EFFECT OF SEED CONTAINERS AND STORAGE CONDITION ON STORABILITY OF VEGETABLE SEEDS: A REVIEW

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ABSTRACT

Initial seed quality needs to be established as a base for evaluation of seed deterioration. Seed is a living entity and is subjected to various environmental stresses which affect the quality. In storage, the viability and vigour of the seeds not only vary from genera to genera and variety to variety, but it also regulated by many physico-chemical factors like moisture content, atmospheric relative humidity, temperature, initial seed quality, physical and chemical composition of seed, gaseous exchange, storage structure, packaging materials, etc. The effect of seed containers and storage condition on storability of vegetable crops seeds is reviewed herewith, which may help to the researchers in planning their research very precisely and in right direction to get more fruitful results.

KEY WORDS: Container, Storage environment, Vegetable

INTRODUCTION

Vegetables are the fresh and edible portions of herbaceous plants, which can be eaten raw, or cooked (Oyenuga and Fetuga, 1975, Fayemi, 1999, Dhellot *et al*., 2006, Hassan *et al.*, 2007). They are important food and highly beneficial for the maintenance of health and prevention of diseases. They contain valuable food ingredients which can be successfully utilized to build up and repair the body. Vegetables are valuable in maintaining alkaline reserve of the body. They are valued mainly for their high carbohydrate, vitamin and mineral contents. There are different kinds of vegetables. Vegetables may be edible roots, stems, leaves, fruits or seed. Each group contributes to diet in its own way (Robinson, 1990).

Vegetables contribute minerals, vitamins and fiber to the diet. Minerals are naturally occurring inorganic substances with a definite chemical composition and an ordered atomic arrangement. Vegetables also act as buffering agents for acidic substances produced during the digestion process (Fayemi, 1999). Vitamins are organic compounds occurring in natural foods especially in vegetables either as such or as utilizable "precursors". Vegetables contain low calories and negligible quantities of utilizable energy; hence, they are ideal for obese people who can satisfy their appetite without consuming much carbohydrate (Oke and Ojofehintimi, 1988).

Good seed is a basic input in vegetable production. Successful olericulture programme depends on the

quality of seeds used for sowing. Thus, the seed producers hold greater responsibility in maintaining genetically pure seeds and to preserve the quality of seeds from harvest to next sowing. Since, seed is a living entity and is subjected to various environmental stresses which affect the quality. In storage, the viability and vigour of the seeds not only vary
from genera to genera and variety to variety, but it also regulated by many physico-chemical factors like moisture content, atmospheric relative humidity, temperature, initial seed quality, physical and chemical composition of seed, gaseous exchange, storage structure, packaging materials, etc., (Doijode, 1988a). Among these, the major factors affecting the seed quality during storage are temperature and relative humidity, which results in drastic deterioration of seed. Apart from this, fungi associated with stored seeds are mainly responsible for deterioration of quality and reduction in germination potential.

Deterioration of seed is associated with ageing phenomenon which is defined as an irreversible degradation change in the quality of a seed after it has reached stage. Its maximum quality level and the seed deterioration also start immediately after attaining the physiological maturity on the plant itself (Abdul-Baki and Anderson, 1973).

Temperature and moisture play a fundamental role in determining the storage longevity of seeds (Krishnan *et al.,* 2004). Hence, storage of seeds after harvest till next planting time assumes prime importance for successful seed production programme.

Effect of seed containers on quality of vegetable seeds

The type of seed packaging materials/containers used can also have an effect on shelf life, particularly if the relative humidity is high. It is a well-known fact that the seed moisture plays a major role in the viability and vigour of the seed during storage (Padma and Reddy, 2002; Joshi *et al.,* 2007). Packing of seed also plays a vital role in enhancing the shelf life of the seeds (Garg and Chandra, 2005; Rao *et al*., 2006; Joshi *et al*., 2007; Tripathi and Lawande, 2014). The viability and vigour of seed to a great extend depends on the storability, which determined by the moisture of seed, relative humidity and temperature. High content of seed moisture and relative humidity are congenial for seed metabolites as well as for growth of fungus. It has been reported that lepoxygenase enzyme generate free radicals as the seed moisture increases. These are responsible for chromosomal abnormalities which adversely affect germination of seed and seedling growth. As the seed aged, the proportionate of genetic mutation increase. Many of these mutations can be detected as chromosomal aberrations. These chromosomal aberrations delay seedling growth and adversely affect seed germination (Murata *et al.,* 1984).

There are a wide variety of materials that can be used to store seed for short-term storage. Most of these are non-rigid materials such as cotton, burlap, paper, and composite materials such as multi-wall paper and plastic film, or polyethylene bags. Materials used for short-term storage are generally porous. They adequately contain and protect the seeds from mixing, but do not provide protection from moisture or loss of seed viability. Metal and glass containers, properly sealed to prevent the exchange of moisture and gas, are the most commonly used containers. They are the only reliable means of protecting seeds against humidity, insects, rodents, floods, and mechanical damage. Plastic should not be used for long-term storage. Storing the seeds in moisture vapor proof containers like polythene bag, aluminium foil or any sealed container is found more useful in maintaining the desired seed quality for longer period unlike non

moisture proof containers like cloth bag (Singh and Singh, 1992). Seeds stored in cloth bags showed wider fluctuations in seed moisture content and greater loss of seed quality due to its permeable nature of pores (Baskin *et al.*, 1987). Harrington (1973) reported that a package, which is moisture proof or moisture resistant would be more valuable in prolonging germination and vigour of seeds.

Miyagi (1966) dried the seeds of onion, carrot, cabbage, cucumber and tomato in dessicator and stored in moisture vapour proof resistant and impervious containers and observed higher viability and vigour for longer period in moisture proof containers followed by moisture resistant and impervious containers, respectively. Pillayarsamy *et al.* (1973) treated chilli seeds cv. K-1 with thiram 2 g/kg of seed and stored in plastic containers produced higher germination compared to control during storage period of 18 months. Ader (1978) stored the seed of lettuce and carrot in different containers like paper bag, polythene bag and air tight glass jars and showed that there was no loss of germination in both the crops when stored in airtight glass jars up to seven years, but it reduced in paper bags drastically. Fischer (1980) stored the chilli seeds in five different containers and obtained the best results with the seeds stored in sealed jars and plastic bags and retained the germination of 96 per cent at the end of seven years. Ellis and Roberts (1981) suggested that commercial onion seed may be dried to about 6.3 per cent moisture content and sealed into moisture proof containers to keep seed viable for at least three years. Shindha and Spatkki (1986) found the highest germination (51%) at 180 days after storage when the seeds were stored in plastic container. Vanagamudi *et al.* (1986) reported that field emergence and vigour potential of 40 months old field bean seeds stored in 700 guage polythene bags were superior to those stored in cloth bag. Saxena *et al.* (1987) stored the seeds of onion, cabbage, radish, cauliflower, okra and peas in polythene and cloth bag at room temperature for 24 months and found that the decrease in germination, root length, shoots length and vigour index with the increase in storage period was greatest in the seeds stored in cloth bag and was least in polythene bag.

