International Journal of Allied Practice, Research and Review
Website: www.ijaprr.com (ISSN 2350-1294)

Effect of Some Euphorbiaceae Plant Formulations on Adult Emergence of Stored Grain Pest *Callosobruchuschinensis Linn.*

Heena Kosar, Anuradha Swami, Kailash K. Swami and Meera Srivastava
Laboratory of Entomology,
Post Graduate Department of Zoology,
Government Dungar College, Bikaner, Rajasthan, India

Abstract - The genus *Callosobruchus*attacks grain legumes during both pre and post- harvest stages all over the world. Efficient control of stored grain pests has long been the aim of entomologists throughout the World and synthetic chemical pesticides have been used for many years to control stored grain pests. However, the persistent use of these insecticides in granaries of small-scale farmers has led to a number of problems. Plants contain a large number of secondary metabolites and have been tried with good degree of success as protectants against a number of stored grain insect pests. The present work was therefore carried out to screen certain formulations of plants belonging to family Euphorbiaceae against the pulse beetle *Callosobruchuschinensis* Linn. raised on grains of *Vignaradiata*. The plants selected for the study included *Euphorbia hirta*, *Phyllanthusamarus* and *Jatrophagossypiifolia*employing different formulations and recording the adult emergence (per cent).During the present study mean adult emergence (%) of *C. chinensis* in normal sets was observed to be 82%, while in control sets treated with glass distilled water it was noted to be 70% and in sets treated with ethanol extract it was observed to be 57.50% and in those treated with DEE it was documented as 58.50%. No adult emergence of the bruchid was found in sets treated with all the different concentrations of crude extract, aqueous suspension, aqueous extract and ethanol extract of *P. amarus*. Crude extract of *J. gossypiifolia*also resulted in no emergence of the pest. Overall, crude extract, aqueous suspension, aqueous extract and ethanol extract of *P. amarus* were found to significantly decrease the adult emergence of the bruchid.

Keywords - *Callosobruchuschinensis*, Euphorbiaceae,*Euphorbia hirta*, *Phyllanthusamarus*, *Jatrophagossypiifolia*, formulations, adult emergence

I. Introduction

Insects have a direct impact on agricultural food production as on one side they act as pollinators while on the other act as pests, not only in the fields but also in store houses to post harvest commodities.Pulses constitute major source of protein in the diet of people of developing countries and play an important role in Indian economy and are traditionally recognized as an indispensable constituent of Indian food. In India, where the population is predominantly vegetarian, pulses are the most important and rich source of protein and several amino acids. Among the Indian states, Rajasthan stands at third position in pulse production.

According to reports available, in India, over 200 species of insects have been recorded infesting various pulses (CABI, 2007). The genus *Callosobruchus*attacks grain legumes during both pre and post- harvest stages all over the world; but in India, *C.maculatus*, *C. analis*and *C. chinensis*are the predominant pest species of the genera (Dias, 1988). This insect pest has been reported from the Philippines, Japan, Srilanka, Burma and India and is one of the most destructive pest of stored pulses.

Efficient control of stored grain pests has long been the aim of entomologists throughout the World and synthetic chemical pesticides have been used for many years to control stored grain pests (Salem et al., 2007; Ani, 2010; Bhalla et al., 2008). However, the persistent use of these insecticides in granaries of small-scale farmers has led to a number of problems such as killing of non-target species, user hazards, toxic residues in food, development of genetic resistance in the treated pest, increased cost of application and the destruction of the balance of the ecosystem (Shaheen&Khaliq, 2005; Boateng&Kusi, 2008). But now, scientists have started working for the development and establishment of plant based pesticide, usually called as phytopesticide, botanical pesticide, biopesticide or natural pesticides (Verma et al., 2006; Yan-Zhang et al., 2007; Siddiqui et al., 2009; Tariq et al., 2010). Plants contain a large number of secondary metabolites and those categorized under terpenoids, alkaloids, glycosides, phenols, tannin, flavanoids etc. play a major role in plant defense and cause behavioural and physiological effect on insects. Various locally available plant products have been tried with good degree of success as protectants against a number of stored grain insect pests (Gill & Lewis, 1971; Dulia et al., 1999; Varma & Dubey, 1999; Swain &Baral, 2004; Salam et al., 2005) and over 200 plant species have been reported to have insecticidal properties capable of controlling insects (Golob& Webley 1980). Besides the other works include those by Srivastava & Mann (2002a), Srivastava & Mann (2002b), Kaur & Srivastava (2004), Srivastava & Gupta (2007), Srivastava & Ghei (2007), Gupta & Srivastava (2008), Kiradoo & Srivastava (2009), Kiradoo & Srivastava (2010), Kiradoo & Srivastava (2011), Rawat & Srivastava (2011), Rawat & Srivastava (2012), Mann & Srivastava (2013a, b, c, d, e, f), Kosar & Srivastava (2013), Mann & Srivastava (2014).

The plant family Euphorbiaceae is a large family of flowering plants with 300 genera and around 7,500 species. A number of plants of this family are of considerable economic importance. *Ricinuscommunis*, *Jatropha curcas*, *Euphorbia pulcherima* are used as prominent ornamental plants. Some members of Euphorbiaceae have medicinal properties for eg. *P. amarus*, *P. nirurim*, *E. hirta*, *J. curcas* and *J. gossipifolia*. Many plant species have been used to control stored product pests which include the physic nut, *Jatropha curcas* L. The efficacy of

Jatropha seed oil against insect has been reported by Huis (1991), Adabie- Gomez et al. (2006) and Henning (2007). Aqueous leaf extract of *Ricinuscommunis* L (Euphorbiaceae), a cultivated plant in tropical countries, showed excellent insecticidal activity against *Callosobruchuschinensis* L (Coleoptera: Bruchidae) as documented by Upasani et al. (2003). They isolated and tested flavonoids as insecticidal and antimicrobial agents. The isolated flavonoids showed potential insecticidal, ovicidal and oviposition deterrent activities against *C. chinensis* L. Experiments were conducted by Hossain &Haque (2010) to study the efficacy of some indigenous leaf and seed extracts including *Jatropha curcas* against pulse beetle, *Callosobruchuschinensis*(L.) on chickpea seeds. The botanicals were extracted by using acetone, ethanol, n-hexane, petroleum ether and water. The efficacy was evaluated by considering ovi position, adult emergence, seed infestation and weight loss caused by the insect. All the tested extracts of euphorbiaceous plants were found significantly effective in checking the oviposition, adult emergence, seed infestation and weight loss as compared to control. Repellency of hydroethanolic extracts of *Ricinuscommunis* to *Scyphophorusacupunctatus* in the laboratory have also been studied by Cinthia et al. (2012).

The present work was therefore carried out to screen certain formulations of plants belonging to family Euphorbiaceaeagainst the pulse beetle *Callosobruchuschinensis* Linn. raised on grains of *Vignaradiata*. The plants selected for the study included *Euphorbia hirta*, *Phyllanthusamarus* and *Jatrophagossypiifolia*employing different formulations and recording the adult emergence (per cent).

II. Materials and Method

The leaves of the selectthree plants viz., *Euphorbia hirta*, *Phyllanthusamarus* and *Jatrophagossypiifolia* belonging to family Euphorbiaceaewere collected from Bikaner city (27º11' & 20º 03' North latitude and 71º54' & 74º12' East longitude), Rajasthan and its vicinity and used fresh as well as in dry form. Different formulations employing glass distilled water; diethyl ether and methanol solvents were prepared and applied on the test insect *Callosobruchuschinensis* Linn. in various dose concentrations ranging from 1 to 25%.

The test insect selected for the investigation was pulse beetle *Callosobruchuschinensis* L. which was raised on green gram *Vignaradiata*. The seeds of the grain for culture were purchased from the local market, cleaned and then exposed to a temperature of 60ºC for four hours in an incubator to remove infestation, if any.The culture of pest insect on the host grains was developed by releasing a single pair of adult insects. This culture was maintained in glass jar covered with muslin cloth tied with the help of rubber band. The adults emerging from this initial culture were used for maintaining subsequent cultures. There jars were kept in an incubator maintained at 28±2ºC temperature and 70% relative humidity. During experiments forceps and camel hair brushes were used for transferring the seeds and insects respectively.

The leaves of the select three plants were used to prepare different formulations. For this, fresh as well as dried leaves were used. For crude extracts fresh leaves were taken while, for rest of the formulations they were shade dried for 10-15 days and kept in airtight plastic container for further use. For crude extract, fresh green leaves of each plant were taken and churned in a grinder and sieved through muslin cloth. The juice thus obtained was used in the form of crude extract of 100% concentration. It was further diluted using GD water to make extracts of 1, 5, 10 and 25% concentrations. For aqueous suspension, 10g of powdered leaves were weighed to which 10ml of GD water was added, this served as stock solution of powder suspension from which further dilutions of 25, 10, 5 and 1% were made. For aqueous extract, 10g of powdered plant material was kept in a thimble. The thimble was placed in a flask containing 50ml of distilled water and boiled till the volume reduced to 10ml to get concentration of 100 percent. Further dilutions were made by adding required amount of distilled water for getting lower concentrations viz., 1,5,10 and 25 %. For ethanol extract, 10g of dried and powdered leaves were taken in a thimble. It was placed in a soxhlet extraction unit with petroleum ether (Assay 99.50%) and distilled. The extract so received was made to a fix volume of 10ml having concentration of 100%.This worked as stock solution. Further dilutions were made to have 1, 5, 10 and 25% concentration. The ethanol extracts were prepared fresh at the time of application to avoid evaporation loss and concomitant alteration in concentrations. For diethyl ether extract, the same procedure as for ethanol extract was followed except for, in this extract preparation, ethanol was replaced by solvent diethyl ether (Assay 99.0%).

Normal, control and five experimental sets were laid out. Each set comprised of three replicas. In all these sets, 10g host grains were inoculated with 10 pairs of freshly emerged adults of the pest insect *C. chinensis*, kept in a beaker covered with muslin cloth fastened with rubber bands. Normal and control sets were also kept along with experimental ones for comparisons.

