Original Research Article

Impact of Seed Protectants on Seed Quality and Pest Infestation in Pigeon Pea Seeds during Storage

Abstract:

This study investigates the efficacy of diverse seed protectants on key parameters affecting seed quality and pest infestation in pigeon pea seeds during storage. Over 3, 6, and 9-month storage periods, the impact of seed protectants on germination percentage, moisture content, vigor index, insect infestation by pulse beetles, and seed weight loss was assessed. Notably, Emamectin benzoate and Deltamethrin consistently maintained high seed quality, with germination percentages ranging from 88.33% to 84.33% and 87.33% to 83.00%, respectively. These insecticidal treatments also exhibited minimal insect infestation, ranging from 0.33% to 1.00%. In contrast, botanical protectants showed varying effectiveness, with Lantana camara and Vitex negundo displaying germination percentages ranging from 86.67% to 80.67% and 87.00% to 82.67%, and insect infestation levels ranging from 0.33% to 1.33%. These findings highlight the importance of seed protectants in preserving seed viability and minimizing pest damage during storage, thereby enhancing crop yield and reducing post-harvest losses in pigeon pea cultivation.

Keywords: *Pigeon pea, seed protectants, pest infestation, Emamectin benzoate, Deltamethrin, and botanical protectants,*

Introduction:

Seed quality serves as a cornerstone in agricultural practices, exerting a significant influence on crop productivity and yield potential. High-quality seeds not only ensure optimal plant population in the field but also foster vigorous seedling growth, enabling plants to withstand abiotic and biotic stresses more effectively (Jacob *et al*., 2016). However, seed deterioration during storage is an inevitable phenomenon, characterized by metabolic shifts, compositional changes, and declines in enzymatic activity, among other alterations (Doijode, 2000). Such degradation poses a considerable challenge to maintaining seed viability and vigor over prolonged storage periods.

Conventionally, controlling seed deterioration involves costly measures such as storing seeds under controlled environments. Alternatively, seed treatment with various chemicals has emerged as a viable strategy to mitigate seed deterioration and preserve seed quality (Jacob *et al*., 2016). Over the years, seed treatment technology has undergone significant advancements, yielding products capable of enhancing seed performance and subsequent crop yield (Jacob *et al*., 2016). Seed treatment finds diverse applications, ranging from synchronizing flowering in parental lines to enhancing seed quality, delivering nutrients, and protecting against pests and diseases (Johnson *et al*., 1999; Kumar *et al*., 2007; Farooq *et al*., 2012; Sherry *et al*., 2007).

One promising aspect of seed treatment technology is polymer film coating, which has demonstrated efficacy in enhancing crop establishment, particularly under adverse conditions (Lagoa *et al*., 2012). The thin polymer film not only facilitates accurate application of chemicals but also provides protection against accelerated aging and fungal invasion (Vanangamudi *et al*., 2003). Additionally, polymer coating aids in the adherence of seed treating chemicals, reduces chemical wastage, and ensures dust-free handling, making it both practical and environmentally friendly (Guan *et al*., 2013).

In the context of pigeon pea seeds, the efficacy of seed protectants and polymer coating in preserving seed quality and mitigating pest damage holds significant implications for crop productivity and sustainability. Therefore, this study aims to evaluate the impact of diverse seed protectants and polymer coating on key seed quality parameters of pigeon pea seeds during storage.

Materials and Methods

***Seed Material Preparation*:**Chickpea (*Cicer arietinum* L.) seeds were sourced from a reputable agricultural research institution, specifically selected for their suitability for the study. The seeds were obtained from the experimental farm located at Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya. Prior to experimentation, the seeds underwent a thorough examination to ensure uniformity in size, shape, and maturity. Any damaged or immature seeds were discarded to maintain consistency in the seed material.

