AJAB

Asian J Agri & Biol. 2017;5(2):99-106.

Review Article

# Eco-Friendly Management of Pulse Beetle (*Callosobruchus Chinensis*) By Using Different Plant Materials

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*Received:*
*February 27, 2017*

*Accepted:*
*April 24, 2017*

*Published:*
*June 20, 2017*

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## Abstract

Legumes (pulses) are ancient crops of the Sub-continent, Middle East and various parts of the Africa. These provide high quality protein and considered to be the best food for vegetarian population in India, South Asia, West Asia and Southern European countries. Chickpea is valued for its nutritive grains with high protein content of 25-29%. These grain legumes are, however, susceptible to different species of beetles of the family Bruchidae in storage commonly known as Dhora. At current, insect manage procedures frequently rely on synthetic insecticides and fumigants. Other than substance safety actions may be result as like numerous severe drawbacks. Insecticides have wide and unsystematic application causes natural imbalance confrontation to insect, insect recovery and epidemic of secondary insect creates phyto-toxicity. Insecticide residues in diet and nourish. Furthermore, non-stop use of insecticides leads to harmful result on insect pollination, biological agent like different Predators, parasitoids and too become cause of the ecological contamination. Owing to these drawbacks, internationally scientists are annoying to approve substitute methods of insect manage. The make use of close by obtainable native place resources in the management of harmful insects are a primeval technology. Now in modern world, in numerous parts of the earth a range of crop of vegetation have been tried lately by researchers with an elevated amount of achievement as granule. Protestants next to pulse beetle to decrease plague in storage space. Observance these views in brain, the in attendance learning was conducted to examine the pesticide efficiency of a number of native botanicals powders as granule protestant next to *Callosobruchus chinensis* legumes grains. Reviewed shows that different plant material which are friendly with ecosystems have significant results against pulse beetle and serve as an alternative methods for the pest control.

**Keywords:** Dhora beetle; pulse beetle; pest management; environment friendly pest control

## Introduction

Legumes engaged in recreation a fundamental part in the food of ordinary citizens of third earth state as well as Pakistan. These are also food source of protein for those who cannot take meat and because of less amount of protein from desire level will suffer from disease like thiamin, niacin, calcium, and iron (Sharma, 1984; Bhalla et al., 2008; Egesa et al., 2016; Rehman et al., 2016). Special types of legumes are

developed during the cool weather in Pakistan create an entire 2, 05,000 million tunes of legumes. Along with the legumes, chickpea only in use 4.06% region of legumes farming and contributed seven thousand metric tons of yearly production (BBS, 2008). However one of the main restrictions for rising legumes manufacture is victims of germ capability and harm of legumes from insect nuisance attack in storage space. legumes in rising countries bear lofty qualitative and quantitative losses from the harass of Dohra beetle main nuisance invasion in storeroom (Ahmed et al.,2003; Aslam, 2004). They cause damage to legumes both in the field and also storeroom but swarm is further vital in stored form. The adult beetles do not effect spoil to the legumes via feeding but them assemble and oviposition on legume and pollute through excreta. The larva is only dependable for the legume spoil the larvae devastate grains by feeding indoor to some extent or entirely and build them in poor condition for human being use on 4 to 98% defeat of legume seeds might be practical owing to the invasion through the Dohra beetle in cargo space (Mookherjeeet *et al.*, 1970).

Pest seldom effect broad harm to stored food which could sum to 5-10% in the moderate and 20-30% in the temperate region (Nakakita, 1998). Foodstuff particle fatalities are extremely region particular and far above the ground heat and moisture generally help the development, of loss causing organisms. In India; storage losses to various food grain commodities, stored for 6 months after harvest, have been estimated 2.5% due to insect pests alone. Legume seeds are stored in godowns and warehouses in huge and minute quantities and are attacked by different pests. Pulse beetle (PB), *Callosobruchus chinemis* L. is one of the most destructive pests of legumes in store-room. It is broad-based and a severe insect of mung, peas, cowpeas and lentil and has been too reported aggressive legume seed, sorghum and maize (Ahmed et al. 2003). The male PB has pectinate while female has serrate type of antennae (Halstead. 1963). Its damage generally starts in matured pods in the ground from where it is passed to storage space godowns. Both grubs and adults are dependable for causing the harm. They complete their life cycle in 25-34 days during summer whereas 40-50 days in winter (Ghosh and Durbey, 2003). Gujar and Yadav (1978) evaluated that 55-60% loss in the weight of the seed and 45.50-66.30% loss in protein content due to the damage of Dhora and its seeds became unfit for human utilization as well as for further agriculture purpose. The varieties with hard, rough, wrinkled and thick seed coat showed less seed damage and number of holes and were more tolerant than varieties with smooth, soft and thin seed coat.