The observations pertaining to adult emergence were recorded as follows:

The total number of insects which emerged out as adults was counted and percent adult emergence was calculated as:

$$\text{Percent adult emergence} = \frac{E}{T} \times 100$$

Where, E= Total number of adults emerged

T= Total number of eggs laid

The average values for were calculated by using observations from the three replicates and compared with Control and Normal treatments. The data obtained was subjected to analysis of variance (ANOVA) using MS-Excel software. The critical difference at 1 and 5% level of significance was worked out.

III. Result

The mean adult emergence (%) by the bruchid*C. chinensis* under different treatments of various plants has been presented in Table 1a and Figs. 1 to 5. ANOVA has been presented in Tables 1b to 1n.

During the present study mean adult emergence (%) of *C. chinensis* in normal sets was observed to be 82%, while in control sets treated with glass distilled water it was noted to be 70% and in sets treated with ethanol extract it was observed to be 57.50% and in those treated with DEE it was documented as 58.50%. No adult emergence of the bruchid was found in sets treated with all the different concentrations of crude extract, aqueous suspension, aqueous extract and ethanol extract of *P. amarus*. Crude extract of *J. gossypiifolia*also resulted in no emergence of the pest. Overall, crude extract, aqueous suspension, aqueous extract and ethanol extract of *P. amarus* were found to significantly decrease the adult emergence of the bruchid.

For comparing the effect of different formulations ANOVA was applied and has been presented Table 1b. Further, based on this analysis, Tables 1c to 1n were constructed. The perusal of the results presented in Table 1c indicates that the emergence of the beetle was significantly reduced in various experiments sets.

Table 4b clearly shows that the results of emergence of the bruchid pertaining to effect of plants (A), extracts (B), concentrations (C), plants and extracts (AXB), plants and treatments (AXD), extracts and concentrations (BXC), extracts and treatments (BXD), concentrations and treatments (CXD), plants, extracts and concentrations (AXBXC), plants, extracts and treatments (AXBXD), plants, concentrations and treatments (AXCXD), extracts, concentrations and treatments (BXCXD) and plants, extracts, concentrations and treatments (AXBXCXD) were highly significant ($p<0.01$), while plants and concentrations (AXC) was non-significant.

On the basis of ANOVA (Table 1c) with respect to the efficacy of the three plants studied, it was found that treatments of *P. amarus* significantly ($p<0.01$) decreased the emergence of the bruchid as compared to treatments of *J. gossypiifolia* and *E. hirta.*

When comparisons were made on the basis of ANOVA (Table 1d), it could further be inferred that all the extracts of *P. amarus*significantly ($p<0.01$) reduced the emergence of the bruchid.

When the effect of different concentrations on the emergence of the *C. chinensis* was compared, it was noted that 10 and 25% extracts resulted in significant ($p<0.01$) decrease in the emergence of the bruchid as compared to other two concentrations viz., 1% and 5% which differed non-significantly from one another.

In experimental sets treated with plants and their extracts the efficacy of emergence of *C. chinensis* was found to be significantly low ($p<0.01$) in sets treated with ethanol extract of *P. amarus* (Table 1d).

Further, when the effect of plants and treatments on the emergence of *C. chinensis* was observed, it was found that all treatments of select three plants decreased the emergence of the beetle as compared to normal and control sets (Table 1f).

IV. Discussion

During the present study no adult emergence of the bruchid was found in sets treated with all the different concentrations of crude extract, aqueous suspension, aqueous extract and ethanol extract of *P. amarus*. Crude extract of *J. gossypiifolia* also resulted in no emergence of the pest.

Jatropha oil inhibits hatching of eggs in potato tuber moth has been reported by Shelke et al. (1987). Sathyaseelan et al. (2008) noted 73.3% reduction in adult emergence of *C. chinensis* when the host grains of green gram were treated with leaf extract of *Acalypha* species belonging to *Euphorbia*ceae. The present findings are in conformation with the earlier works which include the reports of Roger &Hamraoui (1994) who studied the efficacy of hydro-distilled and intact Lamiacea plants and found *M. piperita*, *O. vulgare*, *T. vulgaris*, *S. hortensis*, *R. officinalis* effective in reducing adult emergence of *A. obtectus*. According to Kathuria& Kaushik (2006) treatment of leaves of *O. sanctum* L.adversely affected the percentage adult emergence of *H. armigera*. Raja et al. (2001), suggested that volatile oils derived from *M. arvensis*, *M. piperita*and *M. spicata* significantly influenced adult emergence of *C. maculatus*. 68.7% reduction in adult emergence of *C. chinensis* was recorded in sets treated with leaf extracts of *Ocimum*by Sathyaseelanet al. (2008). Mishra et al. (1981) observed reduction in the emergence of *C. chinensis*when treated with oil vapours of three species of *Mentha* viz., spicata, piperita and citrata.Iloba&Ekraken (2006) observed the treatments of *Hyptissuaveolens* to perform better in reducing emergence of *C. maculatus*and *S. zeamais* as compared to *A. indica*and *O. gratissimum*.Mbaiguinam et al. (2006) documented significantly low adult emergence of *C. maculatus*employing extracts of *A. indica*, *R. communis*, *T. nerifolia*, *Balaniteseagyptiaca*, *Moringaoleifera*and *Kaya sanegalensis*. Udo et al. (2004) noted a significant reduction in progeny emergence of *S. zeamais* and *C. maculatus* when treated with formulation of *Z. zanthoxyloides*.Adedire&Akinneye (2004) observed a drop in adult emergence of *C. maculatus*when treated with extracts of tree marigold (*Tiphoniadiversifolia*). All these reports by earlier workers give support to the present findings.

During the present study different formulations were found to influence adult emergence of the pulse beetle. Overall, crude extract, aqueous suspension, aqueous extract and ethanol extract of *P. amarus* were found to significantly decrease the adult emergence of the bruchid. Earlier, Lale (1992) and Lale&Abdululrahman(1999) observed that acetone extract of fruit of *C. frutescens* was effective and reducing adult emergence of *C. maculatus*, while, Gupta (2004) recorded aqueous extract of leaf of *W. somnifera* to result in minimum adult emergence. Ghei (2001) noted minimum adult emergence in sets treated with ether extract of pods of *Trigonella*. Echendu et al. (1988) documented reduction in emergence of *C. maculatus*when treated with dry gingerroot powder and dried neem fruit. Significant decrease in adult emergence of *C. chinensis* was also observed by Prakash & Rao (1989) when leaves of *V. negundo* were admixed with grain of *V. mungo*. Mann (1997) found formulations of *Peganum*and *Tribulus* to reduce emergence. No adult emergence of *C. chinensis*was observed when sets were treated with extracts of leaves of *Tephrosia*and stem of *Crotolaria* by Ghei (2001), while, Gupta (2004) recorded minimum adult emergence when grains were treated with leaf extract of *W. somnifera* which also support the present findings. Sharma & Srivastava (1984) observed no fresh emergence of *R. dominica*and *S. oryzae* when the grains were treated with neem kernel. Pandey et al. (1985) found reduction in emergence of *C. cephalonica* when neem oil kernel powder and babul gum was employed. Pareek&Batta (1998) used various plants products against *C. partelus*and observed significantly lowered adult emergence. Either no larval emergence or otherwise poor larval survival was observed by Siddique et al. (1990) when neem products were used against *C. partelus*, all these are in agreement with also the present findings.

During the present study the concentration of various formulations were found to significantly affect the adult emergence of the pest insect, being significantly low in in sets treated with 10 and 25% dose concentrations. *Jatropha* seed oil concentrations of 5, 10, 15 and 20% were tested for biological activity against the 3rd nymphal instar of the desert locust *S. gregaria* by Basher &Shafie (2013). They reported that all tested concentrations caused significant ($p < 0.05$) reduction in percent of egg hatch after seven days of application. Boetang&Kusi (2008) suggested Jatropha seed oil to be highly toxic to the egg of *C. maculatus* at different dose treatments of 0.5, 1.0, 1.5 and 2ml and resulted in a significantly reduced number of adults emerging from the seeds. Kamakshi et al (2000) also found dry and fresh leaf extracts of *M. arvensis* and *O. sanctum* to be effective in reducing adult emergence of pulse beetle at 5 and 10% concentrations. Earlier Sharma (1985) also observed reduced emergence of *R. dominica*when the concentration of treatments of *Calotropis* flowers was increased from 0.1 – 1000 ppm. El Ghar et al. (1987) reported *I. palmata* and*N. oleander* extract at 0.5% (W/V) to prevent adult emergence of *C. chinensis*. Jacob &Shiela (1993) suggested leaf powder of *C. procera*, *C. odorata*and *A. indica* at 2.5 and 5% concentration to significantly reduce the number of adults of *R. dominica*emerging from the grains. A dose of 2% turmeric powders was reported by Chanderet al. (1992) to suppress the progeny of T. *castaneum* by 60%, all these reports are in conformation with the present findings.

Oils of different plants have been used by various workers, which have been found to reduce adult emergence. These include the works of Khaire et al. (1992), who employed karanj oil; Naik&Dumbre (1984), who besides using karanj also found oils of neem, castor and undi to be effective in reducing adult emergence; Mueke&Apuuli (1986), who observed no emergence when treated with vegetable oils; Yadav (1985), who reported neem seed oil to suppress adult emergence; Olaifa&Erhun (1988), who found reduced emergence when treated with volatile oil of *P. guineense*; Singhal& Singh (1990), according to whom groundnut, soybean and rape seed oils adversely affect the adult emergence of bruchid; Uvah&Ishaya

(1992), who documented groundnut and palm oil to reduce emergence, while, no emergence was observed in grains treated with castor, neem, karanj and groundnut oil by Kachare et al. (1994) and when treated with hoonge oil by Sangappa (1977) of *C. chinensis*. The citrus oils were found to almost completely prevent the emergence of adults of *S. granarius*when applied at 0.75% by El Sayed et al. (1989). They further reported that 2.5 and 5 ml/kg maize oil reduced the progeny of the bruchid to 1.3 and 0.25 after one month as compared with 158 days for no treatment and no progeny was observed when coconut oil was used. The dose of 0.4% mustard oil was reported by Chanderet al. (1992) to suppress the progeny of *T. castaneum* by 84%. No adult emergence of *C. maculatus* was observed by Ramzan (1994) in green gram when coated with 5 and 10 ml of the oil of cottonseed, sunflower, groundnut, soybean and mustard. Decreased adult emergence of *C. maculatus* was observed from chickpea seeds treated with soybean and castor oil at 5 ml/kg concentration by Ivanaia et al. (1995). Huang et al. (1997) observed that nutmeg oil significantly affected hatching and emergence of *T. castaneum* in the concentration ranging from 1.4 to 3.2 mg/cm^2. An increase in dose concentration was found to decrease per cent adult emergence of *C. chinensis*by Negi et al. (1997) when treated with pongam oil. In view of efficacy, a dose of 1.5% was considered to be good additive in inhibiting adult emergence by them, and therefore, are in agreement with the present findings.

