GERMINATION, VIGOR AND SEEDLING ATTRIBUTES OF WHEAT VARIETIES AS INFLUENCED BY FERTILIZER SOURCES AND STORAGE CONTAINER

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BY

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CERTIFICATE

This is to certify that the thesis entitled, **'Germination, Vigor and Seedling Attributes of Wheat Varieties As Influenced By Fertilizer Sources and Storage Container'** submitted to the Institute of Seed Technology, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of **Master of Science in Seed Technology,** embodies the result of a piece of bona fide research work carried out by **Mir Istiak Ahmed Rokib,** Registration number: 12-05009 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has duly been acknowledged.

Dated: June, 2018
Dhaka, Bangladesh

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Dedicated

To

My Beloved Parents

ABBREVIATIONS

Elaborated Form		Abbreviated Form
Agro Ecological Zone	=	AEZ
And others (Co-workers)	=	*et al.*
Day After Storage	=	DAS
Centimeter	=	cm
Coefficient of Variation	=	CV
Degree centigrade	=	^{o}C
Degree of freedom	=	df
Example	=	viz.
Genetically Modified	=	GM
Least significant difference	=	LSD
Million tons	=	mt
Nitrogen	=	N
Non-significant	=	NS
Per Hectare	=	ha^{-1}
Percentage	=	%
Phosphorus	=	P
Potassium	=	K
Completely Randomized Design	=	CRD
Relative humidity	=	RH
Standard Week	=	SW

Elaborated Form		Abbreviated Form
Sher-e-Bangla Agricultural University	=	SAU
Standard Error	=	SE
that is	=	i.e.
tons	=	t

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The Author

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ABSTRACT

The experiment was conducted at the laboratory condition of Agronomy Department of Sher-e-Bangla Agricultural University (SAU), Dhaka during the period from April to November 2018 to evaluate the aftermath effect of variety and fertilization on the germination and seedling attributes of the seed stored under different storage containers. The seeds were collected from a previously implemented experiment having different fertilizer levels and wheat varieties. And as such the experiment comprised three factors viz. factor A: storage containers (three containers) like Tin container, Plastic pot and Polythene; factor B: seven fertilizer sources during crop production from where seeds were stored such as recommended dose, poultry manure + 25% recommended dose, poultry manure + 50% recommended dose, poultry manure + 75% recommended dose, compost + 25% recommended dose, compost + 50% recommended dose, compost + 75% recommended dose; and Factor C wheat varieties (BARI Gom 29, BARI Gom 30). The experiment was laid out in a Completely Randomized Design (CRD) with three replications. The result revealed that tin container showed the highest germination percentage, shoot length, root length and seedling dry weight at 60, 120 and 180 DAS (days after storage). Lowest quality performance was observed from polythene. BARI Gom 30 showed the higher quality performance in respect of the germination percentage, shoot and root length, seedling dry weight. Among the fertilizer levels, poultry manure applied at recommended dose showed the best performance in all the cases.

CHAPTER I

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important winter crops and is temperature sensitive and the second most important grain crop after rice in Bangladesh. In this country, it is cultivated over an area of 4, 15,339 hectares with an annual production of 13, 11,473 metric tons and average yield of 3.158 mt/ha (BBS 2017). Rice and wheat are the principal sources of food, calorie, and protein intake for most of the people of Bangladesh.

Once wheat was a food for the poorer people in Bangladesh. Most of the people used to take wheat as ‘Chapati’ (locally known as ruti). The dietary habit of people of Bangladesh has changed to a considerable extent during the past decade (Karim *et al.* 2010). Wheat has now become an indispensable food item of the people of Bangladesh and it continues to fill the food gap caused by possible failure of rice crop. Wheat cultivation is easier and requires less time and irrigation than other alternative crops like Boro rice, legumes, and potatoes; additionally, it has low cultivation costs (Nabila *et al*. 2016).

In addition to being a major source of starch and energy, wheat also provides substantial amounts of a number of components which are essential or beneficial for health like protein, vitamins (notably B vitamins), dietary fiber, and phytochemicals. Of these, wheat is a particularly important source of dietary fiber, with bread alone providing 20% of the daily intake in some countries, and well-established relationships between the consumption of cereal dietary fiber and reduced risk of cardio-vascular disease, type 2 diabetes, and forms of cancer (notably colo-rectal cancer). Wheat shows high variability in the contents and compositions of beneficial components, with some (including dietary fiber) showing high heritability (Shewry and Hey 2015).

Losses of wheat due to inadequate storage and other post-harvest factors at the farm, village and commercial levels of up to 4 percent have been observed (Abdullahi and Haile 1991, McFarlane 1989), though losses in excess of 40 percent for other cereals are not uncommon (NRC 1996). Deterioration of stored grain is influenced by physical (temperature, humidity), biological (microflora, arthropod, vertebrate) and technical (storage conditions, methods and duration) factors. Experience has shown that such losses are not easily reduced in the absence of well-integrated policies and plans to develop the total system of production, marketing, storage and distribution (Tyler and Boxall 1984).

Seed characteristics are usually essential attributes in seedling establishment and plant development to obtain seedling numbers resulting in higher seed crop (Almansouri *et al*. 2001). Seed germination is the first critical stage in any plant life cycle and determines the optimal plant density, crop uniformity and management options. Certain quantities of seeds remain unsold every year and are kept at various storage conditions. Environmental temperature, relative humidity, gas composition of air and pathogenic microorganisms are the most important factors influencing seed viability and longevity during the storage period. Interdependence of these four factors during seed storage and their subsequent effect on germination have been recognized for different regions (Strelec *et al.* 2010, Al-Yahya 2001)

Seed deterioration occurs during storage, leading to reduction of vigor, germination percent, and decreasing seedling growth rate. Temperature and moisture content are the important factors, which influence the viability of seeds during storage (Roberts 1972). In most cases, it has been shown that reducing the temperature of the warehouse and the moisture content of the seeds led to increasing the period of viability. Seed viability and vigor decreased with prolonging storage period. Electrical conductance of seed leachates also increased with storage under unfavorable conditions. Packaging container and storage duration significantly affected viability and seedling vigor (Rao *et al.* 2006). Seeds must be properly stored in order to maintain an acceptable level of germination and vigor until the time of planting. The storage period may vary from as little as 6 months, if the seeds are to be planted the next season, or longer if the seeds are to be carried over for one or more seasons. It was noticed that during storage, the seed quality can remain at the initial level for short period and started to decline to a level that may make the seed unacceptable for planting purposes, (El- Borai *et al.* 1993).

Seed of most species may be safely stored for several years by careful control of temperature and relative humidity. Although such conditions require high cost for most agricultural seed lots, they may be extremely valuable for preserving germplasm ad certain high value seed stocks. In some parts of the world, especially in the tropics conditioned storage is necessary in order to maintain high viability of some seeds from harvest to planting (Hurrington 1973). Proper storage minimizes the rate of deterioration and prolongs the first phase, in which relatively little loss of viability occurs.

In Bangladesh, only 15-20% of the total quantity of wheat seed required for planting is supplied by Bangladesh Agricultural Development Corporation (BADC) and other seed producing agencies, where large seed godowns with moderate cooling and periodic drying facilities are available. The rest 80-85% of the total requirement of wheat seed is usually met up through farmer to farmer exchange of seeds stored in different kinds of small to medium sized containers kept at room temperatures. Although considerable research works have been done on various aspects of storage management of wheat and useful findings were obtained, the information on its storage behavior, impact of the crop’s management conditions such as varietal selection and fertilization on seed quality and seeding attributes are limited in the country (Islam and Fakir 1988, Rahman *et al.* 1985).

Considering the above mentioned situation, the present study was therefore, undertaken with the following objectives-

1. To assess the effect of variety on different seed and seedling attributes of wheat.
2. To evaluate the impact of different fertilizer levels on seed and seedling attributes of the produced seeds which were stored under different storage containers.
3. To assess the effect of different storage containers on seed viability, vigor and germination percentage wheat seeds.
4. To assess the interaction effect of storage containers, variety and varying fertilizer doses on seed and seedling attributes of wheat.

CHAPTER II

REVIEW OF LITERATURE

An attempt has been made to bring out review relating to the "Germination, vigor and seedling attributes of wheat varieties as influenced by fertilizer sources and storage container." A brief resume of the work done in the past by various workers given in this chapter.

2.1. Taxonomic position of wheat

Domain: Eukaryota

Kingdom: Plantae

Phylum: Spermatophyta

Subphylum: Angiospermae

Class: Monocotyledonae

Order: Cyperales

Family: Poaceae

Genus: Triticum

2.2. Biology of wheat

Triticum is a genus of the family Graminae (Poaceae) commonly known as the grass family. Of the cultivated wheats, common wheat, *T. aestivum*, is economically by far the most important.

T. aestivum L. as described by Lersten (1987), is a mid-tall annual or winter annual grass with flat leaf blades and a terminal floral spike consisting of perfect flowers. The vegetative state of the plant is characterized by tillers bearing axillary leafy culms. Culms comprise five to seven nodes with three to four foliage leaves. The uppermost, or flag leaf, subtends the inflorescence. Each culm produces an inflorescence or composite spike, the basic unit of which is termed the spikelet. Spikelets are born on a main axis, or rachis, and are separated by short internodes. Each spikelet is a condensed reproductive shoot consisting of two subtending sterile bracts or glumes. The glumes enclose two to five florets which are born on a short axis, or rachilla. Wheat florets contain three stamens with large anthers and the pistil which comprises a single ovary, with a single ovule, two styles, and two branching plumose stigmas at the end of each style.

T. aestivum L. is hexaploid (AABBDD) with a total of 42 chromosomes (2n=42, six times seven chromosomes). Similarly, the different wheat species also contain some multiple of the basic haploid set of seven chromosomes. Modern wheat cultivars are either tetraploid (durum, AABB) or hexaploid (common and club-types, AABBDD).

Wheat probably derived from a wild form of diploid einkorn (*T. monococcum sensu lato*) in an area that bordered the countries of Iran, Iraq, Syria, and Turkey (Feldman, 1976). Tetraploid species evolved first through a combination of hybridization and amphidiploidy between *T. monococcum* and *T. searsii*, where *T. monococcum* is the source of the "A" genome and *T. searsii* the source of the "B" genome. The result was the tetraploid *T. turgidum* (AABB) which later was domesticated as emmer wheat and gave rise to the modern durum wheat cultivars. Hexaploid cultivars originated through a cross between tetraploid *T. turgidum* and *T. tauschii* (source of the "D" genome). Following an amphidiploidy event, a new species, *T. aestivum*, arose with a genome complement of AABBDD.

The cultivation of wheat began with wild einkorn and emmer (Cook and Veseth 1991). The earliest plant breeding efforts with these wheats probably gave rise to plants with heads that did not shatter to facilitate harvest. Also, hull-less types were selected by early farmers for ease of threshing. In terms of plant adaptation, hexaploid wheat cultivation was adapted to cool climates due to the contribution of winter hardiness traits present on the "D" genome. Wheat plants were further adapted for cultivation in different environments via flowering behaviour.

Spring wheat is planted in locations with severe winters and flowers in the same year yielding grain in about 90 days. Winter wheat is grown in locations with less severe winters. Winter wheat will only head after it has received a cold treatment (vernalization) and is therefore planted in the fall and harvested in the spring of the following year. Wheat varieties were adapted for cultivation in dry climates through the introduction of dwarf traits resulting in small plants that required less water yet produced good grain yield. Modern wheat cultivars have been developed to resist various diseases such as rusts and smuts. In addition to disease resistance, wheat breeding also focuses on increasing overall grain yield as well as grain quality (protein and starch).

2.3. Wheat production in Bangladesh: history and present scenario

Immediately after independence in 1971, a series of disastrous harvests (attributable largely to unfavourable weather) led to widespread food shortages in Bangladesh. This forced the government to appeal to the international community for emergency relief assistance. Massive imports of cereals, edible oils and dairy products became a regular feature of the economy, and Bangladesh developed a reputation as one of the world's most impoverished nations (IFPRI 1997). From March to December 1974, Bangladesh faced an acute food shortage as the price of rice increased sharply in the world market (OECD-FAO 2009) and production decreased (Alamgir 1980). World rice prices increased sharply from 1971 to 1975, resulting in food shortages in Bangladesh (OECD 2008).

Rice production declined (Index Mundi 2012a) because of disruptions to virtually all agricultural activities during the War of Liberation in 1971 and various natural disasters, such as floods, droughts, cyclones and rapid population growth (Hugo 2006). At that time, it was realized that rice alone could not meet the food requirements of the country (Banglapedia 2006). Wheat was therefore chosen as an alternative winter food crop. Two Mexican varieties ('Sonora 64' and 'Penjamo 62') were tested first in the northern part of Bangladesh in 1965 (BARI 2010). Their spectacular performance encouraged scientists to introduce wheat more generally to this part of the country. By the time of independence, Bangladesh had become highly dependent on wheat imports while dietary preferences were changing such that wheat was becoming a highly desirable food supplement to rice.

In the first half of the 1980s, domestic wheat production rose to more than 1 million tons year^{-1}, but was still only 7-9 % of total food grain production (BARI 2010). About half of wheat was grown on irrigated land and the proportion of land devoted to wheat remained essentially unchanged between 1980 and 1986, at a little less than 6 % of the total planted area (Index Mundi 2012b). Wheat also accounted for the greatest bulk of imported food grains, exceeding 1 million tons annually and rising above 1.8 million tons in 1984, 1985 and 1987 (Index Mundi 2012b). The great bulk of wheat importation is financed under aid programmes of the USA, the European Union and the World Food Programme (Index Mundi 2012b). A 3-year (2008–09 to 2010–11) examination by O'Brien (2011) indicated that Bangladesh imported 3.1 million metric tons of wheat each year to ensure local demand.

Initially, 4000 tons of 'Sonalika' and 'Kalyansona' seeds were imported from India in 1975 and distributed to farmers (BARI 2010). Prior to 1975–76, wheat was grown sporadically and was almost an unknown crop in Bangladesh (Banglapedia 2006). Between 1970-71 and 1980-81, the cropped area under wheat jumped from 0.126 million ha to 0.591 million ha and production rose 10-fold from 0.11 million tons to 1.07 million tons, a 24.93 % annual mean growth rate (BARI 2010). Among the cereals, wheat is second to rice in economic and consumption importance. It occupies ~4 % of the total cropped area and 11 % of the area cropped in rabi (winter crops starting from November to February), and contributes 7 % to the total output of food cereals.

The cultivation of wheat in Bangladesh has been decreased this year in relation to previous year. DAE discouraged to cultivate wheat the farmers of south-west districts due to blast disease at last year. This discouraging program of government agency is to consider as main reasons of decreased area of wheat. In 2017, the total area under wheat crop has been estimated 10, 26,343 acres (4, 15,339 hectares) compared to 10, 99,158 acres (4, 44,805 hectares) of the last year. The weather condition was favourable during sowing period in the survey year 2016-17. Average yield rate of wheat has been estimated 34.23 maunds per acre (3.158 metric tons per hectare) which is 4.19% higher than that of last year. Total production of wheat has been estimated 13, 11,473 metric tons compared to 13, 48,186 metric tons of the last year, which is 0.2.72% lower (BBS 2017).

2.4. Storage of orthodox seed

Orthodox seeds are seeds which will survive drying and/or freezing during ex-situ conservation (Walters and Towill 2004). Where basic processing and storage facilities are available, orthodox seeds are generally easy to store. Most orthodox seeds will maintain high viability under ambient temperature conditions, at least from harvest to the first subsequent seeding season, if the seeds have been thoroughly dried before storage and are stored away from insects. Many orthodox seeds have maintained viability under these conditions for several years. Often improved storage conditions are required for long-term storage and storage of more sensitive orthodox seed. Where temperature and humidity are controlled. It should be noted that it has been shown that several species previously considered short-lived or recalcitrant have extended viability. A group of species which can he dried to a moisture content low enough to qualify as orthodox, but are sensitive to low temperatures typical for orthodox seeds has recently been termed 'intermediate' (Ellis *et al*. 1990). Although most non-hard coated orthodox seeds easily deteriorate under natural conditions, they have long storage potential and can often maintain viability for many years when stored under optimal conditions (Willan 1985).

2.5. Storage of recalcitrant and intermediate seeds

Recalcitrant seeds (subsequently known as unorthodox seeds) are seeds that do not survive drying and freezing during ex-situ conservation and vice versa (Marcos-Filho 2014). Although the group is very diverse, there are a number of common features of species with recalcitrant or intermediate seed that justify discussing their group storage. The storage behaviour ranges from some mangrove species extremely recalcitrant and viviparous seeds to at least some desiccation tolerant seeds. Desiccation sensitive indicated that for some extremely recalcitrant species, the lowest safe moisture content is 60-70% and for some intermediate species, 12-14%. Sensitive to chilling revealed that injury is dependent on species, moisture content and possible chilling time. Lot sensitive species chilling injury may occur below 20°C. Some species are tolerant of low temperatures (2-5°C). It seems, at least to some degree, to be restricted to intact seeds: cryopreservation of excised embryos of recalcitrant seeds has shown that several species-maintained viabilities at ultra-low temperatures (Krishnapillay and Engelmann 1996). Metabolic active means partially connected to the high content of moisture when trying to shed the feature. No dormancy referred germination processes begin soon after shedding, and in certain cases the process of maturing is a direct continuation.

The fragile idea of recalcitrant seeds to a great extent restrains the control of capacity conditions and makes the potential for capacity restricted even under the best conditions. In light of the thin scope of ecological conditions in which seeds stay quiet, for example without germination and without fast crumbling, the requests on capacity conditions are regularly more burdensome than those for universal seeds. Seed must be put away inside a thin scope of dampness and temperature conditions.

Albeit some advancement has been made particularly for transient storage. furthermore, for less unmanageable and moderate species, the fundamental component of the executives of recalcitrant seeds is to downplay capacity period. The general wants to lessen capacity by a rapid conveyance from handling to nursery turns into an absolute necessity for these seed. Be that as it may where capacity can't be evaded, capacity conditions must be painstakingly adjusted between lessening digestion by diminishing temperature and dampness substance, without hampering reasonability by too exceptional a decline in these components. Storage conditions should basically aim at the following (King and Roberts, 1979): prevent desiccation; control microbial contamination: prevent germination and maintain adequate oxygen supply.

