Plant Archives Vol. 26, Supplement 1, 2026 pp. 540-547 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-1.073

PDKV HERBAL TABLETS USED FOR MANAGEMENT OF STORED PULSE GRAIN PEST

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(Date of Receiving : 07-09-2025; Date of Acceptance : 05-11-2025)

ABSTRACT

The present investigation was conducted at AICRP on PHET, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS) laboratory. The experiment were carried out in Completely Randomized Design with eight treatments, replicated thrice. Initially for seven formulation were prepared with Black pepper fruit powder, clove Fruit powder, Hing powder, Garlic bulb paste, Neem seed powder, starch powder, Menthol, Sodium benzoate preservative and water. One kg of mung bean grains were took for each replication of treatment. Among seven formulation tested on mungbean grain, best formulation IIIrd selected for preparation of tablets and according no, as per seven treatments of tablets were kept at one kg mung bean grain and untreated control. Result revealed that tablet Formulation III was recorded negligible damage upto 120 DAS in mung bean, however (0.50 %) damage was noticed at 180 days after storage. Followed by tablet formulation VIIth (2.67 % at 180 DAS) and VIth (3.17 % at 180 DAS). Whereas the maximum damage (16.67%) was observed in untreated control. Same trend was noticed in per cent grain weight loss. Formulation III were made up from black paper 15 %, Hing 20%, clove 35 %, Garlic 5 %, Neem seed + starch 1:1 ration 5 %, Menthol 19 %, Sodium benzoate 1 % and distilled water were used.

During three and six month of storage the number of beetles (2.67) was recorded significantly lowest in the grains with tablets prepared from IIIrd formulation followed by VIIth and VIth formulation. Ttreatment T3, T4, T5 and T6-Tablet recorded negligible damage and weight loss at 30, 60, 90, 120, 150 and 180 DAS. Followed by treatment T1-(Tablet 2 /5kg) and T-2 (tablet 3/5kg). On the basis of cost economics Herbal tablets @4 tablet /5kg grain is effective for management of pulse beetle in respect of minimising per cent grain damage and per cent weight loss due to pulse beetle damage.

Keywords **:** Pulse beetle, mung bean, formulations, damage per cent, herbal tablet, Neem seed powder, Garlic bulb powder, efficacy & pulse beetle

Introduction

Store grain pest causes the heavy losses to store grains *viz.* cereals and pulses all over the world. The problem is from prehistoric time and still not a novel remedy has sought out. The literature describes the use of one or two plants or herbs by the people from India and Asia to control the store grain pests. The pulse beetle, *Callosobruchus chinensis*, is a serious pest of stored food grains and causes damage to cowpea, gram, soybean, and pulses. This pest is distributed worldwide and is commonly found in India.

Pulses are one of the important group of worldwide crops and play a major role in the daily diet of low-income groups of people. India is the major producer of green gram in the world, and it is grown in almost all the states. It is grown on about 40.38 lakh hectares with a total production of 31.5 lakh tonnes with a productivity of 783 kg/ha and contributes 11 % to the total pulse production in the year 2021-22. In

Maharashtra 378 lakh hectares with a total production of 147 lakh tones during 2021-22 (Source: www.indiastat.com and eands.dacnet.nic.in).

In India Gujar and Yadav (1978) recorded 32.2 to 55.7 per cent loss in seed weight and 17.0 to 53.5 per cent loss in protein content. In case of severe infestation 100 per cent damage is caused by the pest (Pruthi and Singh, 1950). It is well known fact that food constituents play a vital role in the survival and reproduction potential of the insects. The grain characters, which also interfere the normal physiology or feeding of the insect, affects the biology of the pest adversely and these make a variety resistant to insect attack.

Prevention of loss in stored product due to insect's pest is one of most important aspects in Indian agriculture. For the control of stored grain insect pests, the use of insecticidal protectants is a common preventative measure to protect store grain from insect damage, but these chemicals have lost their effectiveness due to development of resistance in *Callosobruchus chinensis*. Moreover, toxic residues of these chemicals may pose risk to human health and the environment. Therefore, botanicals (plant powders) are used as grain protectants as these have insecticidal properties against stored grain insect pests (Bakkali *et al.,* 2008) as well as safer for human health and the environment.