The reduction in adult emergence could be either due to egg mortality or reduction in hatching of the eggs. The egg mortality has been attributed to the toxic compound present in the plant additives by Su et al. (1972), while, Singh et al. (1978) considered the physical properties which cause change in surface tension and oxygen tension within the eggs. Oil exert some lethal action on developing embryos or its I[st] instar larvae has been reported by Don Pedro (1989), who suggested that by the reduction in rate of gaseous exchange due to some 'barrier effect' and/or direct toxicity of the penetrated oil fraction resulted in lethality. Oil infiltration under the operculum may block respiration or disrupt the water balance of eggs and developing embryos has been suggested by Messina & Renwick (1983). Verma et al. (1983) also suggested that the reduction in the hatching of the eggs treated with different oil cakes and oil might be due to the fact that oil entered eggs from the micropyle and stopped the protoplasmic movements of freshly laid eggs. The structure of the bruchid eggs could also contribute to the ovicidal effect of the extracts was suggested by Creland (1992). Neem seed powder has been found to significantly reduce egg hatching by Mathur et al. (1985), who attributed this to be due to more effective adhesion of powder particles on micropyle of eggs which either create obstacle in their rupturing or induce some unknown physiological changes resulting in the failure of hatching. This could be true for the present findings also. Ogigianbe&Onigbinde (1996) reported that tannic acid significantly reduces F_1 progeny and consequently the percentage adult emergence of *C. maculatus*. They suggested that tannic acid content of the cotyledons reduce larval growth and development, while that of the seed coat reduced penetration of the I[st] instar larvae into the seed and before, also the adult emergence.

The results overall suggest that the plant formulations employed during the present work do prove their efficacy reducing the adult emergence pf the pest *C. chinensis*.

V. References

1. **Adabie- Gomez, D.A., Monford, K.G., Agyir-Yawson, A., OwusuBiney, A. and Osae, M. 2006. Evaluation of four local plant species for insecticidal activity against *Sitophilus Zeamais*Mots (Coleoptera: Curculionidae) and *CallosobruchusMaculatus* (F.) (Coleoptera: Bruchidae). *ChanaJ. Agric. Sci*. 39: 147-154.**

2. **Adedire, C.O. &Akinneye, J.O. 2004. Biological activity of tree marigold, *Tithoniadiversifolia*, on cowpea seed bruchid, *Callosobruchusmaculatus*(Coleoptera: Bruchidae). *Annals of Applied Biology* 144(2): 185–189.**

3. **Ani Dialoke Sunday, 2010. Screening of some Biopesticides for the contral of *Callosobruchuschinensis* in stored black beans (*Vigna mango*) in Imo state. Journal of American science; 6(5).**

4. **Bashir, Ebtisam&Hamadltu El Shafie 2013. Insecticidal and antifeedant efficacy of Jatropha oil extract against desert locust, *Schistocercagregari*a (Forskal) (Orthoptera: Acrididae). *Agriculture and Biology Journal of North America*, 4(3):260-267.**

5. **Bhalla, S., Gupta, K., Lal, B., Kapur, M.L., Khetarpal, R.K. 2008. Efficacy of various non-chemical method against pulse beetle, *Callosobruchusmaculatus*Fab. Endure Diversifying Crop Protection, p. 4.**

6. **Boateng, B. A. &Kusi, F. 2008. Toxicity of *Jatropha* seed oil to *Callosobruchusmaculatus*(Coleoptera: Bruchidae) and its parasitoid, *Dinarmus basalis* (Hymenoptera: Pteromalidae). *Journal of Applied Science Research* 4, 945–951.**

7. **CAB International 2007. Crop Protection compendium. Walling ford, UK: CAB International.**

8. **Chander, H., Kulkarni, S. G. and Berry, S. K. 1992. Studies on turmeric and mustard oil as protectant against infestation on red flour beetle, *Triboliumcastaneum*(Herbst.) in stored milled rice. *J. Insect. Sci.*, 5 (2): 220-222.**

9. **CinthiaPacheo-Sanchez, Patricia Villa- Ayala, Roberto Montes-Belmont, Rodolfo Figueroa Brito, Alfredo Jimencz- Percz. 2012. Effect of *Ricinuscommunis* extracts on weight and mortality of *Scyphophorusacupunctatus*(Colcoptera: Curculionidae) http://www.ijastnet. *International Journal of Applied Science and Technology,* 2(L)83-94.**

10. **Creland, P. F 1992. The structure of bruchid eggs may explain the ovicidal effects of oils. *J. Stored Products Res.*, 2 8 : 1 - 9.**

11. **Dhulia, F.K. Patel, A.J. and Patel I.S. 1999. Efficacy of various vegetable oils for protecting green gram (*Vignaradiata* L.) against pulse beetle in storage. *Pest Management and Economic Zoology,* 2: 177-179.**

12. **Don Pedro, K. N. 1989. Mode of action of fixed oils against eggs of *Callosobruchusmaculatus*(E). *Pesticide Science,* 26 (2): 107-115.**

13. **Echendu, T. N. C, Njoku, B. O., Oti, E., Odurukwe, S, O. and Ene, L. S. O. (eds.) 1988. Preliminary investigations into the use of ginger, neem and cashew nutshell liquid (CNSL) to reduce damage caused to stored cowpeas by *Callosobruchusmaculatus. Proc. of the First Nat. Ginger Workshop, Umudike.* Nigeria, 124-128.**

14. **El-Ghar, G. E. S. A. & El-Sheikh, A. E. 1987. Effectiveness of some plant extracts as surface protectants of covvpea seeds against the pulse beetle, *Callosobruchuschinensis. Phytoparasitica,* 15: 109-113.**

15. **El-Sayed, F. M. A., Etman, A. A. M. and Abdel Razik, M. 1989. Effectiveness of natural oils in protecting some stored products from two stored product pests. *Bull. of Fac. of Agric, Univ. of Cairo,* 40 (2): 409-418.**

16. **Ghei, Meenakshi. 2001. Screening of certain leguminous plants for their insecticidal efficacy against pulse beetle*Callosobruchuschinensis*Linn. (Coleoptera: Bruchidae) Ph. D, Thesis, M.D. S. University, Ajmer (India), p. 146.**

17. **Golob, P. & Webley, D. J. 1980. The use of plants and minerals as traditional protectants of stored products. *Tropical products Institute,* London, pp. 32.**

18. **Gupta, Latila, 2004. Management of pulse beetle *Callosobruchuschinensis* employing extracts of some solanaceous plants. Ph.D. Thesis, MDS University, Ajmer (India).**

19. **Gupta, Lalita& Srivastava, Meera2008. Effect of various extracts of plant *Withaniasomnifera* on the mortality of *Callosobruchuschinensis* L. *Journal of Biopesticides,* 1(2): 190-192.**

20. **Huang, Y, Tan, J. M. W. L., Kini, R. M. and Ho, S. H. 1997. Toxic and antifeedant action of nutmeg oil against *Triboliumcastaneum*(Herbst) and *S. zeamais*(Motsch.). *J. Stored Products Res.,* 33 (4): 289-298.**

21. **Iloba, B.N. &Ekrakene, T. 2006. Comparative assessment of insecticidal effect of *Azadirachtaindica, Hyptissuaveolens and Ocimumgratissum*on *Sitophilus zeamais*and *Callosobruchusmaculatus*. *Journal of Biological Sciences* 6 (3): 626–630.**

22. **Ivania, A., Pacheco, M., Fernanda, R R M., De Castro, Dalmo C, De Paula, Andre, L., Lourencao, ScheillaBolonhezi and Margarida K. Barbieri 1995. Efficacy of soybean and castor oils in the control of *Callosobruchusmaculatus*(F.) and *Callosobruchusphaseoli*(Gyllenhal) in stored chickpeas *(Cicerarietinum). J. Stored Prod. Res.,31* (3): 221-228.**

23. **Jacob, S. & Sheila, M.K. 1993. A note on protection of stored rice from lesser grain borer. *Rhyzoperthadominica*Fab. by indigenous plant products. *Ind. J. Ent.*. 55:337-339.**

24. **Kachare, B. V., Khaire,V. M. and Mote, U.N. 1994. Efficacy of different vegetable oils as a seed treatment in increasing storage ability of pigeonpea seeds against pulse beetle *Callosobruchuschinensis*Linn. *Ind. J. Ent.,* 56 (1): 58-62.**

25. **Kamakshi, B., Rabaiah Ibrahim, S., Raja, N. and Ignachimuthu, S. 2000. Control of pulse beetle *Callosobruchusmaculatus*using edible plant leaf extract. *Uttar Pradesh J. Zool.,* 20 (2): 143-146.**

26. **Kathuria, V. & Kaushik, N. 2006. Evaluation of insecticidal property of some plant species against*Helicoverpaarmigera*. *Indian Journal of Agricultural Science*, 76 (10): 617–617.**

27. **Kaur, Amandeep & Srivastava, Meera 2004. Comparative toxicity of certain plant formulations against stored grain pests. *Indian J. Appl. Ent*. 18(2): 94-100.**

28. **Khaire, V. M., Kachare, B. V. and Mote, U. N. 1992. Efficacy of different vegetable oils as grain protectants against the pulse beetle, *Callosobruchuschinensis*L. in increasing storability of pigeon pea. *J. Stored. Prod. Res.* ,28: 153-156.**

