EVOLUTION OF VALIDITY PERIOD OF DIFFERENT OILSEED CROPS STORED AT DIFFERENT LOCATIONS

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I. INTRODUCTION

Oilseed crops have been the backbone of agricultural economy of India from time immemorial. In India, oilseed crops are cultivated on an area of 207.3 lakh hectares, with total production of nearly 20.46 million tones (Anon., 2003). The major oil seed crops cultivated in India are groundnut, mustard/rapeseed, soybean, sunflower, castor, sesamum, linseed, safflower and niger. Oilseeds are the main source of raw materials for vegetable oils. They are essential component of human diet and are rich source of energy and earners of fat soluble vitamins A, D, E and K. The fat and oils are also the major source of raw materials of industrial products such as cosmetic, soaps, surface coatings, lubricants, pharmaceuticals etc. and also used for animal feed.

Area under oil seed crops is increasing every year but the required quantity of high quality seeds are not available for sowing in time to the farmers. Non-availability of seeds is mainly due to lower seed yield, constraints in seed production, lesser area in seed production and lesser participation of farmers owing to involvement of high risk, finance and technical knowledge. Further non-availability of seed is also due to rapid loss of viability of oil seeds compared to cereals and pulses (Delouche, 1973) as oil seeds contain more of poly unsaturated fatty acids which undergo rapid deterioration owing to lipid autoxidation and fungal activity (Roberts, 1972 and Koostra and Harrington, 1969). Loss of viability in oilseed crops is also attributed to non-congenial storage environmental factors like higher relative humidity and temperature during storage. In this context storage of seeds has been considered as most important as “seed saved is seed produced”.

Seeds stored under controlled condition of lower relative humidity and temperature always store for longer period but in developing countries like India, storage of seeds under controlled conditions is costly and not practicable. Hence only alternative is to store seeds under suitable areas (locations) where ambient relative humidity and temperature are well below the safer upper limits seems to be better and economical.

In this aspect earlier workers taking 30°C temperature and 70 per cent relative humidity as safe upper limits have identified locations as good, moderate, poor and very poor storage places in our country (Agrawal, 1976, Bhattacharya and Chatterjee, 1980 and Kulkarni and Vyakarnahal, 1987).

In recent years more emphasis is given for storage of seeds in suitable areas where ambient conditions are optimum for most of the months so that seeds produced in one locations can be transported to suitable locations for storage. Hence there is a need to identify good storage places so that fresh and carry over seeds could be stored for longer period without loss of viability and vigour.

As per the Indian minimum seed certification standards (MSCS) the certified seeds of various crops are validated for initial nine months and revalidated for further six months until they meet the minimum seed standards of germination as per seed certification norms. But not all kinds of seed store equally well and maintain viability but loose their viability at varying rates even some time earlier to nine months and become unfit for sowing. So several researchers have opined that the present validity period of nine months fixed for all the crops need to be revised based on the actual storage potential of seeds (Desai, 1986). The finding of Kurdikeri *et al.* (2000) in different oilseeds, cereals and pulses, Basavegowda and Kenchanagouder (2000) and Narayanaswamy (2003) in groundnut, Kalappa (2002) in sunflower also indicated the need for revision of validity period based on actual storage potential of seeds in different locations, since most of the Indian minimum seed certification standards are adopted from foreign country.

Hence the present study has been formulated entitled “Evaluation of validity period of different oilseed crops stored at different locations” with the following objectives,

1. To ascertain viability and vigour of oilseed crops during storage under ambient conditions
2. To study the effect of locations on viability and vigour of oilseed crops during storage.
3. To fix validity period for different oilseed crops based on actual storage potential under ambient conditions at different locations.

II. REVIEW OF LITERATURE

A number of separate, but interacting factors like genetic, biotic and abiotic factors like seed moisture content, relative humidity, temperature, pest and disease affect the viability of seeds during storage. Besides these, locations in which the seeds are stored on commercial scale differ considerably in respect of climatic factors like temperature and relative humidity which influence storability of seeds. The available literature on storability of oilseeds in various locations is presented in this chapter. In the absence of sufficient literature on oilseeds the reviews on related crops have also been included.

2.1 Causes of Seed Deterioration

Generally, seed viability and vigour are maximum at the time of physiological maturity. After physiological maturity, seeds begin to deteriorate at varying rates depending on genetic factor and on the conditions of storage environment (Roberts, 1972). Seed deterioration is defined by Delouche (1973) as summation of all physical, physiological, biochemical changes occurring in a seed, which ultimately lead to its death. He also characterized seed deterioration as inexorable, irreversible, inevitable, minimal at the time of physiological maturity and variable among the seed kinds, varieties, seed lots of same variety and among individual seeds. Many researchers opined that seed deterioration is a progressive deleterious process which has far reaching consequences (Ellis and Roberts, 1981 and Ghosh *et al*., 1981).

2.1.1 Biochemical manifestation of seed deterioration

Delouche *et al.* (1973) and Copeland (1988) has highlighted the consequences of deteriorative changes leading to death of seed which include membrane degradation, accumulation of toxic metabolites, decreased enzymatic activity, lipid autoxidation, failure of repair mechanisms, genetic degradation, reduced yield, finally loss of germination or death. Some of the major physiological and biochemical events of deterioration are presented below.

2.1.2 Membrane degradation

It is generally accepted that loss in cellular membrane integrity is one of the chief causes for loss of viability, presumably, a loss in membrane permeability under unfavourable conditions of storage leading to increased leaching of seed constituents and thus loss in viability. It has been postulated that cell membranes contain relatively high proportion of polyunsaturated lipids and in the presence of oxygen these may react to form free-radicals and unstable peroxides which inturn destruct lipid itself and biomembranes or cause lipid-protein complexes and damage to amino acids (Ching and Schoolcraft, 1968 and Sen, 1977).

Phospholipids form the major constituent of cell membrane. Koostra and Harrington (1969) showed that decline in membrane bound phospholipids owing to enzymic and non-enzymic peroxidation may be the cause of leaky cell membrane.

The leachate excdates as measured by electrical conductivity were associated with loss of vigour and viability (Perry, 1969, Bradnock and Mathews, 1970, Roberts, 1972 and Powell and Mathews, 1986).

Abdul-Baki and Anderson (1970, 1972) observed that leaching of sugars increased with increased seed age and increased mechanical injury to endosperm resulting in low metabolic activity and reduction in seed quality.

Evidences from ultra-structural and cytochemical investigations in increased membrane aberrations in aged seeds of maize strongly support the loss of viability during storage (Berjak and Villiers, 1972).

Pollock and Roos (1972) formulated a method of evaluating relative vigour of seed lot by measuring the amount of material leached from the seed soaked in water, the lower the vigour the greater the amount of leaching.

According to Srivastava and Gill (1975), the increase in electrical conductivity of leachates indicated the increase in seed deterioration.

Villiers (1980) concluded that the most common and consistent ultrastructural changes in all the cell organelles was the loss in integrity of membranes. Further Ghosh *et al.* (1981) demonstrated in aged seeds by the extent of leakage of cytoplasmic components to the external medium when the seeds were soaked in water which was related to damage to cell membranes.

Krishnaveni and Ramasamy (1985) reported that the electrical conductivity and the leaching of free amino acid and sugars significantly increased with the increase in storage periods of maize seeds which was ascribed to the membrane aberrations.

Similarly Dey and Mukherjee (1988) and Deshpande (1988) reported that electrolyte leakage increased with storage. Likewise membrane degradation during seed deterioration as judged by increased seed leachate and electrical conductivity were reported by Agrawal (1980) Dighe *et al.* (1995) in sunflower.

Deswal and Sheoran (1993) reported that permeability of membrane increases with increase in storage period and leads to loss of electrolytes, sugars, amino acids and phenols.

Meng (1993) reported that when soybean seeds were naturally aged or aged at high or low temperature seeds deterioration caused damage to cell structure and function of cell membrane leading to increased electrical conductivity and reduced germination and also respiration rates.

Shanmugavel *et al.* (1995) noticed that decline in seed germination and seedling vigour was associated with greater electrolytes leakage and higher production of volatile aldehydes, in soybean seeds stored in muslin cloth at 70 per cent relative humidity and 35°C for one to five weeks.

Vieira *et al.* (1999) reported that decline in seed germination, field emergence and seedling vigour was found to be negatively correlated with greater electrolytes leakage in soybean.

Peroxidation of unsaturated fatty acids leads to leaching of electrolytes and other solutes (Singh and Dadlani, 2003) in soybean.

2.1.3 Enzymatic activity

It has been well documented that certain anabolic enzymes help in maintaining viability while some catabolic enzymes decrease viability.

Free radicals and hydrogen peroxides are produced from various metabolic reactions and could be destroyed by the activity of scavenger enzymes like catalyse and hydrogen peroxidase. Peroxidase activity decrease appreciably with ageing making the seeds more sensitive to the effects of oxygen and free radicals in membrane unsaturated fatty acids and to the production of secondary lipid peroxidation products such as monaldehyde and lipid conjugants. Association of loss of viability with enzymatic activity decline was reported in barley (Harrison and Perry, 1976) and in sorghum (Perl *et al.*, 1978).

Loss of seed viability in storage has also been related to enzymatic activity by Abdul-Baki (1980) who pointed out that the respiratory and associated enzymes viz., paroxidase, glutamic acid oxidase and catalase activity decreased with loss of seed viability. While, the activity of hydrolytic enzymes viz., phytase, protease and phosphatase increased during storage. The increased activity of these enzymes was associated with the degradation of organocellular membranes, nucleoproteins, etc. Similar decline in peroxidase activity with increase in storage period has been reported by Nkang (1988).

Francis and Coolbear (1988) reported accumulation of phospholipase activity in aged seeds of tomato which acts on membrane phospholipids and releases fatty acids, thus indicating the loss of membrane phospholipid and subsequent lipid peroxidation.

Biochemical changes in free amino acids, free sugars and volatile aldehydes such as pentane, acetaldehyde and methanol is a consequence of lipid peroxidation mediated by free radicals and lipoxygenase enzymes (Wilson and McDonald, 1986).

Lipase production in storage conditions by pathogens like *Aspergillus flavus* and *Pencillium* sps. leads to seeds spoilage in linseed (Saraswat and Mathur, 1985).

Zhang *et al.* (1993) suggested that the decrease in lipoxygenase activity was related to the increase in protein content.

Taung and McDonald (1995) reported that enzymes and free lipid hydroperoxides also damage membranes and leads to lipid autoxidation reaction in groundnut.

Increase in propetinase, polygalactrunase, pectidepolymerase and lipase enzymes activity resulted in seed deterioration by reducing total germination and oil content and increase in free fatty acid in safflower (Saxena and Mohana, 1998).

2.1.4 Changes in chemical constituents of cell

Changes in chemical constituents of cell have been related to viability of seeds by several researchers.

Sedenko (1975) observed that content of phospholipids and phytin in non-viable seeds of maize were reduced.

Arulnandhy and Senanayake (1991) observed significant decrease in protein, oil content and total sugars and increase in free fatty acids and reducing sugars in deteriorated soybean seeds.

Studies indicated that oligosaccharide which has been associated in stabilising membranes decreased during storage due to non-enzymatic browning reaction between the carbonyl groups of carbohydrates and amino groups of amino acids and proteins (Crowe *et al*., 1992).

Bernal-Lugu and Leopold (1992) showed that sucrose and raffinose level declined in stored seeds of maize although the monosacharides, glucose fructose and galactose diminished faster.

Verma *et al.* (2003) showed that carbohydrates increased with decrease in protein content in deteriorated seeds.

2.1.5 Reduced metabolic activity

High relative humidity hastens deterioration and results in reduction of total extractable nucleic acids with increased storage period (Ketring, 1971).

Metabolic activity of seeds was reported to be low in non-viable seeds than in viable seeds. Sedenko (1975) reported that the ability to form nucleic acids and nucleotides during long-term storage decreased.