The herbal pallets made from neem seed ('neem' (*Azadirachta indica* (A.) Juss.) Powder, `Sitafal' (Annona swuamosa) Annona seed powder, Hing or asafoetida (*Serula foetida*) & chilli powder in water were tried to control the pest. Results compared with Parad tikia available in market. After 48 hours pest insect get killed. In Tablets soaked in eucalyptus oil start killing insect pest after 5 minutes. Home made pallets are cheapest, non poisonous for human being (Chaudhari, 2013). Ginger can also be used for effective storage, "30 g of ginger rhizome powder and 50 g of neem kernel powder can be mixed with one kg of any of the pulses such as cowpea, soya bean, pigeon pea, red gram etc. Grains and pulses can also be stored by mixing them with Neem oil (2-3 ml/kg of seed). The neem oil 1-2% is also effective against stored grain pests." Farmers mix the dried and powdered leaves of banyan tree (*Ficus benghalensis*) with the harvested grain for keeping it safe from pests. Sometimes neem (*Azadirachta indica*) leaves are also mixed with it. Camphor (kapoor) evaporates over time when stored. To prevent this, grains of pepper are placed along with camphor in the container. A handful of rock salt kept at the base of the storage place helps preventing pests in pulses and grains. The pests of stored rice grains can be prevented by keeping ten to fifteen dry chilies along with the rice in a container or in bags. Fine sand is added to the seeds of red gram (*Cajanus cajan*) and cement to seeds of; sorghum as protection against storage pests. Good quality garlic bulbs, with the plant intact are brought from the fields and hung from the roof of the house. Hing or asafoetida (*Serula foetida*) has the properties of ceasing the unwanted growth of plants such as banyan (*Ficus benghalensis*) and wild herbs that grow in cracks and corners in buildings during the rains, mainly in the eastern; part of India. These plants grow again even when pulled out from the roots and make cracks in walls. Duryodhan Biswal says that people generally get rid of this problem by sprinkling hing powder on the part of the stem from where it is cut. Hing acts as herbicide. Storing grains for a long period of time has always proved tedious for the farmers. The above literature indicates traditional use of plants and herbs for control of storage grain pest. For the control of stored grain insect pests, grain protectants and fumigants have been in use for the last many years. These chemicals have lost their effectiveness due to development of resistance in store grain insect pest. Moreover, toxic residues of these chemicals may pose risk to human health and the environment (Isman, 2006; Rajendran and Sriranjini, 2008). Therefore, use of effective herbal products for pulse beetle management may prove better alternative.

Protecting Pulses and grains by using the leaf of neem, neem seed powder, black pepper powder, ginger are the common practices. However due to incorporating whole seed, leaf, oil and seed powder; screening and cleaning the grain and washing with the hot water before use to avoid the effect on taste and smell of the produce becomes necessary. To avoid these difficulties, it was proposed to prepare herbal tablets of different formulations.

The aim of the present project is to formulate the herbal tablets for control of storage grain pest, to provide scientific base to traditional knowledge, and promote the use of herbal pesticides so as to prevent the use of synthetic fumigants and pesticides and there by reducing the hazards caused by chemical pollutants. The population of Pulse beetle increased during storage condition and cause serious damage therefore control measure become necessary. In the present study different formulation were prepared from herbal product and finalized the formulation made different tablet doses against pulse beetle at storage conditions.

Material and Methods

Rearing of experimental insects: Laboratory culture of pulse beetle *Callosobruchus* spp. had been established (Plate 3) from infested grains/seeds of mungbean. The stock culture of these insect were maintained to obtain newly emerged adult of the insect of same generation.

Neem seed, Black pepper, Garlic bulb, Clove were dried and pulverized in powder form and along with Hing and Menthol powder all these ingredients mixed thoroughly (Plate 1) and passed through 40 mesh sieve used for making tablets by adding sodium benzoate as preservative and starch powder as a binding agent + distilled water in traces. Seven different formulations were prepared for 0.5 g tablet weight of herbal commodity in particular proportion (Plate 2) were prepared and dried. About 10 individual of pulse beetle were released in 1.0 kg of mung bean placed in sealed plastic container. Four tablets (finalized by filler trial) as prepared above were placed in each plastic container. At the same time control experiment was also run without any herbal pesticide to record the emergence of adult pulse beetle and its natural death and per cent infestation. The observations was recorded after every week at room temperature. The results obtained was statistically analysed with completely randomized design and tabulated. After testing the efficacy of the above treatments against the major stored grain pest, i.e. pulse beetle the effective one was reported.