29. **Kiradoo, Murli Manohar & Srivastava, Meera 2009. Lamiaceae plants: An alternate to hazardous chemical insecticides. Proceedings National Conference on Environmental Health Hazards 2009. Dec. 17-18, JDB Govt. College, Kota, India. 201.**

30. **Kiradoo, Murli Manohar & Srivastava, Meera 2010. A comparative study on the efficacy of two Lamiaceae plants on egg-laying performance by the pulse beetle *Callosobruchuschinensis* Linn. (Coleoptera:Bruchidae). *Journal of Biopesticides,* 3 (3): 590 – 595.**

31. **Kiradoo, M.M.& Srivastava, Meera 2011. Insecticidal efficacy of some Lamiaceae plant extracts against *Callosobruchuschinensis* Linn. (Coleoptera: Bruchidae). *Asian J.Agric. Sci*. 3 (2): 100-103.**

32. **Kosar, Hina&Meera Srivastava 2013. A study on mortality of *Callosobruchuschinensis* L. (Coleoptera: Bruchidae) when treated with various formulations of plant *Phyllanthusamarus* (Euphorbiaceae). *International Journal of Chemical, Environmental & Biological Sciences*, 1(1):177-179.**

33. **Lale, N. E. S. 1992. Oviposition-deterrent and repellent effects of products from dry chilli pepper fruits, *Capsicum* species on *Callosobruchusmaculatus. Posthanest Biology and Technology,* 1: 343-348.**

34. **Lale, N.E.S. &Abdululrahman, H.T. 1999. Evaluation of neem (*Azadirachtaindica A. Juss*) seed oil obtained by different methods and neem powder for the management of *Callosobruchusmaculatus*(F.) (Coleoptera: Bruchidae) in stored cowpea. *Journal of stored products* Research, 35: 135–143.**

35. **Mann, Amandeep Kaur 1997. Evaluation of pesticidal efficacy of certain desert plants against some stored grain pests. Ph. D. Thesis, M. D. S. University, Ajmer (India), p. 197.**

36. **Mann, Amandeep Kaur & Meera Srivastava 2013a. Effect of smoke treatment of plant *Aervatomentosa* on the mortality of pest *Rhizoperthadominica* (Fab.) (Coleoptera: Bostrichiadae). *Indian Journal of Applied Research*, 3(7):650-651.**

37. **Mann, Amandeep Kaur & Meera Srivastava 2013b. Efficacy of plant *Peganumharmala* on the percentage of damaged grains infested by pulse beetle *Callosobruchuschinensis* Linn. *International Journal of Scientific Research*, 2(8): 512-513.**

38. **Mann, Amandeep Kaur &Meera Srivastava 2013c. Study on biopesticidal potential of some desert plants. *Journal of Entomology and Zoology Studies*, 1(3): 79-82.**

39. **Mann, Amandeep Kaur &Meera Srivastava 2013d. Efficacy of plant *Fagoniacretica* on the percentage of damaged grains of *Triticumvulgare* infested by beetle *Triboliumcastaneum*. *Int. J. Scientific Res*. 2(11): 62-63.**

40. **Mann, Amandeep Kaur &Meera Srivastava 2013e. Efficacy of plant *Tribulusterrestris* on the percentage of damaged grains of *Triticumvulgare* infested by beetle *Triboliumcastaneum*. *Int. J. Scientific Res*. 2(12): 562-563.**

41. **Mann, Amandeep Kaur Mann &Meera Srivastava 2013f. Effect of smoke treatment of plant *Peganumharmala* on the mortality of pest *Rhizoperthadominica* (Fab.) (Coleoptera: Bostrichidae). *Int. J. Scientific Res*. 2(12): 564-65.**

42. **Mathur, Y. K., KirpaShankar and Salik Ram 1985. Evaluation of some grain protectants against *Callosobruchuschinensis*Linn, on black gram. *Bull. Grain Tech.,* 23 (2): 253-259.**

43. **Mbaiguinam, Mbailao; Maoura, Nanadoum; Bianpambe, Automne; Bano, Gabra and Alladoumbaye, Emmanuel, 2006. Effects of six common plant seed oils on survival, egg laying and development of the cowpea weevil, *Callosobruchusmaculatus*(F.) (Coleoptera: Bruchidae) *Journal of Biological Sciences*. 6(2): 420-425.**

44. **Mishra, R.C., Masih, D.B. and Gupta P.R. 1981. Mint oil as grai fumigant against *Callosobruchuschinensis*L. *Bull Grain* Tech. 19(1): 12–15.**

45. **Mueke, J. M. &Apuuli, J. K. K. 1986. The use of vegetable oils and ash in the protection of cowpea seeds *(Vignaunguiculata)* (L.) (Walp.) against *Callosobruchusmaculatus (F.)* (Coleoptera: Bruchidae). *East African Agric. and Forest J.,* 52 (2): 101-105.**

46. **Naik, R. L. &Dumbre, R. B. 1984. Effect of some vegetable oils used in protecting stored cowpeaon biology of pulse beetle *Callosobruchusmoculatus*(F.) (Coleoptera: Bruchidae). *Bull. Grain Tech.,* 22 (1): 25-32.**

47. **Negi, R. S., Srivastava, M. and Saxena, M. M. 1997. Egg-laying and adult emergence of *Callosobruchuschinensis*on green gram (*Vignaradiata)* treated with pongam oil. *Indian Journal of Entomology,* 59: 170-172.**

48. **Ogigiangbe, N. O. &Onigbinde, A. O. 1996. The association between some physicochemical characteristics and susceptibility of cowpea *[Vignaunguicidata*(L. Walp)] to *Callosobruchusmaculatus*(F). *J. Stored Products Res.,* 32 (1): 7-11.**

49. **Olaifa, J. I. &Erhun, W. O. 1988. Laboratory evaluation of *Piper guineense*for the protection of cowpea against *Callosobruchusmaculatus. Insect Science and its Application.* 9: 55-59.**

50. **Pandey, N. D., Pal, Krishna., Pandey, Sanjeev., Tripathi, R. A. and Singh, Y. P. 1985. Use of neem, *Azadirachtaindica A.* Juss. as seed protectant against rice moth. *Coreyracephalonica*stain. I. Effect on the development and damage. *Bull. Grain. Tech.,* 23(2): 147-153.**

51. **Pareek, R. A. & Bhatta, J. K. 1998. Laboratory and field evaluation of plant products against Maize stem borer, *Chilopartellus. Proc. Nat. Sem. Ent. in 21st Cent.,* Udaipur, p. 127.**

52. **Prakash, A. & Rao, J. 1989. Leaves of Begunia: a pulse grain protectant. *Indian Journal of Enmtomology,* 51(2): 192-195.**

53. **Raja, N., Albert, S., Ignacimuthu, S., Dorn, S. 2001. Effect of plant volatile oils in protecting stored cowpea *Vignaunguiculata* L. Walpers against *C. maculatus*F. (Coleoptera: Bruchidae) infestation. *J. Store. Prod. Res.,* 37(2): 127 – 132.**

54. **Ramzan, M. 1994. Efficacy of edible oils against pulse beetle, *Callosobruchusmaculatus* (Fab.). *J. Insect Sci.,* 7 (1): 37-39.**

55. **Rawat, Shailja& Srivastava, Meera 2011. Evaluation of qualitative and quantitative losses caused by *Callosobruchuschinensis* to some pulses. *J. ent. Res*. 35(2): 117-120.**

56. **Rawat, Shailja& Srivastava, Meera 2012. Evaluation of efficacy of formulations of plant *Prosopisjuliflora* against *Callosobruchuschinensis* Linn. *Global J. Sci. Front. Res. Agric. Bio.* 12 (4): 29-31.**

57. **Roger, R.C., &Hamraoui, A. 1994. Comparison of the insecticidal effects of water extracted and intact aromatic plants on *Acanthoscelidesobtectus*, a bruchid beetle pest of kidney beans. *Chemoecology*, 5: 1–5.**

58. **Sangappa, H. K. 1977. Effectiveness of oils as a surface protectant against the bruchid*Callosobruchuschinensis*Linn, infestation on red gram. *Mysore J. Agri. Sci.,* 11 (3): 391-397.**

59. **Sathyaseelan, V., Baskaran, B., and Mohan, S. 2008. Efficacy of some indigenous pesticidal plants against pulse beetle, *Callosobruchuschinensis* (L.) on green gram. *Journal of Entomology* 5 (2) ; 128–132, 2008.**

60. **Sharma, A. K. & Srivastava, R. C. 1984. Effects of groundnut oil on embryonic development of *Callosobruchuschinensis*L. *Bull. Grain Tech.,* 22 (3): 221-224.**

61. **Sharma, Y. 1985. Effect of aak flower extract on different larval stages of the lesser grain borer *Rhyzoperthadominica. J. Adv. Zool.,* 6(1): 8-12.**

62. **Singh, S.R., Luse, R. A., Leuschner, K. and Nangju, D. 1978. Groundnut oil treatment for the control of *Callosobruchusmaculatus*(F.) during cowpea storage. *J. Stored Products Res.,* 14 (2): 77-80.**

63. **Salam, M.A., Taleb, M.A and Rahman, M.A. 2005. Screening of some plant materials for controlling *Callosobruchuschinensis* of *lentil* in storage. *J. Agric. Rural Dev.* 3(1/2): 67-72.**

64. **Salem S, Abou-Ela MM, Elkholy M. 2007. Entomocidal effect of *Brassica hapus* extracts on two storepests, *Sitophilus oryzae* (L.) and *Rhyzoperthadominica* (Fab.) (Coleoptera) *J. Appl. Sci. Res*. 3:317-322.**

65. **Shelke, S.S., Jadhav, L.D. and Salunkhe, G.N. 1987. Ovicidal action of some vegetable oils and extracts on the storage pest of potato, *Phthorimaeaoperculelia* Zell. *Biovigyanam*, 13: 40-41.**

66. **Siddiqui B, Alis, Tariq R, Gulzar T., Rasheed M, Mehamood M. 2009. GC-based analysis of insecticidal constituents of the flower of *Azadirachtaindica* A. Juss. *Nat. Prod. Res*. 23: 271-283.**