2.1.6 Free radical damage

Ageing has been partially attributed to the accumulation of free radicals produced by the metabolic process (Tappel, 1973). Under very dry conditions, lipids are subjected to direct autocatalytic attack by atmospheric oxygen (Koostra and Harrington, 1969 and Justice and Bass, 1978).

Seed storage subjects lipids to slow consistent attack by oxygen, forming hydroperoxides, other oxygenated fatty-acids and free-radicals. The free radicals are unstable and may react with and damage nearby molecules. Oxygenated fatty-acids in the absence of enzymes activity in the dry seed would accumulate, representing damage which would be manifested upon hydration. The total amount of oxygenated fatty-acid would be proportional to the age of seed and the rate of formation (Wilson and McDonald, 1986). Pammenter *et al.* (1974) supported the hypothesis of free-radical damage to cellular components leading to deterioration in aged seeds of maize.

Arulnandhy and Senanayake (1991) and Anuja Gutpa and Aneja (2004) observed that increase in free fatty acids caused seed deterioration in soybean.

Basu (1993) considered lipid peroxidation and free radical formation as the major causes for the seed deterioration in storage.

2.1.7 Chromosomal aberration

One of the changes associated with ageing is aberration of chromosome, some times referred to as mutagenic effects. Some of the chromosome aberrations in aged seeds include fragmentation, bridges, fusion, ring formation of chromosomes and variation in nuclear size.

Chromosome damage increases with in increase seed storage and moisture content in seeds (Roberts *et al*., 1967), due to stress condition and somatic mutation (Curtis, 1966), chromosomal aberrations increases during storage and affects germination and vigour of seeds (Villiers, 1971).

Kristov and Kristova (1978) related the degree of deterioration or aging to the spectrum of chromosome aberration in maize.

Dourado and Roberts (1984) reported that deteriorated seeds of pea contained more chromosomal aberrations.

Priestley (1986) recorded that in addition to loss in membrane integrity, another manifestation of seed deterioration was an increase in chromosomal aberration that may be lethal to the cell through impairment of DNA template function.

2.2 Influenced of seed moisture content, storage temperature and relative humidity on seed quality

Harrington (1960) proposed a rule of thumb for seed storage, according to him, the sum of per cent relative humidity and the temperature in degree Fahrenheit should not exceed hundred for storage.

McNeal (1966) studied that soybeans at 14.6 per cent moisture content could be stored for one year at 60°F without suffering excessive loss in germination percentage or rise in FFA content.

Christensen (1969) revealed that the seeds of sunflower stored at moisture contents 10, 12 and 14 per cent and temperatures of 3-5, 8-10 and 27-28°C, invasion by fungi and decrease in germinability were proportional to increasing moisture content, temperature and time of storage.

Gavrielit-Gelmond (1970) concluded that at 4°C and 30 per cent relative humidity groundnut seeds remained viable for three years. Storage at 7-12°C and 60-65 per cent relative humidity caused deterioration after 2 years.

Singh and Maurya (1972) reported that soybean seeds with 8 and 11 per cent moisture maintained above 80 per cent germination in cold storage but germination dropped down to 70 per cent after six months of storage at room temperature.

Ketring (1973) reported that germination percentage of seeds of groundnut cv. Starr stored with no fungicide treatment at 3°C and 100 per cent relative humidity decreased from 100 to 63 per cent in 8 months.

Srivastava and Sareen (1974) observed that the germination was dropped down to 75, 50 and 45 per cent when the soybean seeds were stored at room temperature, (22±6°C), 20° and 25°C, respectively for a period of six months.

Boakye-Boateng and Hume (1975) concluded that soybean seeds stored at high temperature (27°C) and moisture content (17.8%) rapidly lost viability after 9 to 10 weeks of storage. Lowering temperature (20°C) and seed moisture content (11.2%) retained viability for longer period.

The results of Norden (1981) indicated that the storage of shelled peanut seed at a controlled temperature of 17 to 23°C kept the seed from deteriorating appreciably for four year period, after which seed viability rapidly diminished. The kernels with higher moisture content (8.11%) when stored had a shorter life span, whereas low moisture content (2-6%) improved longevity.

Rheenen (1981) observed that, sesame seeds stored in bast bags, polyethylene bags and paper envelops in a room temperature and humidity control under warm and humid condition, lost viability in four to five years whereas, seeds kept at low moisture content with

the help of silica gel, either sealed with polythene or not sealed remained viable for more than ten years.

Results of Dange and Patil (1984) indicated that deterioration of groundnut genotypes in storage at different relative humidity (62, 72, 85 and 93%) differed significantly and they can be stored at 62 per cent relative humidity without loss of viability for considerable time.

Parmil Singh and Khatra (1984) demonstrated that, groundnut stored in gunny bags at low temperature (11°C) had the highest viability, followed by those in a storage bin at room temperature, finally concluded that, the germination percentage and vigour index decreased with increased ageing of seeds.

Dange *et al.* (1985) reported that in groundnut pods of three cultivars stored at different relative humidity, there was no reduction in viability of seed at 62 per cent relative humidity and there was very less invasion by fungi. There was complete loss of viability when seeds were stored at 85 per cent relative humidity for 120 days and all most total loss of viability at 93 per cent relative humidity when stored for 90 days in all the three cultivars.

Singh (1987) observed that temperature and relative humidity prevailed during storage affected the germination of soybean cv. Bragg seeds. The seeds stored at 30°C showed lower germination percentage than those stored at 20°C. The maximum reduction in germination percentage was observed when seeds were stored for 50 days at 30°C and 85 per cent relative humidity.

Ramamoorthy and Karivaratharaju (1986) reported that at 6 per cent moisture content groundnut pods can be stored well in high density laminated polyvinyl bag with germination 83.6 per cent while in cloth bag 81.2 per cent.

Balamurugan *et al.* (1989) studied storability in sunflower seeds dried to eight per cent and stored in cloth bag under ambient condition for 20 months. The per cent germination, root length, seedling dry matter and vigour index remained high upto ten months and decreased with further increase in storage period.

Soybean cv PV-78-28, PM-78-13, Pb-1, Bossier and F-73-14 were stored for 3, 6 and 9 months under controlled (20°C and 50% RH) and ambient conditions (18-26°C and 73.2% RH). There was a sharp decline in viability of seeds stored in ambient conditions beyond three months and further no seeds were germinated in field conditions after nine months of storage (Arulnandhy and Senanayake, 1991).

Nautiyal and Joshi (1991) reported that, viability and vigour of the rabi/summer groundnut could be maintained satisfactorily for more than eight months by lowering the moisture content using a desiccant like $CaCl_2$.

Reddy *et al.* (1992) stored groundnut seeds for 30 days at three temperature conditions (20, 27 and 34°C) and three water activity (0.80, 0.90 and 0.95 regimes) at Mysore. The results indicated that the greater the water activity and higher the storage temperature, the faster is the lipid peroxidation and deterioration of groundnut seeds.

Madanagopal and Dharmalingam (1993) reported that sesamum cv. TMV-3 dried to 4 to 5 per cent moisture content and stored in cloth bag under ambient temperature (26 ± 2°C) and relative humidity (65 ± 7%) maintained 93.33 per cent germination with 6.31 cm root length and 28.0 dry matter /mg/10 seedlings) upto 12 month of storage.

Gao-Ping ping *et al.* (1996) reported that seeds of five soybean varieties stored at temperature of –4, 0, 4°C and room condition for 8 years to determine their retention capacity of vigour. They found that the seeds stored a room temperature showed faster decline in vigour as compared to the seeds of lower temperatures.

Nkang and Umar (1997) reported that the temperature of 25°-30°C and relative humidity of 55-66 per cent found to be optimum for better storage of soybean seeds.

Sharma *et al.* (1998) reported that soybean seeds stored in gunny bag deteriorated completely within 6 months of storage when kept at 25 to 30 per cent low humidity with 40 to 45°C high temperature and 4 to 5 per cent moisture content.

Chowdhury *et al.* (2003) reported that groundnut variety Co-Amber stored at moisture content of 5.85 per cent recorded 71 per cent of germination after eight month of storage.

Narayanaswamy (2003) reported that groundnut seeds at 8.00 to 9.53 per cent moisture content could be stored for 8 months without loss in germination under ambient conditions of Bangalore.

Anuja Gupta and Aneja (2004) reported that soybean seeds stored in cloth bag showed decline in germination per cent after seven months of storage due to increase in temperature about 30°C and relative humidity about 75 per cent.

Keshavulu and Krishnasamy (2005) reported that soybean seed stored with initial moisture content of 9 per cent recorded highest germination per cent (84%), root length, shoot length, speed of germination, vigour index and field emergence.

2.3 Seed storage locations

Agrawal (1976) identified several good storage places in India for building seed storages based on safer upper limits of relative humidity (70%) and temperature (30°C). He classified storage places as good where relative humidity did not exceed for one month and temperature for four months, as medium where both relative humidity and temperature limits did not exceed three months and as poor where both relative humidity and temperature limits exceeded more than 4-6 months and very poor where relative humidity and temperature exceeded more than 7-11 months.

Bhattacharya and Chatterjee (1980) identified the storage places in West Bengal based on ambient mean relative humidity and temperature limits. Seeds of rice and wheat stored at Perulia and Bankura had germination nearer to certification standards upto 17-18 months. So they consider Perulia and Bankura as moderate storage places and are said to be the best locations in the West Bengal.

Kulkarni and Vyakarnahal (1987) opined that seed storage for short term (6-9 months) and medium term (9-8 months) a temperature of 30°C and relative humidity 70 per cent were considered as safe upper limits for most of the seeds. Further based on prevailing relative humidity and temperature, Dharwad has been considered as poor storage places Bijapur and Raichur as good storage places, while Honnavar, Mangalore as very poor storage places of Karnataka.

Seeds of rice, greengram and bajra stored in humid places like Nellore, Bapatla, Marutru, showed lesser storability (upto 6 months only) than those stored at dry places like Rajendranagar, Rudrur and Ananthapur of Andhra Pradesh had 12 months storability (Anon., 1990).

Dhanasekaran and Vadivelu (1994) observed significant differences in germination potential of the groundnut kernels due to location, period of storage, seed treatment and their interactions. Similar pattern was also observed in vigour, EC and oil content in groundnut CV-TMV-2 seed pods collected from 30 locations in Tamil Nadu.

Almeida and Morais (1997) concluded that seed quality increased with increase in impermeability of packaging. Storage of pods resulted in greater viability than storage of Kernals. Germination percentage of stored pods was significantly higher when stored in Campina grande location rather than in Potos location in China.

Sharma and Singh (1997) reported that seeds of some crop species stored under ambient storage conditions of Palampur maintained germination for a period of 30 months in wheat, 27 months in linseed cv. Himalini and lentil, 24 months in linseed cv. Janki, 21 months in barley cv. Doma and Pea, 18 months in linseed cv. Jeevan and oat, 15 months in barley cv. Sonu and rapeseed cv. BHS-1 and DK-1 and 12 months in mustard cv. Varuna.

Teari *et al.* (1998) reported that certified seeds of mustard varieties varuna and vardan packed in gunny bags retained germination percentage upto 18 months under ambient conditions of central plain zone of Uttar Pradesh with vigour index of 9.71 and 6.41 respectively. They concluded that the mustard seeds can be stored in gunny bags under ambient conditions for eighteen months without much loss in viability and vigour.

Ponnam Singh *et al.* (1998) reported that seeds of soybean cv. PK-327 maintained satisfactory germination upto 8 months in double polythene bag and for 6 months in gunny bag under Kanpur conditions.

Sharma *et al.* (1998) stored different cultivars of soybean in cloth bag and placed in Rajasthan, Kota and mechanized university farm (MAF). Among cultivars highest germination was recorded in MACS-13 (90%) whereas minimum was observed in Pusa-16 (75.3%), they reported that difference in the germination of the same variety at two locations might be due to differences in the time of harvesting, threshing and processing procedures.

