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Effect of plant powders on quality characters of treated pea seeds (*Pisum sativum* L.) damaged by *Callosobruchus chinensis* L (Coleoptera: Bruchidae)

Kamal Deep Kaur, SC Verma and PL Sharma

Abstract
Seven plant powders *viz.* neem (*Azadirachta indica* J.), Camphor (*Cinnamomum camphora* L.), sweet flag (*Acorus calamus* L.), lemongrass (*Cymbopogon citratus* L.), eucalyptus (*Eucalyptus sp.*), wild marigold (*Tegetes minuta* L.) and drek (*Melia azadirachta* L.) were used to coat the seeds @ 5, 3, and 1g /100g seeds. There eight treatments including control. Minimum seed damage (0.33%) and weight loss (0.22%) was recorded with sweetflag plant powders. No seed damage and weight loss was recorded in pea seeds treated with sweet flag powder at 3g/100g and 5g/100g doses. Maximum seed germination was in sweet flag plant powder (93.67%). Maximum seed vigour index-I (2042.68) and seed vigour index-II (3481.67) was with sweet flag plant powder followed by neem. Thus, sweetflag (*Acorus calamus* L.) plant powder was best in protecting pea seeds against *C. chinensis.*

Keywords: Plant powders, *Callosobruchus chinensis*, pea seeds. seed damage, weight loss, seed vigour index

Introduction
A number of insect-pests attack the stored grains, seeds and other products. Among the important insect pests of stored grains, the pulse beetle, *Callosobruchus chinensis* L. (Bruchidae: Coleoptera), causes substantial losses to the pulses in the storage though the initial infestation occurs in the field itself. It causes weight loss, decreased germination potential and reduction in the commercial value of the seed [1-3]. In order to keep stored seed grains free from insect-pests infestation various synthetic pesticides are used [4]. The use of synthetic organic pesticides for the control of insect-pests of stored seeds has led to the development of resistance, toxic residues in food grains, pose risk to human health and destruction of the balance of the ecosystem [5-7] besides being costly. Therefore, there is a need of some other alternative of chemical pesticides and fumigants to protect stored seed grains from insect-pests infestations. The use of botanical insecticides is now receiving increased attention due to their safety and effectiveness [8-10]. Botanicals can be used to keep the stored grains free from pulse beetle attack and for long term storability and quality parameters of stored grains. Various locally available plant products have been tried recently with good degree of success against a number of stored grain insect pests [11-16]. Therefore, use of botanical pesticides is considered to be the most viable and environmentally safe approach to offset ever increasing danger caused by conventional pesticides [17, 18]. Therefore, the present study aims to find the ecofriendly approaches particularly plant powders against *C. chinensis*.

Materials and Methods
Raising of insect culture: The pure culture of *C. chinensis* was raised on pea seeds and maintained under controlled conditions at 27 ±1 ^{0}C and 70% R.H. The freshly harvested seeds of pea seeds were sterilized in oven at 55 ^{0}C for 4 hours [19]. The sterilized grains were put in half kg capacity glass jars and 5 pairs of freshly emerged *C. chinensis* adults were released in the jars. The jars were tightly covered with muslin cloth and were kept in BOD incubator for raising the culture.

Plant material: Seven plant powders viz. neem (*Azadirachta indica* J.), Camphor (*Cinnamomum camphora* L.), sweet flag (*Acorus calamus* L.), lemongrass (*Cymbopogon*