At current bother manage procedures in storage space on the employ of synthetic pesticides and fumigants. Their unsystematic apply in storage space, though has led to a figure of troubles with pest fight lethal residues in diet legume (Fishwick, 1988), ecological toxic waste (WMO, 1995) and increasing costs of inputs and their appliances (Hashmi, 2016). Moreover, the poor storage facilities of traditional farmers in the developing countries are unsuitable for effective conventional chemical control, as most of the storage types are open to re-infestation by insect pests (Tapondjou *et al* 2002). In the light of mentioned problems together with the up-coming WTO regulations, there is a need to restrict their use globally and implement safe alternatives of conventional insecticides and fumigants to protect stored seed grains from insect damage (Yusof and Ho, 1992; Subramanyam and Hag strum, 1995). At current bother manage procedures in storage space on the employ of synthetic pesticides and fumigants. Their unsystematic apply in storage space, though has led to a figure of troubles with pest fight lethal residues in diet legume, ecological toxic waste. At present merely two fumigants, methyl bromide and phosphine, are commonly old beside stored produce creature vermin. according to the 1997 choice of the 9$^{th}$ Montréal procedure ,methyl bromide, which is a verified ozone depletor in the environment ,will be phased out by 2005 in the superior countries and by 2015 in the upward countries .moreover phosine conflict is appropriate extra ordinary(tyler et al, 1983) and is a material of extensive disquiet. therefore there is critical require to enlarge secure alter sow substance based pesticides are aim precise, safe to human being and helpful organisms, fewer level to pest conflict and revival, recyclable and fewer costly and are capable legume safer. Natives usual pesticides and fumigants to keep stored legumes from creature insect invasion.

Although plant based allelochemicals are widely used herbicide (Arora et al., 2015; Yazlik and Uremis, 2016). In a country like ours; significant work rarely done to recognize the insecticidal potency of plant materials against stored grain pests except neem *{Azadirachta indica),* which is very effective against several insect pests including pulse beetles (Jilani and Malik, 1973; Naqvi, 1987 and Jilani *et al.* 1988; Elzaki and Ali, 2015).

The utilize of sow supplies can direct to recognition of latest bio-pesticides for the help of humid cultivation. Crucial oils have been broadly experienced and have certain hopeful consequences as physically powerful pesticidal action alongside bruchid vermin in laboratory situation (ketoh et al.2005).According to thought (2004), neem work as revolting via disturbing the hunger of creature and retreating their advice to repeat.

According to Bowers (1983), place in the ground pesticides are one occasion some time ago further receiving more and latest notice. There is a much need of knowing the insecticidal potential of indigenous plants against major stored product insect pests as those will be environmentally and socio-economically feasible. Set down income consist of well-off origin of bioactive chemicals (Wink. 1993); that's why they can show to enlargement of new plan of caring annoyance handle agents. A group effort has so been attentive on set down imitative funds for potentially expensive foodstuff as gainful nuisance manage agents. Minute try has been finished to organize stored make vermin throughout with aromatic medical vegetation in spite of their pharmacological measures (Kim et al, 2003). Native lodge equipment are cheaper and risk free of charge in contrast with element pesticides. The occurrence of applications or efficiency of the normal crop useful to stored legumes, though, has not been carefully investigated. These turn into all the further significant since several of the stand crop perform as repellents, gentle pesticides or chemosterilants (saxena et al, 1992). Graing and Ahmad (1988) Reported new than 2400 lodge class possessing insect manage properties. Neem seed oil and neem seed kernel powder individually prevented egg laying of PB for up to 8 months of storage whereas coal ash and soft stone were ineffective. The mortality of PB was dependent on the concentration and duration of exposure to plant materials. High insecticidal activity was complemented by a low adverse effect on grain quality (Singal and Chauhan, 1997). Jacobson critical absent that the the majority capable plants pest manage properties. Agents were in lodge families, of Annonaceae, Asteraceae, Clamiaceae, Meliaceae and Rutaceae. frequently actives next to a partial number pest type as well as exact mark pest and are frequently eco-friendly to harmless food; therefore potentially appropriate for utilize incorporated insect managing.