Kurdikeri *et al.* (2000) reported that seeds of various crops stored under ambient condition of Dharwad maintained minimum prescribed germination for different durations in storage. Niger and bengalgram seeds maintained prescribed per cent germination only for 9 months and soybean for 11 months, maize, paddy, sunflower and mustard seeds upto 13 months and rabi sorghum, groundnut and sesamum upto 15 months, cowpea and safflower seeds for 17 month. greengram, blackgram seeds for 21 and 23 months respectively.

Prasad Rao *et al.* (2001) stored seeds of sunflower cv. Morden, Rice cv. IR-64, maize cv. DHM-103 in godowns of Andhra Pradesh at Vijanagaram, Tanuku, and Vijayawada (coastal humid region), Nizamabad, Warangal and Rampalli (Telangana dry region) and Srikalahasti, Anantapur and Karnool (Ragalasoma dry region) having different agro-climatic condition and they identified Kompalli and Nizamabad for rice, Anantapur, Warangal and Komalli for maize and Kompalli, Anantapur, Warangal and Nizamabad for sunflower as best places for storage and others as poor places for seed storage.

Kalappa (2002) reported that seeds of sunflower (BSH-1) maintained satisfactory germination upto 14, 10, 6 months of storage under ambient conditions of Raichur, Bangalore and Dharwad respectively with higher vigour index, shoot length, root length and field emergence.

Chowdhury *et al.* (2003) concluded that the validity period fixed for 9 months found appropriate for groundnut seeds stored in Kanpur, Rahuri, Jamnagar and Bangalore except for seeds stored in coastal areas of Bhubaneshwar.

Narayanaswamy (2003) reported that groundnut pods stored in Bangalore had retained satisfactory germination (70%) upto 8 months, 6 months in Navile and Kathalagere, 4 months in Kundali and 2 months in Brahmavar, oil, protein content and field emergence decreased but free fatty acid and EC increased with advancement of storage period in all locations.

Kurdikeri *et al.* (2003) noticed differential storage potential among different cultivars of groundnut and storage potential ranged between 3 to 7 months among cultivars when stored in cloth bag under ambient conditions of Dharwad.

Chitra Devi and Dadlani (2003) reported that mustard cv. Pusa Bold seeds stored under ambient condition of Delhi recorded maximum germination per cent (92%), higher field emergence (67.08%) and 1000-seed weight (8.46 g) with lower electrical conductivity (13.26 mhos/g) and sinapine leakage (15.87%) upto 31 months of storage.

2.4 Effect of genotypes / varieties on seed quality

Tewari and Gupta (1981) reported that seeds of sunflower var., Perodavik followed by those of Sunrise selection, had greater viability and vigour than of VNI IMK at the end of 8 months storage in ambient storage as well as in cold storage.

Bhaskar (1988) reported that sunflower cultivar RHA-274 maintained satisfactory germination upto 13 months of storage with increased field emergence, root length, shoot length, with decreased free fatty acid content while, morden, KBSH-1 and CMS-234A maintained satisfactory germination upto 12 months of storage and 6D-1 maintained upto eleven months.

Vanangamudi (1988) stored large and small seeds of 15 varieties of soybean in cloth bag for 16 months. The results revealed varietal differences in seed longevity. Small seeds retained viability longer than bigger seeds.

Jawaregowda and Bhole (1989) reported that bajra seeds deteriorated faster followed by maize, sorghum paddy and ragi in all storage condition viz., ware flat ventilated and air-conditioned storage.

Zode and Patil (1990) reported that germination above the certification standard was maintained for 9-22 months in sorghum, 37 months in Jute and Bajra and 28 months in maize under ambient storage conditions.

Venkatareddy *et al.* (1992) observed varietal differences in the storability of soybean. They found that Monetta maintained highest germinability (66.40%) as compared to Hardee (59%) followed by KHSB-2, Bragg and PK-471 even after nine months of storage under ambient conditions of Bangalore.

Kalavathi *et al.* (1994) reported that soybean genotypes, UGM-21, UGM-35, CO-1, JS-72-185, UGM-36 and KHSB-2 recorded higher germination (80%), root length, shoot length and dry matter production while UGM-24 recorded lower germination (18.0%) after eighth month of storage.

Basavaraju (1996) observed significant differences between varieties for germination wherein cultivar TMV-2 was able to maintain germination above the minimum seed certification standards (70%) for ten months whereas JL-24 for only nine months.

Gurmit Singh and Gill (1996) observed that the soybean cultivar PK-472, had a short storability of about 6 months while, cultivars SL-107, SL-144 and SL-129 stored better even after 16 months of storage.

Kurdikeri *et al.* (1996) observed significant differences between soybean varieties for germination. Variety Monetta maintained germination above the minimum seed certification standard (70%) for 13 month whereas, JS-335 and MACS-58 for 9 month and PK-472 and KHSB-2 for 7 months under ambient storage conditions of Dharwad.

Tungeswara (1996) reported that KBSH-1 hybrid sunflower maintained satisfactory germination upto eight months of storage, while RHA-60-1 maintained upto six months of storage with lower field emergence per cent, shoot length, root length, seedling dry weight with increased electrical conductivity and fungi infection.

Groundnut pods of two varieties TMV-2 and JL-24 when stored for twelve months under ambient condition of Bangalore showed significant differences in germination and vigour index (Golasangi, 1997).

Kharb *et al.* (1998) reported that soybean genotypes, T-49, MO-40, PK-262 deteriorated at faster rates and considered them as poor storers. Whereas, Kalitur, JS-8021, JS-8759, JS-8918, Punjab 1, KB-92, NRC-2, MACS-335 and Pusa-20 as good storers as these genotypes maintained the germination percentage above the certification standard (70%) after nine months of storage.

Vamadevappa (1998) studied varietal difference in soybean genotypes among which MACS-124 showed higher germination (79%) upto end of 10 month of storage while PK-1029 had low germinability (70%).

Krishnappa *et al.* (2001) observed significant varietal differences in germination, vigour index, seedling dry weight and electrical conductivity; cultivar ICGS-30 and DH-3-301 retained satisfactory germination above the minimum seed certification standards even after 12 months of storage, while TAG-24 and ICGS-10 for only eight months under ambient storage conditions of Bangalore.

Diwakar *et al.* (2002) observed the varietal difference in the storability of sesamum. They found that TKG-21 was having the most table and nutritionally best quality oil as compared to RS-160, OS-10, OS-18, ORM-17, JTS-8 and TC-25, RT-274.

Deshpande *et al.* (2003) noticed groundnut varietal differences in storage potential. Among the varieties R-8808 maintained satisfactory germination for 7 months, ICGS-11 for 6 months and JL-24 for 5 months when stored in cloth bag under ambient storage condition of Dharwad.

Kathmale *et al.* (2003) noticed that groundnut varieties differed in viability. ICGS-11, B-95, DRG-12 lost germination by 8 motnhs, while TG-26, TAG-24, SB-4 ICGV-86347 maintained germination upto 8 months.

Kurdikeri *et al.* (2003) observed significant varietal difference for germination in groundnut. Among six genotypes of groundnut stored in cloth bag under ambient condition of Dharwad, cvs. DH-330, JL-24, TMV-2 and ICGS-76 maintained satisfactory germination as

per MSCS (70%) upto 15 months, while, Mardur local and DH-40 for 11 and 9 months, respectively.

Verma *et al.* (2003) reported that mustard variety RH-8113 maintained satisfactory germination upto 3 years with increase root length, shoot length, seedling dry weight, seedling vigour, oil content, field emergence compared to variety RH-30.

Anuja Gupta and Aneja (2004) reported that soybean cv. Pusa-16 maintained higher germination (85.8%) with lower leakage of electrolytes and amino acid of about 42 per cent and 39.5 per cent respectively compared to variety JS-80-21.

2.5 Effect of containers on storage potential and seed quality

Agrawal (1980) stored seeds of pea, mung, lentil and soybean in cloth bag under ambient conditions. The satisfactory germination was maintained in moong for 37 months, in pea and lentil for 18 months and in soybean for only 6 months.

Radhakrishna (1982) reported that seeds of soybean stored in airtight glass containers maintained 40 per cent germination during 4^{th} month storage, while in gunny or polyethylene bags maintained viability for only 2 months.

Bhattacharya *et al.* (1983) revealed that seeds of sunflower stored in tin containers and polythene bag gave germination above 90 per cent at the end of one year while seed stored in other moisture previous container gave 90 per cent germination upto 6 months.

Kumar and Singh (1983) reported that the seeds of sesamum stored in polyethylene bags and glass bottle maintained satisfactory germination throughout storage period while seeds stored in gunny bags lost viability after 6 months of storage.

Ramamoorthy and Karivaratharaju (1986) found that groundnut pods stored in cloth bag showed decrease in oil content and protein content with increase free fatty acid content and fungi infection with advancement of storage period.

Baskin *et al.* (1987) concluded that polythene bag was superior in preserving viability, quality and extending storage life of soybean seeds over other types of storage containers (polythene, paper and cloth bag).

Gurmit Singh and Hari Singh (1992) reported that soybean seeds with 10 per cent moisture content could be stored for 6 months in gunny bags without loss of viability.

Venkatareddy *et al.* (1992) observed that soybean seeds harvested from August sown crop and stored in cloth bag maintained more than 80 per cent germination even after 12 months under Bangalore condition. Whereas, seeds harvested from December sown crop maintained viability only for 9 months under similar condition.

Majhi and Bandopadhyay (1993) noticed in freshly harvested groundnut seeds dried to moisture content of 9 per cent of stored in glass bottles, polythene bag, paper packets and cloth bags for one to nine months that germination percentage, root and shoot length and dry weight of the seedling were highest in glass bottles or polythene bag compared to low in paper and cloth bag.

Narayanaswamy (1993) reported that groundnut pods stored for 16 months in cloth bag recorded significantly lower per cent germination, field emergence, hypocotyls length, vigour index and higher electrical conductivity values, fungal infection and more fluctuation in moisture content compared to the pods stored in the polythene bag (700 guage) with both the groundnut cultivars JL-24 and TMV-2.

According to Shanmugavel *et al.* (1995) seeds of soybean stored in muslin bag at 70 per cent relative humidity and 35°C temperature for one to 5 weeks resulted in faster decline in germination per cent seedling vigour and phospholipid content and greatest electrolytes leakage in all the soybean genotypes tested.

Gurmit Singh and Gill (1996) observed that cultivars PK-472, of soybean had short storability of about 6 months while cultivars SL-107, SL-144 and SL-129 stored better even after 16 months of storage in cloth bags under ambient conditions.

Bindu (1997) revealed that groundnut pods subjected to halogen treatment maintained high germination, whereas the untreated ones stored in cloth bags lost their viability within 3 months of storage.

Rajendraprasad *et al.* (1998) observed significant differences for seed germination and moisture content in groundnut kernels stored in jute bag and cloth bag with germination as per the minimum seed certification standard (70%) for three months only, for 12 months on GI bins and 15 months in polythene bag (700 guage).

Sangwan and Duhan (1998) reported that sunflower seeds treated with Dithane-M-45 stored in gunny bag retained satisfactory germination and vigour index upto 8 months of storage.

Soybean seeds stored in polylined bag, single and double polythene bags maintained above 70 per cent germination upto eight months of storage while seeds stored in gunny bag maintained above 70 per cent germination upto six months of storage (Ponnam Singh *et al.*, 1998).

Sharma *et al.* (1998) recorded 60 per cent germination of soybean seeds when stored in gunny bags and 74.3 per cent in polythene lined gunny bags after 5 months of storage.

Savithri *et al.* (1998) reported that groundnut seed of cv. TMV-2 treated with thiram maintained satisfactory germination with higher vigour index (2332) and less fungi infection upto 6 month of storage in cloth bag.