Doijode (1988b) stored the seeds of *Capsicum* and onion in aluminium foil, polythene bags under partial vacuum and in paper bags (control) and observed no germination after 30 months in both the cases. After 18 months, the vacuum packed and control in onion seeds gave 54 and 27 per cent germination, respectively, and the corresponding values of *Capsicum* were 59 and 41 per cent. Doijode (1988c) stated that among different containers polythene bags were promising, as it was effective in preserving the seed viability (81%) and vigour of french bean for longer storage period. Horky (1988) stored the onion, carrot, lettuce and cabbage seeds for 65 months in paper biaxially oriented polyprophylene film and triple laminated aluminium foil packets and reported that wrapping material had no effect on germination per cent and the per cent germination decreased with increase in storage period in all species. Verma *et al.* (1991) reported that the seeds of tomato and cauliflower maintained the germination well within specified certification standards, when stored in laminated bags under ambient condition for 10 months, as compared to the seeds stored in paper bags. Vijaykumar *et al.* (1991) observed that the onion seeds treated with captan with 2 g/kg of seeds and stored in polythene bag maintained the highest germination percentage (70%) and vigour index (945) as

compared to the seeds stored in cloth bag at the end of ten months of storage period.

Gupta *et al.* (1992) reported that the chilli seeds stored in tin container retained the germinability (60%) up to 19 months of storage. Shelar *et al.* (1992) stored the onion seed with 5 per cent moisture content in moisture permeable cloth bag, paper bag, cardboard box line with wax paper, plastic bag and aluminium foil packets and observed the germination per cent above 70 even after one year storage in plastic and aluminium foil packets, whereas 70 per cent germination was seen only 10 months in other three containers. Patil and Shelar (1993) stored the brinjal and tomato seeds in moisture pervious and impervious containers indicated that the seed germination in both the crops was maintained above minimum certification standard (70%) for 18 months in impervious containers like polythene bag and aluminium pouch as compared to moisture pervious containers like cloth bag and paper bag which could maintain the germination per cent of 70 only up to 14 months. De Silva and Peiris (1994) revealed that the best packing material for maintaining viability and vigour of chilli seeds in triple laminated aluminium foil as seeds exhibited less variation in the moisture content. Fischer (1994) reported that seeds of *Capsicum annum* stored in sealed plastic flask and glass jars have maintained higher germination even after 20-22 years, while the seed stored in cloth bags showed marginal decrease in germination after three years at room temperature. Jagadish *et al.* (1994) stored fresh seed of onion cv. Pusa red in sealed tin, kraft paper, aluminium pouch (50 mm), aluminium pouch (20 mm), polythene bag (500 guage) and paper bag for 18 months in ambient conditions. Both aluminium pouches retained maximum germination after 18 months compared to other containers. Sahee *et al*. (1994) stored the seeds of tomato in impermeable and permeable packets and observed a decline in germination per cent below certification standard (70%) before one year in the seeds stored in permeable pack, whereas the seeds of impermeable packet maintained higher viability for more than one year. Saxena (1994) reported that polythene bags of 700 guage may be used for long term storage of various vegetable seeds like onion, tomato, okra and cabbage which were with six per cent moisture content.

Caneppele *et al.* (1995) stored the onion seeds in six types of packing materials. The highest loss of germination was observed in permeable containers than in impermeable containers. This difference was due to change in seed moisture content in permeable packing materials and the degree of hygroscopic equilibrium between seeds and their surroundings. Doijode (1995) reported that seed onion cv. Nasik red stored for seven years with 6.5 per cent moisture content in a glass container and aluminium foil laminated pouches compared to polythene bag (200 guage) and kraft paper. The germination and vigour was greater in the seeds stored in glass containers, aluminium foil laminated pouches than in polythene (200 guage) and paper bags (kraft paper). Ilic (1995) noticed the highest germination (97%) in red pepper seeds after five years of storage in polythene bag as compared to paper bag. Stumpf *et al.* (1997) reported that the seed moisture content (5.5-6.5, 6.5-7.0, 7.0-7.5%) and storage periods (1-10 years) increases the viability equation becomes less accurate being practically useful up to 3 years and retained high physiological quality in onion seeds in hermatic storage. Sharma *et al.* (1998) reported the seeds of two varieties of chilli *viz*., Pusa Jwala and Mathania local sun dried to about 6 per cent moisture content and stored in polythene bags (700 guage) and paper bags. Generally, the seed germination declinity was more in the seeds

stored in paper bags. In paper bag, germination of both the varieties declined below the minimum seed certification standard (60%) after 21 months of storage, whereas in polythene bags, the germination was maintained above 60 per cent up to 25 months of storage. Bankole *et al.* (1999) stored melon seeds in jute and polyethylene bags for 12 months. The moisture content (mc), incidence of visible moldiness and germinability of the stored seeds were determined monthly. The moisture content ranged from 6.1 to 6.7 per cent in jute and 6.2 to 6.5 per cent in polyethylene bags.

Doijode (2000) stored the seeds of winter squash (*Cucurbita maxima* cv. Arka Suryamukhi) in kraft paper bag, polyethylene bags, glass containers and aluminium foil laminated pouches at ambient (16-35^0 C), low (5^{0}C) and sub-zero (-20^0 C) temperature for five years. The initial percentage of seed germination was retained for two year at ambient temperature, thereafter, it reduced to 50 per cent during fourth year and 20-30 per cent during fifth year of storage. High seed viability preserved for five year both at low (5^0 C) and sub-zero (20^{0}C) temperature. All the packaging except kraft paper bags at 20^{0}C showed high percentage of germination during low temperature storage. Seed vigour was successfully retained at 5^{0}C and -20^{0}C storage. Seed storage either in polythene bags at 5^{0}C or in aluminium foil laminated pouches at -20^{0}C was effective in preserving high viability and vigour. Huda (2001) mentioned that seed kept in metal container had the lowest moisture content followed by those in polythene bag, earthen pot, jute bag and bamboo bin sealed partially or completely. The metal container can restrict movement of moisture from ambient atmosphere into the seed better than other containers. Hunje (2002) observed that chilli seeds stored in aluminium foil recorded significantly higher germination (89.67 - 82.83%), field emergence (84.0 - 76.7%), root length (9.77 - 6.85 cm), short length (8.55 - 6.38 cm), vigour index (1643 - 1076) and lower electrical conductivity (0.808 - 1.57 dSm^{-1}) at the end of 20 months of storage period followed by polyethylene bag (700 gauge). Padma and Reddy (2002) reported the fluctuation of moisture content in brinjal seeds to an extent of 2.4 per cent in moisture pervious and moisture semi pervious containers, while no such fluctuation in vapour proof containers (polythene and aluminium pouch) was observed. Electrical conductivity increased with increase in storage period. Brinjal seeds stored in cloth bag and paper bag retained the germination of certification standard up to 28-30 months, while seed stored in polythene and aluminium pouch up to 44-46 months. Sharanamma (2002) reported that chilli seeds treated with thiram (2 g/kg) and stored in polythene bag recorded the highest seed quality parameters, while untreated control seeds stored in paper bag recorded lowest seed quality parameters. Ghimire (2003) found that after 9 months of storage, the mean germination per cent was the highest in laminated pouches (70.81%) followed by plastic containers (68.50%), polyethylene bags (67.38%), plastic sacks (57.88%) and cloth bags (57.13%) in case of okra and also stated that the seed qualities were maintained for longer period in laminated pouches, plastic containers and polyethylene bags.