Powdered spices (flowers of cloves, rhizomes of ginger and turmeric, fruits of black and chili peppers and bulbs of garlic),malathion s(1.5%) and milled stems of *Combretuminmber be* were mixed with grains. Results revealed that Malathion was more effective; however, cloves and black pepper also gave significantly similar effectiveness to that of Malathion against *C. maculatus* in stored seed. (Javaid and Poswal 1995) in another study researchers mixed wheat and lentil seeds with the powdered leaves and seeds of neem tree, *Azadirachta indica* and *A.juss*, at 0, 0.5, 1.0 and 5.0% (w/w) concentrations and tested for a repellent effect against the grain weevil *(Sitophilus granarius* L.), the rice weevil *(S. oryzae*L.) and PB using Nawrot'solfacto-meter. The powdered materials were found to exhibits a strong repellent effect on the grain and rice weevils, while these products were less active against PB. The degree of repellency of plant materials increased with the concentration in the grain product. Ignatowicz *et al.* (1995)

By revelation that grains of legumes can be successfully confined as of PB through addition dried out residue of neem saw dust at the rate of 100-400 mg/50g seeds. It provided good quality result in value of poisonous result; protection and country (Singh *et al*, (1996)) , by testing the efficacy of some botanicals against PB. Five types of botanical dusts were used as insecticides. Black pepper powder, neem leaf dust and mangraila powder were proved to be equally effective in respect of number of eggs laid, number of adults emerged and reduction in damage to grains by the pest. Aslam *et al.* (2002) investigated the insecticidal efficacy of some plant spices against Pulse beetle on chickpea which is sorted. The data were taken on days to complete mortality; days to adult emerged, number of adults emerged and grains weight loss. Least existence to 100% death of PB were experimental in casing of cloves and black pepper treated seed compared to the utmost in be in charge of action. Equivalent figure of existence to mature emerged was counted in all treatments together with manage. Lowest amount figure of mature emerged was counted in casing of cloves and black pepper highest amount was experiential in manage behavior. Power failure was also intended in cloves and black pepper treated grains compared to further treatments.

Experience on the effectiveness of a number of fix foodstuffs adjacent to PB. The management incorporated a variety of lodge foodstuffs similar to folio fine particles of dharek *(Melia azedarach)* and sadabahar *(Ipomoea carnea)* at 10 g/kg of seeds; oils of coconut, mustard and groundnut wherever when neem harvest such the same as achook, nimbicidine

and neem-gold at 1 ml/kg of seeds. consequences appeared so as to nimbicidine and achook showed toward exist the the majority effectual in reducing the insect harm awake toward 1.97 and 2.36%, correspondingly, followed by neemgold with 2.61% damage; however, 70.50% damage was recorded in the control. The failure inside power be while elevated since 45.20% into the natural seed, which considerably reduced near a rank of 0.52, 0.93 and 1.07% through the application of nimbicidine. Achook and neemgold correspondingly. (Umrao and Verma 2002)

Neem oil and a number of fix residues going on spawn laying and hatchability of PB spawn resting on stored legume grains. The trial incorporated the action as oil of neem *(A, indica),* residues of grains of golden oleander *(Thevetianeriifolia),* castor *(Ricinuscommunis)* and *Lamanaeamara.* In terms of oviposition, neem oil was the most effective treatment, wherever pest futile on the way to put down progeny resting on the treated grains. But, the smallest amount effectual action was of *L camara.* In conditions of offspring hatchability, golden oleander conduct gave the most excellent consequences with no hatched progeny. Resting on the further supply, action through *R. communis* seed dust was the hatched spawn. On the other hand, treatment with *R. communis* seed residue was the smallest amount effectual, footage a indicate proportion of 90.08 % progeny hatched competent to 93.0% into the natural power. (Angood and Sunaidy 2003). In another study to check the result of neem folio residue lying on swarm of PB in protect seed. Neem leaf powder hence in the direction of exist effectual on the price of 0.5 to 2.0 mg/lOOg of seeds and provided good quality consequences into value of lethal result, protection and country (Singh 2003a).

Customarily old African deposit residues, among a well-known consequence adjacent to (*maculatus,* were extracted with $H_2O$. The extracts, 13 volatile oils, 2 non-volatile oils and 8 slurries were evaluated for their lethal and repulsive special effects aligned with the insect. Appliance of explosive oils led in for the most part gear toward a less amount of progeny lying on treated beans. The explosive oils *Cymbopogon spp.* reasoning greater part of the progeny not toward enlarge interested in mature beetles. Different types of the explosive oils appeared repulsive special effects as non-explosive oils were not repulsive and had no consequence on top of the integer of progeny laid; yet, the enlargement of these spawn was vulnerable, most so through oil of *A. indica.* None of the slurries had a toxic effect on the beetles but some were repellent, whereas the slurry from *A. indica* leaves was attractive (Boeke *et al.* 2004).