Plate 1: Mxing of all ingredients

Plate 2: Tablets

Plate 3: Rearing of pulse beetle for Mass culture

Table 1 : Different natural products and their combinations to be used to prepare tablet formulations

Sr.No.	Material	Part to be used	Amount of different material in tablet formulation of various treatment (%)						
			I	II	III	IV	V	VI	VII
1	Black pepper	Fruit(Powder)	5	10	15	20	25	30	35
2	Hing	Powder	10	15	20	25	30	35	5
3	Clove	Fruit(powder)	25	30	35	5	10	15	20
4	Garlic	Bulb paste	20	25	5	30	5	10	15
5	Neem seed+Starch Powder(1:1)	Powder	23	15	5	10	20	5	10
6	Menthol	*Mentha arvensis*	16	4	19	9	9	4	14
7	Sodium benzoate	Preservative	1	1	1	1	1	1	1
8	Water	Distilled water	Water in traces sufficient to prepare the tablet was used						

Observations recorded

Per cent damaged grains and per cent loss on weight basis due to damaged grains were observed at an interval of 30, 60, 90, 120,150, 180. The emergence of adult/ pulse beetle recorded in every set of experiment with all above treatments at an interval of three months after the treatment application.

Tablets of various botanicals were prepared according to the procedure mentioned above. Observations were taken and the was analysed and presented in the table given below.

Results and Discussion

Pooled mean effect of different treatment on per cent grain damaged due to pulse beetle on stored mungbean

From the table 2 revealed that all the treatments were significantly superior over untreated control in reducing percent damage at 30, 60, 90, 120, 150 and 180 days after storage condition. Formulation III was recorded negligible damage upto 120 DAS in munngbean, however (0.50 %) damage was noticed at 180 days after storage. Followed by tablet formulation VIIth (2.67 % at 180 DAS) and VIth (3.17 % at 180 DAS). Whereas the maximum damage (16.67%) was observed in untreated control. These findings are in agreement with the findings of Lalsingh Rathod et.al (2019) who reported that Acorus calamus rhizome powder @10 g/kg seed and Black pepper powder @ 3g/kg seed was found significantly superior over the rest of treatments in respect to recording minimum seed infestation. These findings derive support from Zia et al. (2011) reported all treatments caused significant decrease in no of holes made per grain by the beetle compared to control. Yet black pepper (*Piper nigrum*) caused highly significant decrease in number of holes for grain (0.06).

Pooled Mean effect of different treatment on per cent grain weight loss by pulse beetle damage in stored mungbean

The per cent grain weight loss by pulse beetle in stored mungbean from data given in Table 3 observed that Formulation III was noticed significantly superior over rest of the treatments for reducing negligible percent weight loss at 30, 60, 90, 120, 150 and 180 days after storage condition. Followed by tablet formulation VIIth (0.08 % at 180 DAS) and VIth (0.16 % at 180 DAS). Whereas the maximum damage (16.67%) was observed in untreated control. The present findings are in conformity with Baral Se (2002) also reported weight loss was nil in case of *A. calamus* treated chickpea seed. Thein Naing Soe *et al.* (2019) reported that the percent mortality of *C. maculatus* adults treated by the clove oil: sesame oil mixture (8:2) increased from 48.00±5.83, 91.56 ± 4.12 and 100.00 ± 0.00 after application by residual contact method at 24, 48 and 72 h respectively. Swamy and Raja (2018) stated that green gram seeds on mixing of black pepper powder @ 0.1, 0.2 and 0.3 per cent treated seeds of green gram were also found significantly effective as very negligible numbers (0.33, 1.0 and 8.33 adults respectively) emerged. Regarding the seed weight loss, *P. nigrum* 1.50 and 2.00 per cent showed no weight loss was observed. Abhijith et al. (2019) suggested the potential of sweet flag formulation for surface treatment of different package materials against storage insects. A plywood piece impregnated with clove oil placed on grain surface could offer better protection of green gram from pulse beetles for more than 120 days. Thakur and Pathia. (2013) also reported the maximum mortality of *Callosobruchus* spp. due to black pepper seed powder (50% to 60%) and mustard oil (38.00%) in stored pigeon pea.

