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A comprehensive review: Effects of different package types and storage techniques on wheat seeds *Triticum aestivum* (L.)

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Abstract
The samples were treated with the recommended dose of malathion, recommended rate of phosphine, the powders and extracts of each of (ficus, camphor, clove), the powder of copper nanoparticles and untreated seed as a control treatment. Treated seed were stored in different packages (Jute, Plastic and Polyethylene) for months. The most important results can be summarized as follows: Increasing storage periods of wheat seed up to months significantly affected storage efficacy, vitality and quality of wheat seed. The best results of storage efficacy of wheat recorded when seed stored in polyethylene packages, followed by seed stored in jute packages and lastly stored in plastic packages. Seed treated with copper nanoparticles were the best in germination percentage, electrical conductivity, acidity, protein percentage, carbohydrate percentage, relative density and 1000-seed weight. The best treatment for acidity, relative density, 1000-seed weight, and insect infestation rate was malathion. In terms of moisture percentage, insect infestation %, and weight loss percentage, phosphine performed best. The length of storage has a significant impact on the quality of wheat seeds. The aim of storage is to offer the best possible preservation of the physiological and physical traits of the seed.
By preserving the initial seed moisture content and lowering respiration, the storage packing should help slow down the rate of deterioration. Depending on how easily water vapour may exchange between the seeds and the atmosphere, the qualities of the packaging containers affect how quickly seeds deteriorate.
Therefore, this experiment was created to ascertain the impact of storage durations, package kinds and the use of natural and synthetic materials to treat wheat seed on storage effectiveness, seed viability and seed quality in relation to environmental factors.

Keywords: Wheat, seed treatment, storability, seed quality

Introduction
Wheat, (*Triticum aestivum* L.) the world's largest cereal crop which belongs to Poaceae family of the genus Triticum. It has been described as the 'King of cereals' because of the acreage it occupies, high productivity and the prominent position in the international food grain trade. Wheat is consumed in a variety of ways such as bread chapatti, porridge, flour, suji etc. The term "Wheat" is derived from many different locations, specifically from English, German and Welsh language. Wheat is most commonly defined by all cultures as "that which is white" due to its physical characteristics of light-colored crops.
Wheat (*Triticum aestivum* and *T.* duram) is the most important winter cereal crop of India and is grown during November to mid-April. The wheat being grown in India is spring type belonging to species aestivum (bread wheat). Wheat growing in India is divided into six zones, since they differ agroecologically. The Indo-Gangetic plain comprising the North Western Plains Zone (NWPZ) and the North Eastern Plains Zone (NEPZ), forms the major wheat tract followed by the Central Zone (CZ) and the Peninsular Zone (PZ). The Northern Hill Zone is still dominated by traditional cereal growing with varieties that mature in May/June, while the Southern Hill Zone has a miniscule area of few hundred hectares under tropical cold humid environment.
The major wheat producing countries are China, India, Russia, USA, France, Canada, Germany, Pakistan and Australia. Globally, total area under wheat production is 215.48 million hectares with production 670.87 million tons and productivity of 31.17 q/ha^{-1}. The productivity increased at a good pace around 3216 kg/ha^{-1} in the latest report by the Indian Department of Agriculture (Agricultural Statistics at a Glance 2017-18). The estimated production of wheat in India is 97.11 million tonnes from an area of 30.42 million hectare during 2017-18 (Department of Agriculture Cooperation & Farmers Welfare, India).

The production of wheat in U.P. is 30.06 million tonnes in 2017-18 with average productivity is 26.91q/ha^{-1} which is considered low as compared to state like Punjab with productivity of 45.31 q/ha^{-1} and Haryana with 40.66 q/ha.$^{-1}$ The top three states like UP, MP and Punjab together contributed about 100% of the total wheat production in India 30.55%, 18.24% and 16.71% respectively. The agriculture ministry has kept a target of 97.50 MT wheat output in 2017-18 crop year and is hoping better production at an all-time high of over 100 MT. Wheat production stood at record 99.70 million tonnes in the 2017-18 (July-June).