Seed Priming:

To prepare the priming solutions, specific concentrations and doses of each seed protectant are required. For Emamectin benzoate, a solution of 2 ppm concentration is prepared, with a dose of 40 mg per kg of seed. Deltamethrin necessitates a solution of 1 ppm concentration, with a dose of 0.04 ml per kg of seed. *Lantana camara* (Tantani) requires 10 mg per kg of seed, while *Vitex negundo* (Nirgundi) uses 10 g per kg of seed. Citronella oil is applied at a rate of 5 ml per kg of seed, *Acorus calamus* (Sweet flag) at 10 ml per kg of seed, and *Azadirachta indica* (Neem) at 10 gm per kg of seed. Additionally, an untreated control batch is included for comparison.

During the seed priming process, each batch of seeds is immersed in its respective priming solution. Following the priming period (Overnight), the seeds are removed from the solution and allowed to air dry until they attain the desired moisture content suitable for planting. This methodical approach ensures consistent application of seed protectants and facilitates proper preparation of seeds for subsequent planting, ultimately contributing to enhanced seedling vigor and pest protection in agricultural systems.

Germination Assay:The selected chickpea seeds were carefully cleaned and surface sterilized to remove any external contaminants. This was achieved by soaking the seeds in a 1% solution of sodium hypochlorite for 5 minutes, followed by thorough rinsing with deionized water toeliminate any residual disinfectant. Only intact, fully developed seeds were chosen for the germination experiment to ensure uniformity and reliability of results. Subsequently, the sterilized seeds were evenly distributed on germination paper (Standard Germination method as per ISTA regulation: Between Paper Method).

For assessing germination percentage, seeds are placed on moistened germination paper in trays and incubated germination chamber. The number of germinated seeds is recorded periodically to calculate the germination percentage. Moisture content is determined by weighing seeds before and after drying in an oven, followed by calculations. Vigor assessment involves observing seedling growth rate and uniformity. Insect infestation is monitored by storing seeds in containers with mesh screens, using traps, and inspecting for signs of pests. Lastly, seed weight loss due to beetles is evaluated by periodically weighing seeds stored. These comprehensive experiments provide insights into seed quality and susceptibility to pests, crucial for agricultural research and management.

***Statistical analysis*:**The statistical analysis was conducted using SPSS version 16. Tukey's test and correlation analysis were employed to examine the relationships between different variables. Tukey's test was applied to compare the means of multiple groups, while correlation analysis was used to assess the strength and direction of the relationships between pairs of variables. This statistical model allowed for a comprehensive examination of the data, providing insights into the significance of differences between groups and the associations among various traits.

Results:

Effect of Treatments on Seed Germination

The effect of different seed protectants on the germination percentage of pigeon pea seeds was assessed over varying storage periods of 3, 6, and 9 months. Across the treatments, *Emamectin benzoate* at a concentration of 2 ppm (40 mg per kg of seed) demonstrated consistently high germination rates throughout the storage period, with values ranging from 88.33% to 84.33%. *Deltamethrin*, applied at 1 ppm (0.04 ml per kg of seed), also exhibited robust germination rates, albeit slightly lower than *Emamectin benzoate*, ranging from 87.33% to 83.00%. *Lantana camara* (Tantani) and *Vitex negundo* (Nirgundi), both botanical protectants applied at 10 mg and 10 g per kg of seed respectively, displayed slightly reduced germination percentages compared to the insecticidal treatments, ranging from 86.67% to 80.67% and 87.00% to 82.67% respectively over the storage period. *Citronella oil*, applied at 5 ml per kg of seed, showed a decreasing trend in germination percentage from 85.33% to 78.33% across the storage period. Among the treatments, *Acrous calamus* (Sweet flag) and *Azadirachta indica* (Neem), both applied at 10 ml and 10 gm per kg of seed respectively, exhibited varying degrees of influence on germination, with *Acrous calamus* displaying germination percentages ranging from 83.67% to 80.33%, and *Azadirachta indica* ranging from 86.67% to 82.67% over the storage period. In comparison, the untreated control group consistently demonstrated lower germination percentages ranging from 79.67% to 72.33% across the storage periods, indicating the importance of seed protectants in maintaining seed viability during storage (Fig. 1).