2.6. Storage container for seeds

Considerable research on the effect of storage conditions on the viability of seeds of a variety of species including legumes, vegetables and cereals has been published. Although the storability of seeds is influenced by many factors. It is generally accepted that by controlling the storage environment, storability can be improved. (Lewis *et al.* 1998). 'Safe' storage conditions were defined as those which maintain seed quality without loss of vigour for three years. Delouche *et al.* (1973) observed that such safe situations are indeed beneficial, but not always financially justified, as they do not occur naturally, apart from small amounts of biologically valuable seed or very expensive vegetable, ornamental or forest seed. (Abba and Lovato 1999). The duration of storage of grass seed without significant germination reduction depends a lot on the species and storage condition.

2.7. Effect of storage condition on seed quality

There is an impact of storage site, packing material, storage length and type of seed on storage viability and the decision of packaging material in a given atmospheric condition would depend on seed type and storage duration (Garg and Chandra

2005). Bass and Clark (1975) speculated that foil - containing materials actually provided excellent protection against moisture and germination. In an experiment to study the viability range, Nizersail and BR 11 rice seeds grown during the Aman season were dried to 12% moisture and then stored in polyethylene tubes, closed metal ware and gunny bags. In the case of Nizersail seed, germination proportion was equally high in the three containers for up to 300 days of storage. But the germination fraction stayed high at this stage in BR 11 seeds stored in sealed polyethylene tubes, but seeds deposited in metal ware and gunny bags lost seed efficacy considerably only after 110 days of storage and after 240 days they lost seeds viability completely (BRRI 1985).

Haque and Harron (1983) found that seed viability range was the highest among three paddy varieties collected during the Boro season when seed was stored in closed containers, but when stored in gunny bags, seed viability worsened quickly. Possibly the impoverished germination was due to storage ambient response or rapid loss of viability. Rahman *et al.* (1985) reported that seed absorbed moisture and reduced germinability when it was stored in indigenous (not air-tight) container. A comparative study was conducted by Miah and Douglass (1992) to scrutinize the effect on the viability of high moisture wheat seeds of storage structures and storage periods. Laboratory tests showed that seed content for sealed clay bins stayed approximately fairly constant over the six-week period but actually decreased in the other structures. For re-wetted seed grain with 23% moisture content the viability fell rapidly after 2-, 4- and 6- weeks storage in the different structures.

There are large differences in the retention of viability of onion seed stored in different moisture pervious and moisture impervious containers at 7.15 and 5.30% seed moisture content. Storage containers, moisture levels and their interactions have significant differences on their germination potential. Seed stored in cloth bag at 10.0 and 7.14 % seed moisture recorded germination over certification standard (65%) up to 22 and 26 months while it could safely be stored up to 50 months in polythene bag irrespective of moisture levels studied. Reducing the seed moisture beyond certification standard did not show any beneficial effect on seed longevity (except for cloth bag storage) under subtropical climate of Rajnagar.

The germination of rice grains stored in gunny bags under ambient conditions decreased from 85% in August to 48% in March while germination of grains stored in a coal tar drum or plywood bean was 80-90% and 84-95%, respectively throughout the storage period.

It was seen that pest infestation and temperature was high in the gunny bags where the grains were stored with the comparison of grain stored in the other containers. Moisture contents were similar in grains stored in the three containers. Seeds stored in perforated containers at 5°C and 35°C failed to germinate after 81 days but maintained 9.3 and 10.1% germination, respectively at 25°C and room temperature even after 172 days. Seed sprayed over the laboratory bench at ambient conditions remained viable up to 263 days with 18.1% germination while those stored at ambient conditions in open container lost complete viability within 2-3 weeks.

Ali (1963) showed that seeds stored in gunny bag and in earthen pots lost viability much earlier than seeds stored in closed tin and in glass bottles. Bhattacharyya and Dutta (1972) recommended double plastic bags for seed storage. Transparent plastic bags are versatile containers for seed storage and suitable for many species and storage conditions. Plastic bags or containers should he filled completely so that as little air as possible is stored with the seed (Boland *et al.* 1990). Vacuum packing or storing in CO_2 in plastic bags practically removes all air and makes the seed samples easy to handle.

It is very important that the seeds must be stored by placing envelops inside large glass jars with a bag of silica or powdered milk. These products absorb excess moisture. Alternatively, a tiny package of powdered milk is made by pouring a pile into the centre of a piece of breathable fabric or tissue paper. Corners are pulled together and closed it up with a piece of string or elastic to create a sachet. The best jars for storage are wide mouth mason jars used for canning. They have the proper airtight seal that is essential for long term storage. If the jars are stored in a cool, dark place the seeds should last from a year to a few years, depending on the type. Ali (1963) recommended tin cans for seed storage. While, Anon. (1985) indicated the possibility of involvement of storage fungi in reducing the germination of gram seeds during storage in the containers.

From an experiment on soybean. Agha *et al.* (2004) reported that, field emergence was significantly different for storage containers. Seed emergence was greater in seed stored in containers. Further data demonstrated that storage containers were significantly affected the percentage of healthy seedlings. The seed stored in containers 51.6% healthy seedlings.

Karim and Amiruzzaman (1991) reported that maize seeds stored in polythene lined motka, improved tin, polythene lined jute bag, traditional tin and polythene lined Dole showed lowest insect infestation rate of 0.46, 0.91, 1.14, 3.02 and 3.38 percent, respectively. The containers were opened once after 13 months. The rate of insect infestation trend was more or less similar, that is 0.23, 1.85, 2.10, 2.34 and 2.37 percent infestation were obtained from the seed stored in polythene lined motka, polythene lined jute bag, improved tin, polythene lined dole and traditional tin, respectively. In terms of viability of seeds polythene lined motka and improved tin gave highest germination rate of' 76.67 and 73.33 percent, respectively. The present moisture of' the maize seed increased in all treatments from initial 10.47 to 13.44% but this moisture level did not affect the germination of seeds.

It is known that storage potential is heritable. Species and sometimes genera typically show an inherited storage behaviour, which may be either orthodox or refractory. Accordingly, every species is likely to respond identically to a given set of storage conditions (Bonner *et al.* 1994). The storage conditions differ significantly between these two main groups, orthodox and recalcitrant seeds (Roberts, 1973). For these reasons, these two groups are considered separately.

A study was conducted by Raza *et al.* (2010) to investigate the changes in wheat grain quality that may occur during storage in different types of' containers commonly used in Pakistan i.e. earthen pots, tin containers, cotton bags, jute bags and polypropylene bags. Freshly harvested grains of three different wheat varieties were stored in these containers for 12 months in two consecutive years i.e. 2003-04 and 2004-05, at existing environmental conditions at Food Quality & Nutrition Program of National Agricultural Research Centre Islamabad. Samples were analyzed before storage and after every 4 months for different quality parameters i.e. moisture content, test weight, flour yield, falling number and Pat acidity. Results of' both years showed an increase in moisture content during storage that was least in cotton bags and earthen pots resulting in higher test weights and flour yield. Tin containers performed better in retaining low fat acidity values. Storage duration of 12 months generally increased moisture and flit acidity while decreased test weight and flour yield in both years. Falling number also increased in all containers during storage but remained with the limits usually required for baking purposes. However, the pattern was not uniform within both the years under study.

2.8. Seed and storage condition effects on seed quality

Viability of many seeds is maintained longer if the seeds are stored at constant rather than fluctuating temperatures (Seeher and Agpaoa, 1976). Khandakar (1980) reported that the factors like moisture, temperature, proportion of infected seeds in storage, presence of' foreign materials, activity of' insects in seed lot, availability of oxygen to seed and it associated micro flora and fauna were related to the seed viability in storage. Reduction of O_2 pressure, e.g. by replacing oxygen with N_2 or CO_2 had little effect on seed longevity as long as temperature and moisture content were stored low. This is in contrast to earlier belief that reduction of O_2 level had a great influence on seed longevity (Willan. 1985).

McGill *et al.* (2002) described that, the conditions in order to maintain seed viability during storage are not very understandable and there are conflicting reports as to whether the seed will hold viability in storage. The reduction in seed viability at relatively low seed moisture content is typical of oil storage seeds and steady with orthodox seed behaviour.

Seed longevity is also called as the time until a certain proportion of a seed lot or seed population is dead. For example, the half viability period, P_{50} is the time taken for 50% of the seeds to die (Roberts, 1972). The measures to quantify the affiliation between seed longevity and the three factors (initial seed quality, seed moisture content and storage temperature) affecting seed deterioration have produced numerous qualitative or quantitative prediction equations (Roberts 1972, Hurrington 1963).

2.9. Seed quality test

Germination in a seed testing laboratory is the emergence and development from the Seed embryo of those essential structures which for the seed in question indicate the seed's ability to produce normal plants under favourable conditions in soil. Laboratory conditions must therefore, not only initiate the seeds growth, but must also favour seedling development in a limited time to a stage in which all essential structures can he fully evaluated. Germination is expressed as a percentage of pure seed number that produces normal seedlings under optimal conditions (IFPRI 1997). Germination test is generally an integral component of seed quality assessment. A test on the germination capacity of seed lot provides reliable information about the field planting value, as a germination test correlates positively with emergence under field conditions. Under controlled optimum conditions it gives most regular, rapid and complete germination for most samples and increases the reproducibility and uniformity of results. Seed vigour determines the potential rapid, uniform emergence and development of normal seedlings under wide range of field conditions (IFPRI 1997).

Seed viability as the capacity of the seed to germinate and produce a normal seedling defined by Larsten (1987). The most practical indicator of seed viability and vigour is germination capacity. The seeds which have low vigour values can't germinate well in rough field condition. At the storage time the vigour of seeds is an important factor that affects seeds storage life. We can't always differentiate vigour and viability in storage environments, exceptionally in seed lots which are rapidly waning. This progressive weakening with age continues until all the seeds became nonviable (Khandakar 1980), Zhang *et al.* (2005) opined that seed vigour will decline to low levels prior to planting, even for seed lots with acceptable germination. Low vigour seed may result in poor field stands, exceptionally if planted in less than ideal field conditions. There is a wide gap between laboratory test and field germination, Khandakar and Bradbeer (1983). The reduction in vigour and death of seeds is considered from two aspects: (i) loss of viability or death of a seed lot, i.e. a small or large quantity of seed or (ii) death of an individual seed. The germination percentage of a seed lot is the proportion of individual seed capable of producing normal plants. So, the reduction in vigour and eventual death of an individual seed should be considered (Justice and Bass, 1978).

A number of laboratory seed vigour test have been developed for modelling the effects of unfavourable conditions on the field performance of seeds. Among these tests cold test, accelerated ageing test, conductivity test etc. are very effective so, these are recommended for specific species (Abba and Lovato 1999). Hugo (2006) observed that the seeds which have the lower vigour value can't germinate well in rough condition and it doesn't help in better crop establishment. Low vigour of seeds can be due to physiological, morphological, mechanical, microbial, genetic, cytological factors.

The mechanical damage during harvesting, processing and transportation are the real causes of low vigour in seeds Roberts (1972). The maximum seed value joins at physiological maturity after which vigour and viability reduce over ageing, Delouche *et al.* (1973).

Threshing, treating, bagging and planting processes may also cause in differences of seed viability. Vigour test information is a seed marketing strategy (Hurrington 1973).

From the conductivity test we get a measurement of electrolyte leakage from plant tissues and it was first recognized for seeds of several crop species by Jahan (2018). The conductivity test has been used for seeds of many species including large seeded legumes, onion, cabbage, cotton, tomato, ryegrass, wheat, maize etc. Conductivity measurement of' the soak water in which a bulk sample (25-50 seeds) has been submerged. It classifies seed lots which have high laboratory germination but poor field emergence potential. Seed lots having high electrolyte leakage are known as low vigour, while those who have low leakage are considered as high vigour (Justice and Bass 1978). The veracity of cell membranes determined by deteriorative biochemical changes and/or physical interruption can be considered the fundamental cause of differences in seed vigour which are indirectly determined as electrolyte leakage during the conductivity test (Miah and Douglass 1992). Leaching of some compounds particularly electrolytes have often been associated with seed quality. When a seed rehydrates during early imbibition, the aptitude of its cellular membranes to rearrange and repair any damage that may have happened will influence the level of electrolyte leakage from the seed. High vigour seed reorganizes its membranes more rapidly and repair any damage to an upper level than low vigour seeds. Consequently, electrolyte leakage generally is measured from high vigour seed is less than that measured from low vigour seed (Nakavama *et al.* 2004). Roberts (1972) said that germination percentage decays with increasing of seed age. In a normal storage condition seed deteriorates slowly with the passing of time. It is known that the deterioration process of seeds is dependent on temperature relative humidity of ambient environment and on initial moisture content of seeds. The deterioration process can be accelerated by subjecting the seeds in a closed environment of high temperature and high relative humidity. In naturally aged seed the degree of deterioration can fluctuate depending on viability, storage environment, initial moisture content and vigour of seeds. Ageing involves the process of deterioration of seeds and eventually lost the ability to germinate.

(Misra *et al.* 1995) The physiological symptoms of seed ageing contain reduced rate of poorer seedling growth, decreased tolerance to sub-optimal conditions and germination and emergence. Ageing can also be resulted in loss of dormancy, germination, growth and produced the abnormal seedlings. (Hampton and Coolbear, 1990) The conductivity test having the marvellous benefit of ease and speed, and meets most of the requirements for a good vigour test.

Mian and Fakir (1989) at the Seed Pathology Centre (SPC), Department of Plant Pathology, Bangladesh Agricultural University (BAU), Mymensingh conducted the experiment. The purpose of the experiment was to regulate the seed quality. Germination category and rate of germination index of farmers saved seeds after 45, 90 and 120 days of seed storing in different containers. Three containers viz. gunny bag, polyethylene bag and kerosene tin were used for seed conservation. Seed samples of rice (var. BR 1) were collected from four upazillas of Bogra districts. In case of seed quality, the highest percentages of bleached and spotted seeds were found in polyethylene bag and it was 2.98-3.72% and 79.51-80.08% respectively. Significantly higher number of' normal seedling (77.35%) was recorded when seeds of kerosene tin was tested and higher number of abnormal seedling (4.44%), diseased seedling (12.06%) and dead seed (15.88%) were found in seeds of gunny bag. The rate of germination index in the seeds of' kerosene tin, polyethylene bag and gunny bag ranged 95.11-97.68%, 93.74-96.17% and 92.07-94.35% respectively.

CHAPTER III

MATERIALS AND METHODOLOGY

The laboratory experiment was conducted during the period from April 2018 to September 2018 to study the different fertilizer levels affected wheat seed quality as influenced by storage containers under ambient condition. The materials and methods those were used for conducting the experiment have been presented in this chapter. It includes a short description of the experimental site, climate condition, materials used for the experiment, experimental design, data collection and data analysis procedure.

3.1. Experimental site

The seeds for laboratory experiment were collected from a previously implemented experiment which was conducted at the Sher-e-Bangla Agricultural University (SAU) farm. The seed and seedling quality trials were made in the laboratory condition of Agronomy department of Sher-e-Bangla Agricultural University (SAU) Dhaka.

3.2. Climatic condition of the experimental site

Experimental area is situated in the sub-tropical climate zone, which is characterized by heavy rainfall during the months of April to September and scanty rainfall during the rest period of the year.

3.3. Experimental material

The variety BARI Gom 29 and BARI Gom 30 were tested as experimental materials. The seeds were collected from the experiment field of department of Agronomy. SAU. Dhaka, which were grown in the cropping season of 2017-18 under different fertilizer level. After collection of seeds they were stored in different container at 20 April, 2018 as per treatment of the experiment.

3.4. Treatments of the experiment

Factor A: Storage container (3 containers)

i. Tin container (S_1)

ii. Plastic pot (S_2)

iii. Polythene bag (S_3)

Two hundred grams of healthy and uniform sized seeds were put in each container as per treatment. After that the containers were made air tight using masking tape and then stored in clean and dry place. The stored containers were kept under keen observation for 6 months for doing test at 60 days interval.

Factor B: Fertilizer sources (7 levels)

i. Recommended dose (F_1)

ii. Compost + 75% Recommended dose (F_2)

iii. Compost + 50% Recommended dose (F_3)

iv. Compost + 25% Recommended dose (F_4)

v. Poultry manure + 75% Recommended dose (F_5)

vi. Poultry manure + 50% Recommended dose (F_6)

vii. Poultry manure + 25% Recommended dose (F_7)

The recommended fertilizer doses for wheat was Urea, TSP, MP, Gypsum, Compost and Poultry manure at the rate of 220, 180, 50, 120 kg ha^{-1}, 10 t ha^{-1} and 8 t ha^{-1} respectively. At first the compost and poultry manure were applied 3 days before sowing. Then before 1 day the whole amount of all the fertilizers except urea were applied at the time of final land preparation as per treatment and thoroughly incorporated with soil with the help of a spade. Urea was split into 3 equal portions, 1^{st} one was applied as basal during final land preparation, 2^{nd} was as 25 days after sowing and the 3^{rd} one at 46 days after sowing.

Factor C: Variety

i. BARI Gom 29 (V_1)

ii. BARI Gom 30 (V_2)

There were total 42 treatment combinations (3X7X2).

3.5. Experimental design

There was a suitable and homogeneous condition of the laboratory; considering this, the laboratory experiment was done in a Completely Randomized Design (CRD) and the treatments was replicated four times. Each replication had 100 wheat seeds in each petridish.

3.6. Sampling and data collection

Three sampling of stored grains was taken at 60 days interval starting from 60 days after storage in different containers for measuring quality of wheat seeds. So, data were collected at 60, 120 and 180 days after storage (DAS) of wheat seeds.

3.7. Data collection

The following data were recorded

i. Number of germinated seedlings
ii. Coleoptile length of seedlings
iii. Root length of seedlings
iv. Shoot length of seedlings
v. Fresh weight of seedlings
vi. Dry weight of seedlings
vii. Vigour Index I
viii. Vigour Index II

Figure 1. Petridishes with seeds set for germination test

Figure 2. Germinated seeds.