Effect of different treatment on population of pulse beetle on stored mungbean

From the Table 4 found that population of pulse beetle at storage condition at 3 month and 6 month during 2016-17, 20217-18 and pooled effect that Formulation III was noticed significantly superior over rest of the treatments. The minimum population of pulse was recorded in Formulation III during 2016-17 (1.00), 2017-18 (0.33) and pooled mean (0.68) at 3 month. However, at 6 month (4.00) (1.33) and (2.67) respectively. Followed by formulation VIIth and VIth. The maximum population of pulse beetle were noticed in untreated control i.e. (14.17) and (23.17). As eported by Isman (2006) the powders contain *limnoids* such as *azadirachtin, salainmeliantriol and nimbin* which are useful bioactive components for insect control. The presence of Azadirachtin has a profound effect on insect: at physiological level, it inhibits the synthesis and release of molting hormones (ecdysteroids) from the prothoracic gland and leads to sterility, thus preventing reproduction and multiplication.

Pooled effect of different doses of tablet prepared from formulation III on per cent grain damaged due to pulse beetle on stored mungbean

The final assessment on pooled data during 2015-16 and 2016-17 of different doses of tablet prepared from formulation III on per cent grain damaged due to pulse beetle on stored mung bean from data given in Table 5 indicating that, treatment T6-Tablet @ 7 tablets/5kg was found significantly superior over control. The treatment T4, T5 and T6 were recorded negligible (0.00) percent damage during 2016-17 and 2017-18 and pooled data. Followed by treatment T3 (4.67) T2 (4.67) and T1 (5.67) in reducing the per cent damaged grains due to pulse beetle infestation at 180 DAS. The highest per cent damage was recorded in untreated control 16.67 at 180 DAS.

Pooled effect of different doses of tablet prepared from formulation III on per cent weight loss due to pulse beetle on stored mungbean

The pooled data indicated in Table 6 on percent weight loss by pulse beetle were statistically significant superior over untreated control. The data were recorded from 30 DAS to 180 DAS period. The treatments T3, T4, T5 and T6 were recorded negligible (0.00) percent weight loss during 2016-17 and 2017-18 and pooled data. Followed by treatment T2 (0.60) per cent T1 (0.94) per cent in reducing the per cent damaged grains due to pulse beetle infestation at 180 DAS. The highest per cent weight loss was recorded in untreated control (6.80) at 180 DAS. The same was recorded in Anyanga *et al.* 2013: Amoabeng *et al.* 2014 : Stevenson, 2014: Aziza and Asma, 2015 and Kamran *et al*., 2015) who reported that the effectiveness of some plant powders in pest control. The study confirms the effectiveness of neem, garlic, hing, black pepper and menthol in the proportion and their tablet for control of storage pest especially pulse beetle . It reveals that prolong exposure of the insect pest to the powders increase efficiency in the control of the pests. The treated grain were not only found safe for consumption but also improved healthiness and growth performance. The tablets are cheap, safe and eco-friendly possible replacement of chemical insecticides for storage pests of pulses.

Cost of Economics for Herbal tablet preparation

The cost of economics of different treatments is presented in Table 7 revealed that for preparation of 1 kg total ingredients as per formulation, Tablets prepared =2000 Nos (each weighing 0.5g), Cost of each tablet was (Rs.)= 0.60. As per best treatment 4 tablet per 5 kg is optimum dose, number of tablet per quintal grain =80 Nos. Therefore Cost of tablet per quintal (Rs.) = 0.60 x 80 = Rs. 48/- was noticed.

Conclusion

It is concluded that Herbal tablets @4 tablet /5kg grain is effective for management of pulse beetle in respect of minimising per cent grain damage and per cent weight loss due to pulse beetle damage.

Proposed Recommendation:

For effective management of pulse beetle it is recommended to use to keep 80 tablets (weighing 0.5g each) per quintal in stored mungbean and chickpea.

