The Pharma Innovation Journal 2023; SP-12(12): 2571-2576

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(12): 2571-2576

www.thepharmajournal.com
Received: 01-09-2023
Accepted: 04-10-2023

GD Bagul
Department of Entomology,
B. A. College of Agriculture,
Anand Agricultural University,
Gujarat, India

JG Dulera
Regional Research Station,
Anand Agricultural University,
Anand, Gujarat, India

Vruti Rank
Department of Entomology,
B. A. College of Agriculture,
Anand Agricultural University,
Gujarat, India

Corresponding Author:
GD Bagul
Department of Entomology,
B. A. College of Agriculture,
Anand Agricultural University,
Gujarat, India

Efficacy of inert materials as seed protectant against *Corcyra cephalonica* (Stainton) in stored pearl millet

GD Bagul, JG Dulera and Vruti Rank

Abstract
An experiment was conducted at Anand Agricultural University, Anand during 2022-23 to investigate different five inert materials *viz.*, sand, saw dust, cow dung powder, rice straw ash and soil collected under the banyan tree @ 5 and 2.5 g/100 g of pearl millet seeds were tested for their efficacy in protecting stored pearl millet against *Corcyra cephalonica* (Stainton). Rice straw ash @ 2.5 and 5.0 g/100 g and cow dung powder @ 5.0 g/100 g pearl millet seeds were found the most effective against *C. cephalonica* as it achieved 93.46, 93.23 and 88.75% oviposition deterrence. Rice straw ash @ 5.0 g/100 g seeds was the most effective as 92.19% highest reduction of adult emergence, 6.07 days male longevity, 6.00 days female longevity and 32.43 eggs per female fecundity. The highest reduction of percent egg viability (44.67, 47.33%) was achieved by the treatment of rice straw at both doses' levels. The sex ratio of males and females ranged from 1:1.00 to 1:1.06 in all the evaluated treatments. None of these inert materials tested at different doses hampered the germination of pearl millet during the storage periods up to 65 days.

Keywords: Inert materials, rice moth, pearl millet, seed protectants, Gujarat

Introduction
Pearl millet [*Pennisetum glaucum* (Linn.) R. Br.] (Family: Gramineae) is the most widely grown type of millet, because of its tolerance to difficult growing conditions such as drought, low soil fertility and high temperature. The majority of the world's 30 million ha of arid and semi-arid tropical regions in Asia and Africa are used to grow millet, which accounts for half of the world's production. It is the main source of nutrition for 90 million poor people. India and Africa are together occupying 90% area of total pearl millet production in the world (Yadav *et al.* 2012) [15].

Nutritionally pearl millet is a good source of energy and has high levels of minerals vitamins, lipids, crude fibers and high-quality protein 9-13% (Uppal *et al.* 2015) [14]. Pearl millet grain has 4.31-5.30% crude fiber, 10-80 mg calcium, 7-18.0 mg iron, 5.3-7.0 mg zinc and 1.0-1.8 mg copper (Abdalla *et al.* 2009) [1]. The pearl millet was grown in 7.41 million hectares in 2019–20, with an average yield of 10.3 million tonnes and productivity of 1391 kg/ha. Rajasthan, Maharashtra, Uttar Pradesh, Gujarat and Haryana are the principal pearl millet-growing states, which produce 90% of national produce (Anonymous, 2021) [3].

The rice moth, *Corcyra cephalonica* (Stainton), popularly known as the "Rice meal moth" or the "Flour moth", belongs to family Pyralidae and order Lepidoptera. The earlier reference to this insect was made by (Stainton, 1866) [12]. It is the major storage pest of pearl millet found in many parts of Asia, Africa, North America and Europe. The adult rice meal moth is grey in color. Mated females lay 100 to 200 eggs near food sources. Eggs hatched in 4-10 days. The larva, however, constructs a feeding tube gallery, consisting of a silken web and food particles, to stay fed and grow inside it. When they are fully grown, they form dense white cocoons to pupate. Pupae are sometimes observed within pallets and sacks or in food. Adults emerge from pupae 3 within four to eight weeks and repeat their life cycle (Pandey, 2011) [8]. The rice moth is one of the serious pests of different stored product commodities like cereals, pulses, oilseeds, millets and other food products. It causes not only sanitation problems in warehouses but also affects the commodities qualitatively and quantitatively.