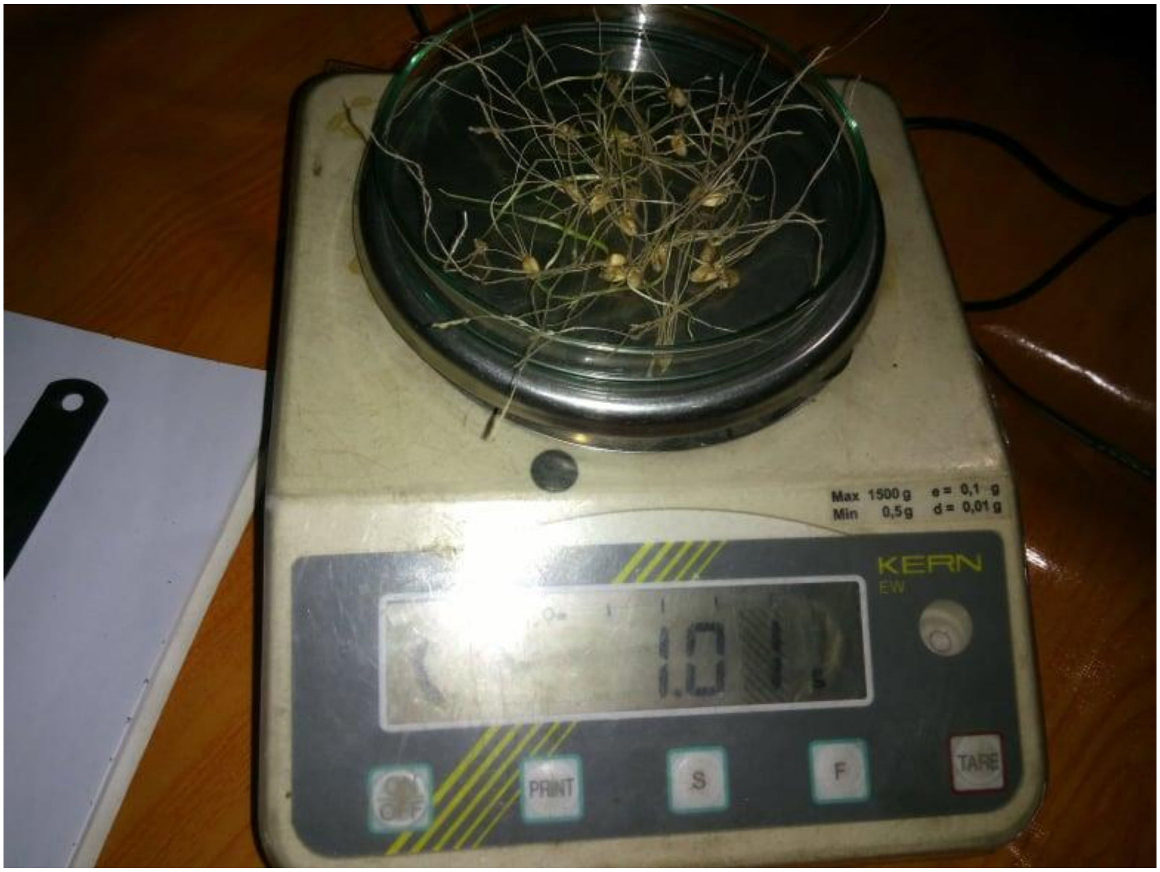

Figure 3. Weighing fresh weight of seedlings

3.8. Data Collection procedure

3.8.1. Number of germinated seedlings

Total 100 pure seeds of each treatment combination were placed in plastic box containing sand. For each test four plastic boxes were used. The boxes were placed in room temperature (25-30°C) in open condition for germination. Seedling was counted everyday up to the completion of germination. A seed was considered to be germinated as the seed coat ruptured and radicle came out up to 2 mm length.

3.8.2. Seedling shoot length

Seedling shoot length was measured with a meter scale from the shoot tip to the junction of root of 10 selected seedlings from each treatment and their average was taken and expressed in cm.

3.8.3. Seedling root length

Seedling root length was measured with a meter scale from the junction of shoot to the root tip point of 10 selected seedlings from each treatment and their average was taken and expressed in cm.

3.8.4. Seedling fresh weight

The fresh weight of seedling was recorded from the average of ten (10) selected seedlings in grams (gm) with a beam balance including root and shoots.

3.8.5. Seedling dry weight

At first 10 selected seedlings were collected, cut into pieces and was dried under sunshine for a 3 (lays and then dried in an oven at 70°C for 72 hours. The sample was then transferred into desiccators and allowed to cool down at room temperature. The final weight of the sample was taken and it was the seedling dry weight.

Figure 4. Collected Seedlings for Measurement.

3.8.6. Vigour Index I & II

Formula of calculating Vigour Index I = Seedling length at 7^{th} day of germination (cm) x (Number of germinated seedlings/7)

Formula of calculating Vigour Index II = Seedling dry weight (g) x Number of germinated seedlings

3.9. Statistical analysis

The data obtained for different parameters were statistically analysed to find out the significant difference of different container and wheat variety. The mean values of all the characters were calculated and analysis of variance was performed by the F (variance ratio) test. The significance of the difference among the treatment means was estimated by the Tukey's HSD test (due to factorial design of experiment) at 5% level of probability.

CHAPTER IV

RESULT AND DISCUSSION

Table 1: Effect of storage medium, fertilizer level, variety and their interaction on germination percentage

Treatment	No. of germinated seedlings (60 DAS)	No. of germinated seedlings (120 DAS)	No. of germinated seedlings (180 DAS)
Effect of storage medium			
S_1	90.33 a	88.71 a	86.14 a
S_2	89.76 a	88.33 a	84.28 b
S_3	89.14 a	87.61 a	82.00 c
$lsd_{0.05}$	1.41	1.51	1.59
Effect of fertilizer level			
F_1	89.66 abc	88.55 ab	85.22 a
F_2	88.44 bc	87.33 ab	84.44 a
F_3	87.22 c	85.88 b	82.44 a
F_4	89.44 abc	87.77 ab	83.11 a
F_5	90.66 ab	88.33 ab	83.11 a
F_6	91.55 a	89.55 a	85.22 a
F_7	91.22 a	90.11 a	85.44 a
$lsd_{0.05}$	2.71	2.91	3.08
Effect of variety			
V_1	89.68 a	88.13 a	84.15 a
V_2	89.81 a	88.32 a	84.12 a
$lsd_{0.05}$	ns	ns	ns
Effect of interaction between storage medium and fertilizer level			
S_1F_1	90.00 ab	89.00 a	87.33 ab
S_1F_2	88.66 ab	87.66 a	85.66 abc
S_1F_3	87.66 ab	86.33 a	84.00 abc
S_1F_4	89.66 ab	88.00 a	85.66 abc
S_1F_5	91.33 ab	88.66 a	85.00 abc
S_1F_6	93.00 a	90.66 a	87.66 a
S_1F_7	92.00 ab	90.66 a	87.66 a
S_2F_1	89.66 ab	88.66 a	85.33 abc
S_2F_2	88.66 ab	87.33 a	85.00 abc
S_2F_3	87.00 b	86.00 a	82.33 abc
S_2F_4	89.33 ab	88.00 a	83.00 abc
S_2F_5	90.66 ab	88.33 a	83.33 abc
S_2F_6	91.66 ab	89.66 a	85.33 abc
S_2F_7	91.33 ab	90.33 a	85.66 abc
S_3F_1	89.33 ab	88.00 a	83.00 abc
S_3F_2	88.00 ab	87.00 a	82.66 abc

S_3F_3	87.00 b	85.33 a	81.00 bc
S_3F_4	89.33 ab	87.33 a	80.66 c
S_3F_5	90.00 ab	88.00 a	81.00 bc
S_3F_6	90.00 ab	88.33 a	82.66 abc
S_3F_7	90.33 ab	89.33 a	83.00 abc
$lsd_{0.05}$	5.74	ns	6.50
Effect of interaction between storage medium and variety			
S_1V_1	90.19 a	88.76 a	86.19 a
S_1V_2	90.47 a	88.66 a	86.09 a
S_2V_1	89.61 a	88.28 a	84.28 ab
S_2V_2	89.90 a	88.38 a	84.28 ab
S_3V_1	89.23 a	87.33 a	82.00 b
S_3V_2	89.04 a	87.90 a	82.00 b
$lsd_{0.05}$	Ns	Ns	2.75
Effect of interaction between fertilizer level and variety			
F_1V_1	90.66 ab	89.77 a	85.55 ab
F_1V_2	88.66 abc	87.33 ab	84.88 ab
F_2V_1	90.00 ab	88.00 ab	85.33 ab
F_2V_2	86.88 bc	86.66 ab	83.55 ab
F_3V_1	85.33 c	83.77 b	80.66 b
F_3V_2	89.11 abc	88.00 ab	84.22 ab
F_4V_1	88.88 abc	87.77 ab	84.00 ab
F_4V_2	90.00 ab	87.77 ab	82.22 ab
F_5V_1	89.77 ab	87.77 ab	83.11 ab
F_5V_2	91.55 a	88.88 a	83.11 ab
F_6V_1	92.00 a	90.00 a	85.33 ab
F_6V_2	91.11 ab	89.11 a	85.11 ab
F_7V_1	91.11 ab	89.77 a	85.11 ab
F_7V_2	91.33 a	90.44 a	85.77 a
$lsd_{0.05}$	4.39	4.71	4.98
Effect of interaction between storage medium, variety and fertilizer level			
$S_1F_1V_1$	91.33 a	90.00 a	88.66 a
$S_1F_2V_1$	90.00 a	88.66 a	86.66 a
$S_1F_3V_1$	85.33 a	84.00 a	82.00 a
$S_1F_4V_1$	89.33 a	88.00 a	86.00 a
$S_1F_5V_1$	90.00 a	88.66 a	84.66 a
$S_1F_6V_1$	93.33 a	91.33 a	88.00 a
$S_1F_7V_1$	92.00 a	90.66 a	87.33 a
$S_2F_1V_1$	90.66 a	90.00 a	85.33 a
$S_2F_2V_1$	90.00 a	88.00 a	86.00 a
$S_2F_3V_1$	85.33 a	84.00 a	80.66 a
$S_2F_4V_1$	88.66 a	88.00 a	84.00 a
$S_2F_5V_1$	90.00 a	88.00 a	83.33 a
$S_2F_6V_1$	92.00 a	90.00 a	85.33 a
$S_2F_7V_1$	90.66 a	90.00 a	85.33 a

$S_3F_1V_1$	90.00 a	89.33 a	82.66 a
$S_3F_2V_1$	90.00 a	87.33 a	83.33 a
$S_3F_3V_1$	85.33 a	83.33 a	79.33 a
$S_3F_4V_1$	88.66 a	87.33 a	82.00 a
$S_3F_5V_1$	89.33 a	86.66 a	81.33 a
$S_3F_6V_1$	90.66 a	88.66 a	82.66 a
$S_3F_7V_1$	90.66 a	88.66 a	82.66 a
$S_1F_1V_2$	88.66 a	88.00 a	86.00 a
$S_1F_2V_2$	87.33 a	86.66 a	84.66 a
$S_1F_3V_2$	90.00 a	88.66 a	86.00 a
$S_1F_4V_2$	90.00 a	88.00 a	85.33 a
$S_1F_5V_2$	92.66 a	88.66 a	85.33 a
$S_1F_6V_2$	92.66 a	90.00 a	87.33 a
$S_1F_7V_2$	92.00 a	90.66 a	88.00 a
$S_2F_1V_2$	88.66 a	87.33 a	85.33 a
$S_2F_2V_2$	87.33 a	86.66 a	84.00 a
$S_2F_3V_2$	88.66 a	88.00 a	84.00 a
$S_2F_4V_2$	90.00 a	88.00 a	82.00 a
$S_2F_5V_2$	91.33 a	88.66 a	83.33 a
$S_2F_6V_2$	91.33 a	89.33 a	85.33 a
$S_2F_7V_2$	92.00 a	90.66 a	86.00 a
$S_3F_1V_2$	88.66 a	86.66 a	83.33 a
$S_3F_2V_2$	86.00 a	86.66 a	82.00 a
$S_3F_3V_2$	88.66 a	87.33 a	82.66 a
$S_3F_4V_2$	90.00 a	87.33 a	79.33 a
$S_3F_5V_2$	90.66 a	89.33 a	80.66 a
$S_3F_6V_2$	89.33 a	88.00 a	82.66 a
$S_3F_7V_2$	90.00 a	90.00 a	83.33 a
$lsd_{0.05}$	ns	ns	ns
CV (%)	3.01	3.28	3.63

Effect of storage medium on the germination percentage

<u>60 DAS</u>

Data from Table 1 shows that there is no statistically significant ($p>0.05$) effect of storage media on the number of germinated seedlings. However, numerically highest number (90.33) of seedlings found from S_1 followed by S_2 (89.76) and S_3 (89.14).

<u>120 DAS</u>

Data from Table 1 shows that there is no statistically significant ($p>0.05$) effect of storage media on the number of germinated seedlings. However, numerically highest number (88.71) of seedlings found from S_1 followed by S_2 (88.33) and S_3 (87.61).

<u>180 DAS</u>

Data from Table 1 shows that there is statistically significant ($p<0.05$) variations and effect of storage media on the number of germinated seedlings. The highest number (86.14) of seedlings found from S_1 followed by S_2 (84.28) and S_3 (82).

Effect of fertilizer level on the on number of germinated seedlings

<u>60 DAS</u>

Data from Table 1 reveals that there is statistically significant ($p<0.05$) effect of fertilizer level on the number of germinated seedlings in case of 60 DAS. The highest number (91.55) of seedlings found from F_6 which was statistically similar with F_7 (91.22). However, the lowest number of seedlings obtained from F_3 (87.22).

<u>120 DAS</u>

Data from Table 1 reveals that there is statistically significant ($p<0.05$) effect of fertilizer level on the number of germinated seedlings in case of 120 DAS. The highest number (90.11) of seedlings found from F_7 which was statistically similar with F_6 (89.55). However, the lowest number of seedlings obtained from F_3 (85.88).

<u>180 DAS</u>

Data from Table 1 reveals that there is no statistically significant ($p>0.05$) effect of fertilizer level on the number of germinated seedlings in case of 180 DAS. However, numerically the highest number (85.44) of seedlings found from F_7 followed by F_6 (85.22) and F_1 (85.22). However, the lowest number of seedlings obtained from F_3 (82.44).

Effect of variety on the number of germinated seedlings

<u>60 DAS</u>

Data from Table 1 reveals that there is no statistically significant ($p>0.05$) effect of variety on the number of germinated seedlings in case of 60 DAS. However, numerically the highest number (89.81) of seedlings found from V_2 followed by V_1 (89.68).

120 DAS

Data from Table 1 reveals that there is no statistically significant ($p>0.05$) effect of variety on the number of germinated seedlings in case of 120 DAS. However, numerically the highest number (88.32) of seedlings found from V_2 followed by V_1 (88.13).

180 DAS

Data from Table 1 reveals that there is no statistically significant ($p>0.05$) effect of variety on the number of germinated seedlings in case of 120 DAS. However, numerically the highest number (84.15) of seedlings found from V_1 followed by V_2 (84.12).

Effect of interaction between storage medium and fertilizer level on the number of germinated seedlings

60 DAS

In case of 60 DAS, data shows that there was significant variation ($p<0.05$) between the interaction of storage medium and fertilizer level. Highest interaction obtained from S_1F_6 (93) and the lowest number of seedlings originated from S_2F_3 (87) and S_3F_3 (87). However, rest of all interactions shows statistical similarity with highest and lowest number of seedlings.

120 DAS

In case of 120 DAS, data shows that there was no significant variation ($p>0.05$) between the interaction of storage medium and fertilizer level. However, numerically highest interaction obtained from S_1F_6 (90) and S_1F_7 (90), where, the lowest number of seedlings originated from S_3F_3 (85.33).

180 DAS

In case of 180 DAS, data shows that there was significant variation ($p<0.05$) between the interaction of storage medium and fertilizer level. Highest interaction obtained from S_1F_6 and S_1F_7 (87.66) and the lowest number of seedlings originated from S_3F_4 (80.66). However, rest of all interactions shows statistical similarity with highest and lowest number of seedlings.

Effect of interaction between storage medium and variety on the number of germinated seedlings

60 DAS

In case of 60 DAS, data shows that there was no significant variation ($p>0.05$) between the interaction of storage medium and variety. However, numerically highest interaction obtained from S_1V_2 (90.47) where, the lowest number of seedlings originated from S_3V_2 (89.04).

120 DAS

In case of 120 DAS, data shows that there was no significant variation ($p>0.05$) between the interaction of storage medium and variety. However, numerically highest interaction obtained from S_1V_2 (88.66) where, the lowest number of seedlings originated from S_3V_1 (87.33).

180 DAS

In case of 180 DAS, data shows that there was significant variation ($p<0.05$) between the interaction of storage medium and variety. It is evident that highest interaction obtained from S_1V_1 (86.19) which is statistically similar with S_1V_2 (86.09) where, the lowest number of seedlings originated from S_3V_1 and S_3V_2 (82).

Effect of interaction between fertilizer level and variety on the number of germinated seedlings

60 DAS

Data reveals that in case of 60 DAS, there was significant variation ($p<0.05$) between the effect of interactions between fertilizer level and variety. It is evident that highest number of seedlings (92) found from F_6V_1 which was statistically similar with F_5V_2 (91.55) and F_7V_2 (91.33). On the other hand, the lowest number (85.33) of seedlings found from F_3V_1 which shows statistical similarity with F_2V_2 and F_1V_2, F_3V_2, F_4V_1.

120 DAS

Data reveals that in case of 120 DAS, there was significant variation ($p<0.05$) between the effect of interactions between fertilizer level and variety. It is evident that highest number of seedlings (90.44) found from F_7V_2 which was statistically similar with F_5V_2, F_6V_1, F_6V_2, F_7V_1. On the other hand, the lowest number (83.77) of seedlings found from F_3V_1.

180 DAS

Data reveals that in case of 180 DAS, there was significant variation ($p<0.05$) between the effect of interactions between fertilizer level and variety. It is evident that highest number of seedlings (85.77) found from F_7V_2 which was statistically similar with other treatments except F_3V_1 which showed lowest number (80.66) of germinated seedlings.

Effect of interaction between storage medium, fertilizer level and variety on the number of germinated seedlings

60 DAS

In case of 60 DAS, data shows that there was no significant variation ($p>0.05$) between the interaction of storage medium and variety. However, numerically highest interaction obtained from $S_1F_6V_1$ (93.33) where, the lowest number of seedlings originated from $S_2F_3V_1$ (85.33).

120 DAS

In case of 60 DAS, data shows that there was no significant variation ($p>0.05$) between the interaction of storage medium and variety. However, numerically highest interaction obtained from $S_1F_6V_1$ (91.33) where, the lowest number of seedlings originated from $S_3F_3V_1$ (83.33).

180 DAS

In case of 60 DAS, data shows that there was no significant variation ($p>0.05$) between the interaction of storage medium and variety. However, numerically highest interaction obtained from $S_1F_1V_1$ (88.66) where, the lowest number of seedlings originated from $S_3F_4V_2$ and $S_3F_3V_1$ (79.33).

