

Original Research Article

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Microencapsulation: A Way to Sustainable Agrotech Development

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ABSTRACT

Agro-textile is important segment of technical Textile. Agricultural textiles can improve quantity, quality and safety of agricultural products. Agricultural textiles should have excellent environmental resistance, mechanical properties, easy processability and durability characteristics. Today, in the field of agriculture and horticulture need has been realized for tomorrow. Various technologies are adopted to get higher overall yield, quality and tasty agro-products. In current scenario the consumer demands increasing for products which are free from harmful effect of chemicals, eco-friendly and suitable for hygienic life style. Demand is growing for textile products finished with natural antimicrobial finish. Therefore to achieve this goal Agrotech products are designed that have no harmful side effects. It will make extremely large impact on the financial state of farmers and well being of general public. Microencapsulation has proven as one of the most effective ways of incorporating desirable qualities to textile materials. There is a need to optimize the methods of producing microcapsules and extend the shelf life of treated materials. Pesticides are microencapsulated to be released over time, allowing farmers to apply the pesticides less often rather than requiring very highly concentrated and toxic initial applications. Similarly, in pharmaceutical industry microencapsulated products are designed for sustained/controlled release by either biodegradation of the shell, or by diffusion through the shell. The present research paper focuses on the work done in the field of application of essential oils as biopesticides in Agrotech. To check the efficacy of treated bag storage test was done. Significant difference was found between dead pests present outside and inside the treated bag. It was found that jute bag treated with Neem oil was found effective against pest. Germination test was done to find out the treatment which proved to be most effective in protecting damage of seed due to poor storage condition. Pigeon pea seeds stored for three months in control bag and treated bag under standard condition and conventional cloth bag under normal condition and after three months germination percentage calculated. It was found that germination percentage of seeds stored in treated bag was highest. Significant difference was found among germination percentage of seeds stored in conventional cloth bag, control bag and treated bag. It was found that germination percentage of seeds stored in microencapsulated bags varied with control bags.

Keywords

Essential oil,
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Introduction

Textiles used in agriculture are termed as Agrotech. With the continuous increase in population worldwide, stress on agricultural crops has increased. So it is necessary to increase the yield and maintain the quality of agro-products. But it is not possible to meet fully with the traditionally adopted ways of using pesticides and herbicides. The most important requirements of agrotech textiles are weather resistance and resistance to microorganisms. In current scenario, the consumer demands increasing for products which are free from harmful effect of chemicals, eco-friendly and suitable for hygienic life style. Demand is growing for textile products finished with natural antimicrobial finish. Therefore to achieve this goal agrotech products are designed that have no harmful side effects. It will make extremely large impact on the financial state of farmers and well being of general public.

According to Alice *et al.*, (2014) Pulses are important item of Indian diet. Developing countries still employ traditional techniques of post harvesting for pulses which incur 20–25% losses. Common drying method adopted for pulses is open sun drying, particularly at farm level. Drying of pulses is essential because the moisture content at the time of harvesting is on the higher side (18–25%) and for safe storage, the optimum moisture content is in the range of 9–12% to avoid production of mycotoxins. Again storage of pulses is a challenging one since pulses are more sensitive to storage pest viz., bruchids and can easily be attacked by them. In developing countries the facility of gas tight enclosure for grain fumigation is generally not available, at farm level. Inadequate gas tightness at the time of fumigation leads to control failure, resistance development and possible exposure hazard of the grain. Traditional use of jute fabric i.e., sacking and hessian will continue for its use as packaging material (Chattopadhyay *et al.*, 2021) and due to its biodegradable property.

Today, in the field of agriculture and horticulture need has been realized for tomorrow and therefore researchers and farmers are opting for various technologies to get higher overall yield, quality and tasty agro-products (Agarwal, 2013).