Ankaiah *et al.* (2004) reported that the germination percentage and seedling vigour index were high in onion seed stored in aluminium foil pouch and polythene bag throughout the storage period when compared with other containers. Onion seed stored in cloth bag, paper bag and poly pouch had only 4 months storability with more than 70 per cent germination. Seed stored in polythene bag and aluminium foil pouch exhibited 75 per cent germination up

to 18 and 10 months, respectively. Among the vapour proof containers, aluminium foil pouch was found very effective for extending the shelf life of seed from 4 to 18 months. Karim *et al.* (2006) found the maximum fungal population at 7-10 per cent moisture content of seeds under normal atmospheric condition in jute bag, polythene bag, unsealed metal container and earthen pot. Malimath and Merwade (2006) observed sharp and progressive decline in both containers (cloth bag and polythene bag) for 100 seed weight, germination, seedling length and vigour index from 23.75 g, 96.0%, 29.86 cm and 2866 at initial month to 15.68 g, 67.43%, 21.11 cm and 1429, respectively at end of ten months period. In the entire storage period, rate of loss in seed quality traits was less in 700 gauge polythene bags as against cloth bag. Obviously, the seeds stored in polythene bag retained better storability throughout the storage period by registering higher 100 seed weight (16.93 g), germination (69.40%), seedling length (21.88 cm), seedling vigour index (1523), but conversely lower values for seed infestation (16.80%) and electrical conductivity of seed leachate (1.321 dSm^{-1}) as against those stored in cloth bags (14.43 g, 65.47%, 20.34 cm, 1335,22.97% and 1.486 dSm^{-1}, respectively). Rao *et al.* (2006) stored the fresh onion seeds desiccated to 6.0 per cent seed moisture content (SMC) in various packaging materials under different storage conditions. Seeds packed in aluminum-laminated pouches beside those stored with silica gel at 25^0C maintained satisfactory germinability and vigour after 12 months. Desiccated seeds stored in moisture impervious containers produced more vigourous seedlings. Germination potential of onion seeds increased with reduced SMC besides storage in moisture impervious packets along with desiccants as physiological and biochemical attributes are regulated. Seed viability and vigour decreased with accelerated ageing due to increased lipid peroxidation, decreased activities of several free radical and peroxide scavenging enzymes. Electrical conductance of seed leachates also increased with ageing.

Basavaraj *et al.* (2008) reported that the onion seeds stored in aluminium pouch recorded higher seed quality parameters as compared to polythene bag throughout the storage period. Gouda *et al.* (2008) reported that onion seeds pelleted with binderpolyvinyl acetate and combination of filler materials, saw dust alone and stored in aluminium foil pouch maintained higher germination, seedling length with higher seedling vigour and dehydrogenase activity and with lower seed infection throughout the ten months of storage period. Manjunatha *et al*. (2008) reported that seed quality parameters were found on par with aluminum foil pouch stored seeds and polythene bag stored seeds. They also reported that chilli seeds can be stored for 12 months without affecting the seed quality in aluminium foil pouch or polythene bag (700 guage). Shashibhaskar *et al.* (2008) reported that the pelleted seeds of tomato stored in polyethylene bag maintained satisfactory germination of 70 per cent up to 9 months compared to seeds stored in cloth bag which lost viability below 70 per cent after 7 months of storage period. Significant and lower qualitative seed quality parameters was observed in cloth bag during entire storage period may be due to its permeable nature which might have favoured the longer fluctuation in moisture content leading to faster metabolic and respiratory activity of the seeds compared to polyethylene bag, wherein seed quality parameters were comparatively superior with reduced EC value with slow rate of increase in moisture content due to impervious nature and also evidenced with high dehdrogenase activity.

Barua *et al.* (2009) studied that the effect of storage containers environment at different storage period on the quality of chilli seed. The seed moisture, abnormal seedling and dead seed were increased with increasing of storage time in tin container, polythene bag and cloth bag. The increasing rate was higher in seeds of cloth bag. On the other hand, germination, root and shoot length and root and shoot dry matter after storage was declined. The decline rate was higher in seed of cloth bags container. Fabunmi (2009) studied the effect of packaging materials on moisture contents of okra (*Abelmoschus esculentus*) at room (28 ± 2^0C) and refrigeration temperatures (15 ± 2^0C) using three different packages (open plastic bowl as control, plastic sieve over–wrapped with low density polyethylene bags and low density polyethylene bags (LDPE)–15 x 15 cm). The results showed that packaging materials had a significant effect on moisture content where okra stored in polyethylene followed by plastic sieve container controlled moisture content. Aktaruzzaman *et al.* (2010) stored the okra seeds in sealed container (C_1), polythene bag (C_2) and gunny bag (C_3) and reported that germination percentage of okra seeds in sealed containers was the highest (69.48%) and at 60^{th} days, germination percentage observed in sealed container. polybag and gunny bag were 63.27 per cent, 62.21 per cent, and 53.62 per cent, respectively and have significant variation among them.

Kandil and Sharief (2011) stored onion seeds in containers of paper or cloth and recorded the highest percentage of onion seed germination compared to those stored in containers of polyethylene, where the average germination percentage (82.1 and 81.6%) after 12 months of storage and decreased to 70.6 % and 69.6% after 21 months of storage for each of the packages of paper or cloth, respectively. Khalequzzaman *et al.* (2012) studied the effect of storage containers on the seed quality of french bean. Tin container showed the highest germination, normal seedlings and vigour index which were followed by polythene bag, whereas gunny bag showed the lowest germination, normal seedlings and vigour index up to 60 days after storage. The highest 1000-seed weight, moisture content, abnormal seedlings, seed rot and incidence of the *Fusarium oxysporum* were recorded in gunny bag, where the lowest of these parameters were recorded in Tin container. Seed colour of Tin container was more or less same as initial colour, but seeds of gunny bag were changed into fade or brown colour at 60 days after storage. Moisture content, 1000 seed weight, abnormal seedlings, seed rot, fungi association were increased, but germination and normal seedlings were decreased with the increase of storage periods.

Deepa *et al.* (2013) studied that influence of vacuum packaging on biochemical constituents in chilli seeds. It was observed that the samples stored in vacuum packed bags maintained the quality with least deterioration in all the quality parameters compared to samples stored in jute bags. Quais *et al.* (2013) stored the radish seeds in three storage containers, such as metal container (Tin)**,** polythene bag and cloth bag under different storage periods and reported that moisture content of the seeds of cloth bag, metal container and polythenebag were found increased from 6.81% to 10.35%, 6.81% to 8.40%, and 6.81% to8.25%, respectively, within 70 days of storage. Impervious containers *viz.*, polythene bag and metal container have recorded lower mean moisture content throughout the storage period compared to previous container (cloth bag). Germination percentage of the seeds of cloth bag, polythene bag, and metal container were decreased from 96 to 75%, 96 to 83%, and

96 to 82.25%, respectively during 70 days of storage. This decrease was closely related with the high moisture contents of the seeds. The highest seedling height, seedling dry weight and vigour index was recorded in polybag container at10 days after storage. The lowest seedling height, seedling dry weight and vigour index was recorded in cloth bag at 70 days after storage.

