SUMMARY AND CONCLUSION
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Improvement of seed quality by physiological treatment is a simple, easy and inexpensive approach to enhance seed performance and agricultural productivity.

The use of good quality seed, which was not considered as a pre-requisite for increased production in traditional farming system has been mainly responsible for the success of “green revolution” in developing countries. Seed is no doubt a vital attribute in modern agriculture, which is responsible for reproduction, storage of food materials for the embryo and protects the embryo. Thus it is very important to keep up the quality of seed so as to increase in the yield.

In eastern parts and coastal belts of our country, it is very difficult to maintain high germinability of the seed due to high temperature and high relative humidity. During monsoon months, seed stored in uncontrolled storage (storage in gunny bag or cloth bag or earthenware vessel or polythene lined gunny bags) absorb a lot of moisture from the humid atmosphere and coupled with high temperature hasten the ageing process of the seed.

Against the above background, the present investigation was taken up (i) to develop a simple and inexpensive seed invigoration treatment, which would facilitate our farmers to maintain the storability of sesame seeds. Different dry and wet treatments (soaking-drying) were given as a pre-storage and mid-storage treatment. Dry-dressing treatments of seed were done by using finely powdered chemicals, pharmaceutical formulations and crude plant materials (ii) to standardize a suitable method of cultivation for improved field performance and productivity.

One of the main reasons for low yield of sesame in West Bengal is the shortage of good quality seed. The cultivators are facing serious problem of loss of seed germinability during storage under the ambient warm humid conditions. Thorough sun-drying after harvest, followed by storage in sealed containers, would greatly reduce the loss of viability. However, even in sealed storage, appreciable loss of seed vigour takes place. The controlled atmospheric (humidity and temperature) storage can effectively slow down the ageing process. But small and marginal farmers do not have well developed facilities to carry out such operations. In the present investigation, attempts therefore been made to develop a simple and inexpensive
method of seed preservation technique which would enable our farmers to maintain the vigour, viability and productivity of stored sesame seeds. The effect of pre- and mid-storage dry treatments with finely powdered chemicals, pharmaceutical formulation and crude plant material and wet treatments on the storability and productivity of stored sesame seeds (cv. Rama and B-67) were studied. Apart from these, experiments were also undertaken to elucidate the physiological and biochemical basis of the beneficial effects of seed invigoration treatments. The major findings of the different experiments conducted in the laboratory and field and suggested interpretations of the important observation are briefly presented here under:

1. Harvest fresh sesame (cv. Rama and B-67) seeds were stored in different containers viz., paper packet, cloth bag, gunny bag, polythene packet, metal tin and glass bottle under ambient conditions (average RH 75.3 ± 2.1% and temperature 28.6 ± 1.6°C) till prior to sowing in the field. Seeds stored in unsealed containers i.e. paper packet and cloth bag deteriorate rapidly during the monsoon season (July to September) due to high humidity and high temperature and as a result germination percentage comes down to below 35% with a concomitant loss of vigour at the time of sowing. Seeds stored in moisture impervious containers like polythene packet, metal tin, and glass bottle deteriorate slowly as compared to moisture pervious containers (cloth bag and paper packet). Among the containers, glass bottle is the best storage container for the preservation of sesame seeds because seeds stored in glass bottle showed better germination percentage and produce vigorous seedling during sowing time. It has also been mentioned that seed protection measures should be taken prior to the commencement of monsoon.

2. Pre-storage dry and wet seed invigoration treatments were given to freshly harvested 1-month-old (high-vigour) sesame seeds (cv. Rama and B-67) with chemicals (bleaching powder and para-amino-benzoic acid), pharmaceutical formulation (aspirin and ascorbic acid), and crude plant material (red chilli powder, lemon leaf powder and spinach leaf powder) in the rubber stoppered glass bottles under ambient conditions. Besides, wet (soaking-drying) treatments were also given to the same high-vigour seed lots. Germination test were carried out immediately after treatment, after accelerated ageing (93% RH and 40°C) and natural ageing for various durations.
Immediately after treatment (before ageing condition), pre-storage seed invigoration treatments of harvest fresh high-vigour sesamum seeds did not show any beneficial effect on vigour and viability over control. But after ageing (accelerated and natural ageing), most of the dry treatments showed significant improvement on germination percentage and seedling vigour over untreated control.