A comprehensive review

Fakir (2000) [22] reported that the average world yield of rice is 3.84 tons/ha (FAO, 2007), which in Bangladesh is 2.52 tons/ha (BBS, 2008). In Bangladesh, out of 43 diseases known to occur on the rice, 27 are seed-born of which 14 are of major importance, the most destructive ones are fungal such as brown spot (*Bipolaris oryzae*), Blast (*Pyricularia oryzae*), Sheath rot (*Sarocladium oryzae*), Sheath blight (*Rhizoctonia solani*), Leaf scald (*Microdochium oryzae*), Seed rot and Seedling blight (*Bipolaris oryzae*, *Sclerotium rolfsii* and *Fusarium* spp.), Grain spot (*Curvularia lunata*, *Nigrospora oryzae*, *Phoma glumarum*, *Cladosporium* spp.).

Bhattacharya *et al.* (2001) [10] reported that effect of three different pesticides on chlorophyll and carbohydrate contents in rice (*Oryza sativa* L.) in Ajoya and MW10 at panicle emergence was studied in the sub-Himalayan Terai region of north-eastern India. The herbicide butachlor brought about significant depletion in both leaf chlorophyll and carbohydrate contents in leaf and grain samples as compared to the insecticide carbofuran and untreated control. Application of the fungicide carbendazim resulted in a decrease in carbohydrate content, whereas carbofuran caused a slight increase. It is suggested that in order to avoid adverse effects on yield parameters at harvest, application of butachlor and carbendazim to rice should be avoided during panicle emergence.

Rajendran and Muralidharan (2001) [51] studied that, the Wheat is more absorptive than most cereals of fumigants, such as methyl bromide and phosphine. Fumigation of bag stacks of paddy rice of the ADT 39, Samba cultivar with phosphine, under both indoor and outdoor storage conditions, was studied. In the 1st trial, new crop wheat stacks were fumigated in indoor and outdoor conditions at moisture contents of 12.2-13.7%, phosphine being applied at 2, 3 or 4 g/t rice, for 7 days. In the 2nd trial, 2 stacks of old wheat of 8.8 and 9.8% moisture were fumigated with 3 g phosphine/t for 7 days. Gas concentration throughout the stacks was monitored and used to calculate concentration time (Ct) products. *Rhyzopertha dominica* adults collected from old wheat before phosphine exposure were tested for phosphine resistance.

Mettananda *et al.* (2001) [41] studied on the storage temperature and relative humidity is important parameters determining seed viability. Moderate temperature (18-20 °C) and RH (50-60%) are ideal storage conditions for many seeds. However, temperature and RH in most ambient seed stores in the dry zone of Sri Lanka are well above these values and are harmful for storage of agricultural seeds of many crops.

Rathinavel *et al.* (2001) [54] studied the seedling vigour evaluated in terms of field emergence of fresh as well as halogen treated, two month stored cotton seeds from 18 genotypes revealed the existence of variability. The storability of halogen treated and untreated seeds of cotton genotypes assessed through a rapid deteriorative process (accelerated ageing) revealed the positive effect of seed treatment in prolonging shelf life.

Ramesh and Saxena (2002) [52] reported that the use of neem can significant economic advantage and service to rural areas in tropical developing reliable recommendations can be made and given to farmers for the protection of stored commodities, and the mixing of neem leaves (2-5%) with wheat rice, or other grains. The farmers (30-60%) of the storage of wheat, rice, sorghum, and millet, used (4-10%) neem leaves for protection, major stored grains pests infesting rice and paddy grains.

Singh *et al.* (2002) [59] studied that the germination and viability of paddy seeds were influenced by this mycoflora and moisture content during storage. Freshly harvested seeds of three important paddy cultivars, Pusa-33, Pusa-169 and Pusa Basmati No.1 were used for various studies. Paddy seeds were treated with fungicides (Captan, Ridomil, metalaxyl, carbendazim, thiram) stored in cloth bags under ambient temperature. After 15 months of storage the germination percentage was found to be higher in Ridomil treated (11.94%) and thiram treated (9.96%) seeds compared with the control.