67. **Singhal, S. K. & Singh, Z. 1990. Studies of plant oils as surface protectants against pulse beetle *Callosobruchuschinensis*in chickpea, *Cicer arietinum* L. in India. *Trop. grain legume Bull.,* 34: 14-15.**

68. **Srivastava, Meera and Mann, Amandeep Kaur 2002a. An evaluation of efficacy of extracts of plant *Peganumharmala* (Zygophyllaceae) against pulse beetle *Callosobruchuschinensis* Linn. (Coleoptera: Bruchidae). *Indian J. Entomology*, 64(2): 138-147.**

69. **Srivastava, Meera& Mann, Amandeep Kaur 2002b. An effect of smoke treatment on the mortality of *Callosobruchuschinensis* Linn. *Insect Environment* 8(3): 108-109.**

70. **Srivastava, Meera&Ghei ,Meenakshi2007. Studies on the efficacy of extracts of *Trigonellafoenum-graecum* on mortality and oviposition of *Callosobruchuschinensis* Linn. *Ind.J.Appl.Entom*. 21(2): 49-52.**

71. **Srivastava, Meera& Gupta, Lalita2007. Effect of formulations of *Solanumsurratense* (Family: Solanaceae) an Indian desert plant on oviposition by the pulse beetle *Callosobruchuschinensis* Linn. *African Journal of Agricultural Research*, 2(10): 552-554.**

72. **Su, H. C. F., Speirs, R. D. and Mahany, P. G. 1972. Toxicity of citrus oils to several stored product insects: laboratory evaluation. *J. Econ. Ent.*, 65 (5): 1438-1441.**

73. **Swain, T.K. and Baral, K. 2004. Effect of Certain Plant Products on some stored grain pests. *J. Appl. Zool. Res*. 15(2): 229-231.**

74. **Tariq M, Naqvi S, Choudhary M, Abbas A. 2010. Importance and implementation of essential oil of Pakistanian*Acrous*calamus (L), as a Biopesticide. *Pak. J. Bot*. 42: 2043–2050.**

75. **Udo, O. Ime, Owusu, Eo, Obeng – Oferi, D. 2004. Efficacy of Candle wood *Zanthoxylumxanthoxyloides*(Lam.) for the control of *Sitophilus zeamais*(Mots.) (Coleoptera: Curculionidae) and *Callosobruchusmaculatus*F. (Coleoptera: Bruchidae). *Global Journal of Agricultural Sciences* 3 (1 & 2): 19–23.**

76. **Upasani S.M. Kotkar, H.M. Mendki, P.S &Maheshwari V.L. 2003. Partial Characterization and insecticidal properties of *Ricinuscommunis* L. Foliage flavanoids. *Pest Management Science*, 59, 1349-1354.**

77. **Uvah, I. I. &Ishaya, A. T. 1992. Effect of some vegetable oils on emergence, oviposition and longevity of the bean weevil, *Callosobruchusmaculatus (F.). Trop. Pest Management.* 38 (3): 257-260.**

78. **Verma P. Subburaj VT, Balakrishnan N. 2006. Larvicidal activity of Artemisia hilagirica (darke) pamp. and *Ocimum sanctum* Linn. -A preliminary study. *J. Nat. Remed*. 6: 157-161.**

79. **Verma, J. and Dubey, N.K. 1999. Prospective of botanical and microbial products as pesticides of tomorrow. *Curr. Sci*. 76(2): 172–179.**

80. **Yadav, T. D. 1985. Antiovipositional and ovicidal toxicity of neem *(Azadirachtaindica)* oilagainst three species of *Callosobruchus. Neem News Letter,* 2(1): 5-6.**

81. **Yan-zhang H, Chang-Ju Y, Dong X, Akinkurolere R, Ying-Juan Y 2007. Contact and repellency activities of ethanol extracts from twenty medicinal plants against *Rhyzoperthadominica* (Fab.) (Coleoptera: Bostrichidae). *ActaEntomologicaSinica* 50:118-123.**

Table 1a. Mean adult emergence (%) of *C. chinensis*under different formulations of leaves of select three plants

Treatments	Plants / Conc.	*Euphorbia hirta*	*Phyllanthusamarus*	*Jatropha gossypiifolia*
Crude extract	Normal	82.00 ± 0.00	82.00 ± 0.00	82.00 ± 0.00
	Control	70.00 ± 0.00	70.00 ± 0.00	70.00 ± 0.00
	1%	58.20 ± 19.40	0.00 ± 0.00	0.00 ± 0.00
	5%	56.40 ± 17.59	0.00 ± 0.00	0.00 ± 0.00
	10%	56.80 ± 16.16	0.00 ± 0.00	0.00 ± 0.00
	25%	34.00 ± 10.84	0.00 ± 0.00	0.00 ± 0.00
Aqueous suspension	Normal	82.00 ± 0.00	82.00 ± 0.00	82.00 ± 0.00
	Control	70.00 ± 0.00	70.00 ± 0.00	70.00 ± 0.00
	1%	71.00 ± 20.12	0.00 ± 0.00	56.80 ± 10.64
	5%	70.40 ± 18.64	0.00 ± 0.00	54.00 ± 15.17
	10%	66.40 ± 20.71	0.00 ± 0.00	54.40 ± 13.37
	25%	35.60 ± 6.27	0.00 ± 0.00	42.40 ± 10.90
Aqueous extract	Normal	82.00 ± 0.00	82.00 ± 0.00	82.00 ± 0.00
	Control	70.00 ± 0.00	70.00 ± 0.00	70.00 ± 0.00
	1%	78.40 ± 6.23	0.00 ± 0.00	67.00 ± 17.18
	5%	78.80 ± 5.76	0.00 ± 0.00	64.20 ± 16.71
	10%	41.00 ± 14.73	0.00 ± 0.00	60.80 ± 15.97
	25%	32.00 ± 10.37	0.00 ± 0.00	41.40 ± 4.77
Ethanol extract	Normal	82.00 ± 0.00	82.00 ± 0.00	82.00 ± 0.00
	Control	57.50 ± 5.00	0.00 ± 0.00	60.00 ± 0.00
	1%	63.00 ± 17.18	0.00 ± 0.00	66.80 ± 14.53
	5%	43.00 ± 4.47	0.00 ± 0.00	55.80 ± 16.47
	10%	45.80 ± 10.35	0.00 ± 0.00	45.20 ± 10.26
	25%	30.00 ± 11.73	0.00 ± 0.00	40.80 ± 5.22
Di-ethyl ether extract	Normal	82.00 ± 0.00	82.00 ± 0.00	82.00 ± 0.00
	Control	58.80 ± 0.00	58.80 ± 0.00	58.80 ± 0.00
	1%	52.80 ± 14.60	0.12 ± 0.03	66.00 ± 15.49
	5%	51.80 ± 13.16	0.07 ± 0.04	63.80 ± 18.95
	10%	45.20 ± 16.89	0.06 ± 0.03	55.00 ± 20.81
	25%	33.20 ± 5.63	0.05 ± 0.03	35.40 ± 10.11

Values given are mean ±SD

Table 1b. **ANOVA for adult emergence showing different interactions and level of significance**

Source of Variation	df	SS	MSS	F-cal	S/NS	S.Em.	CD 5%	CD 1%
A	2	2753.82	1376.91	46.40	**	0.31	0.87	1.15
B	4	436.99	109.25	3.68	**	0.41	1.13	1.48
C	3	135.97	45.32	1.53		0.36	1.01	1.33
D	3	307860.66	102620.22	3457.96	**	0.31	0.87	1.15
A x B	8	525.78	65.72	2.21	*	0.70	1.95	2.57
A x C	6	136.88	22.81	0.77		0.63	1.75	2.30
A x D	6	2988.36	498.06	16.78	**	0.54	1.51	1.99
B x C	12	104.96	8.75	0.29		0.81	2.26	2.97
B x D	12	1694.44	141.20	4.76	**	0.70	1.95	2.57
C x D	9	271.93	30.21	1.02		0.63	1.75	2.30
A x B x C	24	136.22	5.68	0.19		1.41	3.91	5.14
A x B x D	24	966.34	40.26	1.36		1.22	3.38	4.45
A x C x D	18	273.77	15.21	0.51		1.09	3.03	3.98
B x C x D	36	209.92	5.83	0.20		1.41	3.91	5.14
A x B x C x D	72	272.45	3.78	0.13		2.44	6.77	8.90
Error	660	19586.53	29.68					
Total	899	338355.03						

* 5% level of significance ** 1% level of significance S.Em.- standard error of mean
C.D.- Critical difference MSS- Mean sum of square SS- Sum of square
A- Plants B- Extracts C- Concentrations
D- All Treatments

Table 1c. Comparison of different formulations with respect to overall mean of adult emergence (ANOVA) and critical difference

A1	49.08(43.84)
A2	53.48(47.29)
A3	54.41(47.76)
S.Em±	0.31
CD (5%)	0.87
CD (1%)	1.15
B1	52.97(46.57)
B2	53.36(46.86)
B3	53.26(46.84)
B4	50.01(44.98)
B5	52.02(46.23)
S.Em±	0.41
CD (5%)	1.13
CD (1%)	1.48
C1	51.42(45.65)
C2	52.32(46.33)
C3	52.67(46.54)
C4	52.88(46.66)
S.Em±	0.36
CD (5%)	1.01
CD (1%)	1.33
D1	85(67.51)
D2	56.67(48.93)
D3	15.3(22.44)
S.Em±	0.63
CD (5%)	1.75
CD (1%)	2.30

Value in ( ) are angular transformed value.

A1- *P. amarus* A2- *E. hirta* A3- *J. gossypiifolia*
B1- Crude extract B2- Aqueous suspension B3- Aqueous extract
B4- Ethanol extract B5- DEE
C1- 25% C2- 10% C3- 5%
C4- 1%
D1- Normal D2- Control D3- Treatments

Table 1d. Comparison of adult emergence of *C. chinensis* with respect to plants and extracts

A x B

	B1	**B2**	**B3**	**B4**	**B5**	**Mean**
A1	51(44.93)	51.03(44.96)	51.03(44.96)	44.6(41.28)	47.73(43.04)	49.08(43.84)
A2	54.45(47.65)	54.72(48.03)	54.53(47.89)	51.78(46.38)	51.9(46.47)	53.48(47.29)
A3	53.47(47.13)	54.32(47.59)	54.2(47.66)	53.63(47.27)	56.42(49.16)	54.41(47.76)
Mean	52.97(46.57)	53.36(46.86)	53.26(46.84)	50.01(44.98)	52.02(46.23)	
S.Em.±	0.70					
C.D. (5%)	1.95					
C.D. (1%)	2.57					

Value in ( ) are angular transformed value.