citratus L.), eucalyptus (*Eucalyptus sp.*), wild marigold (*Tegetes minuta* L.) and drek (*Melia azadirachta* L.) were evaluated for their insecticidal activity against *C. Chinensis* and their effect on seed quality parameters. The plant materials were collected locally, shade dried and plant powders were made with the help of grinder. Plant powders were taken at different doses viz., 5, 3, and 1g per 100g seeds in separate plastic container of 250cc capacity containing 100 g of sterilized seeds of pea with three replications. Contents were thoroughly mixed in plastic containers by vigorous shaking. In control no plant powder was mixed. Five pair of freshly emerged adults of pulse beetle were then released in each container. These containers were closed by muslin cloth tightly secured by rubber band. The experiment was carried out at room. During the experimental period the average minimum and maximum temperature was 14.5 and 30.5(ºC), respectively and humidity was 57.7 percent. There were eight treatments including control with three replications. The effect of treatment was studied on different biological parameters. All the adults were allowed to remain in the container till their natural mortality under room temperature. After storage period of 2-months data on seed damage, seed weight loss,seed germination and seed vigour index-I and seed vigour index-II was recorded. The percent seed damage was calculated by adopting the procedure given by Adams and Schulten [20]. Loss in seed weight was calculated by taking initial weight and final weight of the seed and percent weight loss was calculated. The percent seed germination was calculated by taking 100 seeds from each container. The seeds were sandwiched between towel paper [21]. The paper towel was then kept in seed germinator chamber at 25 ± 1 ^{0}C. The germination percentage was calculated as per procedure of ISTA [22]. Seed Vigour Index- I was calculated by using the method given by Abdul Baki and Anderson [23]. Seed Vigour Index- II was calculated by using the formula: Germination (%) X Seedling dry weight (mg). The data recorded was analysed through two factor Completely Randomized Design after proper transformation and significance of each treatment was calculated [24].

Results and Discussion

Effect of plant powders on pea seed damage caused by *C. chinensis*

It is evident from the Table 1 that significantly minimum seed damage (0.33%) was recorded with pea seeds treated with sweet flag powder followed by neem (8.91%), eucalyptus (9.61%), camphor (10.30%), lemongrass (10.55%), the latter two were statistically at par with each other. Neem with 8.91 percent seed damage was statistically at par with eucalyptus (9.61%). Wild marigold plant powder with 11.47 percent seed damage was least effective and was superior over control. No seed damage was recorded with sweet flag powder at 5 g and 3 g doses. Pea seed damage recorded with neem at 5 g (5.84%) was statistically at par with eucalyptus (6.07%), camphor (6.16%), lemongrass (6.40%), wild marigold (7.44%) and drek (7.00%) at same dose. Pea seed treated with 1 g plant powders resulted 13.78 percent seed damage which decreased to 11.47 and 8.25 percent seed damage at 3 and 5 g doses, respectively. In the present investigation all the tested plant powders provided significant protection to pea seeds from the damage by *C. chinensis*. Sweet flag was most effective allowing only 0.33 percent damage. Next effective treatment was neem in which seed damage was 8.91 percent. No damage was recorded in pea seeds treated with sweet flag powder at 3g/100g and 5g/100g doses. Reduction in seed damage may be due to the lower oviposition and high ovicidal activity of sweet flag powder thereby inhibiting the adult development of beetle. The present findings were in conformity with the findings of Nandi *et al.* [25] who reported reduced seed damage by *C. chinensis* in stored pigeonpea. The present findings also collaborate with the findings of Latha and Naganagoud [26] who reported reduced seed damage by *Sitophilus oryzae* in sorghum.

Table 1: Effect of plant powders on pea seed damage caused by *C. chinensis* after 2 months

Treatment	Mean seed damage (%) at indicated doses			Mean
	Dose (g/ 100g seed)			
	1	3	5	
Neem	11.44 (3.53)	9.46 (3.23)	5.84 (2.61)	8.91 (3.13)
Camphor	13.94 (3.86)	10.79 (3.43)	6.16 (2.67)	10.30 (3.32)
Sweet flag	1.00 (1.38)	0.00 (1.00)	0.00 (1.00)	0.33 (1.13)
Lemongrass	14.36 (3.92)	10.89 (3.45)	6.40 (2.72)	10.55 (3.36)
Eucalyptus	12.86 (3.72)	9.90 (3.30)	6.07 (2.66)	9.61 (3.23)
Wild Marigold	14.94 (3.99)	12.03 (3.61)	7.44 (2.90)	11.47 (3.50)
Drek	14.63 (3.95)	14.64 (3.56)	7.00 (2.83)	11.09 (3.45)
Control	27.05 (5.27)	27.05 (5.27)	27.05 (5.27)	27.05 (5.27)
Mean	13.78 (3.70)	11.47 (3.36)	8.25 (2.83)	11.17 (3.30)