Harish *et al.* (2003) [25] studied five different plant materials for their ability to act as protectants against contamination of milled rice by the lesser grain borer (*Rhyzopertha dominica*). Plant materials tested included sweet flag rhizome (*Acorus calamus*), kut root (*Saussurea lappa*), turmeric (*Curcuma longa*), curry leaf (*Murraya* sp.) and kin now peel (*Citrus nobilis* x *Citrus deliciosa*), which were added to milled rice at levels of 0.25, 0.5 and 1.0%. Root materials were used as grits or powders, whereas curry leaf and kinnow peel were added either whole or as powders.

Chomchalo (2003) [18] reported that the stored products include materials, which may be dried, rendering them storable for future use as food, industrial raw materials, medicines, or as planting materials. These include cereals, pulses, dried seeds and root crops. Insect infestation is a major contributor to quality deterioration of stored products kept in warm and humid climates. Considerable physical and nutritional loss sustained is due to infestation of stored food products by weevils, brushed and other insects.

Bharathi (2004) [9] reported that the high-quality rice seed store better than low quality rice. Seed storage potential of seed is greatly affected by their quality after the time they enter storage, or their pre-storage history. The pre storage history or a seed lot encompasses all the events in the life of the seeds from the time functional maturity is reached until they are placed in storage.

Larissa *et al*. (2004) [36] found that bean seeds coated with the fungicide recorded higher germination (89%) than non-coated seeds (75.00%) after two months of storage.

Wilkinson and Geneve (2004) [63] also reported more or less similar results in corn. They found higher germination (98.50%), less number of abnormal seedlings (1.50%) and lower conductivity values (41.60 ammos/g) in fungicide treated seeds when compared with non-treated seeds (89.00%, 8.50% and 51.40 µ mhos/g, respectively).

Kavitha (2005) [29] evaluated the effect of various treatments on tomato seeds and found that hardening of tomato seeds, followed by film coating of the seeds with 2 g carbendazim, 1 mL/kg imidacloprid, 30 g DAP, 20 g micronutrient mixture, 3 g red polykote and 50 g/kg *Azospirillum* showed higher germination, growth related parameters and vigour index. Almost similar results were also reported by Praveena (2005) [50], who suggested that treatment of delinked cotton with polykote (3 g/kg) dissolved in 5 ml water, carbendazim (2 g) and imidacloprid (5 g/kg) of enhanced better shelf life of the seeds.

According to Barros *et al.* (2005) [7], treatment of dry bean with fipronil + carbendazim+ thiram showed better compatibility until 150 days of storage. According to Vinitha (2006) [65], tomato seeds coated in sequence with 6 g white red polycot + carbendazim @ 2 g + dimethoate @ 5 mL/kg of seed and stored in aluminum foil pouch showed better seed quality parameters with higher germination (89%), root length (12.10 cm), shoot length (6.10 cm), dry matter (0.029 g) and vigour index (1625) for up to one year of storage period under ambient conditions.

Muangkaeo *et al.* (2005) [43] conducted experiment from February to July, 2004 at the Postharvest Technology Institute and Department of Agronomy, Faculty of Agriculture, Chiang Mai University. From the experiment, seeds in WP bag were highly changed and gave a higher moisture content percentage (10.40%) than seeds in PA (9.81%), PE (9.83%) and MPET (9.89%) bags throughout storage periods.

Rattanaporn, *et al.* (2005) [55] experiments were designed in 4 × 6 factorial in RCB (Randomized Completely Block Design) consisting of 2 factors; packaging material and storage period. Changes in seed moisture content, standard germination, vigour and chemical composition (crude carbohydrate, protein and crude fat) were monthly determined.

Dianxuan *et al.* (2006) [21] studied that, three indoor, sheeted bag-stack fumigations of paddy rice using aluminum phosphide were undertaken in Guangdong Province, southern China. They measured the effect of two types of sheeting (polyvinylchloride [PVC] or polyethylene [PE]) and two types of floor sealing (clips or fixing into a slot with a rubber pipe) on phosphine concentration and retention.