Table 2: Effect of storage medium, fertilizer level, variety and their interaction on coleoptile length of seedlings

Treatment	Length of coleoptile (60 DAS)	Length of coleoptile (120 DAS)	Length of coleoptile (180 DAS)
Effect of storage medium			
S_1	2.73 a	2.83 a	2.99 a
S_2	2.66 ab	2.67 b	2.73 b
S_3	2.59 b	2.55 c	2.55 c
$lsd_{0.05}$	0.11	0.11	0.11
Effect of fertilizer level			
F_1	2.73 a	2.68 ab	2.76 ab
F_2	2.67 a	2.80 a	2.83 ab
F_3	2.63 a	2.57 b	2.69 ab
F_4	2.68 a	2.72 ab	2.79 ab
F_5	2.59 a	2.59 b	2.65 b
F_6	2.68 a	2.80 a	2.89 a
F_7	2.64 a	2.63 ab	2.68 ab
$lsd_{0.05}$	ns	0.21	0.21
Effect of variety			
V_1	2.67 a	2.65 a	2.72 a
V_2	2.65 a	2.72 a	2.79 a
$lsd_{0.05}$	ns	ns	ns
Effect of interaction between storage medium and fertilizer level			
S_1F_1	2.76 a	2.84 abc	2.99 abcd
S_1F_2	2.86 a	2.95 a	3.08 ab
S_1F_3	2.61 a	2.71 abc	2.94 abcde
S_1F_4	2.78 a	2.89 ab	3.05 abc
S_1F_5	2.63 a	2.75 abc	2.87 abcdef
S_1F_6	2.83 a	2.94 a	3.12 a
S_1F_7	2.63 a	2.73 abc	2.88 abcdef
S_2F_1	2.78 a	2.67 abc	2.74 abcdef
S_2F_2	2.52 a	2.81 abc	2.80 abcdef
S_2F_3	2.65 a	2.54 abc	2.65 bcdef
S_2F_4	2.77 a	2.70 abc	2.76 abcdef
S_2F_5	2.58 a	2.57 abc	2.62 cdef
S_2F_6	2.71 a	2.79 abc	2.87 abcdef
S_2F_7	2.63 a	2.62 abc	2.67 abcdef
S_3F_1	2.65 a	2.52 abc	2.55 def
S_3F_2	2.62 a	2.66 abc	2.62 cdef
S_3F_3	2.63 a	2.45 bc	2.49 ef
S_3F_4	2.50 a	2.58 abc	2.55 def
S_3F_5	2.57 a	2.44 c	2.46 f
S_3F_6	2.52 a	2.66 abc	2.70 abcdef
S_3F_7	2.67 a	2.54 abc	2.50 ef

$lsd_{0.05}$	ns	0.43	0.46
Effect of interaction between storage medium and variety			
S_1V_1	2.67 ab	2.78 ab	2.95 ab
S_1V_2	2.79 a	2.87 a	3.03 a
S_2V_1	2.69 ab	2.63 bcd	2.68 cd
S_2V_2	2.63 ab	2.71 abc	2.77 bc
S_3V_1	2.66 ab	2.53 d	2.52 d
S_3V_2	2.53 b	2.57 cd	2.58 cd
$lsd_{0.05}$	0.19	0.18	0.19
Effect of interaction between fertilizer level and variety			
F_1V_1	2.71 a	2.69 abcd	2.74 abc
F_1V_2	2.75 a	2.66 abcd	2.78 abc
F_2V_1	2.79 a	2.91 a	2.87 abc
F_2V_2	2.54 a	2.69 abcd	2.79 abc
F_3V_1	2.63 a	2.56 bcd	2.77 abc
F_3V_2	2.63 a	2.57 bcd	2.61 abc
F_4V_1	2.73 a	2.67 abcd	2.68 abc
F_4V_2	2.64 a	2.78 abc	2.90 a
F_5V_1	2.57 a	2.50 cd	2.55 bc
F_5V_2	2.62 a	2.68 abcd	2.76 abc
F_6V_1	2.73 a	2.76 abcd	2.91 a
F_6V_2	2.64 a	2.83 ab	2.88 ab
F_7V_1	2.55 a	2.44 d	2.52 c
F_7V_2	2.74 a	2.82 abc	2.85 abc
$lsd_{0.05}$	ns	0.33	0.35
Effect of interaction between storage medium, variety and fertilizer level			
$S_1F_1V_1$	2.76 a	2.84 ab	2.97 abc
$S_1F_2V_1$	3.00 a	3.04 a	3.15 a
$S_1F_3V_1$	2.63 a	2.71 ab	3.05 abc
$S_1F_4V_1$	2.66 a	2.81 ab	2.96 abc
$S_1F_5V_1$	2.47 a	2.64 ab	2.75 abc
$S_1F_6V_1$	2.79 a	2.93 ab	3.09 ab
$S_1F_7V_1$	2.39 a	2.52 ab	2.70 abc
$S_2F_1V_1$	2.74 a	2.68 ab	2.71 abc
$S_2F_2V_1$	2.74 a	2.93 ab	2.82 abc
$S_2F_3V_1$	2.61 a	2.53 ab	2.71 abc
$S_2F_4V_1$	2.88 a	2.64 ab	2.64 abc
$S_2F_5V_1$	2.66 a	2.47 ab	2.53 abc
$S_2F_6V_1$	2.69 a	2.75 ab	2.90 abc
$S_2F_7V_1$	2.54 a	2.44 ab	2.50 abc
$S_3F_1V_1$	2.63 a	2.56 ab	2.55 abc
$S_3F_2V_1$	2.65 a	2.77 ab	2.66 abc
$S_3F_3V_1$	2.64 a	2.45 ab	2.56 abc
$S_3F_4V_1$	2.65 a	2.56 ab	2.44 abc
$S_3F_5V_1$	2.58 a	2.38 ab	2.36 c

$S_3F_6V_1$	2.72 a	2.61 ab	2.74 abc
$S_3F_7V_1$	2.72 a	2.36 b	2.37 c
$S_1F_1V_2$	2.76 a	2.85 ab	3.02 abc
$S_1F_2V_2$	2.73 a	2.85 ab	3.01 abc
$S_1F_3V_2$	2.59 a	2.71 ab	2.82 abc
$S_1F_4V_2$	2.91 a	2.96 ab	3.14 a
$S_1F_5V_2$	2.80 a	2.86 ab	3.00 abc
$S_1F_6V_2$	2.86 a	2.96 ab	3.14 a
$S_1F_7V_2$	2.87 a	2.93 ab	3.06 abc
$S_2F_1V_2$	2.82 a	2.66 ab	2.78 abc
$S_2F_2V_2$	2.31 a	2.69 ab	2.78 abc
$S_2F_3V_2$	2.70 a	2.56 ab	2.59 abc
$S_2F_4V_2$	2.65 a	2.77 ab	2.88 abc
$S_2F_5V_2$	2.44 a	2.67 ab	2.71 abc
$S_2F_6V_2$	2.74 a	2.84 ab	2.84 abc
$S_2F_7V_2$	2.72 a	2.80 ab	2.84 abc
$S_3F_1V_2$	2.68 a	2.49 ab	2.55 abc
$S_3F_2V_2$	2.58 a	2.54 ab	2.57 abc
$S_3F_3V_2$	2.62 a	2.42 ab	2.43 bc
$S_3F_4V_2$	2.36 a	2.61 ab	2.67 abc
$S_3F_5V_2$	2.57 a	2.50 ab	2.56 abc
$S_3F_6V_2$	2.31 a	2.71 ab	2.66 abc
$S_3F_7V_2$	2.63 a	2.72 ab	2.64 abc
$lsd_{0.05}$	ns	0.68	0.71
CV (%)	7.78	7.64	7.80

Effect of storage medium the on average coleoptile length of seedlings

<u>60 DAS</u>

Data from Table 2 shows that there is statistically significant ($p<0.05$) effect of storage media on the coleoptile length of seedlings. The highest coleoptile length (2.73 cm) of seedlings found from S_1 followed by S_2 (2.66 cm) and S_3 (2.59 cm).

<u>120 DAS</u>

Data from Table 2 shows that there is statistically significant ($p<0.05$) effect of storage media on the coleoptile length of seedlings. The highest coleoptile length (2.73 cm) of seedlings found from S_1 followed by S_2 (2.66 cm) and S_3 (2.59 cm).

<u>180 DAS</u>

Data from Table 2 shows that there is statistically significant ($p<0.05$) effect of storage media on the coleoptile length of seedlings. The highest coleoptile length (2.99 cm) of seedlings found from S_1 followed by S_2 (2.73 cm) and S_3 (2.55 cm).

Effect of fertilizer level the on average coleoptile length of seedlings

60 DAS

Data from Table 2 reveals that there is no statistically significant ($p>0.05$) effect of fertilizer level on the coleoptile length of seedlings in case of 60 DAS. However, numerically the highest coleoptile length (2.73 cm) of seedlings found from F_1. And the lowest coleoptile length of seedlings obtained from F_5 (2.59).

120 DAS

Data from table 2 reveals that there is statistically significant ($p<0.05$) effect of fertilizer level on the coleoptile length of seedlings in case of 120 DAS. The highest coleoptile length (2.80 cm) was found from F_2 which was statistically similar with F_6 (2.80). And the lowest coleoptile length (2.57 cm) was found from F_3 which was statistically similar with F_5 (2.59 cm).

180 DAS

Data from table 2 reveals that there is statistically significant ($p<0.05$) effect of fertilizer level on the coleoptile length of seedlings in case of 180 DAS. The highest coleoptile length (2.89 cm) was found from F_6. And the lowest coleoptile length (2.65 cm) was found from F_5.

Effect of variety on the coleoptile length of seedlings

60 DAS

Data from table 2 reveals that there is no statistically significant ($p>0.05$) effect of variety on coleoptile length of seedlings in case of 60 DAS. The highest coleoptile length (2.67 cm) was found from V_1 and the lowest was found from V_2 (2.65 cm).

120 DAS

Data from table 2 reveals that there is no statistically significant ($p>0.05$) effect of variety on coleoptile length of seedlings in case of 120 DAS. The highest coleoptile length (2.72 cm) was found from V_2 and the lowest was found from V_1 (2.65 cm).

180 DAS

Data from table 2 reveals that there is no statistically significant ($p>0.05$) effect of variety on coleoptile length of seedlings in case of 180 DAS. The highest coleoptile length (2.79 cm) was found from V_2 and the lowest was found from V_1 (2.72 cm).

Effect of interaction between storage medium and fertilizer level on the coleoptile length of seedlings

60 DAS

In case of 60 DAS, data shows that there is no significant variation ($p>0.05$) between the interaction of storage medium and fertilizer level. Highest interaction obtained from S_1F_2 (2.86 cm) and the lowest coleoptile length originated from S_3F_4 (2.50 cm).

120 DAS

In case of 120 DAS, data shows that there is significant variation ($p<0.05$) between the interaction of storage medium and fertilizer level. Highest interaction obtained from S_1F_2 (2.95 cm) which was statistically similar with S_1F_6 (2.94 cm). And the lowest coleoptile length originated from S_3F_5 (2.44 cm).

180 DAS

In case of 180 DAS, data shows that there is significant variation ($p<0.05$) between the interaction of storage medium and fertilizer level. Highest interaction obtained from S_1F_6 (3.12 cm). And the lowest coleoptile length originated from S_3F_5 (2.46 cm).

Effect of interaction between storage medium and variety on the coleoptile length of seedlings

60 DAS

In case of 60 DAS, data shows that there is significant variation ($p<0.05$) between the interaction of storage medium and variety. Highest interaction obtained from S_1V_2 (2.79 cm) which is statistically similar with S_1V_1, S_2V_1, S_2V_2, S_3V_1. The lowest coleoptile length originated from S_3V_2 (2.05 cm) which was statistically similar with S_1V_1, S_2V_1, S_2V_2, S_3V_1.

120 DAS

In case of 120 DAS, data shows that there is significant variation ($p<0.05$) between the interaction of storage medium and variety. Highest interaction obtained from S_1V_2 (2.87 cm) which is statistically similar with S_1V_1, S_2V_2. The lowest coleoptile length originated from S_3V_1 (2.53 cm) which was statistically similar with S_2V_1, S_3V_2.

180 DAS

In case of 180 DAS, data shows that there is significant variation ($p<0.05$) between the interaction of storage medium and variety. Highest interaction obtained from S_1V_2 (3.03 cm) which is statistically similar with S_1V_1. The lowest coleoptile length originated from S_3V_1 (2.52 cm) which was statistically similar with S_2V_1, S_3V_2.

Effect of interaction between fertilizer level and variety on the coleoptile length of seedlings

60 DAS

Data reveals that in case of 60 DAS, there is no significant variation ($p>0.05$) between the interaction fertilizer level and variety. It is evident that highest coleoptile length (2.79 cm) found from F_2V_1. On the other hand, the lowest coleoptile length (2.54 cm) of seedlings found from F_2V_2.

120 DAS

Data reveals that in case of 120 DAS, there is significant variation ($p<0.05$) between the interaction fertilizer level and variety. It is evident that the highest coleoptile length (2.91 cm) found from F_2V_1. Which is statistically similar with F_1V_1, F_1V_2, F_2V_2, F_4V_1, F_4V_2, F_5V_5, F_6V_1, F_6V_2, F_7V_2. On the other hand, the lowest coleoptile length (2.44 cm) of seedlings found from F_7V_1.

180 DAS

Data reveals that in case of 180 DAS, there is significant variation ($p<0.05$) between the interaction fertilizer level and variety. It is evident that the highest coleoptile length (2.90 cm) found from F_4V_2. Which is statistically similar with F_1V_1, F_1V_2, F_2V_2, F_3V_1, F_3V_2, F_4V_1, F_5V_2, F_6V_2, F_7V_2. On the other hand, the lowest coleoptile length (2.52 cm) of seedlings found from F_7V_1.

Effect of interaction between storage medium, fertilizer level and variety on the coleoptile length of seedlings

60 DAS

In case of 60 DAS, data shows that there is no significant variation ($p>0.05$) between the interaction of storage medium, variety and fertilizer level. The highest interaction obtained from $S_1F_2V_1$ (3.00 cm) where, the lowest coleoptile length of seedlings originated from $S_2F_2V_2$ (2.31 cm).

120 DAS

In case of 120 DAS, data shows that there is significant variation ($p<0.05$) between the interaction of storage medium, variety and fertilizer level. The highest interaction obtained from $S_1F_2V_1$ (3.04). And the lowest coleoptile length was found from $S_3F_7V_1$ (2.36 cm).

180 DAS

In case of 180 DAS, data shows that there is significant variation ($p<0.05$) between the interaction of storage medium, variety and fertilizer level. The highest interaction obtained from $S_1F_2V_1$ (3.15 cm). And the lowest coleoptile length was found from $S_3F_5V_1$ (2.36 cm).

Table 3: Effect of storage medium, fertilizer level, variety and their interactions on root length of seedlings

Treatment	No. of germinated seedlings (60 DAS)	No. of germinated seedlings (120 DAS)	No. of germinated seedlings (180 DAS)
Effect of storage medium			
S_1	6.68 a	6.04 a	6.16 a
S_2	6.41 a	5.36 b	5.49 a
S_3	6.00 b	4.94 c	5.22 a
$lsd_{0.05}$	0.27	0.13	ns
Effect of fertilizer level			
F_1	6.30 a	5.47 a	5.49 a
F_2	6.51 a	5.50 a	5.60 a
F_3	6.36 a	5.48 a	5.68 a
F_4	6.20 a	5.37 a	5.64 a
F_5	6.43 a	5.43 a	5.72 a
F_6	6.34 a	5.43 a	5.63 a
F_7	6.42 a	5.44 a	5.59 a
$lsd_{0.05}$	ns	ns	ns
Effect of variety			
V_1	6.38 a	5.47 a	5.53 b
V_2	6.36 a	5.42 a	5.72 a
$lsd_{0.05}$	ns	ns	0.11
Effect of interaction between storage medium and fertilizer level			
S_1F_1	6.55 ab	5.93 abc	6.06 abcde
S_1F_2	6.95 a	6.28 a	6.17 abc
S_1F_3	6.61 ab	6.11 a	6.19 ab
S_1F_4	6.52 ab	5.95 ab	6.13 abcd
S_1F_5	6.80 ab	6.11 a	6.31 a
S_1F_6	6.58 ab	6.01 a	6.14 abcd
S_1F_7	6.76 ab	5.91 abc	6.11 abcde
S_2F_1	6.44 ab	5.42 bcd	5.33 f
S_2F_2	6.57 ab	5.30 de	5.46 ef
S_2F_3	6.36 ab	5.35 de	5.55 bcdef
S_2F_4	6.23 ab	5.28 de	5.53 cdef
S_2F_5	6.41 ab	5.34 de	5.58 bcdef
S_2F_6	6.38 ab	5.38 cde	5.51 def
S_2F_7	6.51 ab	5.43 bcd	5.49 def
S_3F_1	5.93 ab	5.05 de	5.08 f
S_3F_2	6.02 ab	4.93 de	5.18 f
S_3F_3	6.09 ab	4.97 de	5.31 f
S_3F_4	5.85 b	4.88 de	5.27 f
S_3F_5	6.10 ab	4.85 e	5.27 f
S_3F_6	6.05 ab	4.91 de	5.26 f