The efficacy of vegetable oils next to *C. maculates* violent legume. Groundnut, sesame, soybean, mustard and neem oils (at lOml/kg of seeds) since repulsive, ovipositional deterrent and ovicidal cause beside this beetle were investigated in the laboratory. The entire the oils evaluated were effectual; but, neem oil showed toward be there the most affective whereas every part of the oils except for neem oil showed decreased during efficacy with the wait in action point (Bhatnagar *et al,* 2001).

The period of enlarged stages of PB and known its vulnerable stages on the way to neem and sesame oils. The period for 1-4 instar maggot and pupal condition were 7-12, 12-16, 16-19, 19-22 and 22-27 days living, correspondingly. The consequences appeared to together the oils may possibly manage the maggot within the bean cotyledons indicating so as to oils may penetrate keen on cotyledons and chemically restrain or destroy the young insect within. It was concluded so as to in advance increasing condition were extra liable than the later on ones and the power of maggot site in the bean and its acceptances may exist dependable for the age-dependent property of oils (Ahmad *et al* (2003).

By checking the toxicity of some plant oils of calamus, clove and karanja and its enhancement by combinations of oils against selected insect pests including PB. Calamus oil exhibited the highest toxicity against adults of PB and *Culexquinquefasciatus.* The activity of calamus oil was remarkably enhanced when mixed with inactive oils or other derivatives. The combination of calamus oil and karanja oil (1:1) gave a LC50 of 45.87 p.p.m against *C. quinquefasciatus* larvae, while the combinations of calamus oil and capric acid (1:1) gave a LC50 of 0.51 mg/cm2 against PB (Bhonde *et al.* 2001).

The variant in efficacy of pirimiphos-methyl and oils of neem, sesame, castor and soybean also alone or in combination of four ratios (1:1, 1:2, 1:5, and 1:10) of pirimiphosmethyl and every oil was observed. Each and every type of the oil definitely known preservative, while joint among pirimiphos-methyl except for neem and soybean oils, which exhibit an opposed result on 1:1 percentage not in favor of the beetle. The highest synergism of pirimiphos-methyl was practical on 1:10 percentage having the highest co-toxicity coefficient worth for neem oil (4908.53) obeyed in sesame oil (434.11), castor oil (295.24) and

soybean oil (232.93) (Khlequzzaman and Chovvdhury 2003).

The efficacy of different vegetable oils (castor, neem, pongamia, coconut, mustard, sesame, soybean and sunflower) at 2 and 4 ml/kg, eight plant powders including those of datura and neem at 20 and 40 m/kg and three plant extracts at 2.5, 5.0, 7.5 and 10 ml/kg against PB infesting black gram. All the oil treatments were superior in protecting the seeds from PB attack than Malathion treatment (60 p.p.m.) or control. The oils of neem, castor and coconut at both the doses proved most effective in protecting the seeds for about 9 months after treatment. Among the plant powders, *Lantartacamara*and *Tridaxprocumbens* at both concentrations and *Lantartacamara* and *camara* extracts at all concentrations were promising in protecting the seeds. The use of such botanical products did not affect the permeability of the seeds (Tripathy *et al*, 2001).

The botanicals for the management of Pulse beetle violent lentil and legume grains into storage space. The oils of neem, royna and castor at 8 ml/kg wherever when folio dust and rough materials of neem, bankalmi, bishkatali, marigold, castor and mango at 5% (w/w) and at 8 ml/kg, correspondingly, be effectual in reducing egg-laying of PB. The swarm and power failure in lentil and chickpea were prevented through 100% during action by way of oils, folio residues and rough materials of the experienced botanicals up to 9 months of storage space (Bhuiyah *et al*. 2002).

Leaf extracts of *Tabemacmontanalivaricale* and *Tamar'mdusindica*in acetone were found to be an effective anti-feedant and adulticidal agent against PB. The loss in seed weight was minimum (0.46 and 1.37 g) at 100% concentration of *T. livaricale* and *T. indica*, respectively. Percent adult mortality was 72.9% with 7* *livaricale*and 67.6% with *T. indica (*Dwivedi and Venugopalan 2002).