Materials and Methods
A laboratory experiment was conducted to work out the efficacy of inert material as seed protectants for the safe storage of pearl millet seeds against *C. cephalonica*. For the study on efficacy of inert material, five pairs of newly emerged adults were released in jars containing

300 g pearl millet seeds treated with dose (2.5 and 5.0 g/100 g seeds) of test compounds *viz*., sand, saw dust, cow dung powder, rice straw ash and soil collected under the banyan tree (*Ficus benghalensis* L.) (Figure 1). Each treatment was replicated three times (Figure 2).

Oviposition deterrent activity

For each concentration, 300 g seeds of pearl millet were taken in a conical flask and mixed with each concentration of plant powder and seeds without treatment used as untreated seeds. After thoroughly mixing the seeds they were separated into three lots each having 100 g seeds, stored in jars (8 × 6.5 cm) and 5 pairs of newly emerged adults rice moth were introduced in each container. After 4 days, number of eggs laid in hundred treated seeds (Ts) and hundred untreated seeds (Cs) were recorded. The percentage of oviposition deterrence (POD) was calculated by following formula given by Singh and Jakhmola (2011) [11]. The weight of 1000 seeds was 7.0 g (Anon., 2007) [2].

$$POD = \frac{Cs-Ts}{Cs} \times 100$$

Where,
Ts = number of eggs laid in treated seeds
Cs = number of eggs laid in untreated seeds

Adult emergence activity

After the eggs were counted, the experimental setup was kept undisturbed till the emergence of next generation of adults from the treated and untreated seeds. The number of adults which emerged from the untreated seeds (Ac) and treated seeds (At) were recorded. The percentage reduction in adult (PRA) emergence was calculated by following formula given by Singh and Jakhmola (2011) [11].

$$PRA = \frac{Ac-At}{Ac} \times 100$$

Where,
Ac = number of adults emerged from the untreated seeds
At = number of adults emerged from the treated seeds

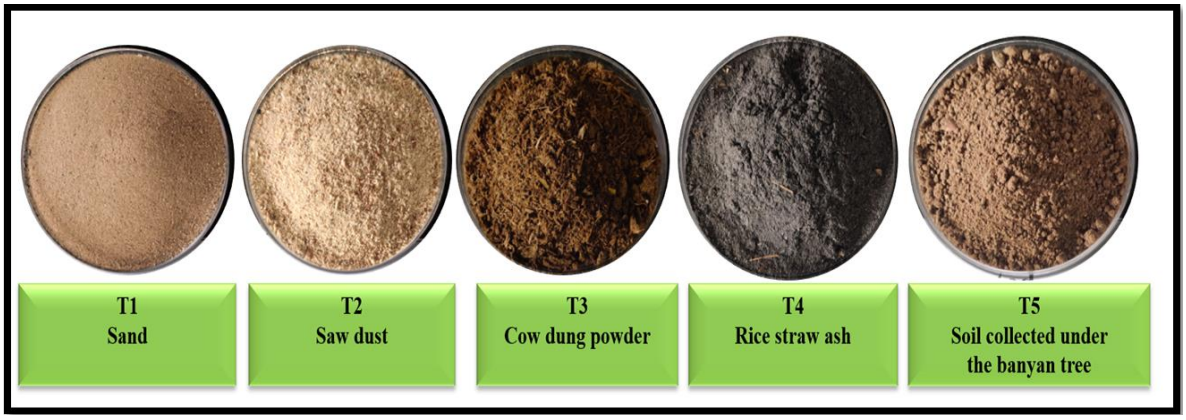

Fig 1: Different types of inert materials used against *C. cephalonica*

Fig 2: Evaluation of the effectiveness of different inert materials against *C. cephalonica*

Longevity of male and female emerged

The longevity of males and females were recorded from treated and untreated seeds.

Fecundity

For recording the fecundity, freshly emerged adults from the larvae reared on treated food were kept in separate jars for egg-laying. The total number of eggs laid by five pair of adults were counted daily till the death of the females in each treatment.