Satishkumar *et al.* (2014) reported that the brinjal seeds stored in polythene bag of 700 gauge recorded significantly higher germination (82.50%), vigour index (790) than the paper bag at the end of 12 months of storage period. Tripathi and Lawande (2014) packed the onion seeds of cv. Agrifound Dark Red of different moisture levels i.e. 5, 6, 7 and 8 per cent in various packing materials i.e. cloth bags, polyethylene bags, laminated aluminum bags and laminated aluminumbags with vacuum packing and stored at ambient condition for 27 months. The results indicated that germination percent and seed vigour index were higher in seed having 5 per cent moisture than seed having 8 per cent moisture. Among the packing materials, lower seed germination and viability was recorded in cotton cloth bags. The seed packed in cloth bags lost their complete viability and vigour within 18 months of storage. The highest seed germination was observed in laminated aluminum bags with vacuum packing. The seed packed in aluminum laminated bags were remained viable for 27 months. Among the various treatments combinations seed having 5% moisture and vacuum packed in aluminums laminated bags remain viable for longer period with percent germination was 61.7% germination 27 months of storage. Judith *et al.* (2015) studied the germination potential of pumpkin (*Cucurbita spp.*) seeds stored in different materials and at different temperatures and reported that pumpkin seeds are best stored at ambient temperature, meanwhile viability is lost with long-term storage. At high humidity conditions, it is best to preserve pumpkin seeds in less water-permeable materials like cocked glass and plastic. Paper materials are best for preserving pumpkin seeds at ambient temperature. Mollah *et al.* (2016) reported that among different containers, plastic pot is the best practice for storing of onion seed for a period of 6-7 months followed by tin container. Nataraj and Jayaramegouda (2017) stored the seeds of vegetable soybean *var*. Karune in room temperature for nine months and noticed higher seed germination (73.11%) in seed stored in tin fallowed by seeds stored in polythene bag (P2) (71.78%) and cloth bag (P3) (68.30 %) at the end of the storage period. Srinivasan *et al.* (2017) reported that seeds of female parent of Tomato COTH 2 packed in polythene laminated aluminum foil pouches recorded the maximum germination percentage and vigour index after 10 months of the storage.

Effect of seed storage conditions on quality of vegetable seeds

The general effect of temperature on longevity is that longevity increases as temperature decreases. This is true of "orthodox" seeds: that is, most seeds that follow some general "rules of thumb" regarding longevity during the storage life of the seeds. The relationship between temperature and seed longevity is that for each $10^{o}F$ ($5.6^{o}C$) decrease in temperature, longevity doubles (Harrington, 1972). This rule applies to seeds stored between temperatures of $32^{o}F$ ($0^{o}C$) and $122^{o}F$ ($50^{o}C$). In reality, the longevity of some vegetable species declines more rapidly than suggested by the rule.

Optimum range of moisture content of seed is 5 and 13 per cent at the time of storage. Above 13 per cent moisture content, seed storage fungi and increased heating due to respiration cause longevity to decline at a faster rate. Once seed moisture reaches 18 to

20 per cent, increased respiration, and the activity of microorganisms cause rapid deterioration of the seed. At 30 per cent moisture content, most non-dormant seeds germinate.

Equilibrium relative humidity is an important factor influencing seed moisture content as indicated by their sorption isotherms. Rapid and uniform emergence is an important component of the definition of seed vigour. The complete loss of ability to germinate is the ultimate result of seed deterioration. However, before that state is reached, various seeds in a population lose vigour at different rates. The majority of seeds come into equilibrium between their internal moisture content and the relative humidity of the atmosphere in which they are stored. As a general rule, the life of the seed is halved for each 1 per cent increase in moisture content of the seed. Generally, the rate of deterioration will be slow if the seeds are stored at lower relative humidity and temperature, but even so, it is almost hard to predict the accurate longevity of any particular batch of seeds when placed in storage.

Different varieties of a particular crop species may have different longevity when stored under the same conditions. This may be explained by differences in enzyme activity, or differences in the chemical constituents of unique varieties.

If the moisture content of the seed is high enough to support bacteria, the seed is more likely to succumb to deterioration due to other causes such as fungi, respiration, heating or premature sprouting. Most seed storage fungi are inhibited when the relative humidity is kept below 65 per cent. Therefore, if the seed is dried to 8% moisture content and the temperature reduced to 64 to 68^{o}F (18 to 20^{o}C), insects should not be a problem.

Agrawal (1980) observed that when seeds of pea, okra, carrot and onion were kept in cloth bag and stored under ambient conditions, the initial germination percentage was maintained in okra cultivar Pusa Sawani for 37 months, carrot cv. Pusa Kesar for 6 months and in onion cultivar Pusa Red for less than 4 months, and in pea for 18 months. Popovska *et al.* (1981) noticed that when pepper and tomato seeds stored under ambient conditions for seven years could retain the viability of 67.8 per cent and 89 per cent in glass bottle, whereas no germination was noticed in cloth bag at the end of storage. Dearman *et al.* (1986) showed that osmoprimed onion seeds, dried to 9 per cent moisture content and stored 18 months at 10°C, maintained high seed vigour and germination capacity. Jayaraj *et al.* (1987) reported higher seed germination in tomato (CO 3) seeds treated with thiram and captan and when packed in aluminium foil and stored for 18 months in tropical and temperate conditions as compared to cloth bag in subtropical conditions. Similarly, chilli (Co 2) and brinjal (PKM-1) seeds recorded higher seed germination when subjected to seed treatment with captan and thiram (2 g/kg seed) and packed in aluminium foil and stored for 12 months under three provenances *viz*., tropical, subtropical and temperate conditions as compared to cloth bag. Palanisamy and Vanangamudi (1987) stored the okra seed in different containers under ambient temperature of 29^{0}C and relative humidity of 89 per cent and could record highest germination in 700 guage polythene bags (80%) followed by thermocole and cloth bags.

Doijode (1989) stored the seeds of cluster bean with 7 per cent moisture content in polythene bag in the environment at 5^{0}C with 40 per cent RH and 16-35^{0}C with 25-90 per cent relative humidity have recorded per cent germination of 97 and 0 (zero), respectively after five years of storage. Currah and Msika (1994) reported that seeds

of onion stored in airtight jars under ambient condition retained higher vigour as compared to the seeds in paper packet. Pandey *et al.* (1994) reported that onion seed stored in cloth bag and polythene bag (750 guage) at room temperature maintained satisfactory germination as per the minimum seed certification standards (70%) up to 9 and 24 months, respectively. Ramanathan and Sivaprakasam (1994) noticed the highest germination and root length in length in chilli seeds stored for one year under ambient condition after treating with thiram @ 0.4 per cent. Devi and Selvaraj (1995) observed the highest mean germination (88.7 and 92.7%) with arappu leaf powder pelleting in ash gourd and ridge gourd, respectively throughout the storage period of ten months under ambient condition. De Silva and Peiris (1994) advised to store the well dried high quality cleaned seed in moisture resistant triple laminated aluminum foil packages or in 500 gauge polythene packages under cold room conditions (20^0C T, 65% RH) to preserve viability and vigour in chilli. If conditioned storage facilities are not available, storing seed in aluminum foil or in 500 gauge polythene packages was recommended with adequate drying, preferable up close to 6 per cent moisture content.