By screening foliar extracts of *Annonasquamosa* for their insecticidal activity against PB. Flavonoids, isolated from aqueous extracts of *A. squamosa*, showed 80% pesticidal action not in favor of PB at a attention of 0.07 mg ml super (-1). Different physico-chemical analysis, chromatographic and spectroscopic study among moderately purify aqueous extort appeared the existence of flavonol sort flavonoids. This could give a helpful start for the growth of botanical insecticides for post-harvest protection of legumes (Kotkar *et al*. 2002). And by studying the pest repulsive action of definite lodge extort next to PB. The extract of *Allium cepa, Eugeniacayophyllifolia, Menthaarvensis, A. indica, Ocimum sanctum* and *Vitexnegundo* showed revolting exploit. In adding up, the revolting motion of delicate take out *of Zingiberofficinale* was as well important not in favor of PB (Kokate and Chintalwar 2003).

The repellent activity of some plant extracts viz..*Acacia Arabica, Dalbergiasissoo, R. communis* and *Partheniumhysterophorus* against PB on chickpea grains under laboratory conditions. *P.hysterophorus* extract showed the maximum repellency against PB. According to Upasani *et al*. (2003), aqueous folio take out of *R. communis*, a cultivate place in tropic. Upasani *et al*. (2003), aqueous folio take out of *R. communis*, a cultivate plant in hot country, appeared outstanding pesticidal action not in favor of PB. Flavonoids were lonely and experienced as pestiticidal and antimicrobial agents. The remote flavonoids appeared latent pesticidal, ovicidal and oviposition restriction behavior not in favor of PB (Sharma *et al*. 2003).

By Evaluation of insecticidal properties of some plants materials against *Callosobruchus* Sp. On gram. – Thesis (RDVV) Jabalpur. Raina (1970) and Pokharkar and Mehta (2011) reported that egg hatching of *C. chinensis* ranged from 94 to 99 per cent on moong bean at 300C temperature and 70 per cent relative humidity and 92 per cent on chickpea, respectively. However, egg hatching of *C. smaculatus* varied from 57.9 per cent in November and 93.1 per cent in September (Gill and Ramzan, 1998).

The combined average larval and pupal period of *C. chinensis* was observed to be 20 days on cowpea and gram seed at room temperature. Singal and Borah (2001) observed that larval and pupal period of *C.chinensis* was 16.2 ± 0.16 and 7.2 ± 0.18 days, respectively on pods of *Cajanuscajan*. Meghwal and Singh (2005) reported that the developmental period (Larval + Pupal) of *C. chinensis* (L.) on moth bean grains ranged from 20 to 22 days with an average of 20.79 days. Bhargava *et al.* (2008) reported that the mean larval and pupal period of *C. chinensis* ranged from 14.80 to 26.20 and 5.40 to 11.40 days, respectively on different pulses. They also reported that the developmental period of *C. chinensis* varied from 24.60 to 44.80 days on grains of gram cultivar including cowpea, moong bean, gram, pigeonpea, pea and soybean. Pokharkar and Mehta (2011) reported 25.26 ± 3.95 days of larval and pupal period of *C. chinensis* on chickpea. Pathania Mandeep: (RinaKumari 2000).

The worth of several stand crop the same as seed protectants in opposition to the pulse beetle. *Callosobruchus chinensis* (L.) chick pea. Studies were undertaken to evaluate five plant powders, viz., neem (Azadirachta indica A. Juss.) leaf, black pepper (Piper nigrum L.) fruit, aonla (Emblicaofficinalis L.) fruit, five leaved chaste tree (Vitexnegundo L.) leaf, curry leaf tree (Murrayakoenigii (L.) Sprengel) used @ 50 g/kg grains and two oils, viz., mustard (Brassica juncea L.) and neem seed kernel oil used @ 7.5 ml/kg grains for their efficacy as grain protectants against the pulse beetle, *Callosobruchus chinensis* (L.), infesting black gram (Vignamungo (L.) Hepper). The results revealed that black pepper fruit powder, neem oil and mustard oil caused 100 per cent mortality after 7 days'(Thakur A. K. 2009)

The efficiency of different seed protection not in favor of pulse beetle, *Callosobruchus chinensis* (L.) infest green gram, Vignaradiata (L.) Wilczek. Efficacy of 11 seed protection viz., neem grain kernel residues @ 20 g/kg seed, neem oil at the rate of 10 ml/kg, mustard and groundnut oil each @ 07.5 ml/kg, turmeric powder @ 3.5 g/kg, mustard oil +turmeric powder @ 03.75 ml+01.75 g/kg, groundnut oil+turmeric powder @ 03.75 ml+01.75 g/kg, 7 cm cover by means of each one of saw dust, sandy soil, dung cake ash and wheat husk was investigated lying on fully developed death (%) and power failure (%) through *Callosobruchus chinensis* lying on treated and coarse green gram grain (power) on an gap of 1, 35, 70 and 105 time later than storage space (Subhash; *et al.* 2010)..