Egg viability

For egg viability, a random sample of 50 eggs were taken from each repetition and placed in a petri dish. The observation of hatched or unhatched eggs were counted with the help of a microscope.

Germination test

The laboratory test was conducted as per the ISTA procedure by adopting the paper method (ISTA, 2015)[6], To determine the effect of plant powders on the germination percentage of pearl millet seeds, a second lot of 100 treated and untreated seeds (without the release of adult moths) were stored for 65 days in three separate repetitions for each treatment. The germination test was carried out with germination paper. After the seeds were placed on the germination paper the between paper roll was kept in the germinator at 20 ± 0.50 ºC temperature and 95 ± 1% relative humidity. The final count's normal seedlings were carried out on seven days of the germination test and germination was expressed in percentage

Results and Discussion

Percent oviposition deterrence

The reduction in eggs over control due to different inert materials presented in Table 1 indicated the significant reduction in all treatments of inert materials with 2.5 and 5 g/100 g seeds, which indicated the higher protectant potential against rice moth damage. Regarding different inert materials, the percent oviposition deterrent property ranged from 75.84 to 93.46%. Maximum percent oviposition deterrence (93.46%) was observed with rice straw ash @ 5.0 g/100 g seeds, which were significantly at par with lower dose of rice

straw ash @ 2.5 g/100 g seeds (93.23%) and cow dung powder @ 5.0 g/100 g seeds with 88.75% reduction of oviposition deterrence. The next best effective treatments were soil collected under the banyan tree @ 5.0 g/100 g seeds, cow dung powder @ 2.5 g/100 g seeds, soil collected under the banyan tree @ 2.5 g/100 g seeds and sand @ 5.0 g/100 g seeds showed (88.00, 87.88, 83.87 and 83.58%, respectively) showed oviposition deterrent activity against *C. cephalonica* in stored pearl millet seeds. The treatments of saw dust @ 2.5 g/100 g seeds, saw dust @ 5.0 g/100 g seeds and sand @ 2.5 g/100 g seeds were least effective (75.84, 77.15 and 81.22%, respectively) in reducing an oviposition deterrent property over other treatments.

The present findings confirmed that the efficacy of different inert materials with doses were found to be significant among the treatments**.** Percent of oviposition deterrence property in all treatments gradually increased with the increase in the concentration of the inert materials. In all the inert materials, the higher doses proved significantly effective over lower doses. The treatment of rice straw ash with the two-dose level i.e. 2.5 and 5.0 g/100 g seeds showed a significant reduction in oviposition properties. It is noteworthy that this inert material showed significant deterrent activity even at lower concentrations. This finding is more or less similar to Swain and Baral (2005) [13], who reported similar inhibitory effects on the population growth of *Sitophilus oryzae* when using wood ash, rice straw ash, bamboo ash, cow dung ash, rice husk ash and ply ash at a dose of 0.5 g/100 g of seeds. Yadav *et al.* (2018) [16] found that ash powder treated wheat grains were the most effective in deterring larvae after 24, 48 and 72 hr. Not much work was available on *C. cephalonica* hence, this part remains undiscussed.

Percent reduction of adult emergence

The reduction of adult emergence over control due to different plant powders varied significantly with two different concentrations (Table 1). The reduction of adult emergence showed a considerable increase with the increase in the dose level of concentration. Rice straw ash @ 5.0 g/100 g seeds (92.19%) resulted in significantly highest reduction in adult emergence, however, it was at par with rice straw ash @ 2.5 g/100 g seeds (90.33%). The treatments of cow dung powder @ 2.5 and 5.0 g/100 g seeds were also given better reduction of adult emergence (78.28 and 79.04% reduction, respectively) which were significantly at par with each other. The treatments of soil collected under the banyan tree @ 2.5 and 5.0 g/100 g seeds were also showed a reduction of adult emergence (53.76 and 55.66% reduction, respectively) and significantly at par with each other. The treatments of saw dust at higher and lower dose levels (2.5 and 5.0 g/100 g seeds) were least effective and recorded 28.98 and 25.19% reduction of adult emergence, respectively. The reduction in adult emergence could either be due to egg mortality or larval mortality or even a reduction in the hatching of the eggs There was a little study done on the *C. cephalonica* but a more or less similar study was carried out by Arve and Patel (2013) [4] they found that diatomaceous earth at a 10% concentration was the most effective treatment for suppressing the emergence of adult *S. oryzae*. Cow dung ash at 30% concentration exhibited similar efficacy to sand at 10%, while sawdust resulted in the highest number of adult emergences. In another study by Yadav and Tiwari (2017) [17], ash powder, sand and cow dung powder at a rate of 2 g/100 g of wheat grains were investigated for their efficacy against rice weevils and lesser grain borers.