Table 1e. Comparison of adult emergence of *C. chinensis* with respect to plants and concentrations

A x C

	C1	**C2**	**C3**	**C4**	**Mean**
A1	49.27(44.03)	49.16(43.93)	48.88(43.62)	49.01(43.76)	49.08(43.84)
A2	52.08(46.25)	53.09(47.05)	54.32(47.88)	54.41(47.96)	53.48(47.29)
A3	52.92(46.68)	54.69(48)	54.8(48.13)	55.21(48.25)	54.41(47.76)
Mean	51.42(45.65)	52.32(46.33)	52.67(46.54)	52.88(46.66)	
S.Em.±	0.63				
C.D. (5%)	1.75				
C.D. (1%)	2.30				

Value in ( ) are angular transformed value.

Table 1f. Comparison of adult emergence of *C. chinensis* with respect to plants and treatments

	A x D			
	A1	**A2**	**A3**	**Mean**
D1	85(67.51)	85(67.51)	85(67.51)	85(67.51)
D2.	54(47.36)	56(48.54)	60(50.9)	56.67(48.93)
D3	8.24(16.64)	19.43(25.8)	18.22(24.88)	15.3(22.44)
Mean	49.08(43.84)	53.48(47.29)	54.41(47.76)	

S.Em.± 0.54
C.D. (5%) 1.51
C.D. (1%) 1.99
Value in ( ) are angular transformed value.

Table 1g. Comparison of adult emergence of *C. chinensis* with respect to extracts and concentrations

	B x C					
	B1	**B2**	**B3**	**B4**	**B5**	**Mean**
C1	51.93(45.83)	53.71(47.17)	52.07(45.95)	49.18(44.37)	50.22(44.96)	51.42(45.65)
C2	52.71(46.46)	53.2(46.84)	53.04(46.73)	50.04(45)	52.58(46.6)	52.32(46.33)
C3	53.27(46.68)	53.02(46.64)	53.78(47.26)	50.67(45.47)	52.6(46.67)	52.67(46.54)
C4	53.98(47.31)	53.49(46.8)	54.13(47.41)	50.13(45.08)	52.67(46.67)	52.88(46.66)
Mean	52.97(46.57)	53.36(46.86)	53.26(46.84)	50.01(44.98)	52.02(46.23)	
S.Em.±	0.81					
C.D. (5%)	2.26					
C.D. (1%)	2.97					

Value in ( ) are angular transformed value.

Table 1h. **Comparison of adult emergence of *C. chinensis* with respect to extracts and treatments**

B x D

	B1	**B2**	**B3**	**B4**	**B5**	**Mean**
D1	85(67.51)	85(67.51)	85(67.51)	85(67.51)	85(67.51)	85(67.51)
D2	60(50.9)	60(50.9)	60(50.9)	50(45)	53.33(46.97)	56.67(48.93)
D3	13.92(21.29)	15.07(22.18)	14.77(22.1)	15.02(22.43)	17.72(24.2)	15.3(22.44)
Mean	52.97(46.57)	53.36(46.86)	53.26(46.84)	50.01(44.98)	52.02(46.23)	
S.Em.±	0.70					
C.D. (5%)	1.95					
C.D. (1%)	2.57					

Value in ( ) are angular transformed value.

Table 1i.Comparison of adult emergence of *C. chinensis* with respect to concentrations and treatments

C x D

	C1	**C2**	**C3**	**C4**	**Mean**
C1	85(67.51)	85(67.51)	85(67.51)	85(67.51)	85(67.51)
C2	56.67(48.93)	56.67(48.93)	56.67(48.93)	56.67(48.93)	56.67(48.93)
C3	12.6(20.51)	15.28(22.54)	16.33(23.18)	16.97(23.52)	15.3(22.44)
Mean	51.42(45.65)	52.32(46.33)	52.67(46.54)	52.88(46.66)	
S.Em.±	0.63				
C.D. (5%)	1.75				
C.D. (1%)	2.30				

Value in ( ) are angular transformed value.

Table 1j. Comparison of adult emergence of *C. chinensis* with respect to plants, extracts and concentrations

A x B x C

		C1	**C2**	**C3**	**C4**	**mean**
A1	**B1**	51.07(45.01)	51.33(45.28)	50.47(44.33)	51.13(45.08)	51(44.93)
	B2	51.07(45.01)	51.13(45.08)	50.6(44.48)	51.33(45.28)	51.03(44.96)
	B3	51.33(45.28)	51.07(45.01)	51.13(45.08)	50.6(44.48)	51.03(44.96)
	B4	44.87(41.54)	44.53(41.22)	44.47(41.15)	44.53(41.22)	44.6(41.28)
	B5	48(43.32)	47.73(43.05)	47.73(43.05)	47.47(42.76)	47.73(43.04)
A2	**B1**	52.27(46.15)	53.53(47.12)	55.87(48.55)	56.13(48.78)	54.45(47.65)
	B2	55.47(48.48)	54.2(47.69)	54.2(47.68)	55(48.29)	54.72(48.03)
	B3	52.6(46.43)	54.2(47.71)	55.87(48.88)	55.47(48.54)	54.53(47.89)
	B4	50.07(45.12)	51.93(46.46)	52.73(47.1)	52.4(46.87)	51.78(46.38)
	B5	50(45.06)	51.6(46.29)	52.93(47.22)	53.07(47.31)	51.9(46.47)
A3	**B1**	52.47(46.32)	53.27(46.98)	53.47(47.15)	54.67(48.07)	53.47(47.13)
	B2	54.6(48.01)	54.27(47.75)	54.27(47.75)	54.13(46.84)	54.32(47.59)
	B3	52.27(46.14)	53.87(47.47)	54.33(47.82)	56.33(49.21)	54.2(47.66)
	B4	52.6(46.44)	53.67(47.32)	54.8(48.17)	53.47(47.15)	53.63(47.27)
	B5	52.67(46.49)	58.4(50.47)	57.13(49.74)	57.47(49.95)	56.42(49.16)
	mean	51.42(45.65)	52.32(46.33)	52.67(46.54)	52.88(46.66)	()
S.Em.±	**1.41**					
C.D. (5%)	**3.91**					
C.D. (1%)	**5.14**					

Value in ( ) are angular transformed value.

Table 1k. Comparison of adult emergence of *C. chinensis* with respect to plants, extracts and treatments

A x B x D

		D1	D2	D3	Total
A1	B1	85(67.51)	60(50.9)	8(16.37)	51(44.93)
	B2	85(67.51)	60(50.9)	8.1(16.48)	51.03(44.96)
	B3	85(67.51)	60(50.9)	8.1(16.48)	51.03(44.96)
	B4	85(67.51)	40(39.1)	8.8(17.24)	44.6(41.28)
	B5	85(67.51)	50(45)	8.2(16.62)	47.73(43.04)
A2	B1	85(67.51)	60(50.9)	18.35(24.53)	54.45(47.65)
	B2	85(67.51)	60(50.9)	19.15(25.69)	54.72(48.03)
	B3	85(67.51)	60(50.9)	18.6(25.25)	54.53(47.89)
	B4	85(67.51)	50(45)	20.35(26.64)	51.78(46.38)
	B5	85(67.51)	50(45)	20.7(26.9)	51.9(46.47)
A3	B1	85(67.51)	60(50.9)	15.4(22.98)	53.47(47.13)
	B2	85(67.51)	60(50.9)	17.95(24.36)	54.32(47.59)
	B3	85(67.51)	60(50.9)	17.6(24.57)	54.2(47.66)
	B4	85(67.51)	60(50.9)	15.9(23.4)	53.63(47.27)
	B5	85(67.51)	60(50.9)	24.25(29.07)	56.42(49.16)
	Total	85(67.51)	56.67(48.93)	15.3(22.44)	
S.Em.±	1.22				
C.D. (5%)	3.38				
C.D. (1%)	4.45				

Value in ( ) are angular transformed value.

Table 1l. Comparison of adult emergence of *C. chinensis* with respect to plants, concentrations and treatments

A x C x D

		D1	D2	D3	Mean
A1	C1	85(67.51)	54(47.36)	8.8(17.23)	49.27(44.03)
	C2	85(67.51)	54(47.36)	8.48(16.91)	49.16(43.93)
	C3	85(67.51)	54(47.36)	7.64(15.98)	48.88(43.62)
	C4	85(67.51)	54(47.36)	8.04(16.42)	49.01(43.76)
A2	C1	85(67.51)	56(48.54)	15.24(22.69)	52.08(46.25)
	C2	85(67.51)	56(48.54)	18.28(25.11)	53.09(47.05)
	C3	85(67.51)	56(48.54)	21.96(27.6)	54.32(47.88)
	C4	85(67.51)	56(48.54)	22.24(27.82)	54.41(47.96)
A3	C1	85(67.51)	60(50.9)	13.76(21.63)	52.92(46.68)
	C2	85(67.51)	60(50.9)	19.08(25.59)	54.69(48)
	C3	85(67.51)	60(50.9)	19.4(25.97)	54.8(48.13)
	C4	85(67.51)	60(50.9)	20.64(26.33)	55.21(48.25)
	Mean	85(67.51)	56.67(48.93)	15.3(22.44)	()
S.Em.±	1.09				
C.D. (5%)	3.03				
C.D. (1%)	3.98				

Value in ( ) are angular transformed value.