Table 1: Impact of Seed Protectants on Seed Quality Traits and Pest Infestation in Pigeon Pea Seeds during Storage of 3, 6, and 9 months.

Treatment	Seed protectant (Insecticide/Botanical)	Dose (kg1 Seed)	Storage Month After Treatment (Germination %)			Storage Month After Treatment (Moisture %)			Storage Month After Treatment (Vigour index)			Storage Month After Treatments (Insect infestation %)			Seed weight loss (%)	Seed saved (%)
			3	6	9	3	6	9	3	6	9	3	6	9		
T1	Emamectin benzoate 2 ppm	40 mg	88.33	85	84.33	12.9	15.1	12.5	1711.25	2352.8	2618.35	0.33	0.33	0.33	0.29	93.27
T2	Deltamethrin 1 ppm	0.04 ml	87.33	84.67	83	13.2	14.9	12.8	1589.49	2272.5	2548.93	0.33	0.67	1	*0.3*	93.04
T3	Lantana camara (Tantani)	10 mg	86.67	83.67	80.67	13.3	14.7	14.4	1504.24	2067.39	2386.28	0.33	0.67	1.33	0.97	77.49
T4	*Vitex negundo* (Nirgundi)	10 g	87	84.33	82.67	13.5	14.8	15	1538.22	2206.13	2511.51	0.33	0.67	1.33	0.74	82.83
T5	*Citronilla*oil	5 ml	85.33	80.67	78.33	13.3	14.8	12.6	1425.36	1934.3	2306.71	0.33	1.33	3.67	1.46	66.12
T6	*Acrous calamus* (Sweet flag)	10 ml	83.67	82.33	80.33	13.5	14.8	14	1452.19	1985.07	2376.16	0.67	1.67	2	1	76.79
T7	*Azadirachtain dica* (Neem)	10 gm	86.67	84	82.67	13.9	15	14.7	1517.25	2126.86	2503.24	0.33	0.67	1.33	0.78	81.9
T8	Untreated	Control	79.67	76	72.33	12.7	14.8	15.1	1175.57	1770.8	2127.22	1.67	3	6.33	4.31	-
C.D. (5%)			**0.43**	**0.62**	**0.68**	**0.10**	**0.06**	**0.21**	**0.1**	**0.06**	**4.86**	**0.52**	**0.32**	**1.91**	**0.34**	
SEM±			**1.17**	**1.47**	**1.86**	**0.28**	**0.15**	**0.58**	**0.28**	**0.15**	**10.31**	**NS**	**NS**	**5.89**	**0.92**	

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Effect of Treatments on Seed Moisture Content

The impact of various seed protectants on the seed moisture content (%) of pigeon pea seeds at different storage periods was investigated. Across the treatments, *Emamectin benzoate* at a concentration of 2 ppm (40 mg per kg of seed) displayed fluctuating moisture content percentages ranging from 12.9% to 15.1% over the 9-month storage period. Similarly, *Deltamethrin*, applied at 1 ppm (0.04 ml per kg of seed), exhibited moisture content percentages ranging from 13.2% to 12.8% over the same storage period. *Lantana camara* (Tantani) and *Vitex negundo* (Nirgundi), both botanical protectants applied at 10 mg and 10 g per kg of seed respectively, demonstrated relatively stable moisture content percentages ranging from 13.3% to 14.4% and 13.5% to 15.0% respectively over the storage period. *Citronella oil*, applied at 5 ml per kg of seed, showed variations in moisture content percentages ranging from 13.3% to 12.6% across the storage periods. Similarly, *Acrous calamus* (Sweet flag) and *Azadirachta indica* (Neem), both applied at 10 ml and 10 gm per kg of seed respectively, displayed varying moisture content percentages ranging from 13.5% to 14.0% and 13.9% to 14.7% respectively over the storage period. In contrast, the untreated control group exhibited relatively consistent moisture content percentages ranging from 12.7% to 15.1% across the storage periods (Fig. 2).