S_3F_7	6.00 ab	4.97 de	5.17 f
$lsd_{0.05}$	1.10	0.56	0.65
Effect of interaction between storage medium and variety			
S_1V_1	6.64 a	6.02 a	6.11 a
S_1V_2	6.72 a	6.06 a	6.21 a
S_2V_1	6.35 ab	5.39 b	5.37 bc
S_2V_2	6.47 ab	5.32 b	5.61 b
S_3V_1	6.13 bc	4.98 c	5.12 c
S_3V_2	5.87 c	4.89 c	5.32 c
$lsd_{0.05}$	0.47	0.23	0.28
Effect of interaction between fertilizer level and variety			
F_1V_1	6.09 a	5.42 a	5.47 a
F_1V_2	6.50 a	5.44 a	5.51 a
F_2V_1	6.74 a	5.58 a	5.52 a
F_2V_2	6.29 a	5.42 a	5.69 a
F_3V_1	6.39 a	5.48 a	5.62 a
F_3V_2	6.32 a	5.47 a	5.74 a
F_4V_1	6.29 a	5.48 a	5.48 a
F_4V_2	6.10 a	5.26 a	5.81 a
F_5V_1	6.27 a	5.41 a	5.54 a
F_5V_2	6.60 a	5.46 a	5.90 a
F_6V_1	6.40 a	5.37 a	5.53 a
F_6V_2	6.23 a	5.50 a	5.7 a
F_7V_1	6.44 a	5.45 a	5.55 a
F_7V_2	6.40 a	5.42 a	5.63 a
$lsd_{0.05}$	ns	ns	ns
Effect of interaction between storage medium, variety and fertilizer level			
$S_1F_1V_1$	6.29 a	5.93 abcdef	6.04 abcdef
$S_1F_2V_1$	7.10 a	6.43 a	6.12 abcde
$S_1F_3V_1$	6.73 a	6.16 abc	6.26 ab
$S_1F_4V_1$	6.40 a	5.96 abcde	6.13 abcde
$S_1F_5V_1$	6.71 a	5.90 abcdefg	6.12 abcde
$S_1F_6V_1$	6.48 a	5.90 abcdefg	6.03 abcdefg
$S_1F_7V_1$	6.80 a	5.90 abcdefg	6.06 abcdef
$S_2F_1V_1$	6.09 a	5.47 bcdefgh	5.30 bcdefg
$S_2F_2V_1$	6.80 a	5.33 cdefgh	5.36 bcdefg
$S_2F_3V_1$	6.19 a	5.36 cdefgh	5.40 bcdefg
$S_2F_4V_1$	6.33 a	5.46 bcdefgh	5.30 bcdefg
$S_2F_5V_1$	6.00 a	5.40 cdefgh	5.37 bcdefg
$S_2F_6V_1$	6.46 a	5.33 cdefgh	5.40 bcdefg
$S_2F_7V_1$	6.63 a	5.40 cdefgh	5.47 bcdefg
$S_3F_1V_1$	5.91 a	5.06 fgh	5.09 fg
$S_3F_2V_1$	6.32 a	5.00 h	5.07 fg
$S_3F_3V_1$	6.26 a	4.92 h	5.21 cdefg
$S_3F_4V_1$	6.15 a	5.00 h	5.02 g

$S_3F_5V_1$	6.10 a	4.93 h	5.14 efg
$S_3F_6V_1$	6.27 a	4.90 h	5.17 defg
$S_3F_7V_1$	5.90 a	5.06 fgh	5.13 efg
$S_1F_1V_2$	6.82 a	5.93 abcdef	6.08 abcdef
$S_1F_2V_2$	6.80 a	6.13 abcd	6.22 abc
$S_1F_3V_2$	6.50 a	6.06 abcd	6.13 abcde
$S_1F_4V_2$	6.65 a	5.93 abcdef	6.13 abcdef
$S_1F_5V_2$	6.88 a	6.33 ab	6.50 abc
$S_1F_6V_2$	6.68 a	6.13 abcd	6.26 abcde
$S_1F_7V_2$	6.72 a	5.93 abcdef	6.16 abcde
$S_2F_1V_2$	6.80 a	5.37 cdefgh	5.36 a
$S_2F_2V_2$	6.35 a	5.26 defgh	5.56 ab
$S_2F_3V_2$	6.54 a	5.33 cdefgh	5.70 abcd
$S_2F_4V_2$	6.13 a	5.10 bcdefgh	5.77 bcdefg
$S_2F_5V_2$	6.83 a	5.29 gh	5.79 abcdefg
$S_2F_6V_2$	6.30 a	5.43 h	5.62 abcdefg
$S_2F_7V_2$	6.39 a	5.46 h	5.52 abcdefg
$S_3F_1V_2$	5.90 a	5.03 h	5.08 fg
$S_3F_2V_2$	5.72 a	4.86 h	5.28 bcdefg
$S_3F_3V_2$	5.92 a	5.02 h	5.40 bcdefg
$S_3F_4V_2$	5.54 a	4.76 h	5.53 abcdefg
$S_3F_5V_2$	6.10 a	4.76 h	5.40 bcdefg
$S_3F_6V_2$	5.83 a	4.93 h	5.35 bcdefg
$S_3F_7V_2$	6.19 a	4.87 h	5.22 cdefg
$lsd_{0.05}$	ns	0.87	1.01
CV (%)	8.11	4.81	5.44

Effect of storage medium the on average root length of seedlings

<u>60 DAS</u>

Data from Table 2 shows that there is statistically significant ($p<0.05$) effect of storage media on the root length of seedlings. The highest root length (6.68 cm) of seedlings found from S_1 followed by S_2 (6.41 cm) and the lowest root length was found from S_3 (6.00 cm).

<u>120 DAS</u>

Data from Table 3 shows that there is statistically significant ($p>0.05$) effect of storage media on the root length of seedlings. The highest root length (6.04 cm) of seedlings found from S_1 followed by S_2 (2.66 cm) and S_3 (2.59 cm).

180 DAS

Data from Table 3 shows that there is no statistically significant ($p<0.05$) effect storage media on the root length of seedlings. The highest root length (6.16 cm) of seedlings found from S_1 which was statistically similar with S_2 (5.49 cm) and S_3 (5.22 cm).

Effect of fertilizer level on root length of seedlings

60 DAS

Data from Table 3 shows that there is no statistically significant ($p<0.05$) effect of fertilizer level on the root length of seedlings. However, numerically the highest root length (5.72 cm) was found from F_5 and the lowest (5.49 cm) found from F_1.

120 DAS

Data from Table 3 shows that there is no statistically significant ($p<0.05$) effect of fertilizer level on the root length of seedlings. However, numerically the highest root length (5.50 cm) was found from F_2 and the lowest (5.37 cm) found from F_4.

180 DAS

Data from Table 3 shows that there is no statistically significant ($p<0.05$) effect of fertilizer level on the root length of seedlings in case of 180 DAS. However, numerically the highest root length (5.72 cm) was found from F_5 and the lowest (5.49 cm) found from F_1.

Effect of variety on root length of seedlings

60 DAS

Data from Table 3 reveals that there is no statistically significant ($p>0.05$) effect of variety on root length of seedlings in case of 60 DAS. The highest root length (6.38 cm) was found from V_1 and the lowest was found from V_2 (6.36 cm).

120 DAS

Data from Table 3 reveals that there is no statistically significant ($p>0.05$) effect of variety on root length of seedlings in case of 120 DAS. The highest root length (5.47 cm) was found from V_1 and the lowest was found from V_2 (5.42 cm).

180 DAS

Data from Table 3 reveals that there is statistically significant ($p<0.05$) effect of variety on root length of seedlings in case of 180 DAS. The highest root length (5.72 cm) was found from V_2 and the lowest was found from V_1 (5.53 cm).

Effect of interaction between storage medium and fertilizer level on root length of seedlings

60 DAS

In case of 60 DAS, data shows that there is significant variation ($p<0.05$) between the interaction of storage medium and fertilizer level on root length of seedlings. Highest interaction obtained from S_1F_2 (6.95 cm) and the lowest root length originated from S_3F_4 (5.85 cm).

120 DAS

In case of 120 DAS, data shows that there is significant variation ($p<0.05$) between the interaction of storage medium and fertilizer level on root length of seedlings. Highest interaction obtained from S_1F_2 (6.28 cm) which was statistically similar with S_1F_1, S_1F_3, S_1F_4, S_1F_5, S_1F_6, S_1F_7. And the lowest root length originated from S_3F_5 (4.85 cm) which was statistically similar with S_2F_2, S_2F_3, S_2F_4, S_2F_5, S_2F_6, S_3F_1, S_3F_2, S_3F_3, S_3F_4, S_3F_6, S_3F_7.

180 DAS

In case of 180 DAS, data shows that there is significant variation ($p<0.05$) between the interaction of storage medium and fertilizer level on root length of seedlings. Highest interaction obtained from S_1F_5 (6.31 cm) which was statistically similar with S_1F_1, S_1F_2, S_1F_3, S_1F_4, S_1F_6, S_1F_7. And the lowest root length originated from S_2F_1 (5.08 cm).

Effect of interaction between fertilizer level and variety on root length of seedlings

60 DAS

Data reveals that in case of 60 DAS, there is no significant variation ($p>0.05$) between the interaction fertilizer level and variety. It is evident that the highest root length (6.74 cm) found from F_2V_1. On the other hand, the lowest root length (6.09 cm) of seedlings found from F_1V_1.

120 DAS

Data reveals that in case of 120 DAS, there is no significant variation ($p>0.05$) between the interaction fertilizer level and variety. It is evident that the highest root length (5.58 cm) found from F_2V_1. On the other hand, the lowest root length (5.26 cm) of seedlings found from F_4V_2.

180 DAS

Data reveals that in case of 180 DAS, there is no significant variation ($p>0.05$) between the interaction fertilizer level and variety. It is evident that the highest root length (5.90 cm) found from F_5V_2. On the other hand, the lowest root length (5.47 cm) of seedlings found from F_1V_1.

Effect of interaction between storage medium, variety and fertilizer level on root length of seedlings

60 DAS

In case of 60 DAS, data shows that there is no significant variation ($p>0.05$) between the interaction of storage medium, variety and fertilizer level on root length of seedlings. The highest interaction obtained from $S_1F_2V_1$ (7.10 cm) where, the lowest root length of seedlings originated from $S_2F_2V_2$ (5.72 cm).

120 DAS

In case of 120 DAS, data shows that there is significant variation ($p<0.05$) between the interaction of storage medium, variety and fertilizer level on root length of seedlings. The highest interaction obtained from $S_1F_2V_1$ (6.43 cm) which was statistically similar with $S_1F_1V_1$, $S_1F_3V_1$, $S_1F_4V_1$, $S_1F_5V_1$, $S_1F_6V_1$, $S_1F_1V_2$, $S_1F_2V_2$, $S_1F_3V_2$, $S_1F_4V_2$, $S_1F_5V_2$, $S_1F_6V_2$, $S_1F_7V_2$. The lowest root length (4.76 cm) of seedlings was found from $S_3F_4V_2$ and $S_3F_5V_2$ which was statistically similar with $S_2F_1V_1$, $S_2F_2V_1$, $S_2F_3V_1$, $S_2F_4V_1$, $S_2F_5V_1$, $S_2F_6V_1$, $S_2F_7V_1$, $S_3F_1V_1$, $S_3F_2V_1$, $S_3F_3V_1$, $S_3F_4V_1$, $S_3F_5V_1$, $S_3F_6V_1$, $S_3F_7V_1$, $S_2F_1V_2$, $S_2F_2V_2$, $S_2F_3V_2$, $S_2F_4V_2$, $S_2F_5V_2$, $S_2F_6V_2$, $S_2F_7V_2$, $S_3F_1V_2$, $S_3F_2V_2$, $S_3F_3V_2$, $S_3F_4V_2$, $S_3F_5V_2$, $S_3F_6V_2$, $S_3F_7V_2$.

180 DAS

In case of 180 DAS, data shows that there is significant variation ($p<0.05$) between the interaction of storage medium, variety and fertilizer level on root length of seedlings. The highest interaction obtained from $S_1F_5V_2$ (6.50 cm) where, the lowest root length of seedlings originated from $S_3F_4V_1$ (5.02 cm).

Table 4: Effect of storage medium, variety, fertilizer level and their interactions on shoot length of seedlings

Treatment	Shoot length (60 DAS)	Shoot length (120 DAS)	Shoot length (180 DAS)
Effect of storage medium			
S_1	2.86 a	3.04 a	3.19 a
S_2	2.81 a	2.86 ab	2.96 b
S_3	2.65 a	2.69 b	2.75 c
$lsd_{0.05}$	ns	0.25	0.20
Effect of fertilizer level			
F_1	2.72 ab	2.84 ab	3.04 abc
F_2	2.63 ab	2.70 ab	2.81 bc
F_3	2.35 b	2.50 b	2.69 c
F_4	3.03 a	3.12 a	3.21 a
F_5	3.03 a	3.05 a	3.04 abc
F_6	2.96 a	3.13 a	3.11 ab
F_7	2.69 ab	2.72 ab	2.88 abc
$lsd_{0.05}$	0.55	0.48	0.39
Effect of variety			
V_1	2.79 a	2.91 a	3.01 a
V_2	2.77 a	2.82 a	2.93 a
$lsd_{0.05}$	ns	ns	ns
Effect of interaction between storage medium and fertilizer level			
S_1F_1	2.83 a	2.98 a	3.26 abc
S_1F_2	2.66 a	2.94 a	3.04 abc
S_1F_3	2.48 a	2.63 a	2.88 abc
S_1F_4	3.15 a	3.28 a	3.48 a
S_1F_5	3.15 a	3.21 a	3.27 abc
S_1F_6	2.96 a	3.34 a	3.35 ab
S_1F_7	2.80 a	2.88 a	3.08 abc
S_2F_1	2.74 a	2.84 a	3.05 abc
S_2F_2	2.72 a	2.73 a	2.82 abc
S_2F_3	2.35 a	2.50 a	2.69 abc
S_2F_4	3.03 a	3.12 a	3.17 abc
S_2F_5	3.03 a	3.05 a	3.03 abc
S_2F_6	3.13 a	3.12 a	3.08 abc
S_2F_7	2.71 a	2.71 a	2.87 abc
S_3F_1	2.61 a	2.70 a	2.80 abc
S_3F_2	2.53 a	2.42 a	2.57 bc
S_3F_3	2.23 a	2.38 a	2.51 c
S_3F_4	2.92 a	2.97 a	2.98 abc
S_3F_5	2.92 a	2.88 a	2.81 abc
S_3F_6	2.81 a	2.94 a	2.91 abc

S_3F_7	2.58 a	2.56 a	2.69 abc
$lsd_{0.05}$	ns	ns	0.81
Effect of interaction between storage medium and variety			
S_1V_1	2.86 a	3.09 a	3.25 a
S_1V_2	2.85 a	2.99 ab	3.14 a
S_2V_1	2.84 a	2.91 ab	3.01 ab
S_2V_2	2.79 a	2.82 ab	2.91 ab
S_3V_1	2.66 a	2.75 ab	2.77 a
S_3V_2	2.65 a	2.64 b	2.73 a
$lsd_{0.05}$	ns	0.43	0.34
Effect of interaction between fertilizer level and variety			
F_1V_1	3.16 ab	3.16 ab	3.34 a
F_1V_2	2.29 bc	2.52 bcd	2.73 abc
F_2V_1	2.57 abc	2.66 abcd	2.72 abc
F_2V_2	2.70 abc	2.73 abcd	2.90 abc
F_3V_1	2.52 abc	2.65 abcd	2.84 abc
F_3V_2	2.18 c	2.36 cd	2.54 bc
F_4V_1	3.13 ab	3.23 ab	3.23 a
F_4V_2	2.93 abc	3.01 abcd	3.19 a
F_5V_1	2.82 abc	2.97 abcd	3.15 ab
F_5V_2	3.25 a	3.13 abc	2.93 abc
F_6V_1	3.16 ab	3.41 a	3.28 a
F_6V_2	2.77 abc	2.86 abcd	2.94 abc
F_7V_1	2.15 c	2.34 d	2.52 c
F_7V_2	3.24 a	3.10 abcd	3.24 a
$lsd_{0.05}$	0.89	0.79	0.62
Effect of interaction between storage medium, variety and fertilizer level			
$S_1F_1V_1$	3.26 a	3.35 a	3.58 a
$S_1F_2V_1$	2.67 a	2.81 a	3.02 a
$S_1F_3V_1$	2.63 a	2.78 a	3.05 a
$S_1F_4V_1$	3.27 a	3.42 a	3.55 a
$S_1F_5V_1$	2.93 a	3.11 a	3.38 a
$S_1F_6V_1$	3.06 a	3.73 a	3.53 a
$S_1F_7V_1$	2.23 a	2.41 a	2.67 a
$S_2F_1V_1$	3.19 a	3.17 a	3.38 a
$S_2F_2V_1$	2.58 a	2.66 a	2.74 a
$S_2F_3V_1$	2.54 a	2.63 a	2.84 a
$S_2F_4V_1$	3.14 a	3.23 a	3.19 a
$S_2F_5V_1$	2.81 a	2.95 a	3.15 a
$S_2F_6V_1$	3.46 a	3.38 a	3.24 a
$S_2F_7V_1$	2.15 a	2.33 a	2.50 a
$S_3F_1V_1$	3.02 a	2.97 a	3.05 a
$S_3F_2V_1$	2.46 a	2.51 a	2.40 a
$S_3F_3V_1$	2.40 a	2.52 a	2.63 a
$S_3F_4V_1$	2.98 a	3.04 a	2.96 a

$S_3F_5V_1$	2.71 a	2.85 a	2.92 a
$S_3F_6V_1$	2.96 a	3.11 a	3.08 a
$S_3F_7V_1$	2.08 a	2.27 a	2.38 a
$S_1F_1V_2$	2.40 a	2.60 a	2.94 a
$S_1F_2V_2$	2.64 a	3.08 a	3.06 a
$S_1F_3V_2$	2.33 a	2.48 a	2.71 a
$S_1F_4V_2$	3.03 a	3.14 a	3.41 a
$S_1F_5V_2$	3.36 a	3.32 a	3.17 a
$S_1F_6V_2$	2.85 a	2.96 a	3.17 a
$S_1F_7V_2$	3.36 a	3.35 a	3.49 a
$S_2F_1V_2$	2.30 a	2.51 a	2.71 a
$S_2F_2V_2$	2.86 a	2.80 a	2.91 a
$S_2F_3V_2$	2.16 a	2.36 a	2.54 a
$S_2F_4V_2$	2.92 a	3.01 a	3.15 a
$S_2F_5V_2$	3.25 a	3.15 a	2.91 a
$S_2F_6V_2$	2.79 a	2.85 a	2.92 a
$S_2F_7V_2$	3.28 a	3.10 a	3.24 a
$S_3F_1V_2$	2.19 a	2.44 a	2.55 a
$S_3F_2V_2$	2.60 a	2.33 a	2.74 a
$S_3F_3V_2$	2.06 a	2.25 a	2.39 a
$S_3F_4V_2$	2.85 a	2.89 a	3.00 a
$S_3F_5V_2$	3.13 a	2.92 a	2.71 a
$S_3F_6V_2$	2.66 a	2.78 a	2.74 a
$S_3F_7V_2$	3.07 a	2.86 a	3.00 a
$lsd_{0.05}$	ns	ns	ns
CV (%)	19.67	16.92	12.86

Effect of storage medium the on average shoot length of seedlings

<u>60 DAS</u>

Data from Table 4 shows that there is no statistically significant ($p<0.05$) effect of storage media on the shoot length of seedlings. The highest shoot length (2.86 cm) of seedlings found from S_1 followed by S_2 (2.81 cm) and the lowest shoot length was found from S_3 (2.65 cm).

<u>120 DAS</u>

Data from Table 4 shows that there is statistically significant ($p>0.05$) effect of storage media on the shoot length of seedlings. The highest shoot length (3.04 cm) of seedlings found from S_1 which was statistically similar with S_2 (2.86 cm) and the lowest shoot length was found from S_3 (2.69 cm) which was also statistically similar with S_2.