Sex ratio

The sex-ratios **(♂:♀)** of *C. cephalonica* ranged from 1:1.00 to 1:1.06 (Table 2). The minimum number of adults emerged in rice straw ash treated seeds with the dose level of 5 g/100 g seeds. Out of 33 adults, 16 were found to be males and 17 were females. Thus, the sex ratio (Male: Female) was 1:1.06. These same treatments @ 2.5 g/100 g seeds were also better in response sex ratio. Out of 41 adults, 20 were found to be males and 21 were females. Thus, the sex ratio (Male: Female) was 1:1.05. Maximum number of adult emergences observed in saw dust @ 2.5 and 5 g/100 g seeds, at both doses levels. Out of 317 adults, 158 were males and 159 females and out of 301 adults, 150 were males and 151 were females, respectively. Not much work is available on this particular aspect, hence this part remains undiscussed.

Longevity of male and female

The longevity of male and female adults gradually decreased with the increase in the dose level of test compounds (Table 3). Assessing the results of different inert materials, it was observed that rice straw ash @ 5.0 g/100 g seeds (6.07 days) was found to be the most effective in reducing the longevity of male adults and it was at par with rice straw ash @ 2.5 g/100 g seeds (6.38 days). The next best treatments, cow dung powder @ 5.0 g/100 g seeds, soil collected under the banyan tree @ 5.0 g/100 g seeds and cow dung powder @ 2.5 g/100 g seeds were also found excellent which recorded moderately effective treatments with (7.12, 7.36 and 7.43 days) longevity, respectively. The longest adult longevity assessed from saw dust @ 2.5 g/100 g seeds (8.81 days) which was at par with saw dust @ 5 g/100 g seeds (8.59 days).

The treatment of rice straw ash @ 5.0 g/100 g seeds gave excellent results over control with (6.00 days) longevity of female adults. The next best effective treatment was rice straw ash @ 2.5 g/100 g seeds with (6.81 days) longevity in female adults. The treatments of cow dung powder @ 5.0 g/100 g seeds, cow dung powder @ 2.5 g/100g seeds and soil collected under banyan tree @ 5.0 g/100 g seeds were highly significant over control with obtaining (7.45, 7.71 and 8.00 days) female longevity, respectively. The treatment of saw dust @ 2.5 g/100 g seeds with (9.63 days) was found least effective in reducing the longevity of females and was at par with saw dust @ 5 g/100 g seeds with 9.28 days longevity. The results indicated that females lived longer than males. Not much work is available on the effect of inert materials on the longevity of male and female adults of *C. cephalonica*. However, Dulera (2017) [5] reported that the higher adult mortality of *S. oryzae* is due to the application of cow dung ash and cow dung powder @ 2 g/100 g wheat seeds. Not much work is available on this particular aspect, hence this part remains undiscussed.

Fecundity

All the doses of different test compounds were found to be significantly better in reducing the fecundity over control (Table 3). The per female fecundity ranged from 32.43 to 116.10 eggs per female. The treatment of rice straw ash @ 5.0 g/100 g seeds (32.43 eggs per female) was highly significant for reducing per female fecundity. The next best effective treatment was rice straw ash @ 2.5 g/100 g seeds for reducing female fecundity and reported 38.03 eggs per female. The treatments of cow dung powder @ 2.5 and 5.0 g/100 g seeds

were excellent for reducing female fecundity and reported (50.36 and 52.65 eggs per female), respectively. The treatments of saw dust @ 2.5 and 5.0 g/100 g of seeds were least effective for reducing per female fecundity and recorded 88.05 and 87.35 eggs per female, respectively. It is worth noting that not much work was available on this particular aspect.