Khare (2006) [32] reported that, generally there are two way of storing grain; storage in sacks and loose grain storage. The grain is dried to a moisture level of 8 to 12 percent. Bag storage requires considerable labor, but is undoubtedly the most satisfactory, if absolute minimum is to be spent on permanent storage facilities and equipment. A farmer cannot afford to have capital spend to at one time in constructing a big storage facility. Bag storage has merit for short term storage.

Biradar and Shekhargouda (2007) [12] reported that the storage of seeds till the next sowing season is an essential segment of seed industry. The seed deterioration intermit of loss in viability and vigour. The seed viability and vigour largely depends on the genotypes, production location and mechanical injury to the seed, initial seed quality and seed treatment, packaging material and storage conditions.

Giang and Gowda (2007) [23] reported that the maintenance of seed vigour and viability during storage is a matter of prime concern. Research on storability of hybrid rice in India is of recent origin. Freshly harvested seed produce of F1 hybrid rice KRH-2 were dried to safe level moisture (<13%), graded to uniform size and used for the study. The seeds were treated with synthetic polymers viz. Polykote TM and Littles Polykote W. Yellow. Then the ploy-coated seeds were shade dried and further treated with chemicals viz. Captan, Thiram, Gouch and super red at recommended dosage. Seed senescence or deterioration is irreversible and inexorable process.

Phan and Rame (2007) [48] reported that, the maintenance of seed vigor and viability during storage is poly-coated seeds were shade dried and further treated with chemicals viz. captan, thiram, gouch and super red at recommended dosage. Seed senescence or deterioration is irreversible and inexorable process. Amount of moisture in seeds are probably the most important factor influencing seeds viability during storage. The seed coated with little polycot W yellow, captan + Thiram + gouch + sugar red at 1 ml/kg and stored in polythene bag (700 gauge) recorded higher germination (85.67%) as against the lowest recorded in cloth bag untreated 62% at the end of the storage period.

Kathiravan *et al.* (2008) [28] studied the effects of seed treatments and storage containers on quality of atrophy seed stored at ambient conditions up to 12 months. The results revealed that seeds treated with carbendazim + halogen and stored in high-density polyethylene interwoven bag were superior with regard to vigour and germination, and the viability of these seeds after 12 months of storage.

Ibiam *et al.* (2008) [27] studied to use of seed-dressing fungicides (Bavistin, Carbendazim 12%, Benlate, Fernasan-D, Apron plus 50 DS and Dithane-M45) and soaking and slurry methods at various concentrations, for the control of seed-borne fungi of rice variety Faro 29 *in vitro*, was investigated. The results obtained showed that all the fungicides significantly inhibited the seed- borne fungi associated with the seeds of the variety at concentrations of 40 g/ml, and 50mg/ml ($p<0.05$), in the soaking method, and at all the concentrations in the slurry method ($p<0.05$).

Reddy *et al*. (2009) [66] studied the potential of certain plant extracts and bio-control agents for the reduction of aflatoxin B1 (AFB1) in stored rice was investigated. Among the plant extracts tested, *Syzygium aromaticum* (5 g/kg) showed complete inhibition of Aspergillus flavus growth and AFB1 production. Curcuma longa, *Allium sativum* and *Ocimum sanctum* also effectively inhibited the *A. flavus* growth (65-78%) and AFB1 production (72.2-85.7%) at 5 g/kg concentration.

Shashi Bhaskar *et al.* (2009) [58] reported that seeds pelleted with carbendazim and stored in polyethylene bag gave higher germination (75.75%), seedling length (24.83 cm), vigour index (1862), dry matter production (34.20 mg), dehydrogenase activity (0.303 OD value), speed of germination (21.07) with less moisture content (6.56%), EC value of seed leachate (0.481 dS m^{-1}) and seed infection by pathogen (0.00%) at the end of 10 months of storage.