Plant essential oils in general have been recognized as an important natural source of pesticides. Natural products are an excellent alternative to synthetic pesticides as a means to reduce negative impacts to human health and

the environment. For ages, neem has been used for protecting food and store grains and as a fertilizer and natural pesticide for the fields. It has been used for a far wider array of uses than any other tree (Miro Specos, *et al.*, 2010; Wikipedia, 2017).

Materials and Methods

Jute fabrics were selected on the basis of their suitability for Agrotech products. Development of Agrotech product was done by using microcapsules formed with Acacia gum as shell and Neem oil as core material. The finish applied on jute fabric through simple coacervation technique in which ratio of gum and oil was kept 1:3. Microcapsule formation was done at 40°C temp., at acidic pH. Presence of microcapsule formed was analyzed under a high definition microscope. Prior to microencapsulation jute fabric scoured according to the method given by Ehsan *et al.*, (2017). Scouring was done by taking 4g/l soda ash, 2 g/l sequestering agent, 1g/l detergent, 2g/l wetting agent added to solution bath for each 25.0 g of jute. Material liquor ratio (MLR) was kept 1:20. Scouring of jute was done for 40 minutes at 95°C temp. Then, physical properties of both the control and treated fabrics were evaluated to compare the changes that occurred before and after treatment of the finish, in order to ensure their suitability for the intended purpose.

Storage test and Germination test were used for testing of pest repellent behavior of agrotech product i.e. microencapsulated jute seed bag. For storage test healthy, clean pigeon pea seeds (VPKAS-120) 2 kilograms were stored in control jute bag (given scouring treatment) as well as in treated jute bag (given scouring and microencapsulation finish). Pulse beetles (*Callosobruchus chinensis*) and Rice weevil (*Sitophilus oryzae*) were left near these seed bags to check the pest repellent behavior of jute bag treated with neem oil finish for 24 hours, 48 hours and 72 hours. These bags were stored in standard post harvest laboratory (Plate 1). Reading of pests found dead from both bags (control and treated bag) had been taken to find out the effectiveness of microencapsulated seed bag.

Germination test was done to find out the treatment which proved to be most effective in protecting the seed viability and protecting damage of seed due to poor storage condition. For conducting the test, 2 kilograms *Cajanus cajan* seeds (variety VPKAS-120) procured in November 2020 and stored in three type of container for

three months. Seeds stored in muslin cloth bag under normal condition in case of T₁ treatment while in case of T₂ and T₃ treatment seeds stored in control jute bag and treated jute bag respectively under standard condition (65% R.H. and 37⁰C temp.). For assessing the efficacy of treated bag, seeds stored in cloth bag, scoured jute bag and treated jute bags underwent germination test (Plate 2) given by [Aswathaiath et al., \(1993\)](#). Storage test and Germination test of microencapsulated jute fabric conducted to test Pest repellent behavior and suitability of treated jute fabric for seed bags, respectively.

Results and Discussion

Findings of the study are as follows: Under T₁ treatment, it was observed that after 24 hours of storage period, 5 dead pulse beetles and 1 dead Rice weevil and 25 live pulse beetles and 29 live rice weevils were present outside the bag. In case of T₂ treatment it was found that 9 dead pulse beetles and 3 dead rice weevils and 21 live pulse beetles and 27 live rice weevils were present outside the bag. None of the pests was found inside the treated as well as control bag after 24 hours duration. Again, after 48 hours of storage period the data regarding storage pests were collected and it was found out that 3 dead pulse beetles and 7 dead rice weevils and 20 live pulse beetles and 18 live rice weevils present outside control bag. Two live pulse beetles and 4 live rice weevils were found inside the control bag, whereas in case of T₂ treatment, 7 pulse beetles and 11 rice weevils were found dead outside the bag and 13 live pulse beetles and 15 live rice weevils present outside the bag whereas 1 live pulse beetle and 1 live rice weevil were found inside the bag. After 72 hours of storage period under T₁ treatment, it was found out that 2 dead pulse beetles and 6 dead rice weevils and 18 live pulse beetles and 12 live rice weevils were present outside the bag and 4 live pulse beetles and 4 live rice weevils found inside the bag.

