Summary
Among various legumes crops, cowpea *Vigna unguiculata* (L.), is an excellent subsistence crop and being rich in proteins, it is used for human diet as a green vegetable, pulses and for cattle feed as a green fodder and crop residues as concentrate. It is grown in approximately 9.88 lakh hectares in India. Insects are a serious constraint to cowpea production and to their storage during the post harvest period. The cowpea weevil *Callosobruchus maculatus* (F.) is the most serious post-harvest insect pest of cowpeas throughout the tropics. As high as 100% infestation could occur on unprotected cowpea following 3-5 months storage. The importance of cowpeas, the economic importance of the pests and the damage caused has tempted many workers to find out economic and environmentally feasible ways to protect the pulses and the seed under storage.

The present study has its own importance, as it relates to environmental issues and looking to the present trends of global demand for organic foods, the outcome of the studies of this nature will have ever increasing demand in the coming years. The following were the objectives of this study:

- *Laboratory evaluation of relative susceptibility/ resistance of cowpea germplasm to the seed beetle.*
- *Test the efficacy of botanicals and inert materials against the seed beetle, and*
- *Suggest non-chemical, safe storage methods for cowpea seed beetle.*
On first aspect, the study has been conducted on thirty-two cowpea germplasm having desired production potential and representing diverse seed characters. The seed morphological characters viz., seed coat texture, seed coat colour and seed shape, 100 seed weight, and eye colour were recorded for correlation and other studies to identify morphological factors for resistance. The observations were recorded for number of seeds with eggs laid, number of eggs per seed and the damage/ emergence holes for adult weevils. The percent seeds with eggs, seeds (%) with number of eggs per seed and percent damaged grains were calculated.

The observations on seeds with eggs indicated that genotype IL 1072-1 has the lowest number seeds with eggs i.e., 9.66 percent. This was followed by IL 160-B (11.66%), RA-2 (13.66%), IL 3178 (14.66%), IL 680 (16.66%), Ht78P-5-A (17.66%), IL 1063 (19.33%), IBM (19.33%), HY5P52-2 (19.33%), CO-5 (21.00%), IL 461-4 (21.33%), IL 4166 (26.66%), GFC-3 (29.00%), IL 4216 (31.33%), EC244236 (31.66%), IL 904 (33.33%), IL 460-B (34.33%), IL 362 (37.66%), EC244409 (37.66%), EC240998 (39.00%), IL 855 (43.33%), IL 1086-2 (47.00%), FS-68 (47.66%), GFC-2 (51.00%), IL 1072 (51.33%), EC244243 (53.66%), HFC 42-1 (54.66%), CS-88 (59.33%), IL 1050-3 (67.33%), GFC-4 (71.66%) and GFC-1 (73.66%). Bundel Lobia-1 showed the presence of maximum average number of seeds with eggs i.e., 81.33%.

The lowest average adult weevil emergence was recorded in EC 244236 and IL160-B (29.67), followed by IL 1072-1 (30.33), Ht78P-5-A (31.00), IBM (31.33), CO-5 (36.00), RA –2 (39.33), IL 3178 (41.00), IL 904 (42.00), HY5P52-2 (44.67), IL 362 (45.67), IL 4216 (48.67), GFC-3 (54.33), EC244409
(58.33), IL 1063 (62.33), IL 461-4 (64.67), EC240998 (67.00), IL 680 (81.67), HFC 42-1 (85.67), IL 460-B (88.00), IL 1086-2 (124.67), IL 855 (128.67), GFC-4 (130.33), IL 4166 (141.33), IL 1072 (148.67), EC2442420 (168.00), IL 1050-3 (179.67), FS-68 (186.33), CS-88 (188.33), GFC-2 (206.00), GFC-1 (213.33). The maximum number of adult bruchus those emerged was collected from variety Bundel Lobia-1 (242.33).

The correlation values indicate that none of the seed characters had any relationship with percent seeds with eggs and adult bruchid production. Among the seed characters seed coat colour and seed coat texture were positively correlated (=0.547). The percent seeds without eggs had significant negative correlation with adult bruchid production indicating thereby, less the percent seeds without eggs more the number of bruchid or more the number seeds with eggs results in higher number of bruchid produced.