Portmann *et al.* (2010) [49] studied the effect of type of storage i.e. cloth and polythene bags on germination and quality parameters of rice seeds. Study consisted of two factors viz., type of storage at two levels: cloth bag and polythene bag, and application of thiram (2 g/kg) and carbendazim 12% (2 g/kg) at two levels: applied or not. Observations were recorded after every two months. Application of carbendazim showed significant results in terms of all quality parameters.

Kumar *et al.* (2010) [34] opined that extract of neem contains nimbinin, nimbandiol as active constituents. Alcoholic extract of its leaves have a significant blood sugar lowering effect which are very useful against diabetes. Neem is well known for its anti-viral, anti-fungal and anti-bacterial properties, which makes it use in agro-industries.

Bhowmik *et al.* (2010) [11] reported that the neem tree (*Azadirachta indica*) has been known as the wonder tree for centuries in the Indian subcontinent. It has become important in the global context today because it offers answers to the major concerns facing mankind. Neem (*Azadirachta indica*) is considered harmless to humans, animals, birds, beneficial insects and earthworms, and has been approved by the US Environmental Protection Agency (US.E.P.A) for use on food crops.

Britta (2010) [15] reported that, the high-quality criteria for food, very effective methods are needed to control insects and other pests during storage. Chemical SPP products are widely used for this purpose. However, the number of active substances which may legally be used in storage protection is very limited. High efficacy of the substances is often linked with high toxicity also towards humans.

Khan *et al*. (2010) [30] studied the objective of the present study was to examine the relationship between various seed quality tests and field emergence of the new and old rice and wheat cultivars. Results showed that among all tests, germination index (GI), Accelerated aging (AA) and Electrical conductivity (EC) provided the best estimate of seed vigor for the four wheat cultivars, both for ranking seed lots quality and predicting field emergence. The GI, AA and EC tests better indicated seed lot quality and predicted FE than SG of the four cultivars over the 2-years followed by Radical length (RL).

Milosevic *et al.* (2010) [42] reported that the seed marks the beginning of each plant production and therefore ensuring its quality is the priority of modern seed science and a prerequisite for obtaining high yields of all plant species. Determination of seed quality and its viability indicates what seed lots can be placed onto the market, and for that reason it is very important to have reliable methods and tests to be used for seed quality and seed vigour testing. The term vigour of viability is used to describe the physiological characteristics of seeds that control its ability to germinate rapidly in the soil and to tolerate various, mostly negative environmental factors.

Buriro *et al.* (2011) [16] reported that temperature greatly influences germination of the seeds. Most of the varieties lack the ability to sustain temperature stress with significant differences for germination and related traits. Laboratory investigations were conducted to determine the effect of different temperature regimes on germination traits of various rice seed varieties at Department of Agronomy, Sindh Agriculture University, Tando Jam, Pakistan during 2008. Seeds of five wheat varieties (Moomal 2000, T J-83, Imdad-2005, Abadgar-93 and Mehran-89) were tested for germination and related traits under three temperature regimes (10, 20 and 30 °C) in germinator.

Naguib *et al.* (2011) [45] studied the effects of packaging materials and storage periods on viability and vigor of seed and changes of some chemical components during storage. Seed samples of paddy and five wheat varieties (Sids 12, Sakha 93, Gemmeiza 7, Gemmeiza 10 and Giza 168) have been processed and dried to 12% moisture. The samples were stored in different packages (clothes, plastic, aluminum and polyethylene) for 18 months at room temperature.

Selvaraj *et al*. (2011) [57] evaluated the twenty one rice genotypes and screened under artificially controlled conditions to identify the rice blast disease reaction. Sixteen genotypes which were already reported to have resistance genes reacted negatively to the blast disease.

Mugad (2011) [44] revealed storage experiment was conducted to understand the effect of organic and integrated management practices of seed production and storage containers along with organic (insecticide and fungicide) and organic (botanicals) as seed treatments on seed viability of scented rice cv Mugad Sugandha at University of Agricultural Sciences, Dharwad for 20 months during 2006-07.