Effect of Treatments on Vigour Index

The effect of various seed protectants on the vigor index of pigeon pea seeds at different storage periods was examined. Across the treatments, *Emamectin benzoate* at a concentration of 2 ppm (40 mg per kg of seed) consistently demonstrated high vigor indices throughout the storage period, with values ranging from 1711.25 to 2618.35. *Deltamethrin*, applied at 1 ppm (0.04 ml per kg of seed), also exhibited robust vigor indices, albeit slightly lower than *Emamectin benzoate*, ranging from 1589.49 to 2548.93. *Lantana camara* (Tantani) and *Vitex negundo* (Nirgundi), both botanical protectants applied at 10 mg and 10 g per kg of seed respectively, showed slightly reduced vigor indices compared to the insecticidal treatments, ranging from 1504.24 to 2386.28 and 1538.22 to 2511.51 respectively over the storage period. *Citronella oil*, applied at 5 ml per kg of seed, exhibited a decreasing trend in vigor indices from 1425.36 to 2306.71 across the storage periods. Similarly, *Acrous calamus* (Sweet flag) and *Azadirachta indica* (Neem), both applied at 10 ml and 10 gm per kg of seed respectively, displayed varying degrees of influence on vigor indices, with *Acrous calamus* ranging from 1452.19 to 2376.16, and *Azadirachta indica* ranging from 1517.25 to 2503.24 over the storage period. In comparison, the untreated control group consistently demonstrated lower vigor indices ranging from 1175.57 to 2127.22 across the storage periods, indicating the importance of seed protectants in maintaining seedling vigor during storage (Fig. 3).

Infestation by Pulse Beetle

The impact of different seed protectants on insect infestation by pulse beetle in pigeon pea seeds at varying storage periods was examined. *Emamectin benzoate*, applied at a concentration of 2 ppm (40 mg per kg of seed), consistently showed minimal insect infestation percentages throughout the storage period, with values remaining constant at 0.33% across all time points. *Deltamethrin*, applied at 1 ppm (0.04 ml per kg of seed), also demonstrated effective control of insect infestation, with percentages ranging from 0.33% to 1.00% over the storage period. Similarly, *Lantana camara* (Tantani) and *Vitex negundo* (Nirgundi),applied at 10 mg and 10 g per kg of seed respectively, displayed low levels of insect infestation, with percentages increasing slightly from 0.33% to 1.33% over the storage period. Among the treatments, *Citronella oil* exhibited slightly higher insect infestation percentages, ranging from 0.33% to 3.67% across the storage periods. *Acrous calamus* (Sweet flag) and *Azadirachta indica* (Neem), both applied at 10 ml and 10 gm per kg of seed respectively, also showed effective control of insect infestation, with percentages ranging from 0.67% to 2.00% and 0.33% to 1.33% respectively over the storage period. In contrast, the untreated control group demonstrated significantly higher levels of insect infestation, withpercentages ranging from 1.67% to 6.33% across the storage periods(Fig. 4).

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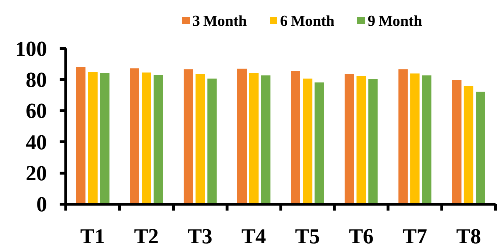