Consequence of safe to eat and non-safe to eat edible oils on the growth and growth of *Callosobruchus maculates* infesting green gram (vigna radiate). Effect of safe to eat and non- oils of sesame, coconut, groundnut, soybean mustard, mahua, castor, karanja, neem and linseed on *Callosobruchus maculatus* infesting green gram was investigated (KatareSubhash *et al.* 2012).

Suppression of the cow-pea bruchid (*Callosobruchus maculatus* (F.) damaging stored cow-pea (*Vignaunguiculata* (L.)Walp.) Seeds with some edible plant product in powder form. 05 Edible Plant Product Powders (EPPP), West African black pepper (Piper guineense Schum and Thonn), clove (Syzgium aromaticum (L.)Merril and Percy), Ethiopian pepper (Xylopiaaethiopica (Dunn.) A. Rich), Alligator pepper (Aframomummelegueta Schum) and African locust bean (Parkiabiglobosa (Jacq.) R. Br. Ex G. Donf.) were studied for their effectiveness in suppressing oviposition, egg hatch and progeny emergence against *Callosobruchus maculatus* (F.) (Ajayi.F.A; Wintola, H. U. 2006)

## Conclusion

It has been concluded that different plant materials which were used are friendly with the ecosystem have significant results against pulse beetle and serve as an alternative methods for the pest control. They are easy to use for the management of the said pest. This review study opens the door for entomologist to work for design techniques for the management according to the locally available plants materials.

## References

Ahmad (2003) determined the duration of developmental stages of PB and identified its susceptible stages to neem and sesame oils. The duration for 1-4 instar larva and pupal stages were 7-12, 12-16, 16-19, 19-22 days.

Ahmed, K. S., T. Itino and T. Ichikawa. (2003). Duration of developmental Stages of *Callosobruchus chinensis* (Coleoptera: Bruchidae) on Adzuki bean and the effects of neem and sesame oils at different stages of their development. Pak. J. Biol.Sci., 6(10): 932-335.

Ajayi. F.A; Wintola, H. U. (2006). Suppression of the cowpea Bruchid (Callosobruchus maculate (F.) infesting stored cowpea (Vignaunguiculata (L.) Walp.) Seeds with some edible plant product powders.

Angood, S., B. and M. A. Sunaidy. ( 2003). Effect of neem oil and some plant powders on egg laying and hatchability of the cowpea beetle, Callosobruchus chinensis eggs on stored cow pea seeds. Uni. Aden J. Natural App. Sci., 7: 195-202.

Arora, K., D.R. Batish, H.P. Singh and R.K. Kohli. (2015). Allelopathic potential of the essential oil of wild marigold (*Tagetes minuta* L.) against some invasive weeds. J. Environ. Agric. Sci. 3: 56-60.

Aslam, M. (2004).Pest status of stored chickpea beetle, Callosobruchus chinensis L. On chickpea. J. Ento mol. 1 (1): 28-33.

Aslam, M., K. A. Khan and M. Z. H. Bajwa. (2002). Potency of Some Spices against *Callosobruchus chinensis* Linnaeus. OJBS, 2(7): 449-452.

Atwal, A.S. and G.S. Dhaliwal. (2005). Agricultural Pests of South Asia and their Management. 5th

edition, Kalyani Publishers, New Delhi, India, 505P.

BBS (Bangladesh Bureau of Statistics). (2008). Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics, Planning Division, Ministry of Planning, Govt. of the People's Republic of Bangladesh, Dhaka, Bangladesh. Pp. 125-126.

Bhalla, S., K. Gupta, B.Lal, M.L. Kapur and R. K. Khetrapal. (2008). Efficacy of various non-chemical methods against pulse beetle, Callosobruchus maculates (F.). ENDURE International Conference, Diversifying Crop Protection, and France.P. 1-4.

Bhalla, S., K. Gupta, B.Lal, M.L. Kapur and R. K. Khetrapal. (2008). Efficacy of various non-chemical methods against pulse beetle, Callosobruchus maculates (F.). ENDURE International Conference, Diversifying Crop Protection, France. Pp. 1-4.

Bhuiyah, M. I. M., A. N. M. R. Karim, B. N. Islam and Z. Alam. (2002). Test of botanicals for the control of the beetle attacking lentil and chickpea in storage. Bangladesh J. Agri. Res., 27: 349-362.