180 DAS

Data from Table 4 shows that there is statistically significant ($p>0.05$) effect of storage media on the shoot length of seedlings. The highest shoot length (3.19 cm) of seedlings found from S_1. And the lowest shoot length was found from S_3 (2.75 cm).

Effect of fertilizer level on the shoot length of seedlings

60 DAS

Data from Table 4 shows that there is statistically significant ($p>0.05$) effect of fertilizer level on the shoot length of seedlings. The highest shoot length (3.03 cm) of seedlings found from F_5. And the lowest shoot length was found from F_3 (2.35 cm).

120 DAS

Data from Table 4 shows that there is statistically significant ($p>0.05$) effect of fertilizer level on the shoot length of seedlings. The highest shoot length (3.13 cm) of seedlings found from F_6. And the lowest shoot length was found from F_3 (2.50 cm).

180 DAS

Data from Table 4 shows that there is statistically significant ($p>0.05$) effect of fertilizer level on the shoot length of seedlings. The highest shoot length (3.21 cm) of seedlings found from F_4. And the lowest shoot length was found from F_3 (2.69 cm).

Effect of variety on the shoot length of seedlings

60 DAS

Data from Table 4 shows that there is no statistically significant ($p<0.05$) effect of variety on the shoot length of seedlings. The highest shoot length (2.79 cm) of seedlings found from V_1. And the lowest shoot length was found from V_2 (2.77 cm).

120 DAS

Data from Table 4 reveals that there is no statistically significant ($p<0.05$) effect of variety on the shoot length of seedlings. The highest shoot length (2.91 cm) of seedlings found from V_1. And the lowest shoot length was found from V_2 (2.82 cm).

180 DAS

Data from Table 4 reveals that there is no statistically significant ($p<0.05$) effect of variety on the shoot length of seedlings. The highest shoot length (3.01 cm) of seedlings found from V_1. And the lowest shoot length was found from V_2 (2.93 cm).

Effect of interaction between storage medium and fertilizer level on the shoot length of seedlings

60 DAS

Data from Table 4 reveals that in case of 60 DAS there is no statistically significant ($p<0.05$) effect of interaction between storage medium and fertilizer level on the shoot length of seedlings. The highest interaction (3.15 cm) of seedlings obtained from S_1F_4. And the lowest shoot length was found from S_3F_3 (2.23 cm).

120 DAS

Data from Table 4 reveals that in case of 120 DAS there is no significant variation ($p<0.05$) effect of interaction between storage medium and fertilizer level on the shoot length of seedlings. The highest interaction (3.34 cm) of seedlings obtained from S_1F_6. And the lowest shoot length was found from S_3F_2 (2.42 cm).

180 DAS

Data from Table 4 reveals that in case of 180 DAS there is significant variation ($p>0.05$) effect of interaction between storage medium and fertilizer level on the shoot length of seedlings. The highest interaction (3.48 cm) of seedlings obtained from S_1F_4. And the lowest shoot length was found from S_3F_3 (2.51 cm).

Effect of interaction between storage medium and variety on the shoot length of seedlings

60 DAS

Data from Table 4 reveals that in case of 60 DAS there is no significant variation ($p<0.05$) effect of interaction between storage medium and variety on the shoot length of seedlings. The highest interaction (2.86 cm) of seedlings obtained from S_1V_1. And the lowest shoot length was found from S_3V_2 (2.65 cm).

120 DAS

Data from Table 4 reveals that in case of 120 DAS there is significant variation ($p>0.05$) effect of interaction between storage medium and variety on the shoot length of seedlings. The highest interaction (3.09 cm) of seedlings obtained from

S_1V_1 which was statistically similar with S_1V_2, S_2V_1, S_2V_2 and S_3V_1. On the other hand, the lowest shoot length was found from S_3V_2 (2.64 cm).

<u>180 DAS</u>

Data from Table 4 reveals that in case of 180 DAS there is significant variation ($p>0.05$) effect of interaction between storage medium and variety on the shoot length of seedlings. The highest interaction (3.25 cm) of seedlings obtained from S_1V_1 which was statistically similar with S_1V_2, S_2V_1, S_2V_2, S_3V_1, and S_3V_2. On the other hand, the lowest shoot length (2.73 cm) was found from S_3V_2.

Effect of interaction between fertilizer level and variety on the shoot length of seedlings

<u>60 DAS</u>

Data reveals that in case of 60 DAS, there is significant variation ($p>0.05$) between the interaction of fertilizer level and variety on shoot length of seedlings. It is evident that the highest shoot length (3.25 cm) found from F_5V_2. On the other hand, the lowest shoot length (2.15 cm) of seedlings found from F_7V_1.

<u>120 DAS</u>

Data reveals that in case of 120 DAS, there is significant variation ($p>0.05$) between the interaction of fertilizer level and variety on shoot length of seedlings. It is evident that the highest shoot length (3.41 cm) found from F_6V_1. On the other hand, the lowest shoot length (2.34 cm) of seedlings found from F_7V_1.

<u>180 DAS</u>

Data reveals that in case of 180 DAS, there is significant variation ($p>0.05$) between the interaction of fertilizer level and variety on shoot length of seedlings. It is evident that the highest shoot length (3.34 cm) found from F_1V_1. On the other hand, the lowest shoot length (2.52 cm) of seedlings found from F_7V_1.

Effect of interaction between storage medium, variety and fertilizer level on the shoot length of seedlings

<u>60 DAS</u>

In case of 60 DAS, data shows that there is no significant variation ($p<0.05$) between the interaction of storage medium, variety and fertilizer level on shoot length of seedlings. The highest interaction obtained from $S_2F_6V_1$ (3.46 cm) where, the lowest shoot length of seedlings originated from $S_3F_3V_2$ (2.06 cm).

120 DAS

In case of 120 DAS, data shows that there is no significant variation ($p<0.05$) between the interaction of storage medium, variety and fertilizer level on shoot length of seedlings. The highest interaction obtained from $S_1F_6V_1$ (3.73 cm) where, the lowest shoot length of seedlings originated from $S_3F_3V_2$ (2.25 cm).

180 DAS

In case of 180 DAS, data shows that there is no significant variation ($p<0.05$) between the interaction of storage medium, variety and fertilizer level on shoot length of seedlings. The highest interaction obtained from $S_1F_1V_1$ (3.58 cm) where, the lowest shoot length of seedlings originated from $S_3F_7V_1$ (2.38 cm).

Table 5: Effect of storage medium, fertilizer level, variety and their interactions on fresh weight of seedlings

Treatment	Fresh weight of 100 seedlings (60 DAS)	Fresh weight of 100 seedlings (120 DAS)	Fresh weight of 100 seedlings (180 DAS)
Effect of storage medium			
S_1	6.38 a	6.37 a	6.48 b
S_2	6.45 a	6.43 a	6.65 ab
S_3	6.64 a	6.46 a	6.81 a
$lsd_{0.05}$	ns	ns	0.17
Effect of fertilizer level			
F_1	6.53 a	6.24 a	6.63 a
F_2	6.32 a	6.31 a	6.54 a
F_3	6.45 a	6.41 a	6.75 a
F_4	6.29 a	6.37 a	6.57 a
F_5	6.64 a	6.60 a	6.64 a
F_6	6.56 a	6.59 a	6.74 a
F_7	6.63 a	6.42 a	6.67 a
$lsd_{0.05}$	ns	ns	ns
Effect of variety			
V_1	6.55 a	6.49 a	6.70 a
V_2	6.42 a	6.34 a	6.60 a
$lsd_{0.05}$	0.27	0.15	0.12
Effect of interaction between storage medium and fertilizer level			
S_1F_1	6.20 a	6.21 a	6.35 a
S_1F_2	6.23 a	6.24 a	6.39 a
S_1F_3	6.30 a	6.39 a	6.57 a
S_1F_4	6.21 a	6.29 a	6.40 a
S_1F_5	6.56 a	6.54 a	6.53 a
S_1F_6	6.63 a	6.58 a	6.64 a
S_1F_7	6.55 a	6.35 a	6.52 a
S_2F_1	6.33 a	6.23 a	6.69 a
S_2F_2	6.31 a	6.31 a	6.56 a
S_2F_3	6.47 a	6.41 a	6.75 a
S_2F_4	6.28 a	6.37 a	6.57 a
S_2F_5	6.65 a	6.69 a	6.59 a
S_2F_6	6.49 a	6.56 a	6.72 a
S_2F_7	6.62 a	6.45 a	6.66 a
S_3F_1	7.08 a	6.30 a	6.85 a
S_3F_2	6.42 a	6.40 a	6.68 a
S_3F_3	6.57 a	6.44 a	6.95 a
S_3F_4	6.39 a	6.45 a	6.74 a
S_3F_5	6.72 a	6.57 a	6.81 a
S_3F_6	6.57 a	6.62 a	6.86 a

S_3F_7	6.71 a	6.46 a	6.82 a
$lsd_{0.05}$	ns	ns	ns
Effect of interaction between storage medium and variety			
S_1V_1	6.47 a	6.46 a	6.57 ab
S_1V_2	6.29 a	6.27 a	6.40 b
S_2V_1	6.56 a	6.53 a	6.68 ab
S_2V_2	6.34 a	6.33 a	6.62 ab
S_3V_1	6.63 a	6.49 a	6.84 a
S_3V_2	6.64 a	6.43 a	6.79 a
$lsd_{0.05}$	Ns	ns	0.30
Effect of interaction between fertilizer level and variety			
F_1V_1	6.30 a	6.34 ab	6.62 ab
F_1V_2	6.77 a	6.14 b	6.64 ab
F_2V_1	6.51 a	6.50 ab	6.76 ab
F_2V_2	6.13 a	6.12 b	6.32 b
F_3V_1	6.67 a	6.54 ab	6.73 ab
F_3V_2	6.23 a	6.28 ab	6.78 ab
F_4V_1	6.56 a	6.41 ab	6.60 ab
F_4V_2	6.02 a	6.32 ab	6.54 ab
F_5V_1	6.55 a	6.54 ab	6.56 ab
F_5V_2	6.74 a	6.66 ab	6.72 ab
F_6V_1	7.10 a	6.90 a	7.03 a
F_6V_2	6.02 a	6.27 ab	6.45 b
F_7V_1	6.18 a	6.22 ab	6.57 ab
F_7V_2	7.07 a	6.61 ab	6.76 ab
$lsd_{0.05}$	ns	0.70	0.53
Effect of interaction between storage medium, variety and fertilizer level			
$S_1F_1V_1$	6.20 a	6.32 a	6.52 a
$S_1F_2V_1$	6.33 a	6.51 a	6.64 a
$S_1F_3V_1$	6.46 a	6.52 a	6.57 a
$S_1F_4V_1$	6.42 a	6.36 a	6.45 a
$S_1F_5V_1$	6.46 a	6.47 a	6.44 a
$S_1F_6V_1$	7.33 a	7.02 a	6.94 a
$S_1F_7V_1$	6.10 a	6.07 a	6.41 a
$S_2F_1V_1$	6.31 a	6.34 a	6.64 a
$S_2F_2V_1$	6.54 a	6.50 a	6.75 a
$S_2F_3V_1$	6.72 a	6.61 a	6.71 a
$S_2F_4V_1$	6.60 a	6.43 a	6.59 a
$S_2F_5V_1$	6.54 a	6.67 a	6.48 a
$S_2F_6V_1$	7.03 a	6.86 a	7.02 a
$S_2F_7V_1$	6.20 a	6.31 a	6.57 a
$S_3F_1V_1$	6.39 a	6.38 a	6.70 a
$S_3F_2V_1$	6.66 a	6.50 a	6.90 a
$S_3F_3V_1$	6.82 a	6.50 a	6.89 a
$S_3F_4V_1$	6.66 a	6.44 a	6.76 a

$S_3F_5V_1$	6.65 a	6.48 a	6.78 a
$S_3F_6V_1$	6.96 a	6.82 a	7.14 a
$S_3F_7V_1$	6.26 a	6.30 a	6.73 a
$S_1F_1V_2$	6.20 a	6.10 a	6.18 a
$S_1F_2V_2$	6.13 a	5.96 a	6.14 a
$S_1F_3V_2$	6.14 a	6.26 a	6.55 a
$S_1F_4V_2$	6.00 a	6.21 a	6.36 a
$S_1F_5V_2$	6.66 a	6.61 a	6.62 a
$S_1F_6V_2$	5.93 a	6.13 a	6.34 a
$S_1F_7V_2$	7.00 a	6.63 a	6.63 a
$S_2F_1V_2$	6.34 a	6.13 a	6.74 a
$S_2F_2V_2$	6.08 a	6.12 a	6.38 a
$S_2F_3V_2$	6.22 a	6.20 a	6.78 a
$S_2F_4V_2$	5.96 a	6.30 a	6.56 a
$S_2F_5V_2$	6.76 a	6.72 a	6.70 a
$S_2F_6V_2$	5.95 a	6.26 a	6.43 a
$S_2F_7V_2$	7.04 a	6.59 a	6.76 a
$S_3F_1V_2$	7.76 a	6.21 a	7.00 a
$S_3F_2V_2$	6.19 a	6.29 a	6.46 a
$S_3F_3V_2$	6.32 a	6.37 a	7.02 a
$S_3F_4V_2$	6.12 a	6.46 a	6.72 a
$S_3F_5V_2$	6.80 a	6.66 a	6.84 a
$S_3F_6V_2$	6.18 a	6.42 a	6.58 a
$S_3F_7V_2$	7.16 a	6.62 a	6.90 a
$lsd_{0.05}$	ns	ns	ns
CV (%)	11.93	6.72	4.90

Effect of storage medium on the fresh weight of seedlings

<u>60 DAS</u>

Data from Table 5 shows that there is no significant variation ($p<0.05$) effect of storage media on the fresh weight of seedlings. The highest fresh weight (6.64 gm) of seedlings found from S_3 followed by S_2 (6.45 cm) and the lowest shoot length was found from S_1 (6.38 cm).

<u>120 DAS</u>

Data from Table 5 shows that in case of 120 DAS, there is no significant variation ($p<0.05$) effect of storage media on the fresh weight of seedlings. The highest fresh weight (6.46 gm) of seedlings found from S_3 followed by S_2 (6.43 cm) and the lowest shoot length was found from S_1 (6.37 cm).

180 DAS

Data from Table 5 shows that in case of 180 DAS, there is significant variation ($p>0.05$) effect of storage media on the fresh weight of seedlings. The highest fresh weight (6.81 gm) of seedlings found from S_3 which was statistically similar with S_2 (6.65 gm). And the lowest weight (6.48 gm) was found from S_2 which was also statistically similar with S_2.

Effect of fertilizer level on the fresh weight of seedlings

60 DAS

Data from Table 5 shows that in case of 60 DAS there is no significant variation ($p<0.05$) effect of fertilizer level on the fresh weight of seedlings. However, numerically the highest weight (6.64 gm) was found from F_5 and the lowest weight (6.29 gm) found from F_4.

120 DAS

Data from Table 5 shows that in case of 120 DAS there is no significant variation ($p<0.05$) effect of fertilizer level on the fresh weight of seedlings. However, numerically the highest weight (6.64 gm) was found from F_5 and the lowest weight (6.24 gm) found from F_1.

180 DAS

Data from Table 5 shows that in case of 180 DAS there is no significant variation ($p<0.05$) effect of fertilizer level on the fresh weight of seedlings. However, numerically the highest weight (6.75 gm) was found from F_3 and the lowest weight (6.54 gm) found from F_2.

Effect of variety on the fresh weight of seedlings

60 DAS

Data from Table 5 shows that there is no significant variation ($p<0.05$) effect of variety on the fresh weight of seedlings. The highest weight (6.55 gm) of seedlings found from V_1. And the lowest weight was found from V_2 (6.42 gm).

120 DAS

Data from Table 5 shows that there is no significant variation ($p<0.05$) effect of variety on the fresh weight of seedlings. The highest weight (6.49 gm) of seedlings found from V_1. And the lowest weight was found from V_2 (6.34 gm).

180 DAS

Data from Table 5 shows that there is no significant variation ($p<0.05$) effect of variety on the fresh weight of seedlings. The highest weight (6.70 gm) of seedlings found from V_1. And the lowest weight was found from V_2 (6.60 gm).

Effect of interaction between storage medium and fertilizer level on the fresh weight of seedlings

60 DAS

In case of 60 DAS, data shows that there was no significant variation ($p<0.05$) between the interaction of storage medium and fertilizer level. Highest interaction obtained from S_3F_1 (7.08 gm) and the lowest weight of seedlings originated from S_1F_1 (6.20 gm). However, rest of all interactions shows statistical similarity with highest and lowest weight of seedlings.

120 DAS

In case of 120 DAS, data shows that there was no significant variation ($p<0.05$) between the interaction of storage medium and fertilizer level. Highest interaction obtained from S_2F_5 (6.69 gm) and the lowest weight of seedlings originated from S_1F_1 (6.21 gm). However, rest of all interactions shows statistical similarity with highest and lowest weight of seedlings.

180 DAS

In case of 180 DAS, data shows that there was no significant variation ($p<0.05$) between the interaction of storage medium and fertilizer level. Highest interaction obtained from S_3F_3 (6.95 gm) and the lowest weight of seedlings originated from S_1F_1 (6.35 gm). However, rest of all interactions shows statistical similarity with highest and lowest weight of seedlings.

Effect of interaction between storage medium and variety on the fresh weight of seedlings

60 DAS

In case of 60 DAS, data shows that there was no significant variation ($p<0.05$) between the interaction of storage medium and variety. However, numerically highest interaction obtained from S_3V_2 (6.64 gm) where, the lowest weight of seedlings originated from S_1V_2 (6.29 gm).

120 DAS

In case of 120 DAS, data shows that there was no significant variation ($p<0.05$) between the interaction of storage medium and variety. However, numerically highest interaction obtained from S_2V_1 (6.53 gm) where, the lowest weight of seedlings originated from S_1V_2 (6.27 gm).

180 DAS

In case of 60 DAS, data shows that there was no significant variation ($p<0.05$) between the interaction of storage medium and variety. However, numerically highest interaction obtained from S_3V_2 (6.64 gm) where, the lowest weight of seedlings originated from S_1V_2 (6.29 gm).

Effect of interaction between fertilizer level and variety on the fresh weight of seedlings

60 DAS

Data reveals that in case of 60 DAS, there was no significant variation ($p<0.05$) between the effect of interactions between fertilizer level and variety. It is evident that highest weight of seedlings (7.10 gm) found from F_6V_1. On the other hand, the lowest weight (6.02 gm) of seedlings found from F_6V_2.