While under T₂ treatment, it was found out that 8 live pulse beetles and 5 live rice weevils were found outside the bag, and 5 dead pulse beetles and 10 dead rice weevils present outside treated bag. It was found that 1 pulse beetle and 1 rice weevil entered inside the treated bag were found dead and no live pulse beetles or rice weevil was found inside the treated bag, after 72 hours of storage period (Figure 1).

It was clear from table 1 that significant difference was found between dead pests of control and treated jute bag as p value is smaller than .05(p=0.043). Significant

difference was found between dead pests present outside and inside the treated bag as p value is smaller than .05(p=0.000). Dead pests present outside and inside the bag varied with microencapsulated bag.

It was clear from table 2 that non significant difference was found between live pests of control and treated jute bag as p value is higher than .05(p=0.142). Significant difference was found between live pests present outside and inside the treated bag as p value is smaller than .05(p=0.000). Live pests present outside and inside the bag varied with microencapsulated bag.

Hence, it can be said that in the present study jute bag treated with neem oil was found effective against pest compared to control bag. This is supported by the study conducted by [Sinzogan et al., \(2006\)](#) in which it was found that damage to cotton by the bollworm *Helicoverpa armigera* can be minimised by mixtures of conventional insecticides at one half the recommended rate by combining extracts of *Azadirachta indica*, *Khya senegalensis* and *Hyptis suaveolens*. It provided greater efficacy than the conventional products alone at their recommended rate.

Findings of Germination test were as follows: After three months of storage germination percentage of seeds stored in conventional cloth bag under normal condition (T₁), seeds stored in control bag (T₂) and seeds stored in microencapsulated bag (T₃) were calculated. It was clear from Figure 3 that in case of T₁, germination percentage found out in replica 1, replica 2, replica 3, replica 4 were 79, 76, 76 and 77 respectively. On an average, germination percentage found out was 77 for T₁ treatment. It was found out that germination percentage of seeds stored using control bag showed in case of replica 1, replica 2, replica 3 and replica 4 were 80, 77, 76 and 78 respectively. On an average, germination percentage found for T₂ treatment was 77.5.

It was clear from results that germination percentage of T₃ bags found in case of replica 1, replica 2, replica 3 and replica 4 were 81, 83, 82 and 81 respectively. On an average, germination percentage found out for T₃ was 81.75. It is clear from results that germination percentage of seeds stored in treated bag was highest i.e. 81.75 (Figure 3). It was found out in the study that seeds stored in treated bag resulted in maximum germination. Significant difference was found among germination percentage of conventional cloth bag, control bag and treated bag as p (=0.002) was less than .05 (Table 3).

Table.1 ANOVA table for comparison between pests found dead between control and treated bag

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	228.292 ^a	7	32.613	7.181	.001
Intercept	210.042	1	210.042	46.248	.000
treatment	22.042	1	22.042	4.853	.043
fact1	187.042	1	187.042	41.183	.000
fact2	2.042	1	2.042	.450	.512
treatment * fact1	15.042	1	15.042	3.312	.088
treatment * fact2	.042	1	.042	.009	.925
fact1 * fact2	2.042	1	2.042	.450	.512
treatment * fact1 * fact2	.042	1	.042	.009	.925
Error	72.667	16	4.542		
Total	511.000	24			
Corrected Total	300.958	23			

a. R Squared = .759 (Adjusted R Squared = .653)

Table.2 ANOVA table for comparison between pests found live between Control and Treated bag