Pereira *et al.* (2011) [47] investigated the performance of wheat seeds treated with fungicide and film coating, prior and after storage. Three seed lots of wheat varieties were collected from different locations and treated with thiabendazole + thiram without polymer, carbendazim + thiram without polymer and without fungicide (control). The physiological quality of the seeds was evaluated initially and after six months storage under environmental conditions. The film coating associated with fungicides does not affect physiological quality of the seeds and treatment with thiabendazole + thiram and carbendazim + thiram improved performance of wheat varieties.

Sitara and Hasan (2011) [60] studied the effects of eight fungicides viz., Metalaxyl + Mancozeb (70% w/w), Mancozeb (82% w/w Dithiocarbamate) and four seed powders of herbicides viz., asafoetida (*Ferula asafoetida*), black cumin (*Nigella sativa*), neem (*Azadirachta indica*) and mustard (*Brassica campestris*) were used @ 0.5, 0.15 and 0.25%, respectively on chili seeds. Ridomil Gold @ 0.35 and 0.25% inhibited the growth of all fungi where as asafoetida and *N. sativa* powder @ 0.25% was found to be better than other fungicides however some fungicidal activity was recorded towards *Fusarium moniliforme.*

According to Debashri and Tamal (2012) [19], neem has insecticidal properties. Azadirachtin, an active compound present in neem is capable to provide resistant against almost 550 insect pests. Bio-degradability, economically affordable and easy availability of neem makes it as a popular pesticide. In India, neem products are mostly used against various pests of field crops and also for stored grains like paddy, wheat, maize, pulses, potato and tomato. The safe path to control the seed-borne disease is the treatment of seeds with botanicals which are cheap, safe and eco- friendly in nature.

Kumar (2012) [33] reported that, seed is a basic and vital input for sustained growth in agricultural productivity and production since ninety percent of the food crops are grown from seed. the role of seed in agriculture sector is of prime importance in developing countries like India where the population and GDP (Gross Domestic Product) considerably depend on agriculture sector.

Lokanadhan, *et al.* (2012) [37] reported that the properties of neem as insecticide, hormonal, antifungal, antiviral and neem acticide properties is well known are brought out with neem use in the form of leaves, leaf extracts, seeds, cakes, oil and fruit extracts.

Adebisi *et al.* (2012) [1] reported that the seeds of 24 West African rice (*Oryza sativa* L.) genotypes were evaluated for seed vigour traits in the laboratory and field in two cropping seasons at the Research Farm of Federal University of Agriculture, Abeokuta, Nigeria.

Bux *et al*. (2012) [17] studied the Present study was carried out to identify wheat genetic resources for stripe rust resistance to enhance cultivar improvement efforts. Wheat germplasm consisting of 20 Chinese cultivars, 95 synthetic hexapods and 85 advanced breeding lines were evaluated under field conditions at two hot spot.

Debashri and Tamal (2012) [19] reported that the synthetic and natural pesticides are used extensively in the agricultural fields to control crop pests; it is well known that natural pesticides are eco-friendly and are safe to the non-target organisms. This review put a light on the use and efficacy of indica based pesticides against various pests of both crop fields as well as stored.

Bang-Yin *et al.* (2013) [6] studied the quality of paddy; fresh paddy bran and aged paddy bran stored under different packaging conditions were studied. Fat stability and total plate count of samples stored in PE/PA (polyethylene/polyamide) bags with a normal atmospheric environment or a vacuum environment were analyzed. Results showed that paddy had better quality stability than paddy bran during storage.

Mathad *et al.* (2013) [40] studied on traditional seed treatment and storage method was conducted in five villages of Northeastern region of Karnataka state in India. The region comprises of six districts. Various methods used by the villagers were documented and scientific analysis was done on exactly how these methods were effective. Seed treatment and storage were important as farmers did not use any chemicals. They used materials available in the form like cow dung slurry, cow urine, common salt, powders of various plant materials, leaf extracts, etc.

Khan *et al.* (2013) [31] showed that neem seed oil control 100% beetles (*Callosobruchus chinensis*) in pulses when applied at 10 ml/kg grain. a positive potential of plant extracts as suitable substitute of conventional synthetic insecticides for the management of insect pest attacking stored commodities. Neem (*Azadirachta indica*) tree, which has many useful compounds such as azadirachtin and tetranortriterpenoid limonoid, are the active ingredient of many neem-based insecticides.