*Mean of three replications

Figures in parenthesis are $\sqrt{x+1}$ tranformed values

CD (p=0.05)

Treatment : (0.15)

Dose : (0.24)

Treatment × Dose : (0.42)

Effect of plant powders on weight loss of treated pea seeds

Minimum weight loss (0.22%) was recorded with pea seeds treated with sweet flag powder followed by neem (6.80%), eucalyptus (8.26%), camphor (8.99%) and lemongrass (9.40%) (Table 2). Camphor and lemongrass were statistically at par with each other. Wild marigold powder was least effective which resulted 10.39 percent weight loss however, statistically lesser than that of untreated seeds (18.17%). No weight loss was recorded in pea seeds treated with sweet flag at 5 g and 3 g which was significantly superior over its lower dose 1 g (0.67%). Seeds treated with camphor (5.73%) at 5 g was statistically at par with eucalyptus (5.67%), lemongrass (5.97%), drek (6.00%) and wild marigold (7.33%) at 5 g dose and neem (7.67%) as well as eucalyptus (8.07%) at 3 g dose.

Pea seeds treated with 1 g plant powder resulted 11.42 percent seed damage which decreased to 9.04 and 6.48 percent with 3 and 5 g dose of plant powders, respectively. In the present study, sweet flag and neem powders minimised the weight loss in treated pea seeds to 0.22 and 6.80 percent, respectively as against 18.17 percent in control. Among all treatments, sweet flag even at lowest dose was effective in minimizing weight loss due to *C. chinensis* infestation. Other effective treatments were eucalyptus (8.26%), camphor (8.99%), lemongrass (9.40%), drek (9.73%) and wild marigold (10.39%). In the present investigation, lower weight loss in sweet flag and neem powder treated seeds may be due to lower seed damage. The present findings corroborate the findings of Govindan and Nelson [27] who reported the reduction in weight loss when seeds were treated with sweet flag powder. The present findings also collaborate with the findings of Chandrakala *et al*. [28] who reported reduced weight loss of green gram seeds treated with neem leaf powder.

Table 2: Effect of plant powders on weight loss of treated pea seeds caused by *C. chinensis* after 2 months

Treatment	Mean seed weight loss (%) at indicated doses			Mean
	Dose(g/ 100g seed)			
	1	3	5	
Neem	9.73 (3.28)	7.67 (2.94)	3.00 (2.00)	6.80 (2.74)
Camphor	12.23 (3.64)	9.00 (3.16)	5.73 (2.59)	8.99 (3.13)
Sweet flag	0.67 (1.28)	0.00 (1.00)	0.00 (1.00)	0.22 (1.09)
Lemongrass	12.63 (3.69)	9.60 (3.26)	5.97 (2.62)	9.40 (3.19)
Eucalyptus	11.03 (3.47)	8.07 (3.01)	5.67 (2.57)	8.26 (3.02)
Wild Marigold	13.50 (3.81)	10.33 (3.36)	7.33 (2.88)	10.39 (3.35)
Drek	13.37 (3.79)	9.83 (3.29)	6.00 (2.65)	9.73 (3.24)
Control	18.17 (4.36)	18.17 (4.36)	18.17 (4.36)	18.17 (4.36)
Mean	11.42 (3.41)	9.08 (3.05)	6.48 (2.58)	8.99(3.02)

*Mean of three replications

Figures in parenthesis are $\sqrt{x+1}$ transformed values

CD (p=0.5)

Treatment : (0.15)

Dose : (0.25)

Treatment × Dose : (0.43)

Effect of plant powders on seed germination of treated pea seeds damaged by *C. chinensis*