Among the dry treatment, aspirin (@ 50 mg/kg of seed), bleaching powder (@ 2g/kg of seed) and red chilli powder (@ 1g/kg of seed) showed better results in improving germinability. Pre-storage wet (soaking-drying) treatments showed marginal improvement on storability over control, probably due to soaking injury in harvest fresh seeds.

3. Mid-storage dry and wet seed invigoration treatments were given to 5-month-old (medium-vigour) sesameum (cv. Rama and B-67) seeds with chemicals (bleaching powder and *para*-amino-benzoic acid), pharmaceutical formulation (aspirin and ascorbic acid), and crude plant material (red chilli powder, lemon leaf powder and spinach leaf powder) in the rubber stoppered glass bottles. Hydration-dehydration (soaking-drying) treatments were also given to the same seed lot.

Germination test conducted immediately after treatment (*i.e.*, before ageing), did not show any improvement on germinability over control. But after subsequent ageing (accelerated and natural) under various duration, mid-storage soaking-drying treatments showed better results in improving storability over control. Mid-storage wet treatments has shown better results in improving germinability over mid-storage dry treatments.

4. Germination test conducted immediately after post-storage (pre-sowing) seed treatment, dry dressing treatment did not show any improvement on germinability over untreated control, only soaking followed by light air drying treatment showed some improvement on vigour of sesameum (cv. Rama and B-67) seeds.

5. Field performance and productivity of the pre-storage treated (dry and wet) and untreated sesameum (high-vigour) seeds (cv. Rama and B-67) were studied in four consecutive years. Most of the pre-storage dry treatments showed significant improvement on field emergence percentage, height per plant, number of branches per plant yield and other yield attributes (number of capsule per plant, total
capsule weight per plant, number of seeds per capsule, seed yield per meter square and more stable character 1000-seed weight) over untreated control. Among the treatments, aspirin (@ 50 mg/kg of seed), bleaching powder (@ 2g/kg of seed) and red chilli powder (@ 1g/kg of seed) showed better results in improving field performance and productivity over control and other treatments. Pre-storage hydration-dehydration (wet) treatments also showed some improvement on field performance and productivity of sesame. But pre-storage dry treatment has shown better results in improving yield and other yield attributes over pre-storage soaking-drying treatment.

6. Mid-storage dry and wet treatments were given to 5-month-old (medium-vigour) sesame seed (cv. Rama and B-67). Mid-storage wet treatments (soaking-drying) significantly improved field performance and productivity over control. Only a few dry treatments, especially aspirin, bleaching powder and red chilli powder also showed a beneficial effects on seed yield and other yield attributes over untreated control.

7. Post-storage (pre-sowing) wet treatments (soaking followed by light air dry) in sesame (cv. Rama and B-67) seeds also significantly improved field performance and productivity over untreated control. But, only a few post-storage dry treatments showed some marginal improvement on yield and other yield attributes over untreated seeds.

8. In seed vigour bioassay, germinating high-vigour jute seeds (bioassay material) were exposed to the gaseous emanations of stock materials (sesame). The growth of the jute seedling (bioassay material) was affected by the volatile aldehyde released during germination by the stock material (sesame) indicating vigour level. Germination test conducted immediately after pre-storage and mid-storage treatment did not show any noticeable difference between treated and untreated sesame (cv. Rama and B-67) seeds, neither in stock material nor in bioassay material. But after natural ageing, pre-storage dry treatments in sesame (stock material) especially, aspirin, bleaching powder and red chilli powder are very much effective in reducing volatile gases than the untreated control after subsequent storage which indicate greater seedling growth of jute seed (bioassay material). A positive correlation between the germinability of stock material and
seedling growth of bioassay material (jute) have been noted after subsequent storage.