Table 1m. Comparison of adult emergence of *C. chinensis* with respect to extracts, concentrations and treatments

B x C x D

		D1	**D2**	**D3**	**Total**
B1	C1	85(67.51)	60(50.9)	10.8(19.07)	51.93(45.83)
	C2	85(67.51)	60(50.9)	13.13(20.97)	52.71(46.46)
	C3	85(67.51)	60(50.9)	14.8(21.62)	53.27(46.68)
	C4	85(67.51)	60(50.9)	16.93(23.52)	53.98(47.31)
B2	C1	85(67.51)	60(50.9)	16.13(23.09)	53.71(47.17)
	C2	85(67.51)	60(50.9)	14.6(22.11)	53.2(46.84)
	C3	85(67.51)	60(50.9)	14.07(21.5)	53.02(46.64)
	C4	85(67.51)	60(50.9)	15.47(22)	53.49(46.8)
B3	C1	85(67.51)	60(50.9)	11.2(19.44)	52.07(45.95)
	C2	85(67.51)	60(50.9)	14.13(21.78)	53.04(46.73)
	C3	85(67.51)	60(50.9)	16.33(23.36)	53.78(47.26)
	C4	85(67.51)	60(50.9)	17.4(23.82)	54.13(47.41)
B4	C1	85(67.51)	50(45)	12.53(20.58)	49.18(44.37)
	C2	85(67.51)	50(45)	15.13(22.49)	50.04(45)
	C3	85(67.51)	50(45)	17(23.9)	50.67(45.47)
	C4	85(67.51)	50(45)	15.4(22.73)	50.13(45.08)
B5	C1	85(67.51)	53.33(46.97)	12.33(20.39)	50.22(44.96)
	C2	85(67.51)	53.33(46.97)	19.4(25.33)	52.58(46.6)
	C3	85(67.51)	53.33(46.97)	19.47(25.53)	52.6(46.67)
	C4	85(67.51)	53.33(46.97)	19.67(25.54)	52.67(46.67)
	Total	85(67.51)	56.67(48.93)	15.3(22.44)	()
S.Em.±	1.41				
C.D. (5%)	3.91				
C.D. (1%)	5.14				

Value in ( ) are angular transformed value.

Table 1n. Comparison of adult emergence of *C. chinensis* with respect to plants, extracts, concentrations and treatments

Ax B x C x D

			D1	D2	D3	Total
A1	B1	C1	85(67.51)	60(50.9)	8.2(16.62)	51.07(45.01)
		C2	85(67.51)	60(50.9)	9(17.44)	51.33(45.28)
		C3	85(67.51)	60(50.9)	6.4(14.58)	50.47(44.33)
		C4	85(67.51)	60(50.9)	8.4(16.83)	51.13(45.08)
	B2	C1	85(67.51)	60(50.9)	8.2(16.62)	51.07(45.01)
		C2	85(67.51)	60(50.9)	8.4(16.83)	51.13(45.08)
		C3	85(67.51)	60(50.9)	6.8(15.03)	50.6(44.48)
		C4	85(67.51)	60(50.9)	9(17.44)	51.33(45.28)
	B3	C1	85(67.51)	60(50.9)	9(17.44)	51.33(45.28)
		C2	85(67.51)	60(50.9)	8.2(16.62)	51.07(45.01)
		C3	85(67.51)	60(50.9)	8.4(16.83)	51.13(45.08)
		C4	85(67.51)	60(50.9)	6.8(15.03)	50.6(44.48)
	B4	C1	85(67.51)	40(39.1)	9.6(18.01)	44.87(41.54)
		C2	85(67.51)	40(39.1)	8.6(17.05)	44.53(41.22)
		C3	85(67.51)	40(39.1)	8.4(16.84)	44.47(41.15)
		C4	85(67.51)	40(39.1)	8.6(17.05)	44.53(41.22)
	B5	C1	85(67.51)	50(45)	9(17.46)	48(43.32)
		C2	85(67.51)	50(45)	8.2(16.64)	47.73(43.05)
		C3	85(67.51)	50(45)	8.2(16.64)	47.73(43.05)
		C4	85(67.51)	50(45)	7.4(15.76)	47.47(42.76)
A2	B1	C1	85(67.51)	60(50.9)	11.8(20.04)	52.27(46.15)
		C2	85(67.51)	60(50.9)	15.6(22.95)	53.53(47.12)
		C3	85(67.51)	60(50.9)	22.6(27.23)	55.87(48.55)
		C4	85(67.51)	60(50.9)	23.4(27.92)	56.13(48.78)
	B2	C1	85(67.51)	60(50.9)	21.4(27.03)	55.47(48.48)
		C2	85(67.51)	60(50.9)	17.6(24.65)	54.2(47.69)
		C3	85(67.51)	60(50.9)	17.6(24.62)	54.2(47.68)
		C4	85(67.51)	60(50.9)	20(26.46)	55(48.29)
	B3	C1	85(67.51)	60(50.9)	12.8(20.87)	52.6(46.43)
		C2	85(67.51)	60(50.9)	17.6(24.72)	54.2(47.71)
		C3	85(67.51)	60(50.9)	22.6(28.22)	55.87(48.88)
		C4	85(67.51)	60(50.9)	21.4(27.22)	55.47(48.54)
	B4	C1	85(67.51)	50(45)	15.2(22.84)	50.07(45.12)
		C2	85(67.51)	50(45)	20.8(26.87)	51.93(46.46)
		C3	85(67.51)	50(45)	23.2(28.77)	52.73(47.1)
		C4	85(67.51)	50(45)	22.2(28.09)	52.4(46.87)
	B5	C1	85(67.51)	50(45)	15(22.67)	50(45.06)
		C2	85(67.51)	50(45)	19.8(26.36)	51.6(46.29)
		C3	85(67.51)	50(45)	23.8(29.14)	52.93(47.22)
		C4	85(67.51)	50(45)	24.2(29.42)	53.07(47.31)
A3	B1	C1	85(67.51)	60(50.9)	12.4(20.54)	52.47(46.32)
		C2	85(67.51)	60(50.9)	14.8(22.53)	53.27(46.98)
		C3	85(67.51)	60(50.9)	15.4(23.04)	53.47(47.15)
		C4	85(67.51)	60(50.9)	19(25.81)	54.67(48.07)

	B2	C1	85(67.51)	60(50.9)	18.8(25.62)	54.6(48.01)
		C2	85(67.51)	60(50.9)	17.8(24.85)	54.27(47.75)
		C3	85(67.51)	60(50.9)	17.8(24.85)	54.27(47.75)
		C4	85(67.51)	60(50.9)	17.4(22.11)	54.13(46.84)
	B3	C1	85(67.51)	60(50.9)	11.8(20.01)	52.27(46.14)
		C2	85(67.51)	60(50.9)	16.6(24.01)	53.87(47.47)
		C3	85(67.51)	60(50.9)	18(25.04)	54.33(47.82)
		C4	85(67.51)	60(50.9)	24(29.22)	56.33(49.21)
	B4	C1	85(67.51)	60(50.9)	12.8(20.91)	52.6(46.44)
		C2	85(67.51)	60(50.9)	16(23.55)	53.67(47.32)
		C3	85(67.51)	60(50.9)	19.4(26.09)	54.8(48.17)
		C4	85(67.51)	60(50.9)	15.4(23.05)	53.47(47.15)
	B5	C1	85(67.51)	60(50.9)	13(21.05)	52.67(46.49)
		C2	85(67.51)	60(50.9)	30.2(32.99)	58.4(50.47)
		C3	85(67.51)	60(50.9)	26.4(30.8)	57.13(49.74)
		C4	85(67.51)	60(50.9)	27.4(31.45)	57.47(49.95)
		Total	85(67.51)	56.67(48.93)	15.3(22.44)	()

S.Em.±	2.44
C.D. (5%)	6.77
C.D. (1%)	8.90

Value in ( ) are angular transformed value.

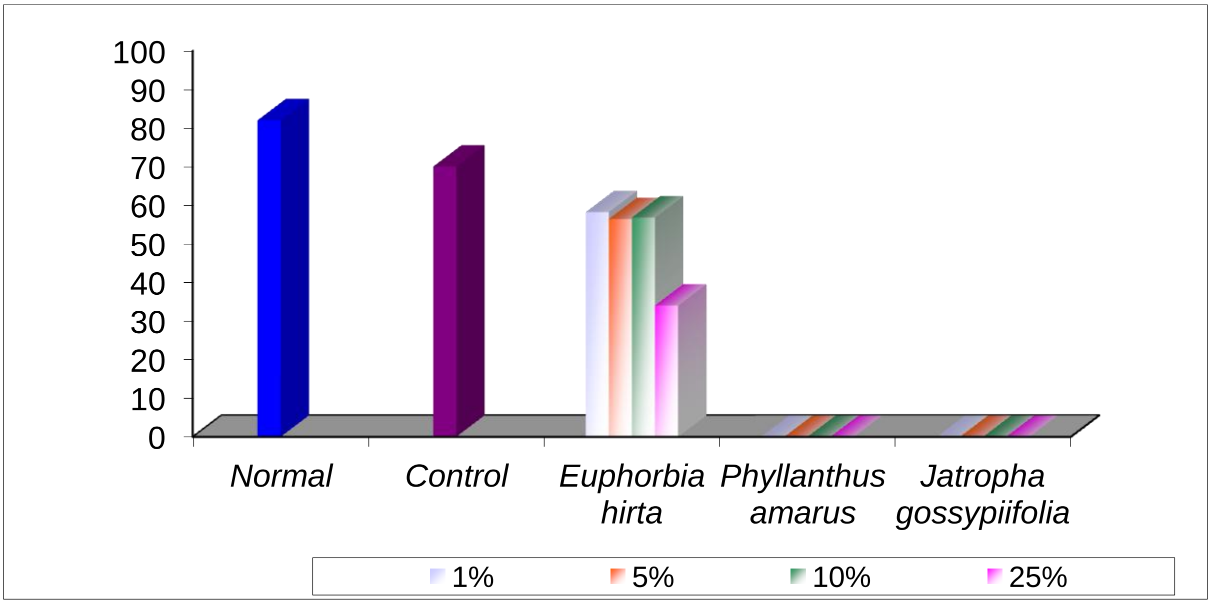

Fig. 1. Comparison of adult emergence (%) of *C. chinensis*under treatments of crude extract of leaves of three Euphorbiaceae plants