Shekhargouda *et al.* (1998) stored sunflower seeds of EC 68414 and morden harvested at physiological and field maturity under ambient conditions of Kanpur in gunny bag, earthen pot, tin container and polythene bag (700 guage). The germination of seeds was reduced from 91 to 56 per cent in moisture impervious container during 12 months of storage. The percentage reduction in vigour index at 12 months of storage was 67 per cent in moisture previous containers and 41 per cent in moisture impervious containers.

Patra *et al.* (2000) revealed that groundnut seeds stored in gunny bag lost viability with advancement of storage period and became nil after 9 months of storage compared to seeds stored in polythene bag.

Basavegowda and Ravikumar (2001) observed highest seed germination in groundnut genotypes viz., KRG-1 and S-206 stored in high density polythene bag with or without silica gel during storage for nine months under ambient conditions of Raichur, followed by gunny bag.

In the pods of groundnut cultivar TMV-2 stored in different packaging materials under ambient condition at Bangalore, Narayanaswamy *et al.* (2001) observed that the pods stored in the poly lined gunny bag (400 guage) had retained germination above the minimum seed certification standards (>70%) for 12 months, while high density polythene bag and gunny bag for 10 and 8 months, respectively. Similar trend was observed for field emergence.

Padma and Muralimohan Reddy (2001) stated that storability of soybean cultivars could be improved by four months after storing seed in polythene bag compared to cloth bag.

Manomani (2002) reported that groundnut seeds stored in cloth bag maintained satisfactory germination only for 6 months of storage.

Moholkar *et al.* (2002) concluded that sunflower cv. 6D-1 maintained above MSCS upto 20 months by drying the seeds to 8 per cent moisture content in polythene bags (700 guage) where in cloth bags upto 10 months of storage.

Krishnappa *et al.* (2003) reported that groundnut pods stored in high density polythene bag retained germination above the minimum seed certification standards (>70%) for 15 months with higher vigour index (958), while in cloth bag retained for 14 months with lower vigour index (541).

Singh and Dadlani (2003) reported that soybean seeds stored in cloth bag maintained satisfactory germination only for 4 months of storage.

Chowdhury *et al.* (2003) reported that seeds of groundnut cv. CO. Amber maintained satisfactory germination upto 2 months stored in gunny bag and for 8 months in polythene bag.

2.6 Effect of storage fungi on seed quality

The fungi that are normally associated with seeds in storage affect adversely the seeds in various ways. Not only they bring down the seed viability and seedling vigour, but also affect the chemical composition of the seed. In oil seed crops, storage fungi are known to affect quality parameters causing complete deterioration of seeds. Several factors such as initial seed moisture, storage temperature, relative humidity are known to govern the activity of storage fungi.

Christensen and Kauffmann (1969) stored seeds of sunflower at moisture content of 10, 12 and 14 per cent and temperature of 3-5°C, 8-10°C and 27-28°C where he found that invasion by fungi and decrease on germinability were proportional to increasing moisture content, temperature and time of storage.

Christensen (1971) reported that no increase in storage fungi occurred even in seeds of high moisture content so long as the temperature remained below 5°C. But a combination of moisture content above 11 per cent and temperature of 21°C or above, resulted in fairly invasion by *Aspergillus glaucus*.

The importance of production of toxic metabolites is obvious, when the pathogen is seed borne. In several cases seed borne fungi are known to affect adversely seed germination and seedling vigour possibly due to the production of toxic metabolites (Chakravarthi *et al.*, 1973).

Jamaria *et al.* (1974) detected seven fungi viz., *Alternaria, Aspertillus, Chaetomium, Cunnigmella, Curvalaria, Rhizopus and Rhizoctonia* sp. from the seeds of sunflower. Among them *Rhizopus, Rhizoctonia* and *Aspergillus* sp. were predominant throughout the storage period.

Chohan and Jasmit Kaur (1975) recorded 18 seed borne fungi on four sunflower varieties namely, Sunrise, local, EC-68413 and EC-68414. Out of them *Alternaria tenuis* (32 to 35%), *Aspergillus flavus* (0.5 to47%) and *Rhizophus arnizus* (4-11%) were common on all the four varieties.

Zad (1978) studied the mycoflora of sunflower seeds and recorded large number of seed borne fungi on poor quality seeds.

Mathur and Sinha (1978) reported that fungi association bring certain biochemical changes in seeds during storage by decreasing reducing sugars and oil content.

Kushi and Khare (1979) identified seventeen fungi in sesamum varieties, among them *Macrophomina phaseolina, Fusarium oxyporum, Fusarium equeseti, Phoma* sp., and *Cephalosporium* sp., *Aspergillus* and *Pencillium* spp. showed a high frequency of occurrence in varieties N63-173, T12, N62-10, NO. 128 and N66-173 and least association of fungi was noticed in N65-8.

Prasanna (1984) observed that the saprophytic fungi were predominant in oil seed sage (*Brassica napus*) which reduce the seed germination when compared to the cabbage, cauliflower and Kale.

Agrawal and Gupta (1989) observed macrophomina sp., *Colletotrichum dematium, Fusarium* spp., *Aspergillus* infection on soybean seeds stored at different locations in India.

Vaidya and Dharemvir (1989) reported loss in oil content of stored groundnut due to *A. flavus* and *A. niger*.

Weidenborner and Hindorf (1989) reported that *Aspergillus flavus* results in poor germination, weight losses, biochemical changes, mycotoxin production in protein enriched seeds such as pigeonpea, soybean, bean, peanut and cotton.

Dwivedi (1990) examined the changes in the level of total phenolic compounds in chickpea as influence by *Aspergillus flavus, A. niger, Fusarium maniliforme* and *Pencillium oxalicum* infection.

Farag (1990) observed that *Aspergillus flavus* was found to affect the chemical compositions like protein lipid, carbohydrate, crude fibre of sesame and soybean. Further he also stated that amylase, lipase and protease activities were higher in infected seeds compared to healthy seeds.

Saxena and Karan (1991) reported gradual loss of protein and carbohydrate content of sesame and sunflower seeds due to *A. flavus* and *A. niger* during storage.

Singh (1992) reported that the fungi *Macrophomia phaseolina* and *Aspergillus* spp., were found to be most harmful in reducing the germination per cent of soybean.

Krishnamurthy and Raveesha (1996) identified 38 species of fungi in cultivars of soybean. Among them *Aspergillus, Penicillium* and *Rhizopus, Nigricans* were most commonly occurring storage fungi which reduces seed germination and seedling vigour and causes a variety of symptoms on seedling.

Seed health during seed storage largely depends on the storage condition packaging materials, physical and chemical properties of the seed, temperature and relative humidity of storage condition.

Ataga and Akueshi (1996) identified nine fungi in sunflower seeds among them *Macrophomina phaseolina, Curvularia lunata* and *Aspergillus niger* showed a high frequency of occurrence, but *Phoma* sps., *Verticillium dahdiae* and *Chaetomium glabosum* had low frequencies.

Rao *et al.* (1996) reported that *Aspergillus niger* and *Rhizoctonia bataticola* registered germination below 25 per cent in untreated seeds of groundnut, but treated with fungicide registered 57-67 per cent by fourth month of storage.

Savithri *et al.* (1998) recorded 203.5 fungal colonies per 100 seeds in groundnut stored in cloth bag and recorded storage fungi *Aspergillus flavus, A. niger, Rhozopus stolonifer, Rhizoctonia bataticola* and *Fusarium moniliforme* which were found to be predominant in storage.

Muthuraj *et al.* (2002) identified species of *Aspergillus, Alternaria, Rhizoctonia, Fusarium, Phoma and Chaetomium* which were known to affect germination and emergence in soybean.

Basavegowda *et al.* (2003) revealed that *Rhizopus* spp., *Aspergillus niger* and *Aspergillus flavus* were the predominant fungi found among different climatic zones of Karnataka. The fungi *Aspergillus flavus, Aspergillus niger, Pencillium* spp. *Fusarium* spp., and *Rhizopus* spp. were commonly found fungi causing considerable reduction in viability of stored seeds (Narayanaswamy and Shambulingappa, 1994).

Krishnappa *et al.* (2003) reported that groundnut pods stored in gunny bag had recorded maximum infection (18.3% in JL-24 and 16.17% in TMV-2) of *Aspergillus flavus, A. niger, Fusarium* spp. And *Pencillium* spp. which caused reduction in germination and vigour index.

Nargund *et al.* (2003) found the presence of *Aspergillus flavus, A. niger, Rhizoctonia* spp. *Fusarium* sp. and *Sclerotium rolfsii* in all the varieties of groundnut and they caused reduction in germination per cent and vigour index.

Basavaraju *et al.* (2004) revealed that *Plasmopara halstedii* is seed borne pathogen and the seeds infected severely by this pathogen (75-100%) resulted in lower germination per cent (47%) with less vigour index (470) in sunflower.

III. MATERIAL AND METHODS

A study on storage potential and evaluation of validity period for different varieties of oilseed crops stored under ambient condition at different locations was carried out in the laboratory of Department of Seed Science and Technology, Agriculture College, University of Agricultural Sciences, Dharwad, during June, 2005 to May, 2006.

The details of the materials used and techniques adopted during the course of investigations are described in this chapter.

3.1 General Description of Locations

3.1.1 Raichur

Raichur lies in the North Eastern dry zone (zone-2) of Karnataka. The meteorological data on minimum, maximum and mean temperature and relative humidity during the storage period from June, 2005, to May, 2006 are presented in Table 1. The average minimum and maximum temperature during storage period ranged from 14.6°C to 40.0°C with an annual mean temperature of 27°C and higher temperature was noticed during April and May (40°C) 2006. The mean relative humidity ranged from 41.1 to 79.6 per cent. The mean relative humidity above 70 per cent was observed in the months of July, August, September and October 2005.

3.1.2 Dharwad

Dharwad lies in the Northern Transitional Zone (Zone-8) of Karnataka. The meteorological data on minimum, maximum and mean temperature and relative humidity during the storage period from June 2005 to May 2006 are presented in Table 1. The average minimum and maximum temperature during storage period ranged from 12.9°C to 37.1°C, with an annual mean temperature of 25.5°C. The higher maximum temperature was noticed during the month of April 2006 (37.1°C). The mean relative humidity ranged from 45 to 85 per cent. The mean relative humidity of above 70 per cent was observed during months of June to October 2005-06.

3.1.3 Sirsi

Sirsi lies in the Hilly Zone (Zone-9) of Karnataka. The meteorological data on minimum, maximum and mean temperature and relative humidity during the storage period from June 2005 to May 2006 is presented in Table 1. The average minimum and maximum temperature during storage period ranged from 12.3°C to 35.4°C with an annual mean temperature of 23°C and higher temperature was noticed during April (35.4°C) 2006 and February (12.3°C) 2006. The mean relative humidity ranged from 58.5 to 93.8 per cent. The mean relative humidity above 70 per cent was observed from June to December 2005-06.

3.2 Treatment details

The storage experiment consisted of totally 24 treatments combinations involving 4 oilseed crops, two varieties and three locations. The details of the experiment are furnished below.