Table 2 : Cumulative Pooled mean effect of different treatment on per cent grain damaged due to pulse beetle on stored mungbean

Tr.No. (Formulations I-VII)	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS
I	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.00 (1.20)	3.50 (1.49)	4.00 (2.12)
II	0.00 (0.71)	1.00 (1.20)	3.00 (1.86)	4.51 (2.22)	5.50 (2.44)	6.15 (2.58)
III	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.50 (0.97)
IV	0.00 (0.71)	0.16 (0.75)	0.16 (0.75)	2.50 (1.72)	4.50 (2.23)	4.84 (2.31)
V	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.33 (1.34)	3.50 (2.00)	4.17 (2.16)
VI	0.00 (0.71)	0.00 (0.71)	0.17 (0.80)	1.00 (1.20)	2.67 (1.77)	3.17 (1.91)
VII	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.83 (1.51)	2.67 (1.77)
Control (with blank Tablet)	1.83 (1.51)	3.00 (1.86)	4.84 (2.31)	6.84 (2.71)	11.67 (3.49)	16.50 (4.10)
Untreated control	1.83 (1.51)	3.17 (1.91)	5.17 (2.38)	7.00 (2.73)	11.84 (3.51)	16.67 (4.14)
F; Test	Sig	Sig	Sig	Sig	Sig	Sig
SE(m)±	0.06	0.11	0.06	0.11	0.08	0.09
CD(0.05)	0.18	0.33	0.18	0.33	0.24	0.27

* Figures given in parenthesis are square root (x + 0.5) transformed values

*DAS- days after storage

Table 3: Pooled Mean effect of different treatment on per cent grain weight loss by pulse beetle damage in stored mungbean.

Tr.No.	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS
I	0.00 (0.71	**0.00 (0.71)**	**0.00 (0.71)**	**0.26 (0.86)**	**0.48 (0.99)**	**0.61 (1.06)**
II	0.00 (0.71	**0.00 (0.71)**	**0.10 (0.78)**	**0.59 (1.05)**	**0.56 (1.03)**	**0.81 (1.15)**
III	0.00 (0.71	**0.00 (0.71)**	**0.00 (0.71)**	**0.00 (0.71)**	**0.00 (0.71)**	**0.00 (0.71)**
IV	0.00 (0.71	**0.00 (0.71)**	**0.00 (0.71)**	**0.26 (0.86)**	**0.40 (0.94)**	**0.48 (0.99)**
V	0.00 (0.71	**0.00 (0.71)**	**0.00 (0.71)**	**0.22 (0.85)**	**0.47 (0.99)**	**0.65 (1.08)**
VI	0.00 (0.71	**0.00 (0.71)**	**0.00 (0.71)**	**0.00 (0.71)**	**0.07 (0.76)**	**0.16 (0.80)**
VII	0.00 (0.71	**0.00 (0.71)**	**0.00 (0.71)**	**0.00 (0.71)**	**0.02 (0.72)**	**0.08 (0.75)**
Control (with blank Tablet)	0.00 (0.71	**0.12 (0.73)**	**0.18 (0.82)**	**0.53 (1.02)**	**2.90 (1.84)**	**5.80 (2.50)**
Untreated control	0.02 (0.72	**0.13 (0.74)**	**0.22 (0.83)**	**0.54 (1.02)**	**2.94 (1.86)**	**5.89 (2.48)**
SE(m)±	0.01	**0.01**	**0.01**	**0.014**	**0.02**	**0.013**
CD(0.05)	NS	**0.03**	**0.03**	**0.04**	**0.06**	**0.04**

*Figures given in parenthesis are square root (x + 0.5) transformed values
*DAS- days after storage

Table 4 : Effect of different treatment on population of pulse beetle on stored mungbean