Doijode (1997a) reported that the tomato seeds could maintain viability up to four years when stored in polythene bags of 700 gauge under ambient temperature of 16-35°C as compared to sub-zero temperature of 2°C. Doijode (1997b) reported that long melon seeds could maintain its viability up to two years when stored in polythene bag of 700 gauge under ambient temperature as compared to sub-zero temperature storage. Doijode (1997c) reported that the okra seeds maintained its viability up to two years when stored in polythene bag of 700 gauge under ambient temperature as compared to storage under sub-zero temperature. Edwin *et al.* (1997) reported that the seeds of carrot, eggplant, onion, pepper and tomato could lose only, 4 per cent of viability as compared to initial germination when stored in sealed containers at 10^0C for 13 years. Sharma *et al.* (1998) reported that seed moisture remained 6 per cent in polythene bags throughout the storage period, whereas it changed in paper bag with changes in relative humidity and temperature of surrounding atmosphere. Thiagarajan (1999) recorded 73 per cent germination over storage period of 30 months of storage from 85 per cent and accounted eight per cent reduction in germination under ambient conditions of storage. Wet treatment with captan 75% wp at 2g+DDT 50% wp at 200 mg kg^{-1} of seed was found better than untreated seeds. Seed germination decreased with increase in storage, while electrical conductivity values increased with increase in storage period.

Doijode (2000) stored the seeds of winter squash at ambient (16-35^0 C), low (5^0C) and sub-zero (-20^0 C) temperature for five years and reported that high seed viability preserved for five year both at low (5^0 C) and sub-zero (20^0C) temperature. Seed storage either in polythene bags at 5^0C or in aluminium foil laminated pouches at -20^0C was effective in preserving high viability and vigour. Yanping *et al*. (2000) reported that the effect of storage temperature and moisture content on the vigour of welsh onion seeds. After two year storage, the seed quality declined as storage temperature and seed moisture content increased. Kumari *et al.* (2001) reported that onion seeds Cv. Hisar-2 recorded higher germination (71%) in aluminium lined bag (ALB) and stored for a period of 12 months in ambient conditions followed by aluminium lined poly bag (ALPB) and polythene bag (PEB) (77.1 and 72.1%, respectively) with eight months of storage

and maintained lower respiration rate at five per cent moisture content. While N-53 retained more germinability only up to four months in all the three containers viz., ALB, ALPB and PEB (89.2, 88.7 and 86.2% respectively) maintained at lower respiration rate at five per cent moisture content.

Amjad and Anium (2002) reported that effect of relative humidity and ageing period on the quality of onion seeds. Germination percentage and rate of germination were higher in seed lots stored for one or two years compared with those stored for three or four years. Although relative humidity of 75% is comparatively high temperature of 5°C was low enough to slow down the biochemical and physiological processes, which lead to seed deterioration. Nagaveni (2005) reported that the seeds stored under cold storage condition recorded higher germination, rate of germination, seedling dry weight, vigour index, field emergence, moisture content and lower electrical conductivity (74.1%, 17.86, 15.18 mg, 1038, 59.90%, 9.10% and 0.545 dSm^{-1}, respectively) compared to the seeds stored under ambient condition (50.5%, 11.96, 14.23 mg,641, 38.10%, 8.43%, 0.558 dSm^{-1}, respectively) at the end of 12 months of storage. Begum *et al.* (2005) evaluated the healthy, moderately and severely infected seeds obtained from local market for their storability for a year using different storage containers (cotton, polyethylene and paper bags) at varied temperatures and found that the moisture content play a key role in amplifying fungal biomass during storage period. Cotton bag at $28^{o}C$ appeared to be the best suited for long storage of seeds. Thus, stored seeds showed significant germination efficiency, seedling vigour without further deterioration of its biochemical constituents. With respect to fluctuation in moisture content cotton bags offer greater protection than that of polyethylene or paper bags. Padma and Reddy (2002) observed differences in retention of germinability of onion seeds Cv. N-53 at different moisture levels i.e., moisture pervious (7.15%) and moisture impervious containers (5.30%). The accelerated ageing test used in predicting storage potential of seed storage. Seeds stored in polythene bag and aluminium pouch extended the storage life by five to seven months respectively compared to seeds stored in cloth bag which retained germinability up to 14 months.

Rao *et al*. (2006) reported that medium term storage of onion seeds under tropical and sub-tropical conditions could be achieved upon desiccation of seeds to 6 ±1% seed moisture, hermetically sealed in moisture impervious containers and stored at 20–25°C. Kavitha (2007) reported that the chilli seeds stored under cold condition recorded better seed quality attributes and minimum quantitative losses throughout the storage period as compared to ambient condition.

Bhuiyan *et al.* (2009) studied the effect of temperature, relative humidity against different seed container of ridge gourd seeds on its moisture content and germination. The different containers are jute bag, impermeable poly bag and tin pot. Ridge gourd seeds were stored in tin pot, poly bag and jute bag with initial moisture of 12.8%, 13.6% and 14.4% respectively in ambient condition during storage period. The seeds of jute bag came into contact with air and their moisture content was increased from 14.4% to 17.0% within the storage period. But the increase of moisture content of seeds of tin pot and poly bag was not as high as the seeds of jute bag during the storage period. The germination capacity of ridge gourd seeds was found decreased with the time of storage. In case of jute bag, initial germination percentage was 45% which was higher than the seeds of poly bag. But at the second observation, germination

percentage was found decreased drastically to 35%. The germination capacity of tin pot was found higher than the seed of other containers and the results of germination percentage were 50%, 47%, 48%, 45% and 41% respectively in each observation. Khaldun and Ehsanul Haque (2009) studied the effect of temporal variation on the cucumber (*Cucumis sativus*) seed quality and reported that the maximum germination parentage was observed when moisture contents was 10.66 and 10.95 per cent, but slightly decreased when the moisture content attained at 11.03 and 11.08 per cent, respectively. The declination of germinability with high moisture content is related to the hygroscopic nature of seeds, especially under worm temperatures, which in turn is associated with the relative humidity of the surrounding air.

Abdullah *et al.* (2011) stored the seeds of four vegetable crops; carrot (*Daucus carota* L**.** cv Nantes 2-Tito), cucumber (*Cuucumis sativus* L. Cv Special), onion (*Alium cepa* L. cv Red Creole) and tomato (*Lycopersicon esculentum* Mill. Cv Tanshet Star) under a wide range of temperature (5, 15, 25 and 35°C) and relative humidity (RH)(11.3, 22.5, 32.5, 43.2, 58.4, 75.3 and 84.3%) conditions for various storage periods (1, 3, 6, 9 and 12 months). Seeds stored at 5°C had the highest SGP (Seed Germination Percentage) and GCV (Germination Coefficient of Velocity) but had the shortest MGT (Mean Germination Time). However, seeds stored at 35°C had the lowest SGP and GCV and the longest MGT. Relative humidity up to 58.4 per cent had no significant effect on SGP, while higher levels of relative humidity significantly lowered SGP and MGT. The highest relative humidity levels (75 and 84%) showed an obvious decrease in seed quality by lowering SGP and increasing MGT. Tomato and cucumber SGP were significantly higher than that of onion and carrot seeds. Cucumber seeds had significantly the shortest MGT and highest GCV, while carrot seeds had the longest MGT and lowest GCV than the other vegetable crops. These results emphasize the importance of storage temperature, relative humidity, choice of seed crop and storage period on the quality and germplasm conservation of vegetable seeds. Dorna *et al.* (2013) reported that for maximal seed viability and germination rate after 6 and 12 months storage, both hydro- and osmoprimed seeds should to be stored at 4°C rather than 20°C. Hydroprimed seeds seem to be less susceptible to higher storage temperature than osmoprimed seeds.