Factor I	Factor II	Factor III
Locations L_1 - Raichur	C_1 – Sesamum	V_1 – DS-1 V_2 – E-8
L_2 - Dharwad	C_2 – Sunflower	V_1 – KBSH-1 V_2 – RFSH-1
L_3 - Sirsi.	C_3 – Soybean	V_1 – JS-9305 V_2 –JS-335
	C_4 – Groundnut	V_1-GPBD-4 V_2-TAG-24

Table 1. Monthly meteorological data for the storage period (June, 2005 to May, 2006) recorded at Raichur, Dharwad and Sirsi

Months	Raichur			Dharwad			Sirsi		
	Temperature (℃)			Temperature (℃)			Temperature (℃)		
	Mean maximum	Mean minimum	Relative humidity (%)	Mean maximum	Mean minimum	Relative humidity (%)	Mean maximum	Mean minimum	Relative humidity (%)
June 2005	37.5	24.1	56.6	30.9	21.5	76	29.9	21.9	80.5
July 2005	32.3	22.6	73.5	27.4	21.5	83	27.2	21.0	93.8
August 2005	31.5	22.8	74.8	27.1	20.4	81	26.9	20.8	93.9
September 2005	30.1	22.4	79.6	27.5	20.3	85	27.8	20.9	90.3
October 2005	31.0	21.8	72.7	29.6	19.1	70	30.3	19.9	84.0
November 2005	30.2	15.5	61.5	29.4	14.9	51	29.3	15.5	83.0
December 2005	30.7	16.3	58.7	28.9	13.1	53	30.2	14.0	76.5
January 2006	31.6	14.6	57.7	29.9	12.9	52	31.3	13.9	65.1
February 2006	34.2	15.7	46.6	32.4	14.8	62	33.5	12.3	59.6
March 2006	35.3	19.4	48.3	34.1	18.1	45	33.6	16.5	60.2
April 2006	40.0	25.2	41.1	37.1	20.3	49	35.4	20.5	58.5
May 2006	40.0	25.0	46.6	35.3	20.9	61	33.2	20.5	67.5

Treatment combinations

L1C1V1	L2C1V1	L3C1V1
L1C1V2	L2C1V2	L3C1V2
L1C2V1	L2C2V1	L3C2V1
L1C2V2	L2C2V2	L3C2V2
L1C3V1	L2C3V1	L3C3V1
L1C3V2	L2C3V2	L3C3V2
L1C4V1	L2C4V1	L3C4V1
L1C4V2	L2C4V2	L3C4V2

Treatment combinations : 3 x 4 x 2 = 24

Design : Completely randomized block design with factorial concept

Replications : Four

3.3 Seed source and storage

The required quantity of fresh seeds of two varieties each of sesamum, sunflower, soybean and groundnut crops produced during *kharif* season 2005 were obtained from the NSP-BSP unit, MARS, Dharwad for conducting the storage studies.

Two hundred grams seeds of each variety of different oilseeds were treated with Thiram (2 g/kg seed) except groundnut pods and were kept in cloth bags. Totally 11 such bags of each variety for each locations were prepared for storage purpose.

3.4 Storage locations

The required number of seed bags was stored in Dharwad, Raichur and Sirsi locations under ambient conditions for 11 months (June 2005 to May, 2006). At monthly intervals seed sample bags were obtained from each locations for taking observation on various seed quality parameters.

3.5 Experimental observations

The procedure followed in recording experimental observations are as detailed below.

3.5.1 Germination (%)

The germination test was conducted as per the procedure prescribed in ISTA Rules (Anon., 1996). Hundred seeds in four replications were kept for germination in rolled rewels in a germinator maintained at 25 ± 7°C and 95 per cent relative humidity. The germination count on normal seedlings was taken on 4^{th} and 10^{th} day for sunflower, 5^{th} and 10^{th} day for groundnut, 5^{th} and 8^{th} day for soybean and 3^{rd} and 6^{th} day for sesamum. The germination was calculated on the basis of number of normal seedlings counted and expressed in percentage.

3.5.2 Speed of germination

The number of seeds germinated was counted daily in all the treatments from first day to final count of the germination test. The seeds which produced seedlings with the plumule and radicle of at least 1 cm growth was considered as germinated. From the mean percentage of germination on each counting date, the speed of germination was calculated employing the following formula suggested by Maguire (1962).

$$N = n_1/1 + n_2/2 + \ldots. n_x/x$$

Where, n_1, n_2, n_x were the number of seeds germinated on day 1 to day x.
1 ……. x are the number of days.

3.5.3 Field emergence (%)

Randomly selected 100 seeds from each treatment were sown in four replications on a well prepared seed bed with optimum soil moisture. The field emergence count was taken

on seedlings which emerged above soil on 15th day after sowing and field emergence percentage was calculated.

3.5.4 Root length (cm)

Ten normal seedlings were randomly selected in each replication from the germination test at final count and the root length was measured from the collar region to the tip of the primary root. The average root length of ten seedlings was computed and expressed in centimetre.

3.5.5 Shoot length (cm)

The same ten seedlings used for root length were taken for shoot length measurement. The length between the collar region and the tip of the primary shoot was considered as shoot length and it was measured. The mean value of shoot length was calculated and expressed in centimetre.

3.5.6 Seedling dry weight (g)

Ten seedlings used for measuring the seedling length were also utilized for determining the dry weight of the seedling. Seedlings were dried in hot air oven maintained at 70±1°C for 24 hr. After drying, seedlings were kept in desiccators for cooling and further weighed and expressed in grams.

3.5.7 Seedling vigour index

Seedling vigour index was computed by adopting the formula as suggested by Abdul Baki and Anderson (1973) and expressed in whole number.

Vigour index = Germination (%) x [(Shoot length (cm) + Root length (cm)]

3.5.8 Electrical conductivity of seed leachate (dSm^{-1})

Five grams of seeds in four replications were surface sterilized with $HgCl_2$ (1%) solution and thoroughly washed in distilled water, later seeds were soaked in 25 ml distilled water and kept at 25±1°C for 24 hr. The leachate was decanted to another container and volume was made upto 25 ml by adding distilled water. The electrical conductivity of seed leachate was measured with electrical conductivity bridge and expressed in dSm^{-1} (Anon., 1996).

3.5.9 Moisture content (%)

The moisture content of the seed was calculated as per the International Seed Testing Association (ISTA) Rules (Anon., 1996) by hot air oven method maintaining 103°C ± 2°C for 17 hr. The moisture content was calculated on wet basis and expressed in percentage by using the following formula

$$\text{Moisture content (\%)} = \frac{(M_2 - M_3)}{(M_2 - M_1)} \times 100$$

Where,
M_1 = Weight of empty moisture tin in (g)
M_2 = Weight of moisture tin and seed material before drying (g)
M_3 = Weight of moisture tin and seed material after drying (g)

3.6 Seed infection

Detection of seed borne fungi was done by Blotter paper method as recommended by ISTA Rules (Anon., 1996). Twenty five seeds in each of four replications were placed equidistantly in circles in glass petridishes of 9 cm diameter, containing 3 moist blotters. The

blotters were dipped in 0.2 per cent 2,4-D solution to prevent germination of seed and petridishes were incubated for 7 days in an incubator at 25℃ ± 1℃ with 12 hr light and 12 hr night alternate cycles. After 7 days the seeds were examined by a low power stereomicroscope and the seeds get infected were recorded and expressed in percentage.

3.6.1 Oil content percentage

Oil content on dry seed weight basis was estimated by using the Nuclear Magnetic Resonance (NMR) spectrophotometer installed at the Regional Research Station, Raichur and was expressed as percentage of oil content.

3.6.2 Statistical analysis

The data collected from the experiment was analyzed statistically by adopting the procedure described by Sundarajan *et al.* (1972) and critical differences were calculated at 5 per cent level. Wherever F test was significant. The data on germination percentage was transformed into arc sine square root percentage values (Snedecor and Cochran, 1967).

IV. EXPERIMENTAL RESULTS

Storage experiment on "Evaluation of validity period of different oil seed crops stored at different locations" was conducted from June 2005 to May 2006. The results obtained on various seed quality parameters viz., germination, speed of germination, field emergence, root length, shoot length, seedling dry weight, vigour index, electrical conductivity, oil content, seed infection and moisture content are presented in this chapter.

4.1 Germination (%)

The data on per cent germination during storage as influenced by locations, crops, varieties and their interaction effects are presented in Table 2.

Irrespective of locations, crops and varieties, the mean germination percentage declined from 95.34 to 36.07 per cent from first month of storage to eleven month of storage respectively.

Due to locations

Seed germination differed significantly throughout the storage period due to locations. Among locations, higher germination was noticed in seeds stored at Raichur (95.82%) followed by Dharwad (95.75%) and lower germination was noticed in the seeds stored at Sirsi (94.46%) at first month of storage. Similar trend was noticed throughout the storage period. At eleven month of storage the seeds stored at Raichur maintained significantly higher germination (49.19%) compared to Dharwad (41.42%) and lower germination was noticed in seeds stored at Sirsi (34.29%).

Due to crops

Germination percentage differed significantly throughout the storage period among oil seed crops. The per cent germination was significantly more (96.40%) in sesamum followed by sunflower (96.34%), soybean (96.25%), while it was less (92.39%) in groundnut in the first month of storage period. Similar trend was noticed from second month of storage to eleven month of storage. At the end of 11 months of storage significantly higher germination percentage was recorded in sesamum (75.59%) compared to sunflower (68.49%), soybean (17.37%) and groundnut (5.09%). The satisfactory germination as per seed standards was maintained upto ten months in sesamum (80.50%), and sunflower (78.50%), seven months in soybean (71.61%) and six months in groundnut (71.65%).

Due to varieties

Germination percentage due to varieties showed non significant results upto three months of storage and differed significantly from fourth month onwards. Variety V_1 in each crop recorded significantly higher germination (95.38 to 42.73%) from initial month to eleven month of storage respectively. While, variety V_2 recorded lower germination percentage (95.31 to 40.54%) from initial month to eleven month of storage respectively.

Interactions

Due to locations and crops (L x C)

Interaction effects of location and crop showed significant difference on germination from fifth month of storage onwards. Significantly highest germination percentage (91.54%) was observed in L_1C_1 and lowest recorded in L_2C_4, L_3C_3 and L_3C_4 (75.50, 77.17 and 69.47%) respectively after 5^{th} month of storage. Similar trend was noticed from fifth month of storage to eleven months of storage. After eleven month of storage significantly higher germination was noticed in L_1C_1 (80.56%) and lower (0.00%) was noticed in L_2C_4, L_3C_3 and L_3C_4. The satisfactory germination percentage as per the seed standards was maintained upto eleven months in L_1C_1 (80.56%), upto ten months in L_2C_2 (71.50%), L_2C_1 (80.52%), L_1C_2 (73.62%), upto nine months in L_3C_1 (80.11%) and L_3C_2 (71.68%), upto seven months in L_1C_3 (75.65%), L_1C_4 (71.85%), L_2C_3 (73.50%) and L_3C_2 (95.43%), upto six months in L_2C_4 (72.33%) and L_3C_3 (71.18%) and upto four months in L_3C_4 (74.00%).