Figure 1: Effect of Treatments on Seed Germination

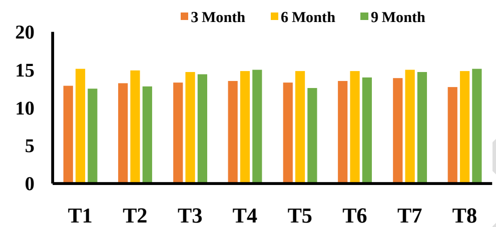

Figure 2: Effect of Treatments on Seed Moisture Content

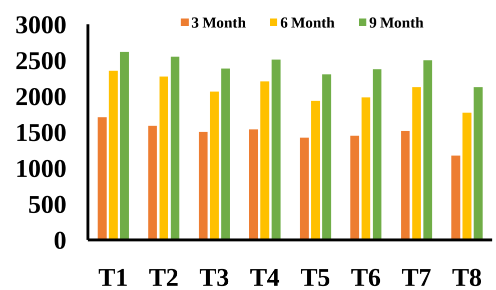

Figure 3: Effect of Treatments on Vigour Index

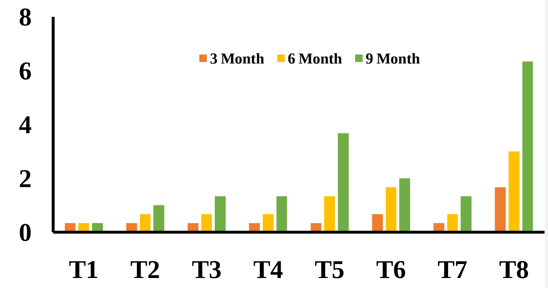

Figure 4: Effect of Treatments on seed infestation

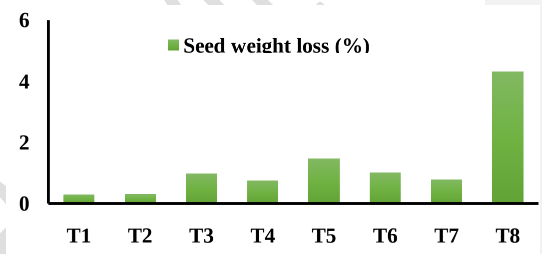

Figure 5: Effect of Treatments on Seed Weight Loss (%)

Effect of Treatments on Seed Weight Loss (%) in Pigeon Pea by Pulse Beetle at 9 Months of Ambient Storage

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The efficacy of different seed protectants on mitigating seed weight loss (%) in pigeon pea caused by pulse beetle infestation after 9 months of ambient storage was assessed. *Emamectin benzoate*, applied at a concentration of 2 ppm (40 mg per kg of seed), and *Deltamethrin*, applied at 1 ppm (0.04 ml per kg of seed), demonstrated relatively low seed weight losses, with percentages of 0.29% and 0.30% respectively. These treatments resulted in high seed saving percentages of 93.27% and 93.04% respectively. *Lantana camara* (Tantani), *Vitex negundo* (Nirgundi), and *Azadirachta indica* (Neem), applied at doses of 10 mg, 10 g, and 10 gm per kg of seed respectively, also showed some effectiveness in reducing seed weight loss, with percentages ranging from 0.74% to 0.97%. However, the seed saving percentages were comparatively lower, ranging from 77.49% to 82.83%. *Citronella oil* and *Acrous calamus* (Sweet flag), applied at 5 ml and 10 ml per kg of seed respectively, exhibited higher seed weight losses of 1.46% and 1.00% respectively, resulting in lower seed saving percentages of 66.12% and 76.79%. In contrast, the untreated control group experienced the highest seed weight loss percentage of 4.31%, indicating significant damage caused by pulse beetle infestation (Fig. 5).

Conclusion:

In conclusion, the study investigated the efficacy of various seed protectants on key parameters related to seed quality and pest infestation in pigeon pea seeds during storage.The results revealed that Emamectin benzoate and Deltamethrin consistently maintained high seed germination percentages and vigor indices, while effectively controlling insect infestation and minimizing seed weight loss. Botanical protectants such as *Lantana camara*, *Vitex negundo*, Citronella oil, *Acrous calamus*, and *Azadirachta indica* also showed promise in preserving seed quality and mitigating pest damage, although their effectiveness varied.Overall, the findings underscored the importance of seed protectants in maintaining seed viability, vigor, and quality during storage, thereby enhancing crop yield and reducing post-harvest losses. Further research could explore optimized application methods and combinations of seed protectants to maximize their efficacy in pest management while ensuring minimal impact on seed quality and the environment.

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