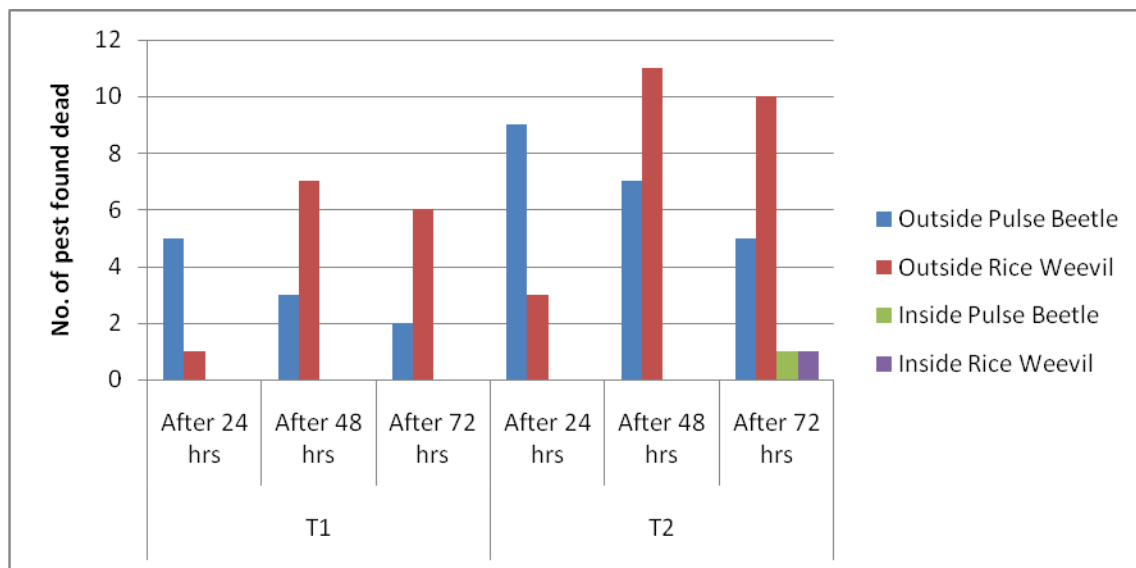
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1725.625 ^a	7	246.518	7.614	.000
Intercept	2109.375	1	2109.375	65.154	.000
Treatment	77.042	1	77.042	2.380	.142
fact1	1617.042	1	1617.042	49.947	.000
fact2	1.042	1	1.042	.032	.860
treatment * fact1	22.042	1	22.042	.681	.421
treatment * fact2	1.042	1	1.042	.032	.860
fact1 * fact2	.375	1	.375	.012	.916
treatment * fact1 * fact2	7.042	1	7.042	.218	.647
Error	518.000	16	32.375		
Total	4353.000	24			
Corrected Total	2243.625	23			

a. R Squared = .769 (Adjusted R Squared = .668)

Table.3 ANOVA table for comparison between Germination percentage of Conventional cloth bag, Control bag and Treated bag

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	52.167	2	26.083	13.414	.002
Within Groups	17.500	9	1.944		
Total	69.667	11			

Figure.1 Comparison between pest found dead in Control and Treated seed bags of jute fabric



T1*= Control bag, T2**=Treated bag

Figure.2 Average Germination percentage of *Cajanus cajan* seeds (variety VPKAS-120) under treatment T1, T2 and T3