Tr.No.	After 3 Month			After 6 Month		
	2016-17	**2017-18**	**Pooled**	**2016-17**	**2017-18**	**Pooled**
I	3.67(2.04)	5.00(2.34)	4.34(2.19)	9.67(3.19)	11.67(3.49)	10.67(3.34)
II	4.67(2.26)	5.33(2.41)	5.00(2.35)	10.67(3.34)	11.33(3.44)	11.00(3.39)
III	1.00(1.22)	0.33(0.88)	0.68(1.05)	4.00(2.11)	1.33(1.34)	2.67(1.73)
IV	5.33(2.41)	5.00(2.34)	5.16(2.38)	11.33(3.44)	10.67(3.34)	11.00(3.39)
V	6.00(2.54)	6.67(2.73)	6.33(2.64)	12.00(3.53)	11.67(3.49)	11.84(3.51)
VI	3.33(1.95)	3.67(2.04)	3.50(2.00)	6.33(2.61)	7.00(2.73)	6.67(2.66)
VII	2.67(1.76)	2.33(1.68)	2.50(1.72)	5.67(2.48)	6.67(2.73)	6.17(2.61)
Control (with blank Tablet)	16.33(4.09)	11.33(3.44)	13.83(3.77)	28.33(5.37)	16.67(4.14)	22.5(4.76)
Untreated control	16.67(4.14)	11.67(3.49)	14.17(3.82)	30.00(5.50)	16.33(4.09)	23.17(4.79)
SE(m)±	**0.13**	**0.14**	**0.14**	**0.16**	**0.17**	**0.17**
CD(0.05)	**0.40**	**0.42**	**0.42**	**0.49**	**0.51**	**0.51**

*Figures given in parenthesis are square root (x + 0.5) transformed values
*DAS- days after storage

Table 5 : Effect of different doses of tablet prepared from formulation III on per cent grain damaged due to pulse beetle on stored mungbean (Pooled data)

Tr.No.	30 DAS			60 DAS			90 DAS			120 DAS			150 DAS			180 DAS		
	2016-17	**2017-18**	**Pooled**	**2016-17**	**2017-18**	**Pooled**	**2016-17**	**2017-18**	**Pooled**	**2016-17**	**2017-18**	**Pooled**	**2016-17**	**2017-18**	**Pooled**	**2016-17**	**2017-18**	**Pooled**
T1 (2 tablet/5kg)	1.00 (1.17)	0.33 (0.88)	0.67 (1.03)	1.67 (1.46)	1.00 (1.17)	1.33 (1.32)	3.67 (2.03)	3.00 (1.87)	3.33 (1.95)	4.33 (2.20)	3.00 (1.87)	3.67 (2.04)	6.33 (2.60)	4.33 (2.20)	5.33 (2.41)	6.33 (2.60)	5.00 (2.34)	5.67 (2.48)
T2 (3 tablet/5kg)	0.67 (1.03)	0.00 (0.71)	0.33 (0.87)	1.00 (1.17)	0.33 (0.88)	0.67 (1.05)	2.67 (1.77)	2.00 (1.58)	2.33 (1.68)	4.00 (2.11)	3.33 (1.95)	3.67 (2.04)	5.33 (2.41)	3.33 (1.95)	4.33 (2.20)	5.67 (2.48)	3.67 (2.04)	4.67 (2.27)
T3 (4 tablet/5kg)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.00 (1.17)	0.33 (0.88)	0.67 (1.05)

T4 (5 tablet/5kg)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
T5 (6 tablet/5kg)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
T6 (7 tablet/5kg)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (1.77)
T7-Control (without tablet)	1.67 (1.46)	1.00 (1.17)	1.34 (1.32)	3.33 (1.95)	2.00 (1.58)	2.67 (1.77)	6.33 (2.60)	3.67 (2.03)	5.00 (2.34)	8.33 (2.97)	5.67 (2.48)	7.00 (2.73)	13.33 (3.71)	10.67 (3.34)	12.00 (3.53)	18.00 (4.29)	15.33 (3.98)	16.67 (4.14)
SE(m)±	0.11	0.10	**0.1**	0.14	0.11	**0.12**	0.13	0.11	**0.12**	0.13	0.14	**0.13**	0.11	0.10	**0.10**	0.16	0.14	**0.15**
CD(0.05)	0.33	0.30	**0.3**	0.42	0.33	**0.36**	0.39	0.33	**0.36**	0.39	0.42	**0.39**	0.33	0.30	**0.31**	0.48	0.42	**0.46**

*Figures given in parenthesis are square root (x + 0.5) transformed values
*DAS- days after storage

Table 6 : Effect of different doses of tablet prepared from formulation III on per cent grain weight loss due to pulse beetle damage in stored mungbean (Pooled data)