The following botanicals and inert materials have been tested for the efficacy against this pest- Sand- coarse sand (0.25-2.00mm) and fine sand (0.05-0.25mm) @ 20 and 40 percent each, coarse sand layer -1cm & 2 cm and fine sand layer 1cm and 2 cm, both above and below the seed; ashes- Ipomea stem ash, cow dung and goat pellets ash each @ 10 and 20%; Neem oil- @ 0.10, 0.25, 0.5 and 1.0%; Karanj oil- @ 0.25, 0.5, 0.75 and 1.0%; Neem leaf powder- @ 5 and 10 percent; Deoiled neem cake- @ 2.5 and 5.0 percent; Inert dust- ABC dust - @ 2.5 and 5.0 percent ; Malathion- @ 0.1% and 0.5%; Malathion dust- @ 0.7 percent and Control- (Untreated). The observations were recorded for number of seeds with eggs, number of eggs per seed and the damage on the basis of emergence holes for adult weevils. The percent of
damaged grains and Weevil Perforation Index was calculated. All the calculations have been done using standard methods.

The results indicate that amongst the botanical oils, neem oil at the dose of 0.5% and 1.0% and Karanj oil at 1.0% are most effective as oviposition deterrent as no egg laying is noticed in these treatments. Similarly 2 cm layer of fine sand was equally effective in preventing egg laying. All these treatments were at par with the chemically treated seeds with Malathion 0.1% and 0.5%. These were followed by treatments - Sand coarse layer 2cm (5% seeds with eggs), Cow dung ash 20% (5.33%), Neem oil 0.25% (6.33%), Fine sand 1cm layer (7.33%), Coarse sand 1cm layer (12.33%), Neem oil 0.1% (21.00%) and Goat pallet ash 20% (26.67%).

The efficacy of the treatment has been worked out on the basis of adult emergence holes and WPI. Fine sand layer 2 cm, Neem oil 0.5 and 1.0%, Karanj oil 1.0% provided absolute control as these treatments did not show a single damaged seed. These were followed by Ipomea ash 20% with 2.00% seeds damaged, Cow dung ash 20% with 2.67% damaged seed. The other treatments showed the damage as- Neem oil 0.25% (4.00%), Coarse sand 2cm layer (4.33%), Fine sand 1cm layer (5.67%), Coarse sand 1cm layer (7.67%), Malathion dust 0.7% (7.67%), Neem oil 0.1% (12.33%), Goat pallet ash 20% (20.00%), Ipomea ash 10% (25.33%), Goat pallet ash 10% (26.33%), Coarse sand 40% (32.00%), Cow dung ash 10% (33.33%), Karanj oil 0.75% (42.33%), Neem leaf powder 10% (45.67%), De-oiled neem cake 2.5% (47.00%), Fine sand 20% (53.00%), Fine sand 40% (56.67%), Inert dust
2.5% (59.33%), De-oiled neem cake 5% (59.67%), Coarse sand 20% (60.33%), Neem leaf powder 5% (65.00%), Karanj Oil 0.5% (72.67%), Inert dust 5% (72.67%), Karanj Oil 0.25% (79.00%). The untreated Control showed the maximum number of damaged seeds (80.33%).

The seeds after the test period were put to germination test to see the effect of the treatment on the germinability. Some of the treatments are seen to effect the germination adversely whereas some like sand seem to promote this. Incidentally sand has come out to be a good protectant and at the same time enhances germination also. The adverse effects of the protectants in some case makes it mandatory that the final identification of non-chemicals to be recommended for use particularly for seeds should be based in addition to its performance as protectant, its effect on germination also.

It can be concluded that there is vast scope for replacement of chemicals with materials those of botanical and other origin for the management of commonly occurring insect pests in commodities under storage. These could be studied further for application/ packaging as technology. It would be important while making a recommendation, to ascertain the availability of that particular material locally. The ethnic knowledge at farmers' level as well at household level needs to be properly documented, scientifically validated for use and integrated in different agricultural package of practices.