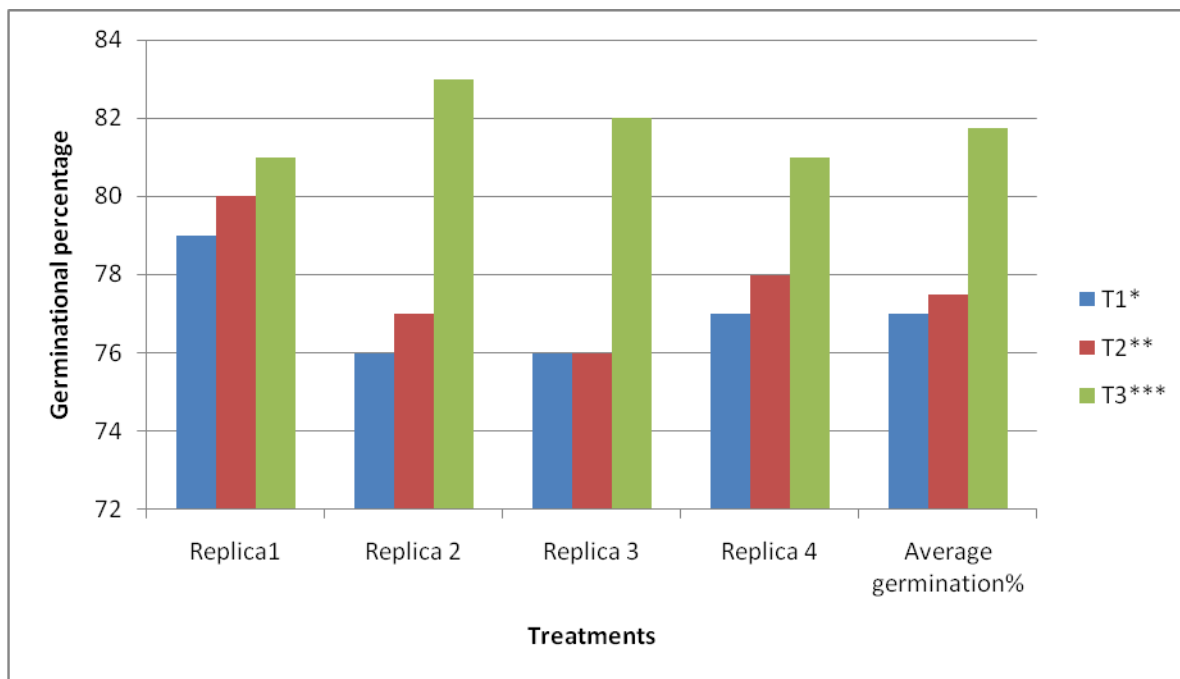
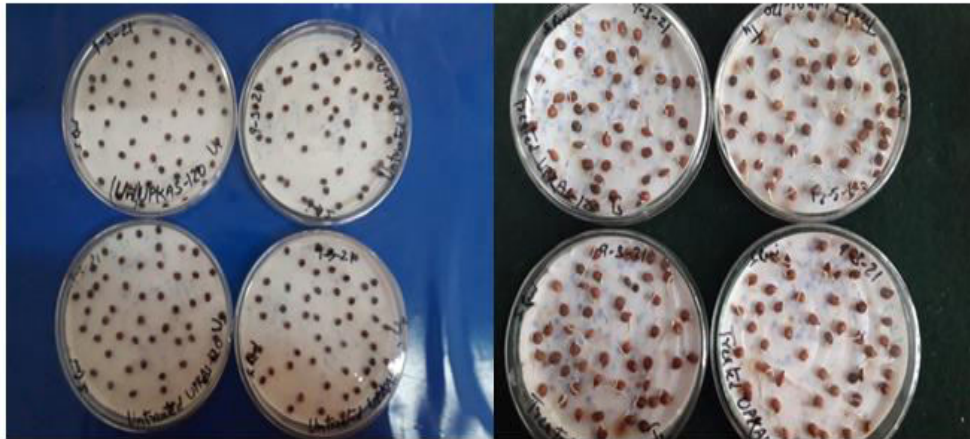


Plate.1 Storage test of jute seed bag microencapsulated with *Azadirachta indica*



Plate.2 Germination test of Tuhar (*Cajanus cajan*) seeds variety, VPKAS-120



Hence, it was found that germination percentage of microencapsulated bags varied with control bags. It may be due to the reason that microencapsulated gunny bag prevents deterioration of seeds. It was found that application of neem oil was found effective for development of jute seed bag. It was found that developed jute seed bag found effective against pests.

It was found in the present study that germination percentage was highest in treated jute bag, it may be due to the reason that treated bag was found effective in protecting damage of seeds due to pests.

Author Contribution

S. Rani: Investigation, formal analysis, writing—original draft. A. Goel: Validation, methodology, writing—reviewing. O. Verma:—Formal analysis, writing—

review and editing. P. Setiya: Investigation, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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