and Islam (2002) mentioned that the botanical extracts like neem and jatropha cause reduced oviposition of *C. chinensis* markedly. Therefore, fecundity and the number of egg-bearing seeds of chickpea are less on acetone and ethanol extracts of neem seeds. Bhuiyah *et al*. (2003) found that the extracts of *A. indica* and *R. communis* show oviposition deterrent of *C. chinensis* in chickpea seed. Upasani *et* *al*. (2003) reported that the extract of *R. communis* leaves show excellent oviposition deterrent against *C. chinensis*, and number adults emerging are almost nil at 6.5 mg ml−1 compared in untreated and solvent controls. Akter *et al*. (2007) studied the effects of garlic clove, neem, and eucalyptus leaf extracts on oviposition of *C. maculatus* in gram seeds. The results showed that the neem leaf extract show the lowest number of laid eggs, lowest adult emergence, and lowest weight loss. Sathyaseelan *et al*. (2008) who observed the efficacy of some indigenous pesticidal plants caused significant oviposition deterrent effect against *C. chinensis* and reduction in adult emergence in green gram seeds. Shukla *et al*. (2009) studied the bioefficacy of *Acorus calamus* in methanol and petroleum ether extracts against *C. chinensis*. They found that leaf and rhizome powders and their solvent extracts show significant inhibition of egg-laying, F1 emergence of *C. chinensis*, and antifeedant. Hossain and Haque (2010) studied the efficacy of some indigenous leaf and seed extracts including *J. curcas* and *A. indica* against *C. chinensis* on chickpea seeds. The results revealed that all the tested extracts except methi were found to significantly inhibit oviposition, adult emergence, and weight loss as compared to control. Rahman *et al*. (2010) mentioned that dodder vine extract at 5% concentration give oviposition deterrent, adult emergence of *C. chinensis*, and less preferred for seed weight loss in gram seeds. Vanmathi *et al*. (2010) studied the effect of ten leaf plant extracts including *A. indica* at three different concentrations 1, 3 and 5% on the black gram, *Vigna munga* (L.) against *C. maculatus*. They found that the aqueous extract of *A. indica* leaves give 80.59 % oviposition deterrence and a 95.93 % reduction in Fl adult emergence of *C. maculatus* at a 5% dose. Abbasipour *et al*. (2011a) who studied the efficacy of plant extract from *D. stramonium* against *Tribolium castaneum* for its antifeedant activity. The results their data showed that there is a significant difference between the plant and different concentrations in the feeding deterrence index of *T. castaneum*, the nutritional indices vary significantly as plant extract concentrations increased. Abbasipour *et al*. (2011b) who reported that the insecticidal activity of extract from *D. stramonium* at different concentrations against *C. maculatus* cause significant oviposition deterrent of *C. maculatus* on mung beans. Patel (2011) reported that extract from seeds of castor, *R. communis* at 2% concentration cause a decrease in fecundity of pulse beetle *C. chinensis*. Singh (2011) investigated six plant extracts and reported that the maximum oviposition deterrence (55.86%) is recorded with neem leaf extract at the highest dose level (1.0ml/100gm) against *C. maculatus*. The reduction in fecundity may be attributed to the toxicity of neem extract, affecting the normal physiology of the insect. Zia *et al*. (2011) studied the bioefficacy of ten plant extracts against

C. chinensis. They reported that leaf extract of *A. indica* shows oviposition deterrent, reduction of adult emergence of *C. chinensis*, and antifeedant in chickpea seeds. Abdul Ahad *et al*. (2012) studied the efficacy of 13 of local plants in solvent n-hexane for screening of their insecticidal activity against *C. chinensis*. All plant extracts were showed insecticidal activity by affecting fecundity and adult emergence of *C. chinensis.* Kumar and Gupta (2013) mentioned that both petroleum ether and chloroform extract of *A. indica* show the highest antifeedant activity against *T. castaneum* and *Trogoderma granarium*. Khatun *et al*. (2014) studied that the efficacy of four plant extracts including neem and castor seeds extract at different doses 10, 15, and 20µml to protect the stored mungbean seeds of *C. chinensis*. Neem seed extract show maximum efficacy in terms of oviposition rate of *C. chinensis* and reduction of the number of adult emergency. Maji *et al*. (2014) who evaluated six plant extracts in ethanolic including neem leaf. They observed that all the botanicals are superior in suppressing the number of eggs laid on pea seeds and adult formation of pulse beetle of *C. chinensis*. Chudasama *et al*. (2015) studied the deterrent effect of different aqueous plant extracts including *A. indica* against *C. maculatus* in stored seeds of cowpea. Among different aqueous extracts of plant materials, neem leaf extract at 5% concentration give the maximum percentage of oviposition deterrence (60.30%) and adult emergence reduction of *C. maculatus* (71.38%). Rehman and Khan (2015) reported that the effect of aqueous extracts of bakain seed (*Melia azadirach* L.) against *C. chinensis* at different concentrations of the extract mixed with chickpea grains. Results revealed that bakain seed extract significantly reduced oviposition, adult emergence of *C. chinensis,* and decreased weight loss of chickpea seeds. Kosar and Srivastav (2016) studied different formulations of leaf plants, crude extract, aqueous suspension, aqueous extract, ethanol extract, and diethyl ether extract against *C. chinensis*. The mean egg-laying by *C. chinensis* was observed to be the lowest 4.10/ pair in experimental sets treated with 25 % DEE extract of leaves of *Jatropha gossypiifolia*. Overall, DEE and ethanol extract of *J. gossypiifolia* are found to significantly reduce oviposition. Taghizadeh and Mohammadkhani (2016) studied the antifeedant activity of aqueous and hydroalcoholic extracts from *Berberis thunbergii* L. and *Alhagi maurorum* Fisch. against *T. castaneum*. Results showed that FDI of *A. maurorum* is greater than that of *B. thunbergii* and hydroalcoholic extract is more effective than aqueous extract. Begum *et al*. (2017) assayed the acetone and water extracts of leaf and seed of castor, *R. communis* for effects on the pulse beetle, *C. chinensis* using different (7.5, 10, 12.5 and 15%) concentrations. Results showed that the pulses treated with castor leaf extracts at 15% dose led to inhibition adults emerged in F1 and decreased weight loss. The acetone extracts of leaf and seed are more effective than those of water extracts. Gangotia and Saddam (2017) mentioned that the effectiveness *Datura inoxia* (Miller) in acetone and methanol extracts were tested on *C. maculatus* fed on cowpea seeds. The extract is effective in decreasing the oviposition and F1 adult emergence of *C. maculatus* in cowpea seeds. Saleem *et al*. (2017) studied some essential oils extracted from some plants including *D. stramonium* were examined for feeding deterrent action against *T. castaneum*, *T. granarium*, and C*ryptolestes ferrugineus*. They found that *D. stramonium* is the most active antifeedant with feeding deterrence index (FDI) from among anther oils.

5. Conclusions

This study shows the impact of the age of each of the fathers on the number of eggs laid by females, as well as the time of development so that the insect can be controlled and reduce the damage it causes. Moreover, neem extract showed strong deterrent activity whereas that of castor extract exhibited poor activity against oviposition, adult emergence of *C. Chinensis*, and feeding, which indicated that these extracts may serve as protectants for treated chickpea seeds.

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