Viability

All doses of various inert materials showed significant improvements in reducing egg viability compared to the control (Table 3 and Figure 3). The results revealed that 95.33% egg viability occurred in untreated seeds. The highest reduction of percent egg viability was observed on pearl millet seeds treated with rice straw ash at 5.0 g/100 g seeds (44.67%) which was at par with rice straw ash at 2.5 g/100 g seeds (47.33%). The next best effective treatment was cow dung powder also giving promising results @ 2.5 g/100 g seeds with 63.33% egg viability. The treatments of soil collected under banyan tree @ 2.5 and 5.0 g/100 g seeds were moderately effective with 68.67 and 67.33% egg viability. The least effective treatments were saw dust at both doses 2.5 and 5 g/100 g seeds which recorded 91.33 and 88.67% egg viability, respectively. However, the lack of available reviews or research on this topic emphasizes the need for further studies and scientific evaluation to validate and expand upon these findings.

Germination (%)

Pearl millet is highly vulnerable to infestations by storage pests such as *C. cephalonica*, so it is important to use protective treatments. However, it is crucial to ensure that these treatments do not hinder the germination of pearl millet. To evaluate this, a laboratory germination test was conducted. The test involved treating pearl millet seeds with different inert materials as seed protectants and then assessing their germination. The results, presented in Table 3 and Figure 4, showed that all the treatments had a non-significant impact on the germination percentage compared to the control. Cent percent germination was observed in all the treatment including control after storage for 65 days. Thus, it can be stated that there was no adverse effect of any inert materials tested at all the concentrations on germination of pearl millet seeds.

The present findings are more or less similar to Dulera (2017) [5]. Who reports that different inert materials *viz.*, sand, saw dust, cow dung ash, cow dung powder and black soil clay @ 2.0 g/100 g wheat seeds had not been hampered and acted as seed protectants against *S. oryzae* in stored wheat seed (GW 366) up to 180 days. It is worth noting that all treatments, including the control, exhibited 100% germination after a storage period of 65 days. Therefore, it can be concluded that none of the inert materials tested at any concentration had an adverse effect on the germination of pearl millet seeds.

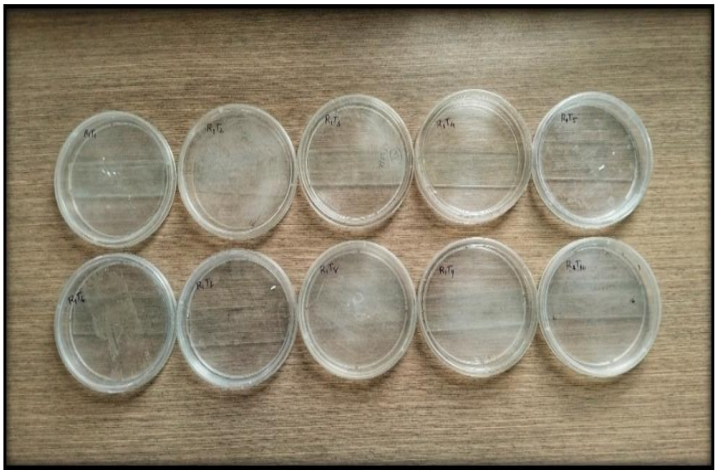

Fig 3: Viability test of eggs of *C. cephalonica in* laboratory conditions

Fig 4: Germination test of healthy pearl millet seeds treated with different inert material

Table 1: Impact of different inert materials on ovipositional deterrence and reduction of adult emergence of *C. cephalonica* in stored pearl millet