CONCLUSION

Storing the vegetable seeds in moisture vapor proof containers like polythene bag, aluminium foil or any sealed container is found more useful in maintaining the desired seed quality for longer period unlike non moisture proof containers like cloth bag. The declination of seed vigour and viability with high moisture content is related to the hygroscopic nature of seeds, especially under worm temperatures, which in turn is associated with the relative humidity of the surrounding air and seed vigour and viability decreased with increase in storage period.

Future line of work

1. Evaluate resistance of polythene and similar packaging material against moisture and relative humidity.
2. Classify vegetable seeds on the basis of their storability and seed coat integrity then after store seeds in containers.
3. Identify suitability and economy of High-density polyethylene (HDPE) bags for vegetable seed storage.
4. To know the effect of different seed containers on pathogenicity in vegetable seed storage.

REFERENCES

Abdul Baki, A. A. and Anderson, J. D. (1973). Physiological and biochemical deterioration of seed. In: Seed Biology (II Ed), Kozlowski, T. T., Academic Press, New York, London, pp. 283-315.

Abdullah, M. A.; Abdullah, A. A.; Khalil, S. O.; Wahb-Allah, M. A.; Nagar, M. E. and Ibrahim, A. A. (2011). Influence of storage conditions on seed quality and longevity of four vegetable crops. *American-Eurasian J. Agric. Environ. Sci*., **11** (3): 353-359.

Ader, F. (1978). Moisture content and storage conditions for pelleted vegetable and seed and their influence on germination and plant growth. *Seed Sci. Technol*., **6**: 1033-1051.

Agrawal, P. K. (1980). Relative storability of seeds of ten species under ambient conditions. *Seed Res.,* **8**: 94-99.

Aktaruzzaman, M.; Azad, M. O. K.; Shiton, K. R.; Akter, M. M. and Habiba, U. (2010). Effect of biotic and abiotic factors on quality of okra seed kept in different containers. *Bangladesh Res. Publi. J.*, **3**(3): 1012-1020.

Amjad, M. and Anjum, M. A. (2002). Effect of relative humidity and ageing period on the quality of onion seed. *Int. J. Agri. Biol*., **2**(4): 291-296.

Ankaiah, R.; Reddy, M. N. and Reddy, M. B. (2004). Effect of vapour proof containers on seed storability in onion. Aabstract: 27th ISTA Congress Seed Symposium, Budapest, Hungary. 60.

Bankole, S. A.; Ikotun, B. and Ekpo, E. J. (1999). Fungal deterioration of melon seeds stored in jute sacks and polyethylene bags in Ago-Iwoye, Southwestern Nigeria. *Mycopathologia*, **146**(3): 135-46.

Barua, H.; Rahman, M. M. and Masud, M. M. (2009). Effect of storage containers environment at different storage period on the quality of chilli seed. *Int. J. Sustain. Crop Prod.*, **4**(4): 28-32.

Basavaraj, B. O.; Biradar Patil, N. K.; Vyakarnahal, B. S.; Basavaraj, N.; Channappagoudar, B. B. and Hunje, R. (2008). Effect of fungicide and polymer film coating on storability of onion seeds. *Karnataka J. Agric. Sci.*, **21**(2): 212-218.

Baskin, C.; Delouche, J. C. and Cabrera, E. R. (1987). The influence of packaging materials, seed storability and performance of soybean. *Newsl. Assoc. Official Seed Analyst,* **61**: 15.

Begum, M.; Lokesh, S.; Ravishankar, R. V.; Shailaja, M. D.; Kumar, T. V. and Shetty, H. S. (2005). Evaluation of certain storage conditions for okra (*Abelmoschus esculentus* (L.) Moench) seeds against potential fungal pathogens. *Int. J. Agric. Biol.*, **7**(4): 550-554.

Bhuiyan, M. S. H.; Izaz A.; Kamrujjaman, M.; Ali, M. Y. and Miah, A. (2009). Effect of temperature, relative humidity against different seed container of ridge gourd seeds on its moisture content and germination. *Int. J. Sustainable Agril. Technol.*, **5**(7): 1-5.

Caneppele, M. A. B.; R. F. D. A.; Allvarenga, G. M.; Junior, C. J. H. and Cardoso, A. A. (1995). Influence of packaging, environment and storage period on seed quality in onion (*Allium cepa* L.). *Revista Brassileriade Sementes*, **17**: 249-257.

Currah, L. and Msika, L. (1994). Cheap methods of storing small quantities of onion seeds without refrigeration. *Onion Newsletter for the Tropics*, **6**: 61-62.

De Silva, S. G. R. and Peiris, B. D. N. (1994). Effect of packaging material on storability of chilli (*Capsicum*

annum L.) seed stored in Sri Lanka. *Trop. Agric. Res*., **6**: 23-30.

Dearman, J.; Bocklehurst, P. A. and Drew, L. K. (1986). Efect of osmotic priming and ageing on onion seed germination. *J. Appl. Biol*., **108**: 639-348.

Deepa, G. T.; Chetti, M. B.; Khetagoudar, M. C. and Adavirao, G. M. (2013). Influence of vacuum packaging on seed quality and mineral contents in chilli (*Capsicum annuum* L.). *J. Food Sci. Technol.*, **50**(1): 153–158.

Devi, J. R. and Selvaraj, J. A. (1995). Seed pelleting and soil types on germination and vigour of seeds in ash gourd and ribbed gourd. *Madras Agril. J.,* **82**(2): 75-77.

Dhellot, J. R.; Matouba, E.; Maloumbi, M. G.; Nzikou, J. M.; Safou-Ngoma, D. G.; Linder, M.; Desobry, S. and Parmentier, M. (2006). Extraction, chemical composition and Nutritional characterization of vegetable oils: Case of *Amaranthushybridus*(Var 1 and 2) of Congo Brazzaville. *African J. Biotech.*, **5**(11): 1095-1101.

Doijode, S. D. (1988a). Effect of storage environment on brinjal (*Sorghum melongena*) seed viability. *PogressiveHorti*., **20**: 292-293.

Doijode, S. D. (1988b), Studies on partial vacuum storage of onion and bell pepper seeds. *Veg. Sci*., **15**: 126-129.

Doijode, S. D. (1988c). Comparison of storage of french bean seeds under ambient conditions. *Seed Res*., **16**: 245-247.

Doijode, S. D. (1989). Deteriorative changes in cluster bean seeds stored in different conditions. *Veg. Sci*., **16**: 89-92.

Doijode, S. D. (1995). Effect of silica gel and storage containers on viability and vigour in onion. *Seed Res*., **18**: 163-165.

Doijode, S. D. (1997a). Effect of storage temperature and packaging on longevity of tomato seeds. *Veg. Sci*., **24**(1): 70-72.