Table 2. Influence of locations, oilseed crops and varieties on germination (%) during storage

Treatments	Months of storage										
	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
Location											
L1	95.82 (78.56)*	93.02 (74.96)	91.81 (73.87)	89.97 (70.02)	85.49 (67.88)	82.35 (65.32)	78.28 (62.40)	73.03 (59.01)	68.44 (56.22)	60.28 (51.35)	49.19 (44.30)
L2	95.75 (78.48)	92.56 (74.52)	91.29 (73.26)	88.71 (70.78)	83.21 (66.08)	79.33 (63.10)	76.03 (60.80)	67.51 (55.62)	58.94 (50.39)	51.22 (43.89)	41.42 (35.94)
L3	94.46 (76.49)	91.34 (73.15)	89.20 (71.53)	85.31 (68.02)	79.59 (63.47)	75.29 (60.40)	66.36 (54.93)	57.71 (49.66)	42.70 (36.73)	35.38 (28.64)	34.29 (27.94)
SEm±	0.41	0.32	0.43	0.38	0.16	0.16	0.22	0.16	0.11	0.09	0.07
CD (5%)	1.16	0.90	1.23	1.09	0.45	0.46	0.63	0.46	0.30	0.25	0.20
Crop											
C1	96.40 (79.22)	94.23 (76.12)	94.18 (76.22)	93.98 (76.02)	89.89 (71.53)	85.52 (67.66)	83.44 (66.03)	82.41 (65.22)	81.52 (64.53)	80.50 (63.42)	78.50 (61.46)
C2	96.34 (79.10)	94.14 (76.07)	93.51 (75.39)	90.52 (72.15)	85.64 (67.75)	82.32 (65.16)	77.68 (61.81)	75.53 (60.35)	73.50 (59.01)	71.05 (57.45)	68.49 (55.83)
C3	96.25 (79.08)	94.04 (75.92)	93.08 (74.74)	87.78 (69.57)	81.03 (64.24)	76.48 (61.06)	71.61 (57.85)	62.09 (52.05)	47.28 (42.95)	30.99 (28.64)	17.37 (20.35)
C4	92.39 (73.97)	86.83 (68.72)	82.32 (65.22)	79.72 (63.33)	74.89 (59.72)	71.65 (57.87)	61.51 (51.82)	44.30 (41.44)	24.47 (24.62)	15.30 (16.66)	5.09 (07.63)
SEm±	0.47	0.37	0.50	0.44	0.18	0.19	0.26	0.19	0.12	0.10	0.08
CD (5%)	1.35	1.04	1.42	1.26	0.52	0.54	0.73	0.53	0.35	0.29	0.24
Variety											
V1	95.38 (77.96)	92.43 (74.32)	91.32 (73.36)	88.78 (70.91)	84.25 (66.94)	82.29 (63.84)	74.69 (60.14)	67.89 (55.89)	58.71 (49.08)	51.07 (43.16)	42.73 (36.81)
V2	95.31 (77.72)	92.19 (74.10)	90.22 (72.42)	87.21 (69.63)	81.27 (64.68)	77.70 (62.04)	72.42 (58.62)	64.27 (53.63)	54.67 (46.47)	46.85 (39.42)	40.54 (35.32)
Mean	95.34 (77.84)	92.31 (74.21)	90.77 (72.89)	88.00 (70.27)	88.76 (65.81)	78.99 (62.94)	73.56 (59.38)	66.08 (54.76)	56.69 (47.78)	48.96 (41.29)	46.63 (36.07)
SEm±	0.33	0.26	0.35	0.31	0.13	0.13	0.18	0.13	0.09	0.07	0.06
CD (5%)	NS	NS	NS	0.89	0.37	0.38	0.52	0.38	0.24	0.21	0.17

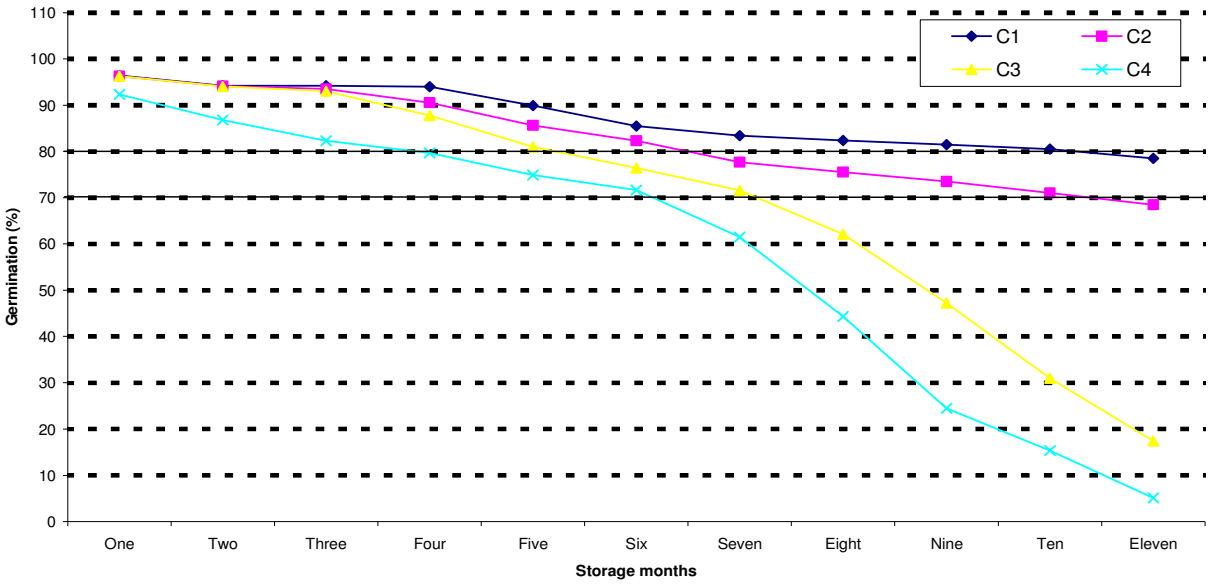

Fig.1. Storage potentials of oilseed crops

Fig.1. Storage potentials of oilseed crops

Treatments	Months of storage										
	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L x C											
L1C1	96.87 (79.97)	94.66 (76.71)	94.45 (76.66)	94.39 (75.91)	91.54 (73.13)	87.71 (69.50)	85.73 (67.86)	84.23 (66.65)	83.39 (65.93)	81.50 (64.50)	80.56 (63.81)
L1C2	96.87 (79.98)	94.58 (76.52)	93.91 (76.07)	92.12 (73.74)	87.65 (69.41)	84.77 (67.07)	79.90 (63.37)	77.69 (61.80)	75.50 (60.31)	73.62 (59.08)	69.23 (56.29)
L1C3	96.82 (79.96)	94.48 (76.59)	93.57 (75.29)	89.62 (71.21)	84.27 (66.61)	80.77 (63.97)	75.65 (60.43)	68.54 (55.87)	64.62 (53.51)	49.50 (44.69)	31.73 (34.23)
L1C4	92.72 (74.33)	88.38 (70.05)	85.32 (67.46)	83.75 (66.21)	78.50 (62.37)	76.16 (60.76)	71.85 (57.94)	61.65 (51.72)	50.28 (45.14)	36.50 (37.12)	15.26 (22.88)
L2C1	96.88 (80.05)	94.61 (76.55)	94.31 (76.29)	94.24 (76.18)	90.08 (71.67)	85.50 (67.60)	83.27 (65.86)	82.06 (64.92)	81.06 (64.18)	80.52 (63.78)	76.45 (60.95)
L2C2	96.82 (79.76)	94.51 (76.61)	93.79 (75.55)	91.24 (72.78)	85.60 (67.68)	82.00 (64.87)	77.69 (61.80)	75.50 (60.31)	73.33 (58.89)	71.50 (57.71)	68.84 (56.05)
L2C3	96.77 (79.98)	94.41 (76.30)	93.44 (75.14)	87.97 (69.70)	81.66 (64.62)	77.50 (61.67)	73.50 (59.00)	64.22 (53.27)	58.23 (49.75)	43.47 (41.22)	20.40 (26.80)
L2C4	)92.55 (74.14)	86.71 (68.60)	83.64 (66.17)	81.40 (62.45)	75.50 (60.35)	72.33 (58.25)	69.66 (56.56)	48.26 (43.98)	23.15 (28.72)	9.41 (12.85)	0.00 (0.00)
L3C1	95.43 (77.65)	93.42 (75.12)	93.78 (75.75)	93.30 (74.98)	88.06 (69.80)	83.34 (65.85)	81.32 (64.38)	80.94 (64.09)	80.11 (63.49)	73.49 (58.99)	69.76 (56.62)
L3C2	95.35 (77.56)	93.32 (75.06)	92.82 (74.56)	88.19 (69.94)	83.66 (66.16)	80.20 (63.55)	75.43 (60.27)	73.41 (58.93)	71.68 (57.83)	68.04 (55.56)	67.40 (55.16)
L3C3	95.17 (77.30)	93.23 (74.90)	92.22 (73.77)	85.76 (67.81)	77.17 (61.48)	71.18 (57.54)	65.68 (54.12)	53.50 (47.00)	19.00 (25.59)	0.00 (00.00)	0.00 (00.00)
L3C4	91.91 (73.46)	85.40 (67.52)	78.00 (62.04)	74.00 (59.33)	69.47 (56.44)	66.47 (54.60)	43.03 (40.97)	23.00 (28.61)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
SEm±	0.82	0.63	0.87	0.76	0.32	0.33	0.45	0.33	0.21	0.18	0.14
CD (5%)	NS	NS	NS	NS	0.91	0.93	1.27	0.93	0.60	0.51	0.41