Treat. No.	Inert materials	Dose g/100 g seeds	Total laid Eggs	Oviposition deterrence (%)	Total adults emerged	Reduction of adult emergence (%)
1	Sand	2.5	401	64.46 (81.22)	258	38.71 (39.12)
2	Sand	5.0	351	66.23 (83.58)	238	41.45 (43.83)
3	Saw dust	2.5	519	60.68 (75.84)	317	30.01 (25.19)
4	Saw dust	5.0	488	61.59 (77.15)	301	32.57 (28.98)
5	Cow dung powder	2.5	259	69.75 (87.88)	92	62.23 (78.28)
6	Cow dung powder	5.0	240	70.53 (88.75)	89	62.77 (79.04)
7	Rice straw ash	2.5	145	75.00 (93.23)	41	71.90 (90.33)
8	Rice straw ash	5.0	140	75.27 (93.46)	33	73.83 (92.19)
9	Soil collected under the banyan tree	2.5	347	66.42 (83.87)	196	47.16 (53.76)
10	Soil collected under the banyan tree	5.0	263	69.77 (88.00)	188	48.25 (55.66)
11	Control	-	2253	-	424	-
S.Em. ±			-	1.76	-	0.91
C.D. at 5%			-	5.16	-	2.65
C.V. (%)			-	4.92	-	3.38

Figures in parentheses are percent oviposition deterrence values and values of percent reduction of `adult emergence, whereas figures outside the parentheses indicate angular transformed values

Table 2: Sex ratios of emerged *C. cephalonica* on stored pearl millet treated with different inert materials

Treat. No.	Inert materials	Dose g/100 g seeds	Sex		Total adult emergence	Sex ratio
			Male	Female		
1	Sand	2.5	129	129	258	1:1.00
2	Sand	5.0	118	120	238	1:1.02
3	Saw dust	2.5	158	159	317	1:1.01
4	Saw dust	5.0	150	151	301	1:1.01
5	Cow dung powder	2.5	46	46	92	1:1.00
6	Cow dung powder	5.0	44	45	89	1:1.02
7	Rice straw ash	2.5	20	21	41	1:1.05
8	Rice straw ash	5.0	16	17	33	1:1.06
9	Soil collected under the banyan tree	2.5	97	99	196	1:1.02
10	Soil collected under the banyan tree	5.0	93	95	188	1:1.02
11	Control	-	212	212	424	1:1.00

Figures indicate total number adults per treated seeds

Table 3: Impact of different Inert materials on longevity, fecundity, egg viability and germination of stored pearl millet seeds

Treat. No.	Inert materials	Dose g/100 g seeds	Longevity (Days)		Per female fecundity	Egg viability (%) (n=50 eggs)	Germination (%) (n=100 seeds)
			Male	Female			
1	Sand	2.5	2.82*(7.96)	2.96*(8.76)	8.40*(70.63)	65.96**(83.33)	75.00
2	Sand	5.0	2.80(7.83)	2.90(8.39)	8.30(68.86)	62.53(78.67)	75.00
3	Saw dust	2.5	2.97(8.81)	3.10(9.63)	9.38(88.05)	73.04(91.33)	75.00
4	Saw dust	5.0	2.93(8.59)	3.05(9.28)	9.35(87.35)	70.44(88.67)	75.00
5	Cow dung powder	2.5	2.72(7.43)	2.78(7.71)	7.26(52.65)	52.73(63.33)	75.67
6	Cow dung powder	5.0	2.67(7.12)	2.73(7.45)	7.10(50.36)	50.00(58.67)	76.00
7	Rice straw ash	2.5	2.53(6.38)	2.61(6.81)	6.17(38.03)	43.47(47.33)	75.33
8	Rice straw ash	5.0	2.46(6.07)	2.45(6.00)	5.69(32.43)	41.93(44.67)	75.67
9	Soil collected under the banyan tree	2.5	2.74(7.51)	2.85(8.14)	8.10(65.68)	55.96(68.67)	75.67
10	Soil collected under the banyan tree	5.0	2.71(7.36)	2.83(8.00)	8.06(64.98)	55.15(67.33)	76.00
11	Control	-	3.07(9.43)	3.39(11.48)	10.76(116.10)	77.84(95.33)	76.00
S.Em. ±			0.02	0.03	0.13	1.35	1.85
C.D. at 5%			0.08	0.11	0.39	3.96	NS
C.V. (%)			1.82	2.23	2.91	3.96	4.25

Figures in parentheses are mean longevity, fecundity and percent egg viability values, whereas figures outside the parentheses indicate transformed values: 1. *square root transformed values
2. **angular transformed values

Conclusions

From the above results, it can be concluded that the effectiveness of rice straw ash and cow dung powder treatments in the management of *C. cephalonica* infestation in pearl millet seeds. Rice straw ash at 2.5 and 5.0 g/100 g, along with cow dung powder at 5.0 g/100 g, achieved oviposition deterrence rates of 93.46, 93.23 and 88.75%, respectively. Notably, rice straw ash at 5.0 g/100 g yielded the highest reduction in adult emergence at 92.19%, impacting adult longevity and female fecundity (6.07 and 6.00 days and 32.43 eggs per female). Egg viability reduction of 44.67 and 47.33% was observed with rice straw ash treatments. The study also highlighted consistent sex ratios (1:1.00 to 1:1.06) across treatments.