120 DAS

Data reveals that in case of 120 DAS, there was significant variation ($p>0.05$) between the effect of interactions between fertilizer level and variety. It is evident that highest weight of seedlings (6.90 gm) found from F_6V_1. On the other hand, the lowest weight (6.12 gm) of seedlings found from F_2V_2.

180 DAS

Data reveals that in case of 180 DAS, there was significant variation ($p>0.05$) between the effect of interactions between fertilizer level and variety. It is evident that highest weight of seedlings (7.03 gm) found from F_6V_1. On the other hand, the lowest weight (6.32 gm) of seedlings found from F_2V_2.

Effect of interaction between storage medium, variety and fertilizer level on the fresh weight of seedlings

60 DAS

In case of 60 DAS, data shows that there was no significant variation ($p<0.05$) between the interaction of storage medium, variety and fertilizer level. However, numerically highest interaction obtained from $S_1F_6V_1$ (7.76 gm) where, the lowest weight of seedlings originated from $S_1F_6V_2$ (5.93 gm).

120 DAS

In case of 120 DAS, data shows that there was no significant variation ($p<0.05$) between the interaction of storage medium, variety and fertilizer level. However, numerically highest interaction obtained from $S_3F_7V_2$ (7.16 gm) where, the lowest weight of seedlings originated from $S_1F_2V_2$ (5.96 gm).

180 DAS

In case of 180 DAS, data shows that there was no significant variation ($p<0.05$) between the interaction of storage medium, variety and fertilizer level. However, numerically highest interaction obtained from $S_3F_6V_1$ (7.14 gm) where, the lowest weight of seedlings originated from $S_1F_2V_2$ (5.14 gm).

Table 6: Effect of storage medium, fertilizer level, variety and their interactions on dry weight of seedlings

Treatment	Dry weight of 100 seedlings (60 DAS)	Dry weight of 100 seedlings (120 DAS)	Dry weight of 100 seedlings (180 DAS)
Effect of storage medium			
S_1	3.31 a	2.84 a	2.59 a
S_2	3.20 ab	2.69 a	2.31 b
S_3	3.05 b	2.47 b	2.01 c
$lsd_{0.05}$	0.17	0.17	0.15
Effect of fertilizer level			
F_1	3.11 a	2.67 a	2.23 a
F_2	3.07 a	2.64 a	2.33 a
F_3	3.29 a	2.73 a	2.36 a
F_4	3.08 a	2.60 a	2.24 a
F_5	3.32 a	2.85 a	2.48 a
F_6	3.19 a	2.59 a	2.22 a
F_7	3.24 a	2.61 a	2.28 a
$lsd_{0.05}$	ns	ns	ns
Effect of variety			
V_1	3.11 b	2.58 b	2.27 a
V_2	3.27 a	2.76 a	2.34 a
$lsd_{0.05}$	0.12	0.11	0.11
Effect of interaction between storage medium and fertilizer level			
S_1F_1	3.23 a	2.84 a	2.50 abcde
S_1F_2	3.24 a	2.79 a	2.59 abc
S_1F_3	3.42 a	2.91 a	2.64 ab
S_1F_4	3.23 a	2.74 a	2.53 abcde
S_1F_5	3.43 a	3.05 a	2.81 a
S_1F_6	3.29 a	2.82 a	2.57 abc
S_1F_7	3.35 a	2.76 a	2.55 abcd
S_2F_1	3.14 a	2.65 a	2.22 abcde
S_2F_2	3.12 a	2.71 a	2.33 abcde
S_2F_3	3.25 a	2.76 a	2.36 abcde
S_2F_4	3.11 a	2.61 a	2.29 abcde
S_2F_5	3.32 a	2.88 a	2.51 abcde
S_2F_6	3.20 a	2.57 a	2.20 abcde
S_2F_7	3.25 a	2.65 a	2.30 abcde
S_3F_1	2.97 a	2.52 a	1.98 cde
S_3F_2	2.84 a	2.42 a	2.07 bcde
S_3F_3	3.21 a	2.53 a	2.08 bcde
S_3F_4	2.92 a	2.44 a	1.91 de
S_3F_5	3.22 a	2.61 a	2.14 bcde
S_3F_6	3.09 a	2.38 a	1.89 e
S_3F_7	3.12 a	2.42 a	1.99 cde

$lsd_{0.05}$	ns	ns	0.64
Effect of interaction between storage medium and variety			
S_1V_1	3.22 ab	2.76 ab	2.51 ab
S_1V_2	3.40 a	2.93 a	2.68 a
S_2V_1	3.12 ab	2.59 bc	2.28 bc
S_2V_2	3.28 a	2.79 ab	2.34 b
S_3V_1	2.98 b	2.38 c	2.02 cd
S_3V_2	3.12 ab	2.57 bc	2.00 d
$lsd_{0.05}$	0.29	0.29	0.27
Effect of interaction between fertilizer level and variety			
F_1V_1	2.90 bc	2.47 bc	2.08 b
F_1V_2	3.32 abc	2.87 ab	2.39 ab
F_2V_1	3.24 abc	2.78 abc	2.48 ab
F_2V_2	2.90 bc	2.49 bc	2.17 ab
F_3V_1	3.32 abc	2.66 abc	2.35 ab
F_3V_2	3.26 abc	2.80 abc	2.36 ab
F_4V_1	2.82 c	2.32 c	2.03 b
F_4V_2	3.35 ab	2.87 ab	2.45 ab
F_5V_1	3.14 abc	2.63 abc	2.32 ab
F_5V_2	3.50 a	3.06 a	2.65 a
F_6V_1	3.21 abc	2.51 bc	2.27 ab
F_6V_2	3.18 abc	2.67 abc	2.16 ab
F_7V_1	3.12 abc	2.66 abc	2.34 ab
F_7V_2	3.35 ab	2.56 abc	2.21 ab
$lsd_{0.05}$	0.53	0.52	0.49
Effect of interaction between storage medium, variety and fertilizer level			
$S_1F_1V_1$	2.99 a	2.67 ab	2.27 abc
$S_1F_2V_1$	3.45 a	2.94 ab	2.73 abc
$S_1F_3V_1$	3.40 a	2.88 ab	2.60 abc
$S_1F_4V_1$	2.94 a	2.43 ab	2.22 abc
$S_1F_5V_1$	3.27 a	2.82 ab	2.58 abc
$S_1F_6V_1$	3.28 a	2.78 ab	2.59 abc
$S_1F_7V_1$	3.25 a	2.79 ab	2.58 abc
$S_2F_1V_1$	2.90 a	2.46 ab	2.10 abc
$S_2F_2V_1$	3.32 a	2.83 ab	2.49 abc
$S_2F_3V_1$	3.26 a	2.68 ab	2.31 abc
$S_2F_4V_1$	2.85 a	2.34 ab	2.09 abc
$S_2F_5V_1$	3.14 a	2.64 ab	2.34 abc
$S_2F_6V_1$	3.23 a	2.48 ab	2.27 abc
$S_2F_7V_1$	3.12 a	2.69 ab	2.38 abc
$S_3F_1V_1$	2.82 a	2.28 ab	1.86 bc
$S_3F_2V_1$	2.96 a	2.58 ab	2.23 abc
$S_3F_3V_1$	3.32 a	2.42 ab	2.15 abc
$S_3F_4V_1$	2.67 a	2.18 b	1.79 c
$S_3F_5V_1$	3.02 a	2.43 ab	2.04 abc

$S_3F_6V_1$	3.11 a	2.28 ab	1.96 bc
$S_3F_7V_1$	3.00 a	2.50 ab	2.08 abc
$S_1F_1V_2$	3.47 a	3.00 ab	2.73 abc
$S_1F_2V_2$	3.04 a	2.64 ab	2.44 abc
$S_1F_3V_2$	3.43 a	2.94 ab	2.68 abc
$S_1F_4V_2$	3.52 a	3.05 ab	2.83 ab
$S_1F_5V_2$	3.60 a	3.28 a	3.04 a
$S_1F_6V_2$	3.30 a	2.86 ab	2.54 abc
$S_1F_7V_2$	3.45 a	2.74 ab	2.51 abc
$S_2F_1V_2$	3.38 a	2.84 ab	2.34 abc
$S_2F_2V_2$	2.92 a	2.58 ab	2.16 abc
$S_2F_3V_2$	3.25 a	2.84 ab	2.40 abc
$S_2F_4V_2$	3.36 a	2.88 ab	2.48 abc
$S_2F_5V_2$	3.50 a	3.12 ab	2.68 abc
$S_2F_6V_2$	3.16 a	2.66 ab	2.13 abc
$S_2F_7V_2$	3.38 a	2.62 ab	2.22 abc
$S_3F_1V_2$	3.12 a	2.76 ab	2.09 abc
$S_3F_2V_2$	2.73 a	2.26 ab	1.90 bc
$S_3F_3V_2$	3.11 a	2.64 ab	2.02 bc
$S_3F_4V_2$	3.18 a	2.70 ab	2.04 bc
$S_3F_5V_2$	3.41 a	2.79 ab	2.23 abc
$S_3F_6V_2$	3.08 a	2.48 ab	1.82 c
$S_3F_7V_2$	3.23 a	2.34 ab	1.91 bc
$lsd_{0.05}$	ns	1.06	0.99
CV (%)	10.20	12.03	13.02

Effect of storage medium on the dry weight of seedlings

60 DAS

Data from Table 6 shows that there is significant variation ($p<0.05$) effect of storage media on the dry weight of seedlings. However, numerically highest weight (3.31 gm) of seedlings found from S_1 followed by S_2 (3.20 gm) and S_3 (3.05 gm).

120 DAS

Data from Table 6 shows that there is significant variation ($p<0.05$) effect of storage media on the dry weight of seedlings. However, numerically highest weight (2.84 gm) of seedlings found from S_1 which was statistically similar with S_2 (2.69 gm). On the other hand, the lowest weight of seedlings found from S_3 (2.47 gm).

180 DAS

Data from Table 6 shows that there is significant variation ($p<0.05$) effect of storage media on the dry weight of seedlings. However, numerically highest weight (2.59

gm) of seedlings found from S_1. On the other hand, the lowest weight of seedlings found from S_3 (2.01 gm).

Effect of fertilizer level on the dry weight of seedlings

60 DAS

Data from Table 6 reveals that there is no significant variation ($p>0.05$) effect of fertilizer level on the dry weight seedlings in case of 60 DAS. The highest weight (3.32 gm) of seedlings found from F_5. However, the lowest weight of seedlings obtained from F_3 (3.07 gm).

120 DAS

Data from Table 6 reveals that there is no significant variation ($p>0.05$) effect of fertilizer level on the dry weight seedlings in case of 120 DAS. The highest weight (2.85 gm) of seedlings found from F_5. However, the lowest weight of seedlings obtained from F_6 (2.59 gm).

180 DAS

Data from Table 6 reveals that there is no significant variation ($p>0.05$) effect of fertilizer level on the dry weight seedlings in case of 180 DAS. The highest weight (2.48 gm) of seedlings found from F_5. However, the lowest weight of seedlings obtained from F_6 (2.22 gm).

Effect of variety on the dry weight of seedlings

60 DAS

Data from Table 6 reveals that there is significant variation ($p<0.05$) effect of variety on the dry weight of seedlings in case of 60 DAS. However, numerically the highest weight (3.27 gm) of seedlings found from V_2. And the lowest weight was found from V_1 (3.11 gm).

120 DAS

Data from Table 6 reveals that there is significant variation ($p<0.05$) effect of variety on the dry weight of seedlings in case of 120 DAS. However, numerically the highest weight (2.76 gm) of seedlings found from V_2. And the lowest weight was found from V_1 (2.58 gm).

180 DAS

Data from Table 6 reveals that there is no significant variation ($p>0.05$) effect of variety on the dry weight of seedlings in case of 180 DAS. However, numerically the highest weight (2.34 gm) of seedlings found from V_2. And the lowest weight was found from V_1 (2.27 gm).

Effect of storage medium and fertilizer level on the dry weight of seedlings

60 DAS

In case of 60 DAS, data shows that there is no significant variation ($p>0.05$) between the interaction of storage medium and fertilizer level on the dry weight of seedlings. Highest interaction obtained from S_1F_5 (3.43 gm) and the lowest weight of seedlings originated from S_2F_3 (2.84 gm). However, rest of all interactions shows statistical similarity with highest and lowest number of seedlings.

120 DAS

In case of 120 DAS, data shows that there is no significant variation ($p>0.05$) between the interaction of storage medium and fertilizer level on the dry weight of seedlings. Highest interaction obtained from S_1F_5 (3.05 gm) and the lowest weight of seedlings originated from S_3F_6 (2.38 gm). However, rest of all interactions shows statistical similarity with highest and lowest number of seedlings.

180 DAS

In case of 180 DAS, data shows that there is significant variation ($p<0.05$) between the interaction of storage medium and fertilizer level on the dry weight of seedlings. Highest interaction obtained from S_1F_5 (2.81 gm) and the lowest weight of seedlings originated from S_3F_6 (1.89 gm). However, rest of all interactions shows statistical similarity with highest and lowest number of seedlings.

Effect of storage medium and variety on the dry weight of seedlings

60 DAS

In case of 60 DAS, data shows that there is significant variation ($p<0.05$) between the interaction of storage medium and variety on the dry weight of seedlings. However, numerically highest interaction obtained from S_1V_2 (3.40 gm) which was statistically similar with S_1V_1, S_2V_1, S_2V_2 and S_3V_2. And the lowest weight of seedlings originated from S_3V_1 (2.98 gm).

120 DAS

In case of 120 DAS, data shows that there is significant variation ($p<0.05$) between the interaction of storage medium and variety on the dry weight of seedlings.

However, numerically highest interaction obtained from S_1V_2 (2.93 gm) which was statistically similar with S_1V_1 (2.76 gm) and S_2V_2 (2.79 gm). And the lowest weight of seedlings originated from S_3V_1 (2.38 gm) which was statistically similar with S_2V_1, S_3V_2.

180 DAS

In case of 180 DAS, data shows that there is significant variation ($p<0.05$) between the interaction of storage medium and variety on the dry weight of seedlings. However, numerically highest interaction obtained from S_1V_2 (2.68 gm) which was statistically similar with S_1V_1 (2.51 gm). The lowest weight of seedlings originated from S_3V_2 (2.00 gm) which was statistically similar with S_3V_1.

Effect of fertilizer level and variety on the dry weight of seedlings

60 DAS

Data reveals that in case of 60 DAS, there is significant variation ($p<0.05$) between the effect of interactions between fertilizer level and variety on the dry weight of seedlings. It is evident that highest weight of seedlings (3.50 gm) found from F_5V_2. On the other hand, the lowest weight (2.82 gm) of seedlings found from F_4V_1.

120 DAS

Data reveals that in case of 120 DAS, there is significant variation ($p<0.05$) between the effect of interactions between fertilizer level and variety on the dry weight of seedlings. It is evident that highest weight of seedlings (3.06 gm) found from F_5V_2. On the other hand, the lowest weight (2.32 gm) of seedlings found from F_4V_1.

180 DAS

Data reveals that in case of 180 DAS, there is significant variation ($p<0.05$) between the effect of interactions between fertilizer level and variety on the dry weight of seedlings. It is evident that highest weight of seedlings (2.65 gm) found from F_5V_2. On the other hand, the lowest weight (2.03 gm) of seedlings found from F_4V_1.

Effect of storage medium, variety and fertilizer level on the dry weight of seedlings

60 DAS

In case of 60 DAS, data shows that there was no significant variation ($p>0.05$) between the interaction of storage medium, variety and fertilizer level on the dry weight of seedlings. However, numerically the highest interaction obtained from $S_1F_5V_2$ (3.60 gm) where, the lowest weight of seedlings originated from $S_3F_4V_1$ (2.67 gm).

120 DAS

In case of 120 DAS, data shows that there was significant variation ($p<0.05$) between the interaction of storage medium, variety and fertilizer level on the dry weight of seedlings. However, numerically the highest interaction obtained from $S_1F_5V_2$ (3.28 gm) where, the lowest weight of seedlings originated from $S_3F_4V_1$ (2.18 gm).

180 DAS

In case of 180 DAS, data shows that there was significant variation ($p<0.05$) between the interaction of storage medium, variety and fertilizer level on the dry weight of seedlings. However, numerically the highest interaction obtained from $S_1F_5V_2$ (3.04 gm) where, the lowest weight of seedlings originated from $S_3F_4V_1$ (1.79 gm).

Table 7. Vigour Index I and II of seedlings observed during 60, 120 and 180 DAS

Variable	60 DAS		120 DAS		180 DAS	
	Vigour Index I	Vigour Index II	Vigour Index I	Vigour Index II	Vigour Index I	Vigour Index II
S_1	215.73	150.00	126.49	201.58	224.17	201.60
S_2	207.41	143.87	119.08	181.85	195.62	178.29
S_3	193.07	136.37	108.65	167.39	165.18	163.58
F_1	202.62	139.54	118.32	184.26	190.68	182.19
F_2	202.43	136.15	115.59	179.09	197.45	177.84
F_3	190.23	144.49	118.16	171.57	196.42	173.18
F_4	206.46	138.43	114.39	186.65	187.46	184.37
F_5	214.89	150.96	126.00	187.48	207.29	182.35
F_6	213.11	146.45	116.23	192.18	190.08	186.75
F_7	208.10	147.86	117.82	184.02	195.56	181.42
V_1	205.72	139.75	113.91	184.99	192.05	180.26
V_2	205.09	147.08	122.24	182.23	197.93	182.06

In case of number of germinated seedlings, storage in polythene bag obtained highest percentage. Our results of germination percentage shows conformity with the study of Malaker *et al.* (2008). They reported that the highest germination percentage was observed under storage in refrigerator followed by polyethylene bag, tin container and earthen pitcher. Our results are also similar to the research of Naguib *et al.* (2011). They reported that wheat seed stored in aluminum and polyester bags showed high seed germination, seedling vigor and kept nutrient contents, and therefore they could delay seed quality deterioration compared with plastic and clothes bags.

Among all the fertilizer levels, F7 is ranked the most effective in case of 120 and 180 DAS followed by F_6 which showed highest germination percentage in 60 DAS. Our result implies that poultry manure is more effective than compost and recommended doses can be used very less if combined with organic manure.

Between the two varieties, BARI Gom 30 (V_2) showed better performance than BARI Gom 29 in most of the cases. It is also evident that interaction between polythene, 50% recommended dose with poultry manure and BARI Gom 33 resulted the best interaction in most of the cases.

It is evident that better growth of coleoptile was experienced in 180 DAS, followed by 120 and 60 DAS. It may due to the fact that seeds become more vigorous and gained more viability in lengthy storage. And good length of coleoptile is a sign of good germination.