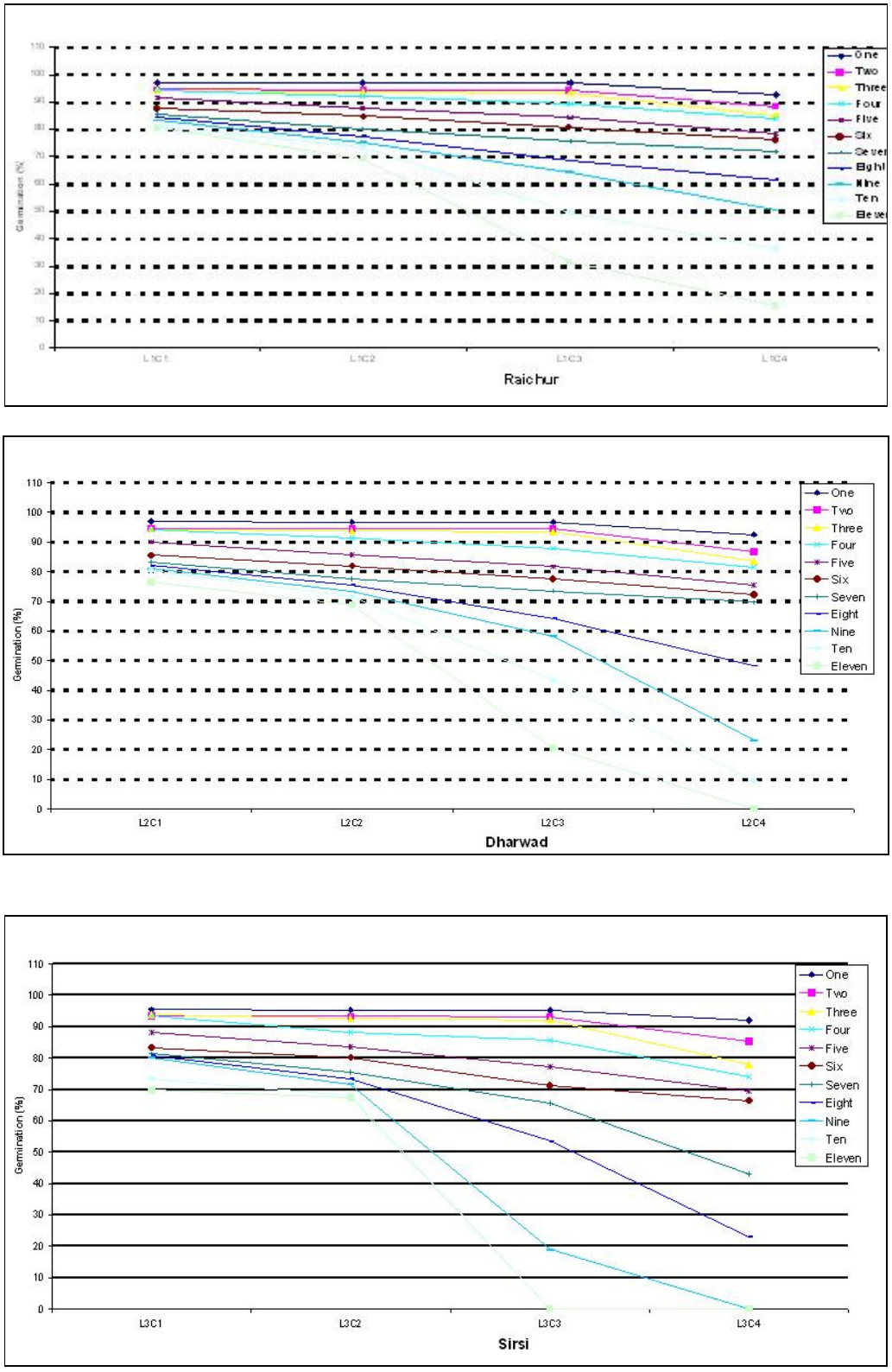

Fig. 2. Influence of locations on storage potentials of oilseed crops

Treatments	Months of storage										
	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L x V											
L1V1	95.83	93.06	92.16	90.70	86.51	83.47	79.29	74.23	70.34	62.45	51.11
	(78.69)	(75.08)	(74.24)	(72.70)	(68.73)	(66.16)	(63.13)	(59.87)	(57.39)	(52.65)	(45.63)
L1V2	95.80	92.99	91.47	89.24	84.47	81.23	77.27	71.72	66.55	58.10	47.22
	(78.43)	(74.85)	(73.50)	(71.37)	(67.03)	(64.48)	(61.66)	(58.15)	(55.06)	(50.05)	(42.98)
L2V1	95.79	92.72	91.86	89.53	84.75	80.58	77.00	69.51	61.41	54.71	42.36
	(78.66)	(74.61)	(73.73)	(71.44)	(67.25)	(63.98)	(61.47)	(56.84)	(51.91)	(47.78)	(36.60)
L2V2	95.72	92.40	90.73	87.90	81.66	78.08	75.07	65.51	56.47	47.74	40.48
	(78.30)	(74.43)	(72.81)	(70.11)	(64.92)	(62.22)	(60.14)	(54.41)	(48.86)	(40.00)	(35.31)
L3V1	94.51	91.51	89.95	86.13	81.48	76.81	67.79	59.84	44.39	36.05	34.71
	(77.54)	(73.28)	(72.11)	(68.62)	(64.84)	(61.38)	(55.82)	(50.97)	(37.95)	(29.06)	(28.21)
L3V2	94.42	91.18	88.46	84.50	77.69	73.78	64.94	55.59	41.00	34.71	33.86
	(77.44)	(73.02)	(70.96)	(67.41)	(62.10)	(59.41)	(54.04)	(48.34)	(35.50)	(28.22)	(27.68)
SEm±	0.58	0.45	0.61	0.54	0.23	0.23	0.32	0.23	0.15	0.13	0.10
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	0.42	0.36	0.29
C x V											
C1V1	96.40	94.25	94.27	94.05	91.13	86.56	84.44	83.07	81.83	80.22	76.02
	(79.35)	(76.19)	(76.34)	(76.05)	(72.72)	(68.52)	(66.82)	(67.73)	(64.77)	(62.77)	(60.74)
C1V2	96.39	94.20	94.09	93.90	88.64	84.48	82.44	81.75	80.02	77.98	75.15
	(79.10)	(76.06)	(76.10)	(76.00)	(70.35)	(66.81)	(65.24)	(64.71)	(64.30)	(62.08)	(60.17)
C2V1	96.36	94.15	93.57	91.15	86.73	82.94	78.66	76.37	74.67	72.27	69.65
	(79.14)	(76.00)	(75.56)	(72.77)	(68.64)	(65.64)	(62.50)	(60.91)	(59.77)	(58.22)	(56.42)
C2V2	96.33	94.12	93.44	89.89	84.54	81.70	76.68	74.69	72.33	69.83	67.53
	(79.05)	(76.14)	(75.23)	(71.53)	(66.86)	(64.69)	(61.12)	(59.78)	(58.25)	(56.68)	(52.54)
C3V1	96.28	94.06	93.24	88.77	82.37	78.22	72.54	65.72	52.56	33.16	19.33
	(79.31)	(76.03)	(74.92)	(70.46)	(65.18)	(62.21)	(58.45)	(54.20)	(46.34)	(29.89)	(21.63)
C3V2	96.22	94.01	92.21	86.79	79.69	74.74	70.67	58.45	42.00	28.82	15.41
	(78.85)	(75.83)	(74.55)	(68.69)	(63.29)	(59.91)	(57.24)	(49.90)	(39.56)	(27.39)	(19.06)
C4V1	92.47	87.25	84.21	81.16	76.75	73.42	63.13	46.39	25.80	19.83	6.11
	(74.06)	(69.07)	(66.62)	(64.36)	(61.22)	(59.00)	(52.79)	(42.74)	(25.45)	(21.77)	(08.45)
C4V2	92.31	86.41	80.42	78.27	72.22	69.88	59.90	42.21	23.15	10.78	4.06
	(73.89)	(68.37)	(63.81)	(62.30)	(58.22)	(56.74)	(50.85)	(40.13)	(23.79)	(11.55)	(06.81)
SEm±	0.67	0.52	0.71	0.62	0.26	0.27	0.36	0.27	0.17	0.15	0.12
CD (5%)	NS	NS	NS	NS	NS	NS	NS	0.76	0.49	0.41	0.33

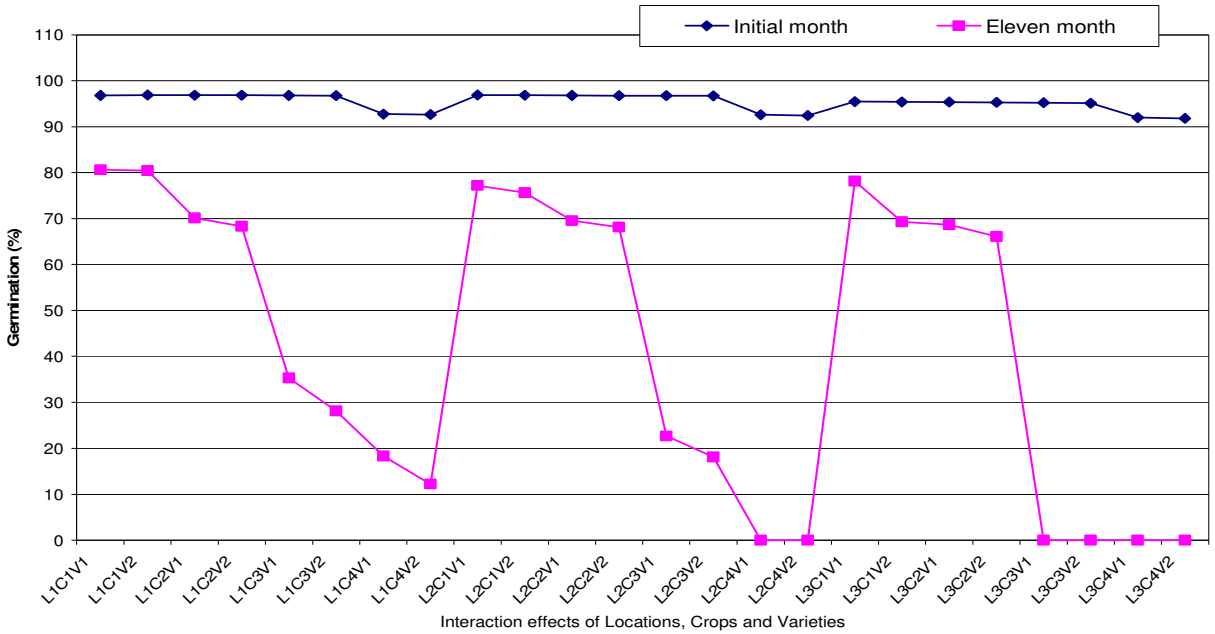

Fig. 3. Influence of locations, crops and varieties on storage potentials of oilsed crops

Fig. 3. Influence of locations, crops and varieties on storage potentials of oilseed crops

Treatments	Months of storage										
	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L x C x V											
L1C1V1	96.84 (80.06)	94.67 (76.82)	94.52 (76.62)	94.48 (76.91)	92.40 (74.08)	88.67 (70.32)	86.78 (68.75)	85.33 (67.53)	83.82 (66.26)	81.66 (64.62)	80.66 (63.89)
L1C1V2	96.90 (79.88)	94.64 (76.59)	94.38 (76.70)	94.30 (76.91)	90.67 (72.19)	86.75 (68.67)	84.67 (66.97)	83.12 (65.77)	82.96 (65.60)	81.33 (64.38)	80.45 (63.74)
L1C2V1	96.88 (80.06)	94.60 (76.54)	93.98 (76.53)	92.67 (74.38)	88.64 (70.28)	85.88 (67.94)	80.88 (64.10)	78.66 (62.46)	76.66 (61.09)	74.82 (59.86)	70.12 (56.84)
L1C2V2	96.86 (79.89)	94.56 (76.49)	93.84 (75.61)	91.57 (73.10)	86.66 (68.55)	83.66 (66.19)	78.92 (62.65)	76.72 (61.13)	74.33 (59.54)	72.42 (58.30)	68.33 (55.73)
L1C3V1	96.84 (80.23)	94.50 (76.82)	93.72 (75.47)	90.82 (72.34)	84.66 (66.92)	81.66 (64.62)	76.63 (61.10)	70.66 (57.18)	68.67 (55.95)	52.66 (46.51)	35.33 (36.45)
L1C3V2	96.79 (79.69)	94.45 (76.35)	93.42 (75.12)	88.42 (70.08)	83.28 (66.30)	79.88 (63.32)	74.66 (59.75)	66.42 (54.56)	60.56 (51.08)	46.33 (42.88)	28.12 (32.01)
L1C4V1	92.77 (74.39)	88.46 (70.12)	86.42 (68.35)	84.82 (67.05)	80.33 (63.65)	77.67 (61.78)	72.88 (58.59)	62.66 (52.31)	52.22 (46.25)	40.66 (39.60)	18.33 (25.34)
L1C4V2	92.66 (72.26)	88.30 (69.97)	84.22 (66.57)	82.67 (65.38)	76.66 (61.09)	74.64 (59.74)	70.82 (57.28)	60.63 (51.12)	48.33 (44.03)	32.33 (34.64)	12.19 (20.42)
L2C1V1	96.90 (80.29)	94.63 (76.58)	94.40 (76.29)	94.32 (76.20)	91.33 (72.85)	86.66 (68.55)	84.33 (66.69)	82.66 (65.37)	81.46 (64.47)	80.87 (64.04)	77.22 (61.47)
L2C1V2	96.86 (79.81)	94.58 (76.52)	94.22 (76.17)	94.16 (76.16)	88.82 (70.50)	84.33 (66.66)	82.22 (65.04)	81.46 (64.47)	80.66 (63.89)	80.16 (63.53)	75.67 (60.42)
L2C2V1	96.84 (79.80)	94.52 (76.44)	93.82 (75.59)	91.82 (73.36)	86.67 (68.56)	82.66 (65.37)	78.67 (62.47)	76.33 (60.87)	74.67 (59.76)	72.33 (58.24)	69.56 (56.49)
L2C2V2	96.80 (79.71)	94.51 (76.79)	93.76 (75.52)	90.67 (72.19)	84.52 (66.80)	81.33 (64.38)	76.72 (61.13)	74.67 (59.76)	71.98 (58.02)	70.67 (57.19)	68.13 (55.61)
L2C3V1	96.78 (80.33)	94.43 (76.33)	93.66 (75.40)	88.98 (70.59)	82.23 (66.12)	78.67 (62.47)	74.33 (59.54)	68.17 (55.63)	64.33 (53.31)	46.82 (43.16)	22.67 (28.42)