References

1. Abdalla AA, Ahmed UM, Ahmed AR, Tinay AH, Ibrahim KA. Physicochemical characterization of traditionally extracted pearl millet starch. Journal of Applied Sciences Research. 2009;5:2016-2027.
2. Anonymous. Retrieved from https://www.millets.res.in/dus/Pearlmillet.pdf Guidelines for the Conduct of Test for Distinctiveness, Uniformity and Stability on (*Pennisetum glaucum* (L.) R. Br.). Plant Variety Journal of India. 2007;1(1):1-14.
3. Anonymous. Retrieved from: http://www.aicpmip.res.in Project Coordinators AICRP Review 2020-21 ICAR- on pearl millet; c2021.
4. Arve SS, Patel MB. Bioecology and management of rice weevil, *Sitophilus oryzae* (Linn.) in stored wheat, *Triticum aestivum.* {Ph.D. (Agri.). Thesis submitted to University of Agricultural Sciences, Navsari}; c2013.
5. Dulera JG. Management of S*itophilus oryzae* (l.) infesting stored wheat. {Ph.D. (Agri.). Thesis submitted to Junagadh Agricultural University, Junagadh}; c2017.
6. ISTA. International Rules for Seed Testing. 2015;(1):99-128.
7. Pandey ND, Krishna Pal, Pandey S, Tripathi RA, Singh YP. Use of neem *Azadirachta indica* L. Adr. Juss. As seed protectant against rice moth, *Corcyra cephalonica* (Stainton). In: Effect on development and damage. Bulletin Grain Technology. 1985;23:147-153.
8. Pandey SK. Evaluation of artificial diets for rearing of *Corcyra cephalonica* (Stainton) for *Trichogramma* mass production. Journal of Progressive Agriculture. 2011;11(1):198-199.
9. Pradyumnsingh, Jakhmola SS. Efficacy of botanical extracts on biological activities of pulse beetle *Callosobruchus maculates* (Fab.) on green gram. Trends in Biosciences. 2011;4:25-30.
10. Senguttuvan, Kareem, Rajendran. Effects of plant products and edible oils against rice moth *Corcyra cephalonica* (Stainton) in stored groundnuts. Journal of Stored Products Research. 1995;31:207-210.
11. Singh P, Jakhamola SS. Efficacy of botanical extracts on biological activities of pulse beetles *Callosobruchus maculatus* (Fab.) on the green gram. Trends in Biosciences. 2011;4(1):25-30.
12. Stainton HT. Description of a new species of family Galleriidae, Entomological monthly Magazine. 1866;2:172-173.
13. Swain TK, Baral K. Low cost technology for controlling some stored grain pests. Journal of Plant Protection and Environment. 2005;2(2):26-29.
14. Uppal RK, Wani SP, Garg KK, Alagarswamy G. Balanced nutrition increases yield of pearl millet under drought. Field Crops Research. 2015;177:86-97.
15. Yadav R, Pandya RK, Singh DP. To study the extent of blast severity of Pearl millet field in Morena, Bhind and Gwalior Districts of Madhya Prasesh. Society for Scientific Development in Agriculture and Technology Progress Research. 2012;7(2):313-314.
16. Yadav U, Tiwari R, Mishra VK. Studies on Relative Orientation of *C. cephalonica* on Wheat Grain. Research Journal of Agricultural Sciences. 2018;9(2):322-324.
17. Yadav U, Tiwari R. Eco-friendly management of *Sitophilus oryzae* and *Rhyzopertha dominica* in stored wheat at Pantnagar, Uttarakhand. Journal of Applied and Natural Science. 2017;9(2):736-743.