Kumawat and Bhanwar (2013) [35] reported maximum fortification of insects using neem oil as well as no grain injury was recorded by neem oil. Apart from this, no adverse effect of neem oil was reported on seed practicality up to 270 days of the treatment. Increase in growth inhibition of insect with increase in dose of neem oil (0.5-1.0% and 2.0% (w/w)) was reported by Tariq *et al.* (2013) [67].

Amin *et al.* (2014) [3] reported that an investigation was carried out to evaluate the efficacy of some selected seed treatments on the incidence and severity of sheath blight (ShB) disease and yield contributing characters of imported hybrid rice in the Eleven seed treating agents viz. untreated control, sun drying, polythene colorization, brine solution, neem leaf extract.

Anitha and Savitha (2015) [4] reported that in the present study impact of carbendazim on seed germination, seedling length, electrical conductivity, Vigour Index, Chlorophyll a, Chlorophyll b, total Chlorophyll, and phenolic contents of rice cultivars were studied. The study was carried out for 14 days after soaking the seeds in different concentration of carbendazim and a control was maintained. The results showed increasing trend in germination percentage, conductance and phenolic contents.

Manikandan and Srimathi (2015) [39] assessed the effect of different treatments on germination of *Amaranthus* seeds, and recorded that seed treatment with carbendazim (2 g/kg of seeds) and imidacloprid (100mg/kg of seeds) stored in poly lined aluminum foil pouch kept at ambient room condition exhibited higher germination (97%) after six months of storage.

Anitha and Savitha (2015) [4] also studied the effect of carbendazim on germination, seedling length, electrical conductivity, vigour index, Chlorophyll a, Chlorophyll b, total Chlorophyll and phenolic contents of rice cultivars. They soaked rice seeds in carbendazim and non-treated seeds served as control in the study. Increase in germination percentage, conductance and phenolic contents with increase in concentration of carbendazim was recorded. The parameters like root length, shoot length and vigour index showed increasing trend up to 9 mg concentration thereafter it declined. In Jyothi and IR cultivar, the chlorophyll content was found to be increased upto 9 mg and thereafter it declined; hoeverer, in cultivar Jaya, maximum chlorophyll content was recorded at 12 mg concentration.

Behrani *et al.* (2015) [8] reported that seed treatment with systemic fungicides such as (Carbendazim) can control the spread of *Fusarium oxysporum* and *Aspergillus niger* and enhances the quality parameters of seed like germination (%) and seed vigour.

Pawar *et al.*, (2016) [46]. reported that controversially used in Queensland, Australia on macadamia plantations. Higher dose of carbendazim may cause sterility and destroy scrotal sacks of laboratory animals. Carbendazim functions by restricting growth of germinal tube, formation of fungal spores and fungal nuclei. It is being used in agriculture because of multi-functional properties over fungi Zakir *et al.* (2016) [64] tested the performance of 20 genotypes of buckwheat. Out of tested genotypes, Sh-914 showed superiority over other genotypes in respect to test weight, maximum grains/plant and grain yield. The genotypes Gh-911, Sh-913, Gh-918 and Gh-916 showed more variance with check variety than the other tested genotypes.

Maliro *et al.* (2017) [38] evaluated the performance of 11 Quinoa genotypes in terms of growth and yield attributing traits at two different locations. At one location (Bunda), genotype. Titicaca recorded highest yield (3019 kg/ha) and at another location (Dembele religion), genotype Multi-Hued recorded highest yield (1603 kg/ha).

Tejaswini *et al.* (2017) [61] evaluated the performance of 27 *Amaranthus* genotypes in randomized block design for 19 traits. Among tested genotypes, five genotypes IC- 522214, IC-536718, IC-536712, IC-536699 and IC-536728 were found to be significantly better in terms of yield than other genotypes. These genotypes also recorded higher leaf length, leaf width, yield/plant, protein content, folic acid etc.