Doijode, S. D. (1997b). Effect of storage temperature and packaging on seed quality in long melon (*Cucumis melo* var. utilissimus). *Veg. Sci.*, **24**: 87-90.

Doijode, S. D. (1997c). Effect of packaging and temperature on seed longevity in okra. *Veg. Sci*., **24**(1): 67-69.

Doijode, S. D. (2000). Seed viability and biochemical changes during storage of winter squash *(Cucurbita maxima* Duch.) seeds. *Veg. Sci.,* **27**(2): 168-171.

Dorna,H.; Jarosz, M.; Szopińska, D.; Szulc, I. and Rosińska, A. (2013). Germination, vigour and health of primed *Allium cepa* L. seeds after storage. *Acta Sci. Pol., Hortorum Cultus*, **12**(4): 43-58.

Edwin, J.; Bass, L. N. and Dorris Clark, C. (1997). Longevity of vegetable seeds stored for 15 to 30 years at Cheyenne, Wyoming. *American Soc. Horticultural Sci*., **84**: 527-534.

Ellis, R. H. and Roberts, E. H. (1981. The quantification of ageing and survival in orthodox seeds. *Seed Sci. Technol*., **9**: 373-409.

Fabunmi, O. A. (2009). Effects of packaging materials and storage temperature on quality of fresh okra (*Abelmoschus esculentus*) fruit. *Agricultura Tropica Et Subtropica*, **42**(4): 151–156.

Fayemi, P. O. (1999). Nigerian Vegetables, 1st Edition, Heinemann Educational Books Nigeria, pp. 1-8.

Fischer, I. (1980). Studies on storage condition affecting the germination capacity of *Capsicum* seeds. *Vizsgalata Zoldsegtermesztesi Kutato Intezet Bulletinje*, **14**: 13-20.

Fischer, I. (1994). Sweet pepper gene conservation in long term storage.

Zoldesegtermesztesi Kutato Intezet Bulletinje, **26**: 47-54.

Garg, M. K. and Chandra, P. (2005). Effect of packaging material and storage place on storability of seeds - A simulation study. *Seed Res.,* **33**(1): 57-60.

Ghimire, S. P. (2003). Influence of locations, storage periods and packaging materials on storability of onion (*Allium cepa* L.) and okra (*Abelmoschos esculentus* L. Moench) seeds. M. Sc Thesis, Department of Horticulture, IAAS, Rampur, Chitwan, Nepal. pp. 87.

Gouda, V. M.; Vasudevan, S. N.; Kurdikeri, M. B.; Basavaraj, N. and Channappagoudar, B. B. (2008). Influence of seed pelleting on storability of onion (*Allium cepa* L.) seeds. *Karnataka J. Agric. Sci.,* **21**(2): 206-211.

Gupta, A.; Singh, D. and Maheshwari, V. K. (1992). Effect of containers on the viability of fungicide treated chilli seeds. *Seed Res.*, **20**(2): 160-161.

Harrington, J. F. (1972). Seed Storage and Longevity, In: Seed Biology, Vol. III. (ed. Kozlowski, T. T.). Academic. New York. p. 145-245.

Harrington, J. F. (1973). Biochemical basis of seed longevity. Seed Sci. Technol., 1: 453-461.

Hassan, L. G.; Umar, K. J. and Tijjani, A. A. (2007). Preliminary Investigation on the feed quality of Monechmacilition Seeds. *Chem. Class J*., **4**: 83.

Horky, J. (1988). Long term storage of vegetable seeds at room temperature in different wrapping materials. *Sbornik, Zabradnictivi*, **15**: 257-269.

Huda, M. N. (2001). Why quality seed? Reality & Vision, Bangladesh Context. Bangladesh-German Seed Development Project, Dhaka, Bangladesh. p. 90.

Hunje, R. V. (2002). Studies on seed production and post-harvest technique in chilli (*Capsicum annum* L.). Ph.D. Thesis (unpublished) submitted to University of Agricultural Sciences, Dharwad.

Ilic, Z. (1995). Possibility of long term storage of seed pepper. *Selekcijai. Semenavstvo*, **2**: 209-211.

Jagadish, G. V.; Prasanna, K. P. R. and Ranganathaiah, K. G. (1994). Influence of storage conditions and containers on seed storability in onion (*Allium cepa* L.). *Seed Tech. News*, **24**: 15.

Jayaraj, T.; Vadivelu, K. K. and Dharmalingam, C. (1987). Effect of seed treatments and containers on vegetable seed storage under different agro-climatic conditions. *South Indian Hort*., **36**(3): 183-187.

Joshi, A. K.; Kumari, Chameli; Pathania, Nandita; Sharma, S. K. andVerma, S. C. (2007). Effect of indigenous and modern packaging materials, temperature and dressers on onion (*Allium cepa*L.). *Acta Hort.,* **752**:553-556.

Judith, T. M.; Oburi, N. W.; Emmanuel, Y. and Godswill, N. N. (2015). Influence of conditioning and storage materials on the germination potential of pumpkin (*Cucurbita* spp.) seeds. *Int. J. Curr. Res. Biosci. Plant Biol.,* **2**(4): 65-75.

Kandil, A. A. and Sharief, A. E. (2011). The impact of storage packages and storage periods on onion (*Allium cepa*, L,) seed viability. *J. Plant Prod. Mansoura Univ.,* **2**(3): 385-391.

Karim, M. R.; Rahim, M. A.; Fakir, G. A. and Anwar, H. R. M. M. (2006). Effect of storage containers, moisture contents and storage conditions on seed health of onion. *Int. J.*

Sustainable Agril. Technol., **2**(6): 9-13.

Kavitha M. (2007). Seed quality enhancement and storability studies in chilli (*Capsicum annuum*L.). M.Sc. (Agri.). Thesis (Unpublished) Submitted to University of Agricultural Sciences, Dharwad.

Khaldun, A. B. M. and Ehsanul Haque, M. D. (2009). Seed quality deterioration due to temporal variation of biotic and abiotic factors in cucumber. *Bangladesh J. Agril. Res.*, **34**(3): 457-463.

Khalequzzaman, K. M.; Rashid, M. M.; Hasan, M. A. and Reza, M. M. A. (2012). Effect of storage containers and storage periods on the seed quality of french bean (*Phaseolus vulgaris*). *Bangladesh J. Agril. Res.*, **37**(2): 195-205.

Krishnan, P.; Nagarajan, S. and Mohari, A. V. (2004). Thermodynamic characteristics of seed deterioration during storage under accelerate ageing conditions. *Biosyst. Eng.*, **89**(4): 425-433.

Kumari, P. S.; Kumar, A.; Tadava, T. P.; Banerjee, M. K. and Dahiya, O. S. (2001_. Efficacy of various containers in maintaining seed quality of onion (*Allium cepa* I.). *Agric. Res. New Series*, **22**(2) : 171-176.

Malimath, S. D. and Merwade, M. N. (2006). Effect of storage containers on seed storability of garden pea (*Pisum sativum* L.). *Karnataka J. Agric. Sci.*, **20**(2): 384-385.