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the laboratory condition of Agronomy department of Sher-e-Bangla Agricultural University (SAU), Dhaka during the period from April to November 2018 to study the wheat seed quality as affected by containers and fertilizer level under ambient condition. Three factors of the experiment were Factor A: Storage container (3 containers)- Tin container, Plastic pot and Polythene, Factor 2: six different fertilizer levels and Factor 3: Wheat variety (2 varieties)- BARI Gom 29 and BARI Gom 30. The experiment was laid out in a Completely Randomized Design (CRD) with four replications. Data on number of germinated seedlings, coleoptile length, shoot & root length, fresh & dry weight of seedling was recorded.

At 60, 120 and 180 DAS the highest number of germinated seedlings (90.33, 88.714 and 88.714 respectively) was found from tin container, whereas the lowest germination was observed from polythene container (89.143, 87.619 and 82 respectively). In case of fertilizer levels, the highest number of germinated seedlings (91.556, 90.111 and 85.444 respectively) was found from F_7, whereas the lowest germination was observed from F_3 (87.222, 85.889 and 82.44 respectively). In case of variety highest number of germinated seedlings (89.81, 88.32 and 84.159 respectively) was found from V_2, whereas the lowest germination was observed from V_1 (89.68, 88.13 and 84.12 respectively).

At 60, 120 and 180 DAS the highest coleoptile length of germinated seedlings (2.7340, 2.8331 and 2.9938 cm respectively) was found from tin container, whereas the lowest germination was observed from polythene container (2.5990, 2.5536 and 2.5579 cm respectively). In case of fertilizer levels, the highest coleoptile length of germinated seedlings (2.7350, 2.8083 and 2.8994 respectively) was found from F_6, whereas the lowest coleoptile length was observed from F_5 in 60 DAS and F_3 in 120 and 180 DAS (2.5983, 2.5722 and 2.6550 respectively). In case of variety, highest coleoptile length of germinated seedlings (2.6779,2.7241 and 2.7987) was found from V_2, whereas the lowest germination was observed from V_1 (2.6554, 2.6516 and 2.7248 cm respectively).

At 60, 120 and 180 DAS the highest root length of germinated seedlings (6.6855, 6.0476 and 6.1629 cm respectively) was found from tin container, whereas the lowest root length was observed from polythene container (6.0043, 4.9405 and 5.2238 cm respectively). In case of fertilizer levels, the highest root length of germinated seedlings (5.7222, 5.5056 and 5.7222 respectively) was found from F_5, whereas the lowest root length was observed from F_1, F_4 and F_1 (5.4939, 5.3739 and 5.4939 respectively). In case of variety, highest root length of germinated seedlings (6.38, 5.4702 and 5.72 cm respectively) was found from V_2, whereas the lowest germination was observed from V_1 (6.36, 5.4290 and 5.53 cm respectively).

At 60, 120 and 180 DAS the highest shoot length of germinated seedlings (2.8631, 3.0419 and 3.1990 cm respectively) was found from tin container, whereas the lowest shoot length was observed from polythene container (2.6588, 2.6993 and 2.7562 cm respectively). In case of fertilizer levels, the highest shoot length of germinated seedlings was found from F_5, F_6 and F_4 (3.0361, 3.1389 and 3.2150 cm respectively), whereas the lowest shoot length was observed from F_3 (2.3561, 2.5083 and 2.6956 cm respectively). In case of variety, highest shoot length of germinated seedlings (2.79, 2.9197 and 3.0151 cm respectively) was found from V_1, whereas the lowest germination was observed from V_1 (6.36, 5.4290 and 5.53 cm respectively).

At 60, 120 and 180 DAS the highest fresh weight of germinated seedlings (6.64, 6.46 and 6.81 g respectively) was found from tin container, whereas the lowest fresh weight was observed from polythene container (6.43, 6.37 and 6.49 g respectively). In case of fertilizer levels, the highest fresh weight of germinated seedlings was found from F_5, F_5 and F_3 (6.65, 6.64 and 6.76 g respectively), whereas the lowest fresh weight of seedlings was observed from F_4, F_1 and F_2 (6.30, 6.25 and 6.55 g respectively). In case of variety, highest fresh weight of germinated seedlings (6.56, 6.50 and 6.70 g respectively) was found from V_1, whereas the lowest fresh weight was observed from V_2 (6.43, 6.35 and 6.61 g respectively).

At 60, 120 and 180 DAS the highest dry weight of germinated seedlings (3.32, 2.85 and 2.60 g respectively) was found from tin container, whereas the lowest dry weight was observed from polythene container (3.06, 2.48 and 2.01 g respectively). In case of fertilizer levels, the highest dry weight of germinated seedlings was found from F_5 (3.33, 2.85 and 2.48 g respectively), whereas the lowest dry weight of seedlings was observed from F_3 (3.07, 2.59 and 2.22 g respectively). In case of variety, highest dry weight of germinated seedlings (3.27, 2.77 and 2.35 g respectively) was found from V_2, whereas the lowest dry weight was observed from V_1 (3.11, 2.58 and 2.28 g respectively).

Based on the above discussion it was found that Tin storage container was superior in relation to different seed quality parameters under the study. BARI Gom 30 was Superior out of the two varieties used in this experiment. Fertilizer levels had different effects on seed storage, however, fertilizer which combined recommended dose and poultry manure showed better performances among others. Tin container and BARI Gom 30 combination seem to be promising for wheat seed storage. Considering the above results of this experiment, further studies in the following areas may be suggested:

1. Other types of containers and preservation condition may be included in future study.

2. More experiments may be carried out with other varieties for specification variety wise storage containers.

CHAPTER VI

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APPENDICES

Appendix 1. Factorial ANOVA Table for number of germinated seedlings at 60 DAS

Source	DF	SS	MS	F	P
Replication	2	240.83	120.413		
Storage	2	29.78	14.889	2.05	0.1357
Fertilizer	6	260.32	43.386	5.96	0.0000
Variety	1	0.51	0.508	0.07	0.7923
Storage*Fertilizer	12	16.44	1.370	0.19	0.9986
Storage*Variety	2	1.59	0.794	0.11	0.8968
Fertilizer*Variety	6	148.83	24.804	3.41	0.0047
Storage*Fertilizer*Variety	12	9.08	0.757	0.10	0.9999
Error	82	596.51	7.274		
Total	125	1303.87			

Appendix 2. Factorial ANOVA Table for number of germinated seedlings at 120 DAS

Source	DF	SS	MS	F	P
Replication	2	260.83	130.413		
Storage	2	25.97	12.984	1.55	0.2179
Fertilizer	6	214.22	35.704	4.27	0.0009
Variety	1	1.14	1.143	0.14	0.7126
Storage*Fertilizer	12	6.92	0.577	0.07	1.0000
Storage*Variety	2	2.48	1.238	0.15	0.8626
Fertilizer*Variety	6	125.08	20.847	2.49	0.0289
Storage*Fertilizer*Variety	12	7.30	0.608	0.07	1.0000
Error	82	685.84	8.364		
Total	125	1329.78			

Appendix 3. Factorial ANOVA Table for number of germinated seedlings at 180 DAS

Source	DF	SS	MS	F	P
Replication	2	197.33	98.667		
Storage	2	361.71	180.857	19.38	0.0000
Fertilizer	6	164.32	27.386	2.93	0.0121
Variety	1	0.03	0.032	0.00	0.9536
Storage*Fertilizer	12	16.06	1.339	0.14	0.9997
Storage*Variety	2	0.06	0.032	0.00	0.9966
Fertilizer*Variety	6	89.52	14.921	1.60	0.1580
Storage*Fertilizer*Variety	12	15.05	1.254	0.13	0.9998
Error	82	765.33	9.333		
Total	125	1609.43			

Appendix 4. Factorial ANOVA Table for coleoptile length at 60 DAS

Source	DF	SS	MS	F	P
Replication	2	0.37776	0.16437		
Storage	2	0.39808	0.19904		
Fertilizer	2	0.38273	0.19136	4.45	0.0146
Variety	6	0.21088	0.03515	0.82	0.5595
Storage*Fertilizer	1	0.01600	0.01600	0.37	0.5435
Storage*Variety	12	0.66119	0.05510	1.28	0.2452
Fertilizer*Variety	2	0.32741	0.16371	3.81	0.0262
Storage*Fertilizer*Variety	6	0.52863	0.08811	2.05	0.0682
Error	12	0.71462	0.05955	1.39	0.1898
Total	82	3.52526	0.04299		
Replication	125	6.76480			

Appendix 5. Factorial ANOVA Table for coleoptile length at 120 DAS

Source	**DF**	**SS**	**MS**	**F**	**P**
Replication	2	0.16035	0.08017		
Storage	2	1.64836	0.82418	19.54	0.0000
Fertilizer	6	0.99382	0.16564	3.93	0.0017
Variety	1	0.16575	0.16575	3.93	0.0508
Storage*Fertilizer	12	0.04113	0.00343	0.08	1.0000
Storage*Variety	2	0.01174	0.00587	0.14	0.8703
Fertilizer*Variety	6	0.91606	0.15268	3.62	0.0031
Storage*Fertilizer*Variety	12	0.02099	0.00175	0.04	1.0000
Error	82	3.45872	0.04218		
Total	125	7.41692			

Appendix 6. Factorial ANOVA Table for coleoptile length at 180 DAS

Source	**DF**	**SS**	**MS**	**F**	**P**
Replication	2	0.2276	0.11382		
Storage	2	4.0412	2.02058	43.50	0.0000
Fertilizer	6	0.8324	0.13873	2.99	0.0109
Variety	1	0.1723	0.17235	3.71	0.0575
Storage*Fertilizer	12	0.0335	0.00279	0.06	1.0000
Storage*Variety	2	0.0049	0.00244	0.05	0.9489
Fertilizer*Variety	6	0.8948	0.14913	3.21	0.0070
Storage*Fertilizer*Variety	12	0.0469	0.00391	0.08	1.0000
Error	82	3.8090	0.04645		
Total	125	10.0626			

Appendix 7. Factorial ANOVA Table for shoot length at 60 DAS

Replication	DF	SS	MS	F	P
Storage	2	1.2415	0.62075		
Fertilizer	2	0.9709	0.48544	1.62	0.2036
Variety	6	6.7561	1.12602	3.76	0.0023
Storage*Fertilizer	1	0.0122	0.01220	0.04	0.8404
Storage*Variety	12	0.2508	0.02090	0.07	1.0000
Fertilizer*Variety	2	0.0088	0.00438	0.01	0.9855
Storage*Fertilizer*Variety	6	10.9347	1.82246	6.09	0.0000
Error	12	0.2817	0.02348	0.08	1.0000
Total	82	24.5273	0.29911		
Replication	125	44.9840			

Appendix 8. Factorial ANOVA Table for shoot length at 120 DAS

Source	DF	SS	MS	F	P
Replication	2	1.1247	0.56235		
Storage	2	2.4652	1.23258	5.23	0.0073
Fertilizer	6	6.3327	1.05546	4.48	0.0006
Variety	1	0.3071	0.30705	1.30	0.2571
Storage*Fertilizer	12	0.1664	0.01386	0.06	1.0000
Storage*Variety	2	0.0052	0.00260	0.01	0.9891
Fertilizer*Variety	6	6.2971	1.04952	4.45	0.0006
Storage*Fertilizer*Variety	12	0.4624	0.03853	0.16	0.9993
Error	82	19.3314	0.23575		
Total	125	36.4922			

Appendix 9. Factorial ANOVA Table for shoot length at 180 DAS

Source	DF	SS	MS	F	P
Replication	2	1.6566	0.82832		
Storage	2	4.1249	2.06244	14.12	0.0000
Fertilizer	6	3.5877	0.59795	4.09	0.0012
Variety	1	0.2272	0.22716	1.56	0.2159
Storage*Fertilizer	12	0.0648	0.00540	0.04	1.0000
Storage*Variety	2	0.0320	0.01600	0.11	0.8964
Fertilizer*Variety	6	5.0619	0.84365	5.78	0.0000
Storage*Fertilizer*Variety	12	0.1263	0.01053	0.07	1.0000
Error	82	11.9768	0.14606		
Total	125	26.8582			

Appendix 10. Factorial ANOVA Table for root length at 60 DAS

Source	DF	SS	MS	F	P
Replication	2	5.4587	2.72935		
Storage	2	9.8994	4.94972	18.55	0.0000
Fertilizer	6	1.1272	0.18786	0.70	0.6471
Variety	1	0.0134	0.01341	0.05	0.8231
Storage*Fertilizer	12	0.5098	0.04248	0.16	0.9994
Storage*Variety	2	0.8911	0.44553	1.67	0.1946
Fertilizer*Variety	6	2.4000	0.40000	1.50	0.1887
Storage*Fertilizer*Variety	12	1.5950	0.13292	0.50	0.9101
Error	82	21.8766	0.26679		
Total	125	43.7712			

Appendix 11. Factorial ANOVA Table for root length at 120 DAS

Source	DF	SS	MS	F	P
Replication	2	0.1915	0.0957		
Storage	2	26.2388	13.1194	190.71	0.0000
Fertilizer	6	0.1903	0.0317	0.46	0.8351
Variety	1	0.0532	0.0532	0.77	0.3816
Storage*Fertilizer	12	0.7188	0.0599	0.87	0.5791
Storage*Variety	2	0.1004	0.0502	0.73	0.4850
Fertilizer*Variety	6	0.3678	0.0613	0.89	0.5054
Storage*Fertilizer*Variety	12	0.4835	0.0403	0.59	0.8478
Error	82	5.6409	0.0688		
Total	125	33.9853			

Appendix 12. Factorial ANOVA Table for root length at 180 DAS

Source	DF	SS	MS	F	P
Replication	2	4.9329	2.46646		
Storage	2	19.6062	9.80312	104.42	0.0000
Fertilizer	6	0.5824	0.09707	1.03	0.4094
Variety	1	1.0827	1.08272	11.53	0.0011
Storage*Fertilizer	12	0.1001	0.00835	0.09	1.0000
Storage*Variety	2	0.1108	0.05540	0.59	0.5566
Fertilizer*Variety	6	0.3948	0.06579	0.70	0.6497
Storage*Fertilizer*Variety	12	0.3212	0.02677	0.29	0.9902
Error	82	7.6986	0.09389		
Total	125	34.8299			

Appendix 13. Factorial ANOVA Table for fresh weight at 60 DAS

Source	DF	SS	MS	F	P
Replication	2	8.7160	4.35798		
Storage	2	1.4539	0.72697	1.21	0.3032
Fertilizer	6	2.1423	0.35705	0.59	0.7337
Variety	1	0.5181	0.51815	0.86	0.3556
Storage*Fertilizer	12	1.9029	0.15858	0.26	0.9931
Storage*Variety	2	0.3546	0.17731	0.30	0.7451
Fertilizer*Variety	6	12.2301	2.03835	3.40	0.0048
Storage*Fertilizer*Variety	12	1.9158	0.15965	0.27	0.9929
Error	82	49.2318	0.60039		
Total	125	78.4656			

Appendix 14. Factorial ANOVA Table for fresh weight at 120 DAS

Source	DF	SS	MS	F	P
Replication	2	2.2853	1.14263		
Storage	2	0.1866	0.09328	0.50	0.6079
Fertilizer	6	1.8935	0.31558	1.69	0.1328
Variety	1	0.7103	0.71025	3.81	0.0543
Storage*Fertilizer	12	0.1370	0.01142	0.06	1.0000
Storage*Variety	2	0.1364	0.06819	0.37	0.6945
Fertilizer*Variety	6	3.0138	0.50230	2.70	0.0193
Storage*Fertilizer*Variety	12	0.2967	0.02472	0.13	0.9998
Error	82	15.2734	0.18626		
Total	125	23.9328			

Appendix 15. Factorial ANOVA Table for fresh weight at 180 DAS

Source	DF	SS	MS	F	P
Replication	2	1.3320	0.66600		
Storage	2	2.2936	1.14680	10.80	0.0001
Fertilizer	6	0.6761	0.11269	1.06	0.3925
Variety	1	0.2707	0.27068	2.55	0.1142
Storage*Fertilizer	12	0.2100	0.01750	0.16	0.9993
Storage*Variety	2	0.0819	0.04096	0.39	0.6812
Fertilizer*Variety	6	2.4188	0.40313	3.80	0.0022
Storage*Fertilizer*Variety	12	0.3006	0.02505	0.24	0.9959
Error	82	8.7064	0.10618		
Total	125	16.2901			

Appendix 16. Factorial ANOVA Table for dry weight at 60 DAS

Source	DF	SS	MS	F	P
Replication	2	0.2483	0.12414		
Storage	2	1.4199	0.70997	6.70	0.0020
Fertilizer	6	1.1286	0.18810	1.77	0.1145
Variety	1	0.7842	0.78416	7.40	0.0080
Storage*Fertilizer	12	0.1365	0.01137	0.11	0.9999
Storage*Variety	2	0.0075	0.00376	0.04	0.9652
Fertilizer*Variety	6	2.6527	0.44211	4.17	0.0010
Storage*Fertilizer*Variety	12	0.1173	0.00978	0.09	1.0000
Error	82	8.6917	0.10600		
Total	125	15.1867			

Appendix 17. Factorial ANOVA Table for dry weight at 120 DAS

Source	DF	SS	MS	F	P
Replication	2	0.3234	0.16172		
Storage	2	2.8865	1.44327	13.95	0.0000
Fertilizer	6	0.9177	0.15295	1.48	0.1957
Variety	1	1.0864	1.08643	10.50	0.0017
Storage*Fertilizer	12	0.1094	0.00912	0.09	1.0000
Storage*Variety	2	0.0040	0.00201	0.02	0.9808
Fertilizer*Variety	6	2.4933	0.41555	4.02	0.0014
Storage*Fertilizer*Variety	12	0.0811	0.00676	0.07	1.0000
Error	82	8.4808	0.10342		
Total	125	16.3828			

Appendix 18. Factorial ANOVA Table for dry weight at 180 DAS

Source	DF	SS	MS	F	P
Replication	2	0.6096	0.30478		
Storage	2	7.2555	3.62776	40.13	0.0000
Fertilizer	6	0.9503	0.15839	1.75	0.1193
Variety	1	0.1650	0.16503	1.83	0.1803
Storage*Fertilizer	12	0.1058	0.00882	0.10	1.0000
Storage*Variety	2	0.1844	0.09218	1.02	0.3652
Fertilizer*Variety	6	2.0969	0.34948	3.87	0.0019
Storage*Fertilizer*Variety	12	0.0875	0.00729	0.08	1.0000
Error	82	7.4120	0.09039		
Total	125	18.8670			