All the seven plant powders significantly improved seed germination as compared to control (Table 3). Maximum seed germination was recorded with sweet flag (93.67%) and lowest with wild marigold (57.78%) where as in control seed germination was 48.00 percent. Sweet flag powder with 93.67 percent seed germination was best among all treatments followed by neem (84.89%), eucalyptus (76.89%), camphor (73.11%), lemongrass (70.44%), drek (67.78%). Pea seeds treated with lowest dose of sweet flag resulted 92 percent seed germination which was statistically at par with higher dose (5g) of neem (90.33%). Maximum seed germination (76.67%) was recorded with pea seeds treated with highest dose (5g) and 67.13 percent with lowest dose (1g). In the present investigation, seed germination in various treatments ranged from 57.78-93.67 percent as against 48.00 percent in control. Powders of sweet flag and neem were the best (93.67 and 84.89%, respectively). Thus seed germination of stored pea was improved due to protection from damage caused by *C. chinensis* provided by these plant powders. None of the treatments reduced the seed germination indicating that these plant powders can be used safely for the control of *C. chinensis*. Effect on seed germination by other plant powders treated pea seeds were recorded as eucalyptus (76.89%), camphor (73.11%), lemongrass (70.44%), drek (67.78%), wild marigold (57.78%) in descending order. Present study finds support from the work of Sandeep *et al.* [29] who reported seeds treated with sweet flag powder resulted higher germination. Similar to present findings Khan *et al*. [30] also reported neem powder to be effective in maintaining higher seed germination.

Table 3: Effect of plant powders on percent seed germination of treated pea seeds damaged by *C. chinensis* after 2 months.

Treatment	Mean seed germination (%) of treated pea seeds at indicated doses			Mean
	Dose (g/ 100g seed)			
	1	3	5	
Neem	80.33 (63.66)	84.00 (66.40)	90.33 (71.92)	84.89 (67.33)
Camphor	68.33 (55.74)	72.00 (58.05)	79.00 (62.75)	73.11 (58.85)
Sweet flag	92.00 (73.56)	93.00 (74.79)	96.00 (78.49)	93.67 (75.61)
Lemongrass	64.00 (53.11)	70.33 (56.98)	77.00 (61.34)	70.44 (57.15)
Eucalyptus	72.33 (58.26)	75.33 (60.22)	83.00 (65.84)	76.89 (61.44)
Wild Marigold	50.33 (45.17)	56.33 (48.62)	66.67 (54.73)	57.78 (49.51)
Drek	61.67 (51.73)	68.33 (55.74)	73.33 (58.90)	67.78 (55.46)
Control	48.00 (43.83)	48.00 (43.83)	48.00 (43.83)	48.00 (43.84)
Mean	67.13 (55.63)	70.92 (58.08)	76.67 (62.23)	71.57 (58.65)

*Mean of three replications

Figures in parenthesis are arc sine transformed values

CD (p=0.5)

Treatment : (1.11)

Dose : (1.81)

Treatment × Dose : (3.14)

Effect of plant powders on Seed Vigour Index-I of treated pea seeds damaged by *C. chinensis* after 2 months

Data contained in Table 4 reveal that all the plant powders, significantly improved the seed vigour index-I (SVI-I), a product of percent germination and seedling length (cm) of treated pea seeds over control. Maximum seed vigour index-I (SVI-I) (2042.68) was recorded with pea seeds treated with sweet flag powder followed by neem (1330.57), eucalyptus (1318.39), camphor (1309.86), lemongrass (1288.18), drek (1005.65) and wild marigold (753.70), but were superior over control (571.40). SVI-I (1713.13) was recorded with sweet flag powder at 1g dose which increased to (2272.20) at 5 g dose of the powder and was significantly superior over rest of the plant powders, next best treatment was neem with (1462.77) SVI-I at 5g dose which decreased to (1315.90) with 1 g dose of plant powder. Least effective of all the treatments was wild marigold with (1004.17) SVI-I at 5g dose which decreased to (604.67) with decrease in dose of plant powder to 1g. The SVI-I was 1349.89 with 5 g dose which decreased to 1190.45 and 1067.32 seed vigour index-I with 3 and 1 g doses of plant powders, respectively.