Hulihalli and Shantveerayya. (2018) [26] studied the productivity of four buckwheat genotypes under integrated nutrient management. Genotype with maximum plant height (73.2 cm), number of clusters/plant (5.2), number of seeds/cluster (8.3), grain yield/ha (6.2 q/ha) and straw yield/ha (10.3 q/ha) ranked first.

Tiwari *et al.* (2018) [62] studied the genetic variance in 54 genotypes of *Amaranthus* along with four check varieties in augmented block design. Among tested genotypes, Durga recorded earliest flowering (63.20) and maturity (128 days). However, maximum plant height (148 cm) was recorded in IC-95339 and seed yield (46.69 g) in IC-82625.

Ahmad *et al.* (2018) [2] evaluated the performance of three elite varieties of buckwheat, namely Himachal local, Gurez local and Kargil local in Kargil region. They reported better results with genotype Himachal local when compared with other two genotypes. Himachal local recorded highest number of internodes, number of leaves plant^{-1}, leaf length and width, number of primary branches, seed index, seed yield plant^{-1} and days to maturity.

Bisht *et al.* (2018) [13] also conducted study on performance of 30 genotypes of buckwheat and variable results. They recorded maximum plant height (121.06 cm), number of primary branches/plant (4.13), number of leaves/plant (29.40) and seed yield (3.48 kg) in genotype PRB^{-1}. However, genotype VL-7 recorded maximum germination percentage (95%) with maximum vigour index. The earliest flowering was recorded in RSR/SKS-106 (43 days), days to maturity in IC-412733 (111 days) and number of internodes plant^{-1} in VL-7 (12.86).

Jangde *et al.* (2018) [68] evaluated the performance of the 23 *Amaranthus* genotypes and found that genotype AMAR 07 was superior over other 22 genotypes which recorded maximum plant height (12.89 cm), number of branches/plant (3.33), leaf length (1.60 cm) and harvest index (113.22). The genotype AMAR 01 recorded lowest plant height (9.85 cm), leaf length (1.1cm) and harvest index (66.25). This showed an indication of existence of sufficient variability among genotypes for leaf yield and its component traits. In Northern zone of Karnataka, Paul and Nandi (2020) [69] conducted a study on performance of five different genotypes of buckwheat, who reported highest dry matter accumulation (23.5 and 22.5 g plant^{-1}) in PRB^{-1} which was found to be statistically comparable with two genotypes (Himpriya and VL UGAL 7). observed variation in yield performance is could be due to variation in bearing of number of seeds/plant by different varieties. In Konkan region of Maharashtra, Haldavnekar *et al.* (2020) [24] conducted a study on evaluation of different *Amaranthus* genotypes. Results recorded that six genotypes (T5, T6, T7, T10, T12 and T13) were superior in terms of yield (per plot or per ha). The genotype T12 recorded highest yield, followed by T13, T7, T6, T5 and T10.

Carbendazim is a systemic fungicide, comes under the group of carbamate, which inhibits mitosis and DNA synthesis of microbes and thereby extend the shelf life of seed and acts on the nicotinic acetylcholine receptor; the chlorination inhibits degradation by acetylcholine-esterase suggested that neem seed oil control 100% beetles (*Callosobruchus chinensis*) in pulses when applied at 10 ml/kg grain a positive potential of plant extracts as suitable substitute of conventional synthetic insecticides for the management of insect pest attacking stored commodities.

Conclusion

The current investigation reaffirmed the significance of optimal storage procedures and their effect on metrics relating to seed quality in wheat seeds. In addition to proper storage, it is important to consider the seeds' original state before storing them because insect damage may be the cause of the issue. Under some circumstances, seed treatments can be very helpful in achieving uniform seedling emergence as well as protecting the seed during storage. This investigation indicates that grain germination capacity reduced over the course of storage for all seed treatments and packing materials.

The control was mostly found infected by fungi during storage and the treatment combination with genotypes showed no traces of fungal infection during the storage period. So, it can be used as combination with the genotypes to maintain seed health during storage.

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