Tr.No.	**30 DAS**			**60 DAS**			**90 DAS**			**120 DAS**			**150 DAS**			**180 DAS**		
	2016 -17	**2017 -18**	**Pooled**	**2016 -17**	**2017 -18**	**Pooled**	**2016 -17**	**2017 -18**	**Pooled**	**2016 -17**	**2017 -18**	**Pooled**	**2016 -17**	**2017 -18**	**Pooled**	**2016 -17**	**2017 -18**	**Pooled**
T1 (2 tablet/5kg)	0.0 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.09 (0.77)	0.13 (0.79)	**0.11 (0.78)**	0.37 (0.93)	0.33 (0.91)	**0.35 (0.92)**	0.73 (1.11)	0.50 (1.00)	**0.62 (1.06)**	1.02 (1.26)	0.86 (1.17)	**0.94 (1.20)**
T2 (3 tablet/5kg)	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.24 (0.86)	0.32 (0.91)	**0.28 (0.88)**	0.62 (1.06)	0.41 (0.95)	**0.51 (1.00)**	0.71 (1.10)	0.49 (0.99)	**0.60 (1.05)**
T3 (4 tablet/5kg)	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**
T4 (5 tablet/5kg)	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**
T5 (6 tablet/5kg)	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (1.77)**
T6 (7 tablet/5kg)	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**	0.00 (0.71)	0.00 (0.71)	**0.00 (0.71)**
T7-Control (without tablet)	0.06 (0.75)	0.02 (0.72)	**0.04 (0.73)**	0.26 (0.87)	0.18 (0.82)	**0.22 (0.85)**	0.37 (0.93)	0.33 (0.91)	**0.35 (0.90)**	0.71 (1.10)	0.49 (0.99)	**0.60 (1.05)**	3.19 (1.92)	2.75 (1.80)	**2.97 (1.86)**	7.68 (2.86)	5.92 (2.53)	**6.80 (2.70)**
'F' Test	NS	NS	**NS**	Sig	Sig	**Sig**	Sig	Sig	**Sig**	Sig	Sig	**Sig**	Sig	Sig	**Sig**	Sig	Sig	**Sig**
SE(m)±	0.01	0.01	**0.01**	0.03	0.02	**0.03**	0.04	0.03	**0.03**	0.07	0.05	**0.06**	0.11	0.07	**0.09**	0.11	0.09	**0.10**
CD(0.05)			**-**	0.09	0.09	**0.09**	0.12	0.09	**0.10**	0.21	0.15	**0.18**	0.33	0.21	**0.30**	0.33	0.30	**0.31**

*Figures given in parenthesis are square root (x + 0.5) transformed values
*DAS- days after storage

Table 7 : Cost of Economics for Herbal tablet preparation

Sr. N	**Ingredients for tablet preparation**	**Rates (Rs.) /kg**	**Per cent to be mix**	**Quantity required in 1 kg. Formulation (g)**	**Cost (Rs.)**
1.	Black pepper power	@Rs.1000/kg	15	150	150=00
2.	Hing powder	@Rs. 600/kg	20	200	120=00
3.	Clove powder	@Rs.1000/kg	35	350	350=00
4.	Menthol	@Rs.2000/kg	19	190	380=00
5.	Sodium Benzoate	@Rs.900/l	01	10	10
6.	Starch soluble	@Rs.1480/kg	2.5	25	37
7.	Garlic paste	@Rs.50/kg	5	50	2.5
8.	Neem seed powder	@ Rs.100/kg	2.5	25	2.5
Total			100	1000	1052.5=00
Processing Charges					150=00
Total(Rs.)					1202.5

In 1 kg total ingredients as per formulation, Tablets prepared =2000 Nos (each weighing 0.5g)
Cost of each tablet (Rs.)= 0.60
Since 4 tablet per 5 kg is optimum dose, number of tablet per quintal grain =80 Nos
Cost(Rs.) of tablet per quintal = 0.60 x 80 = Rs. 48/qt.

Conflict of Interest

The authors have not declared any conflict of interests.

Acknowledgements

The authors thanks to AICRP on Post Harvest Engineering Technology, for providing funds for this research.

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