Table 4: Effect of plant powders on Seed Vigour Index-I of treated pea seeds damaged caused by *C. chinensis* after 2 months

Treatment	Mean seed vigour index-I at indicated doses			Mean
	Dose (g/ 100g seed)			
	1	3	5	
Neem	1315.90	1213.03	1462.77	1330.57
Camphor	1142.53	1342.63	1444.40	1309.86
Sweet flag	1713.13	2142.70	2272.20	2042.68
Lemongrass	1122.47	1303.43	1438.63	1288.18
Eucalyptus	1146.90	1349.77	1458.50	1318.39
Wild Marigold	604.67	652.27	1004.17	753.70
Drek	921.53	948.37	1147.05	1005.65
Control	571.40	571.40	571.40	571.40
Mean	1067.32	1190.45	1349.89	1202.55

*Mean of three replications

CD (p=0.05)

Treatment : 51.31

Dose : 83.79

Treatment × Dose : 145.13

Effect of plant powders on Seed Vigour Index-II of treated pea seeds damaged by *C. chinensis* after 2 months

The data related to seed vigour index-II (SVI-II) which is a product of seed germination and seedling weight (mg) reveals that seedling vigour index-II decreases with decrease in doses of plant powders. SVI-II was maximum with sweet flag (3481.67) followed by neem (3092.89), eucalyptus (2519.11), camphor (2509.89), lemongrass (2508.33), drek (2007.00) and wild marigold (1681.89) in decreasing order. Seed vigour index-II with wild marigold was least and was superior over control (1161.33). Seed vigour index –II (3219.33) recorded with pea seeds treated with sweet flag powder at lowest dose 1 g was statistically at par with neem (3360.33), eucalyptus (3041.67), camphor (3003.00) at 5 g dose. In general seed vigour index-II decreased with decrease in doses of plant powders. Maximum seed vigour index-II (2666.50) was recorded with 5 g dose which decreased to 2350.86 and 2094.28 with 3 and 1 g doses of plant powders, respectively. Seed vigour index-I in various treatments ranged from 753.70 to 2042.68. Maximum seed vigour index-I was recorded in pea seeds treated with sweet flag powder. Next effective treatment was neem leaf powder. Maximum seed vigour index-II recorded with pea seeds treated with sweet flag powder (3481.67). Next effective treatment was neem with 3092.89 seed vigour index-II. The high seed vigour index-II recorded with pea seeds treated with sweet flag and neem plant powders may be due to reduced damage to pea seeds by *C. chinensis*. The present findings were in accordance with the findings of Sandeep *et al.* [29] and Merwade [31] who reported increase in seedling vigour index of chickpea seeds treated with sweet flag powder.

Table 5: Effect of plant powders on Seed Vigour Index-II of treated pea seeds damaged by *C. chinensis* after 2 months

Treatment	Mean seed vigour index-II at indicated doses			Mean
	Dose (g/ 100g seed)			
	1	3	5	
Neem	2837.67	3080.67	3360.33	3092.89
Camphor	2139.00	2387.67	3003.00	2509.89
Sweet flag	3219.33	3545.67	3680.00	3481.67
Lemongrass	2070.00	2620.67	2834.33	2508.33
Eucalyptus	2235.67	2280.00	3041.67	2519.11
Wild Marigold	1467.33	1633.00	1945.33	1681.89
Drek	1623.33	2091.67	2306.00	2007.00
Control	1161.33	1161.33	1161.33	1161.33
Mean	2094.28	2350.86	2666.50	2370.55

*Mean of three replications

CD (p=0.05)

Treatment : 95.30

Dose : 155.63

Treatment × Dose : 269.56

Conclusion

The present study reveal that out of seven plant powders *viz.* neem (*Azadirachta indica* J.), Camphor (*Cinnamomum camphora* L.), sweet flag (*Acorus calamus* L.), lemongrass (*Cymbopogon citratus* L.), eucalyptus (*Eucalyptus sp.*), wild marigold (*Tegetes minuta* L.) and drek (*Melia azadirachta* L.) plant powder followed by neem (*Azadirachta indica* J.) was best in protecting peas seeds against C. *chinensis*.

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