9. Physiological and biochemical studies were carried out to elucidate the mode of action of pre-storage dry seed invigoration treatments for the maintenance of vigour and viability. Physiological and biochemical studies conducted immediately after pre-storage treatment did not show any significant difference between treated and untreated seeds.

But after natural ageing, physiological and biochemical studies revealed that pre-storage dry treatments with aspirin, bleaching powder, red chilli powder in sesamum (cv. Rama and B-67) seeds are much effective in maintaining membrane integrity as evidenced by lower leaching of electrolytes, sugar and amino acid over control. The dehydrogenase enzyme activity was also significantly higher in all the pre-storage dry treatments over untreated control. Besides, the lipid peroxide formation and volatile aldehyde production was significantly lower in the dry treated seeds. Among the treatment, aspirin, bleaching powder and red chilli powder were much effective for the maintenance of membrane integrity and enzyme activity.

More or less similar type of results were obtained in maintaining membrane integrity and enzyme activity when 5-month old seeds were dry dressed with non-toxic chemicals, crude plant materials and pharmaceutical formulations as a mid-storage treatment.

10. Both the cultivars of sesamum (viz., cv. Rama and B-67) are equally effective to seed invigoration treatments in maintaining storability, field performance and productivity along with membrane integrity and enzyme activity which indicate that treatment effects are independent of cultivar variations.

11. The mode of action of dry and wet treatments is yet to be clearly elucidated and interpreted. Based on the results of the present findings and on the basis of earlier research work conducted in this laboratory and elsewhere, several possibilities have been discussed. These are given below in brief:

(i) Advancement of germination process or pre-enlargement of the embryo would not explain the beneficial effects of the hydration-dehydration
treatments because hydration-dehydration treatment was not effective in harvest fresh seed.

(ii) Pattern of absorption of moisture during accelerated or natural ageing by the treated and untreated seed was similar. Differential moisture absorption would not therefore account for the beneficial effects of the treated seeds.

(iii) The beneficial effects of wet and dry treatments cannot be attributed to antifungal action of the treatments as storability was also better in treated seed stored in an environment of 36% RH and 40°C in which storage fungi cannot thrive.

(iv) Repair of bio-organelles by the cellular repair system, would not possibly account for the beneficial effects of hydration-dehydration (wet) treatments as there was little promotion of germinability immediately after treatment; the improvement in germinability was noted only after storage indicating the prophylactic nature of the treatment.

(v) Control of free radical reaction may perhaps explain the effects of the treatments on the maintenance of viability. Studies in this laboratory by other researchers have shown the great efficacy of hydration-dehydration treatments on the counteraction of age and irradiation induced seed deterioration and it has been suggested that the treatments extended seed viability by reducing free radical pathology and lipid peroxidation reactions. It has also been argued that the beneficial effects of hydration-dehydration treatments (wet) and dry treatments on yield may possibly be looked upon as the consequence of reduced physiological deterioration of the treated seeds in storage.

(vi) The chemicals, pharmaceutical products and crude plant materials in the present study were selected on the basis of earlier work conducted in the present laboratory and their possible effectiveness in controlling free radical reaction as antioxidants, antioxidant synergists and radioprotective agents. The protein protective role of acetyl salicylic acid may also be operative in viability maintenance of stored seed.
Practical significance/proposition:

Improvement of seed quality by physiological treatment is a simple, easy and inexpensive approach to enhance seed performance and agricultural productivity.

Whatever may be the exact mechanism operative in the viability maintenance, dry dressing treatments in high-medium vigour sesamum (cv. Rama and B-67) seeds with finely powdered chemicals, pharmaceuticals and crude plant materials especially, aspirin @ 50mg/kg of seed, bleaching powder @ 2g/kg of seed and red chilli powder @ 1g/kg of seed may be suggested for the improvement of germinability and field performance and productivity of the resultant crop.

If the seeds are medium vigour in quality, then soaking-drying treatments are recommended for the maintenance of germinability and field performance of sesamum (cv. Rama and B-67).

In case of low-medium vigour or low vigour seed, then pre-sowing (post-storage) soaking treatments are advocated for improved field performance of sesamum.