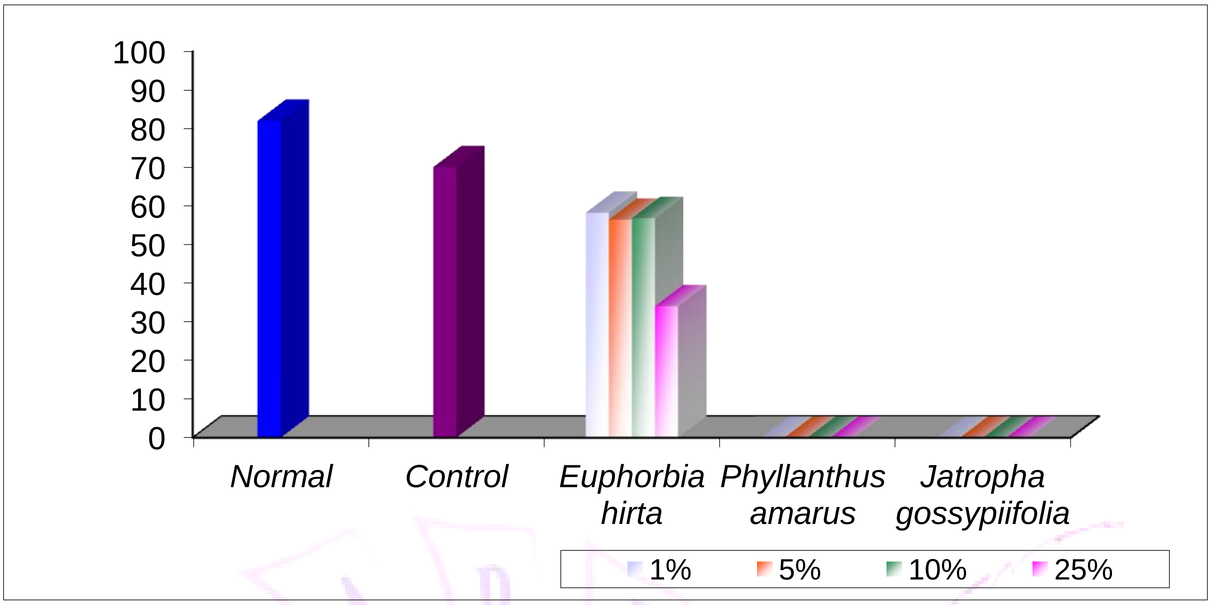

Fig. 2. Comparison of adult emergence (%) of *C. chinensis*under treatments of aqueous suspension of leaves of three Euphorbiaceae plants

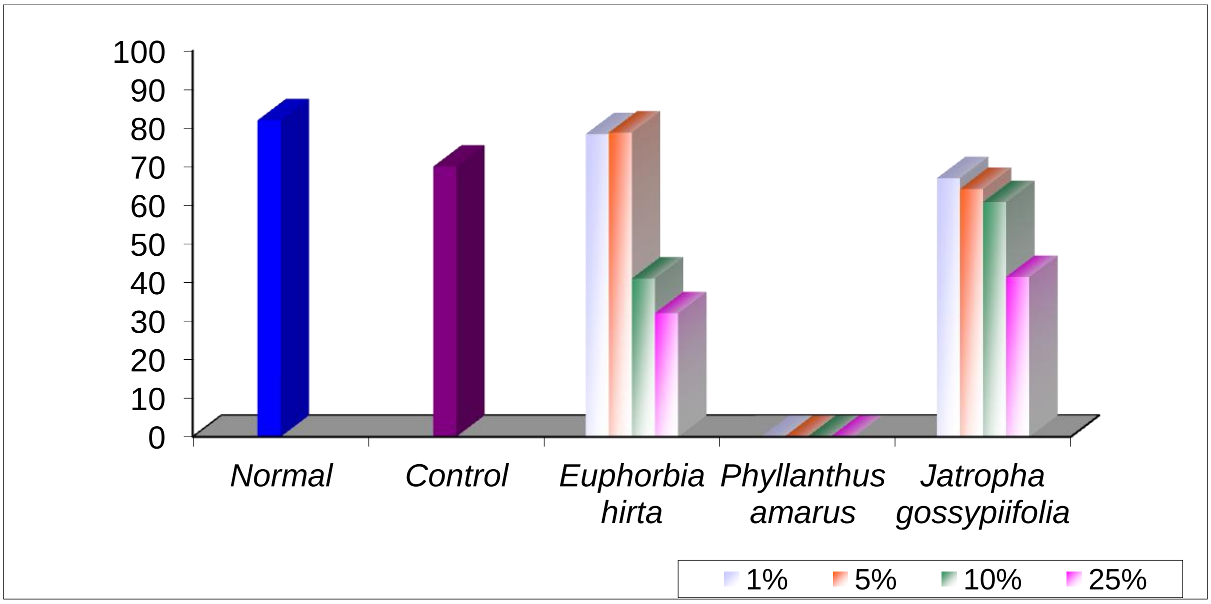

Fig. 3. Comparison of adult emergence (%) of *C. chinensis*under treatments of aqueous extract ofleaves of three Euphorbiaceae plants

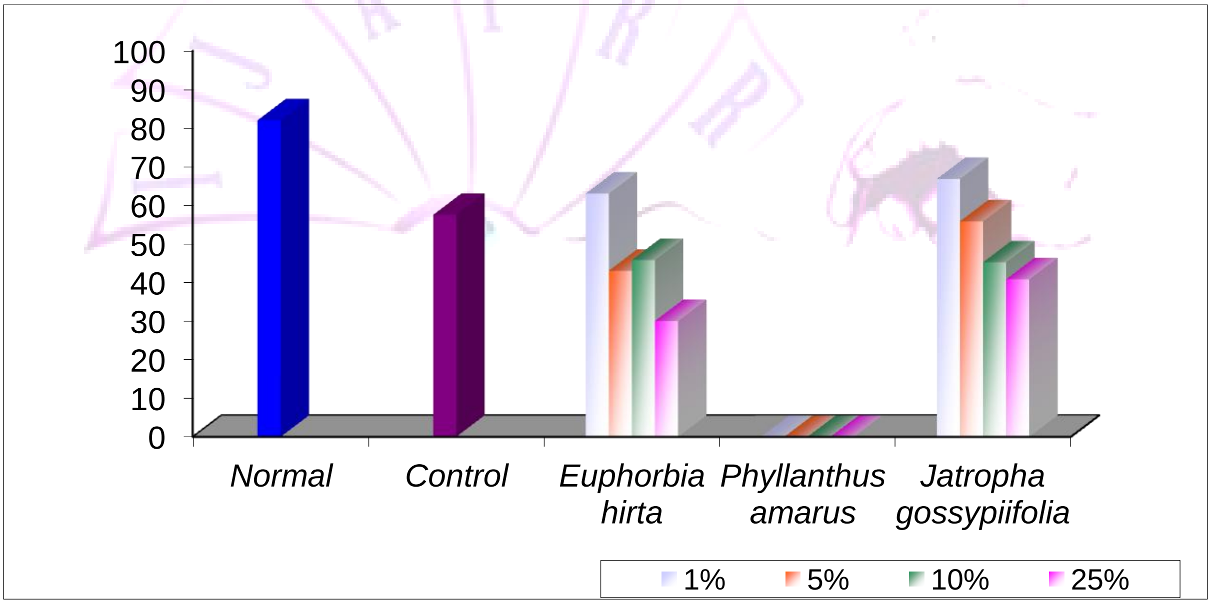

Fig. 4. Comparison of adult emergence (%) of *C. chinensis*under treatments of ethanol extract of leaves of three Euphorbiaceae plants

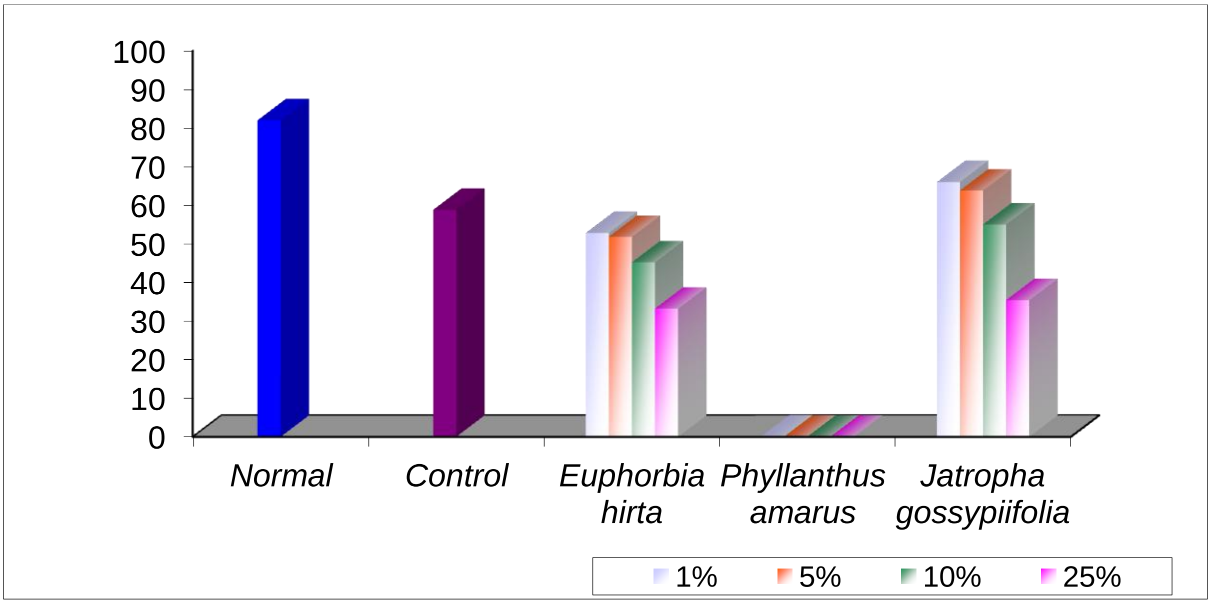

Fig. 5. Comparison of adult emergence (%) of *C. chinensis*under treatments of ditheyl ether extract of leaves of three Euphorbiaceae plants