Boeke, S. J., C. Barnaud, J. J. A. V. Loon, D. K. Kossou, A. V. Huis and M.Dieke. (2004) Efficacy of plant extracts against the cowpea beetle, Callosobruchus maculatus.Int. J. Pest Manag. 50 (4): 251-258.

Bowers, W. S. (1983). The search for fourth-generation pesticides. In "Natural products for innovative pest management" (Eds. Whitehead, D.L and Bowers, W.S.), Pergamon Press Oxford, pp: 47-58.

Dinar musbasalis (Rondani) (Hymenoptera: Pteromalidae).J.Stored Pod. Res. 41: 363-371.

Dwivedi, S. C. and S. Venugopalan.( 2002). Efficacy of Tabernaemontanalivaricate and *Tamarindus indica* as an anti feedant and adulticide against pulse beetle *Callosobruchus chinensis* (L.) (Coleoptera, Bruchidae). Baltic J. Coleop., 2 (2): 159-163.

Egesa, A.O., S.N. Njagi and C.W. Muui. (2016). Effect of facilitative interaction of sorghum-cowpea intercrop on sorghum growth rate and yields. J. Environ. Agric. Sci. 9:50-58.

Elzaki, M.E.A. and A.M. Ali. (2015). Efficacy of neem, basil and chilli powders as antifeedant in the red flour beetle *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). J. Environ. Agric. Sci. 2: 9.

Fishwick, F. B., (1988). Pesticide residues in grain arising from post harvest Treatments. Aspects of Applied Biol., 17: 37-46.

Ghosh, S. K. and S. L. Durbey. (2003). Integrated Management of Stored Grain Pests. International Book Distributing Co., Luck now, India, pp 263.

Gujar, G.T. and T.D. Yadav. (1978). Feeding of Callosobruchusmaculatus (Fab.) and *Callosobruchus chinensis*. in green gram. Indian J.Entomol. 40: 108-112.

Halstead, D. G. H. (1963). External sex differences in stored products coleoptera. Bull. ENT. Res., 54: 119-134.

Hashmi, M.S. (2016). Agrochemical and agricultural sustainability: A case study of Pakistan. J. Environ. Agric. Sci. 9: 1-9.

Ignatowicz, S., B. Wesolowska and K. Banasik. (1995). Potential of common Plants as grain protectants: Repellent effect of powdered leaves and seeds of the neem tree on stored product pests. Insects: Chemical, Physiological and environmental aspects, Pol and University of Wroclaw, 317-322.

Jacobson, M.( 1989). Botanical pesticides: past, present and future. In: Arnason, J.T., Philogene, B.J.R., Morand, P. (Eds.), Insecticides of Plant Origin. ACS Symposium Series No. 387.American Chemical Society, Washington, pp. 1-10.

Javaid, I. and M. A. T. Poswal. (1995). Evaluation of certain spices for the control of *Callosobruchus maculates* (Fabric us) (Coleoptera: Bruchidae) in cowpea seeds. African.Entomol.3: 87-89.

Jilani, G. and M. M. Malik. (1973). Studies on Neem plants as repellent against stored grain insects. Pak. J. Sci. Ind. Res., 16: 251-254.

Jilani, G. and Saxena, R.C. (1988). Evaluation of neem oil, combination of neem oil and Fumigation and Actellic as paddy / rice protectants against storage insects. Proc.Final Workshop on Botanical Pest Control in Rice-based Cropping Systems.Int. Rice Res.Inst. Manila, 1988. Pp.28.

Ketoh, G. K., H. K. Koumaglo and I A. Glitho. (2005). Inhibition of Callosobruchus maculates (F.) (Coleoptera: Bruchidae) development with essential oil extracted from CymbopogonschoenanthusL Spreng. (Poaceae), and the wasp

Kim, S.I, J. Y. Roh, D. H. Kim, H. S. Lee and Y.J.Ahn. (2003). Insecticidal activities of aromatic plant extracts and essential oils against Sitophilusoryzae

and Callosobruchus chinensis. Stored Prod.Res. 39: 293-303.

Kokate, S. D. and G. J. Chintalwar. (2003). Insect repellent activity of certain plant extracts against pulse beetle, *Callosobruchus chinensis*. National Academy Sci. Letters., 26:44-46.

Kotkar, H. M., P. S. Mendki. S. V. G. S. Sadan, S. R. Jha, S. M. Upasani and V. L. Maheshwari. (2002). Antimicrobial and pesticidal activity of partially purified flavonoids of Annonasquamosa. Pest Manage.Sci. 58 (1): 33-37.