Manjunatha S. N.; Ravi Hunje, N. K., Vyakaranahal, B. S. and Kalappanavar, I. K. (2008). Effect of seed coating with polymer, fungicide and containers on seed quality of chilli during storage. *Karnataka J. of Agric. Sci.*, **21**(2): 270-273.

Miyagi, K. (1966). Effect of moisture proof packing on maintenance of viability of vegetable seeds. *Proceedings of International Seed Testing Association*, **31**: 213-220.

Mollah, M. R. A.; Ali, M. A.; Prodhan, M. Z. H.; Rahman, M. M. and Alam, M. J. (2016). Effect of containers on storability of true seeds of onion. *European J. Biometri. Pharmaceutical Sci.*, **3**(1): 1-4.

Murata, M.; Ross, E. E. and Tsuchiya, T. (1984). Chromosomal damage induced by artificial seed aging in barley. III. Behavior of chromosomal aberration during plant growth. *Theor. Appl. Genet.*, **67**: 161-170.

Nagaveni, P. K. (2005). Effect of storage conditions, packing material and seed treatment on viability and vigour of onion seeds. Ph.D. Thesis (unpublished) submitte to University of Agricultural Sciences, Dharwad.

Nataraj, K. and Jayaramegowda. (2017). Effects of packaging materials and seed treatments chemicals on seed quality attribute in vegetable soybean during storage. *Int. J. Curr. Microbiol*. App. Sci., **6**(5): 1609-1614.

Oke, L. O. and Ojofehintimi, O. (1988). *Nutrition for Nurses*, Tropical, 2nd Ed., Health Series, London Group Ltd, Pp: 91-92.

Oyenuga, V. A. and Fetuga, B. L. (1975). First National Seminar on Fruits and Vegetables. *In: Proc. and Recom. & Papers by NIHORT*, Ibadan.

Padma, V. and Reddy, M. B. (2002). Storage of brinjal seed under ambient conditions at two moisture levels. *J. Res. ANGRAU*, **30**(2): 6-10.

Pandey, U. B.; Gupta, R. P. and Srivastava, P. K. (1994). Onion seed viability and vigour influenced by time of drying and packing. *Seed Tech. News*, **24**: 103.

Patil, R. B. and Shelar, V. R. (1993). Storability of vegetable seeds in different containers. *Maharashtra J. Hort.*, **7**: 70-74.

Palanisamy, V. and Vanangamudi, K. (1987). Viability of okra seeds in storage. *Seed Res*., **15**: 221-222.

Pillayarsamy, K., Sivaprakasam, K. and Subbaraj, K. T. (1973). Effect of fungicides on the viability of chilli seeds. *Madras Agril. J.,* **60**: 618.

Popovska, H. P.; Mladenovski, L. T. and Minatlouski, M. (1981). The influence of packaging over germination of pepper and tomato seeds. *Acta Hort*., **111**: 284-290.

Quais, M. K.; Jahan, S.; Haque, M. M. and Khan, M. R. (2013). Variation in seed quality of radish preserved in different storage containers. *Bangladesh J. Agril. Res.,* **38**(3): 545-552.

Ramanathan, A. and Sivaprakasam, K. (1994). Effect of seed treatment with antagonists and fungicides on seed viability and seedling vigour of chilli. *Seed Res.*, **20**(2): 134-137.

Rao, R. G. S.; Singh, P. M. and Mathura Rai. (2006). Storability of onion seeds and effects of packaging and storage conditions on viability and vigour. *Scientia Hort.*, **110**:1–6.

Robinson, D. S. (1990). Food Biochemistry and Nutritional Value. Longman Scientific and Technical Publisher, New York. USA. 52- 58.

Sahee, P.; Kar, D. K.; Das, B. C. and Das, S. K. (1994). Influence of initial moisture level of storability of tomato seeds. *Seed Tech News*, **24**: 27.

Satishkumar; Basavegowda and Sharnkumar (2014). Effect of seed pelleting chemicals and storage containers on storability of brinjal (*Solanum melongena* L.). *Int. J. Plant Sci.,* **9**(1): 173-179.

Saxena, O. P. (1994). Physiological and biochemical changes in relation to storage in some crop seeds. *Seed Tech News*, **29**: 24.

Saxena, O. P.; Singh, G.; Pakeeraiah, H. and Pandey, N. (1987). Seed deterioration studies in some vegetable seeds. *Acta Hort*., **215**: 39-44.

Sharanamma, B. (2002). Effect of provenance, seed treatment and containers on storability of chilli (*Capsicum annuum* L.) seeds. M.Sc. (Ag.) Thesis (unpublished) submitted to University of Agricultural Sciences, Dharwad, Karnataka, India.

Sharma, S. N.; Goyal, K. C. and Kakarlya, B. L. (1998). Chilli seed storage in relation to variety and container. *Seed Res*., **26**: 83-86.

Shashibhaskar, M. S.; Vasudevan, S. N.; Kurdikeri, M. B.; Ravikumar, R. L. and Basavaraj, N. (2008). Influence of seed pelleting on storability of tomato (*Lycopersicon esculentum* Mill.). *Karnataka J. Agric. Sci.*, **22**(5): 1097-1103.

Shelar, V. R.; Patil, R. B. and Gawade, N. D. (1992). Onion seed viability influenced by different storage containers. *Onion Newsletter for the Tropics*, **4**: 39-42.

Shindha, S. S. and Spatkki, R. S. (1986. The storage of seed for the maintenance of viability. *Hort. Sci.,* **7**(4): 170-175.

Singh, G. and Singh, H. (1992). Maintenance of germinability of soybean (*Glycine max* L.) seeds. *Seed Res.*, **20**: 49-50.

Srinivasan, J.; Vijayakumar, A. and Srimathi, P. (2017). Influence of seed treatment, storage containers and storage periods on storability of the female parent of tomato COTH 2. *Int. J. Sci. Nature*, 8(1): 143-148.

Stumpf, C. L.; Peske, S. T. and Bavdet, S. (1997). Storage potential of onion

seeds hermetically packaged at low moisture content. *Seed Sci. Technol*., **25**(1): 25-23.

Thiagarajan, C. P. (1999. Storability of chilli (*Capsicum annum* L.) seed. *Madras Agric. J.,* **81**(8): 442-445.

Tripathi, P. C. and Lawande, K. E. (2014). Effect of seed moisture and packing material on viability and vigour of onion seed. *J. Engi., Comput. Appl. Sci.,* **3**(7):1-3.

Vanagamudi, K.; Karivaratharaju, T. V. and Ramakrishnan, V. (1986). Seed storage studies in field bean (*Lablab purpurens* L.). sweet variety. *Newspaper Assoc. Official Seed Analysts*, **60**: 78-85.

Verma, O. P.; Jaliswal, R. C., Kiran Singh, H. and Gautam, N. C. (1991). Influence of storage conditions on the longevity of tomato and cauliflower seed. *Veg. Sci.,* **18**: 88-92.

Vijaykumar, A.; Palanisamy, V.; Jayaraj and Arumugam, R. (1991). Effect of seed treatments and containers on the storability of onion seed. *South Indian J. Hort.,* **39**: 296-299.

Yanping, Y.; Ronggi, G.; Qingguan, S. and Shengfu, L. (2000). Vigour of welsh onion seeds in relation to storage temperature and seed moisture content. *Seed Sci. & Technol*., **28**: 817-823.

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