Kumari, K and S. N. Singh. (1998). Evaluation of efficacy of botanicals an insecticide against pulse beetle (*Callosobruchus chinensis*.).J.App. Biol., 8:138-140.

Materials on the development of pulse beetle, Callosobruchus chinensis (L.) on stored pigeon pea. Cajanus (L.)Millsp.J.Insect Sci., 10: 196-197.

Mookherjee, P.B., M.G. Jotwani. T.D. Yadav and D. Sircar. (1970). Studies on the Incidence and extent of damage due to insect pests in stored seeds. Leguminous and Vegetable seeds. Indian J. Entomol. 32 (4): 350-355.

Nakakita, H. (1998). Stored Rice and Stored Product Insects. In: Rice Inspection Technology Manual. A. C. E. Corporation, Yokyo, Japan, pp. 49-65. Rahman R., Huda S. and A. Hussain. (1975). Effect of gamma radiation on different stages Of *Callosobruchus maculates*. Bangladesh J. Zool. 3: 103-109.

Naqvi, S. N. H. (1987). Biological evaluation of fresh neem extracts and some components with reference to abnormalities and esterase activity.Proc. 3rdIntl. Neem Conf (Nairobi 1986), pp. 315-330.

Raina, A.K. (1970).Callosobruchusspp.infesting stored pulses (grain legumes) in India and comparative study of their biology. Indian J.Ent. 32.

Saxena S.C. (1992). Biology of Insects. Published by Raju Primlanifor Oxford and IBH Publishing Co. Pvt. Ltd., 66 Janapath, New Delhi 110001. P.366.

Sharma, S. S., G. S. Yadav, and B. S. Chhillar. (2003). Repellent Activity of Some Plant Extracts against *Callosobruchus chinensis* (L.) in Chickpea Grains. Ann. Biol., 19 (2): 217-218.

Sharma, S.S. 1984. Review of literature of the losses caused by *Callosobruchus chinensis* (L.)(Coleoptera: Bruchidae) during storage of pulses. Bull. Grain Technol.22 (1): 62-.68.

Singal and Borah (2001) observed that larval and pupal period of *C. chinensis* was 16.2 ± 0.16 and 7.2 ± 0.18 days, respectively on pods of Cajanuscajan.

Singal, S. K. and R. Chauhan. (1997). Effect of some plant products and other

Singh, S. C, N. K. Pandey and A. Kumar. (1996). Effect of neem saw dust on mortality of the pulse beetle (*Callosobruchus chinensisL.)* on black gram (Vignamungo).J. Ecotoxicol. Environ. Mon It., 6(1) 69-71.

Singh, S. C. (2003a). Effect of neem leaf powder on infestation of the pulse beetle *Callosobruchus chinensis* in stored khesari. Ind. J. Entomol, 65: 188-192.

Tapondjou, L. A., C. Adler, H. Bouda and D. A. Fontem. (2002). Efficacy of Powder and essential oil from Chenopodiumam brosioides leaves as post-harvest grain protectants against six stored product beetles. J. Stored Prod. Res., 38: 395-402.

Tripathy, M. K., P. Sahoo, B. C. Das and S. Mohanty. (2001). Efficacy of botanical plant powders and extracts against *Callosobruchus chinensis* Linn, attacking black gram (Cv. T9). Legume Res., 24(2):82-86.

Tyler, P. S., R. W. Taylor, D. P. Rees. (1983). Insect resistance to phosphine Fumigation in foodware houses in Bangladesh, Int. Pest Control,25: 10-13.

Umrao, R.S. and R.A. Verma. (2002). Effectiveness of some plant products against pulse beetle on pea. Ind. J. Entomol., 64: 451-453.

Upasani, S. M., H. M. Kotkar, P. S. Mendki and V. L. Maheshwari.(2003).Partial characterization and insecticidal properties of Ricinuscommunis L foliage flavonoids. Pest Manage. Sci., 59 (12): 1349-1354.

Wink, M. (1993). Production and application of phyto-chemicals from an Agricultural perspective. In: T.A. van Beek, H. Breteler, (Eds.), Photochemistry and Agriculture, Vol. 34. Clared on, Oxford, UK, pp.171-21.

Yazlik, A. and İ. Uremis. (2016). Evaluation of autotoxic potential of Johnsongrass and its integrated application with herbicides. J. Environ. Agric. Sci. 9: 44-49.

Yusof, O. and S. H. Ho. (1992). A survey of insecticidal resistance in Sitophilus Zeama is Motsch. In Malaysia and Singapore. J. Plant Protec. in the Tropics, 9: 219-225.