Treatments	Months of storage										
	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L2C3V2	96.75 (79.62)	94.38 (76.27)	93.22 (74.89)	86.96 (68.81)	80.98 (64.12)	76.33 (60.86)	72.67 (58.46)	60.26 (50.90)	52.12 (46.20)	40.12 (39.29)	18.12 (25.18)
L2C4V1	92.63 (74.23)	87.30 (69.10)	85.55 (67.63)	82.98 (65.61)	78.66 (62.46)	74.33 (59.54)	70.66 (57.18)	50.86 (45.47)	25.17 (30.10)	18.82 (25.70)	0.00 (00.00)
L2C4V2	92.46 (74.05)	86.12 (68.10)	81.72 (64.66)	79.82 (63.28)	72.33 (58.24)	70.33 (56.97)	68.66 (55.99)	45.66 (42.49)	21.12 (27.35)	0.00 (00.00)	0.00 (00.00)
L3C1V1	95.46 (77.69)	93.46 (75.16)	93.89 (74.10)	93.36 (75.05)	89.67 (71.23)	84.36 (66.68)	82.22 (65.04)	81.22 (64.30)	80.22 (63.57)	74.52 (59.66)	78.18 (56.88)
L3C1V2	95.40 (77.61)	93.38 (75.07)	93.67 (75.41)	93.24 (74.91)	86.44 (68.37)	82.32 (65.11)	80.42 (63.71)	80.66 (63.89)	80.00 (63.41)	72.45 (58.32)	69.33 (56.35)
L3C2V1	95.36 (77.56)	93.34 (75.02)	92.92 (74.55)	88.96 (70.57)	84.88 (67.09)	80.27 (63.60)	76.44 (60.94)	74.13 (59.41)	72.67 (58.46)	69.67 (56.56)	68.67 (55.94)
L3C2V2	95.33 (77.56)	93.30 (71.10)	92.72 (74.57)	87.42 (69.30)	82.44 (65.23)	80.12 (63.50)	74.42 (59.60)	72.68 (58.46)	70.68 (57.19)	66.40 (54.56)	66.12 (54.38)
L3C3V1	95.22 (77.36)	93.26 (74.93)	92.33 (73.90)	86.52 (68.44)	80.12 (63.50)	74.33 (59.54)	66.67 (54.72)	58.33 (49.78)	24.67 (29.77)	0.00 (00.00)	0.00 (00.00)
L3C3V2	95.12 (77.23)	93.20 (74.86)	92.10 (73.65)	85.00 (67.19)	74.22 (59.46)	68.02 (55.54)	64.68 (53.52)	48.67 (44.22)	13.33 (21.40)	0.00 (00.00)	0.00 (00.00)
L3C4V1	92.00 (73.55)	85.98 (67.99)	80.66 (63.89)	75.67 (60.42)	71.26 (57.56)	68.26 (55.89)	45.84 (42.60)	25.66 (30.42)	0.00 (00.00)	0.00 (00.00)	0.00 (00.00)
L3C4V2	91.82 (73.36)	84.82 (67.05)	75.33 (60.20)	72.33 (58.24)	67.67 (55.33)	64.67 (53.51)	40.22 (39.34)	20.33 (26.79)	0.00 (00.00)	0.00 (00.00)	0.00 (00.00)
Mean	95.34 (77.84)	92.31 (74.21)	90.77 (72.89)	88.00 (70.27)	88.76 (65.81)	78.99 (62.94)	73.56 (59.38)	66.08 (54.76)	56.69 (47.78)	48.96 (41.29)	46.63 (36.07)
SEm±	1.16	0.90	1.22	1.08	0.45	0.46	0.63	0.46	0.30	0.25	0.20
CD (5%)	NS	2.57	NS	NS	1.28	NS	NS	1.31	0.85	0.72	0.58

* Figures in brackets are Arc sine values.

Due to locations and varieties (L x V)

Interaction effect of locations and variety showed non-significant difference upto eighth month of storage. In later months seed germination differed significantly from ninth to eleventh months of storage. Significantly maximum germination percentage of (70.34, 62.45, 51.11%) was noticed in L_1V_1 after nine, ten and eleven months of storage respectively. While, it was minimum in L_3V_2 (41.00, 34.71, 33.86%) after nine, ten, eleven month of storage respectively.

Due to crops and varieties (C x V)

Interaction effect of crop and variety showed significant difference in germination from eighth month of storage. Significantly highest germination percentage (83.07%) was recorded in C_1V_1 and lowest in C_4V_2 (42.21%) at the end of 8 months of storage. Similar trend was noticed in later months of storage upto end of 11 month of storage. At eleven month of storage significantly highest germination percentage was recorded in C_1V_1 (76.02%) and lowest in C_4V_2 (4.06%). The satisfactory germination as per the minimum seed certification standards was maintained upto ten month in C_1V_1 (80.22%), and C_2V_1 (72.27%) and upto nine month in C_1V_2 (80.02%), C_2V_2 (72.33%), upto six month in C_4V_1 (73.42%) and upto five month in C_4V_2 (72.22%).

Due to locations, crops and varieties (L x C x V)

Interaction of locations, crops and varieties showed significant difference in germination at five, eight, nine, ten and eleven month of storage. Significantly maximum germination percentage was recorded in $L_1C_1V_1$ (92.40%) and minimum was recorded in $L_3C_4V_2$ (67.67%) after fifth month of storage. Similar trend was noticed at eighth, ninth, tenth and eleventh month of storage. After eleventh months of storage, significantly the highest germination was noticed in $L_1C_1V_1$ (80.66%) and lowest (0.00%) in $L_2C_4V_1$, $L_2C_4V_2$, $L_3C_3V_2$, $L_3C_4V_1$, $L_3C_4V_2$. The satisfactory germination as per seed standards was maintained upto eleven months in $L_1C_1V_1$ (80.66%), $L_1C_1V_2$ (80.45%), $L_1C_2V_1$ (70.12%), upto ten months in $L_1C_2V_2$ (72.42%), $L_2C_1V_1$ (80.87%), $L_2C_1V_2$ (80.16%), $L_2C_2V_1$ (72.33%) and $L_2C_2V_2$ (70.67%), upto nine months in $L_3C_1V_1$ (80.22%), $L_3C_1V_2$ (80.00%), $L_3C_2V_1$ (72.67%) and $L_3C_2V_2$ (70.68%), upto eight month in $L_1C_3V_1$ (70.66%), upto seven months in $L_1C_3V_2$ (74.66%), $L_1C_4V_1$ (72.88%), $L_1C_4V_2$ (70.82%), $L_2C_3V_1$ (74.33%), $L_2C_3V_2$ (72.67%) and $L_2C_4V_1$ (70.66%), upto six months in $L_2C_4V_2$ (70.33%) and $L_3C_3V_1$ (74.33%), upto five months in $L_3C_3V_2$ (74.22%) and $L_3C_4V_1$ (71.26%) and only upto four months in $L_3C_4V_2$ (72.33%).

4.2 Speed of germination

The data on speed of germination as influenced by locations, crops and varieties and their interactions during storage are presented in Table 3. Irrespective of locations, crops and varieties the mean speed of germination declined from 29.05 to 13.10 from initial month of storage to eleven month of storage.

Due to locations

Speed of germination due to location found to differ significantly throughout storage period.Irrespective of crops and varieties significantly highest speed of germination was recorded in seeds stored at Raichur (29.18) followed by Dharwad (29.03) and lowest in seeds stored at Sirsi (28.96) in first month of storage. Similar trend was noticed through out the storage period. After eleventh month of storage seeds stored at Raichur recorded highest speed of germination (16.76) followed by Dharwad (13.24) and lowest was recorded in seeds stored at Sirsi (9.30).

Due to crops

Oilseed crops differed significantly throughout the storage period for speed of germination. Among oilseed crops, sesamum recorded significantly higher speed of germination (38.81) followed by soybean (26.32) sunflower (25.86) and lower speed of germination was recorded in groundnut (25.23) at first month of storage. Similar trend was noticed upto seven month of storage. While, at eight month significantly higher speed of germination was noticed in sesamum (32.22) followed by sunflower (20.23), soybean (19.56) and groundnut (15.77). Similar trend was noticed upto eleven month of storage. Significantly

Table 3. Influence of locations, oilseed crops and varieties on speed of germination during storage

Treatments	Months of storage										
	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
Location											
L1	29.18	28.71	27.92	27.52	26.77	25.76	25.02	24.01	22.10	19.88	16.76
L2	29.03	28.46	27.86	27.49	25.37	24.51	23.80	22.51	20.21	17.05	13.24
L3	28.96	28.24	27.66	27.20	24.62	23.30	21.91	19.32	15.31	10.74	9.30
SEm±	0.05	0.09	0.05	0.06	0.25	0.08	0.03	0.07	0.11	0.08	0.04
CD (5%)	0.14	0.27	0.15	0.17	0.71	0.24	0.09	0.20	0.32	0.22	0.12
Crop											
C1	38.81	37.51	36.82	36.33	34.12	33.50	32.94	32.22	31.20	28.67	26.32
C2	25.86	25.55	24.80	24.59	22.66	21.53	21.25	20.23	19.35	17.86	14.50
C3	26.32	26.39	25.32	25.04	23.87	22.64	21.29	19.56	16.66	10.59	8.41
C4	25.23	24.44	24.33	23.64	21.71	20.44	18.82	15.77	9.63	6.54	3.16
SEm±	0.06	0.11	0.06	0.07	0.29	0.10	0.04	0.08	0.13	0.09	0.05
CD (5%)	0.16	0.31	0.17	0.20	0.82	0.28	0.11	0.23	0.37	0.25	0.14
Variety											
V1	29.07	28.62	27.82	27.45	25.77	24.62	23.76	22.44	19.76	16.90	13.65
V2	29.04	28.32	27.81	27.35	25.40	24.43	23.40	21.45	18.65	14.88	12.55
Mean	29.05	28.47	27.82	27.40	25.59	24.53	23.59	21.95	19.21	15.89	13.10
SEm±	0.04	0.08	0.04	0.05	0.20	0.07	0.03	0.09	0.09	0.06	0.04
CD (5%)	NS	0.22	NS	NS	NS	NS	0.09	0.27	0.26	0.18	0.10

Table 3 Contd…

L x C	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1	38.92	37.76	36.92	36.41	35.77	34.72	34.50	33.90	32.86	30.20	27.72
L1C2	25.97	25.86	24.99	24.62	23.71	22.81	22.43	21.50	20.78	19.17	15.80
L1C3	26.44	26.65	25.43	25.26	24.89	23.91	22.48	21.50	19.06	16.60	14.02
L1C4	25.38	24.61	24.38	23.78	22.72	21.60	20.67	19.15	15.72	13.59	9.50
L2C1	38.80	37.49	36.83	36.32	33.03	33.49	33.24	32.77	31.76	29.12	26.72
L2C2	25.81	25.58	24.81	24.74	22.60	21.59	21.28	20.39	19.50	18.15	15.00
L2C3	26.30	26.27	25.30	25.21	23.84	22.50	21.22	19.90	16.44	14.92	11.22
L2C4	25.21	24.50	24.51	23.66	22.00	20.50	19.46	17.61	13.16	6.03	0.00
L3C1	38.70	37.29	36.70	36.28	33.56	32.29	31.09	30.00	29.00	26.70	24.50
L3C2	25.81	25.21	24.64	24.40	21.66	20.22	20.04	18.83	17.77	16.27	12.70
L3C3	26.22	26.25	25.22	24.64	22.87	21.50	20.17	17.29	14.46	0.00	0.00
L3C4	25.11	24.21	24.10	23.46	20.40	19.21	16.35	11.18	0.00	0.00	0.00
SEm±	0.10	0.19	1.10	0.12	0.50	0.17	0.07	0.14	0.23	0.15	0.09
CD 5%)	NS	NS	NS	NS	NS	NS	0.19	0.40	0.64	0.43	0.25
L x V											
L1V1	29.20	28.89	27.96	27.57	26.84	25.81	25.18	24.20	22.45	20.66	17.52
L1V2	29.15	28.62	27.89	27.46	26.71	25.71	24.86	23.83	21.77	19.10	16.00
L2V1	29.05	28.67	27.82	27.54	25.74	24.67	23.92	22.82	21.06	19.10	13.80
L2V2	29.01	28.25	27.91	27.43	25.00	24.36	23.69	22.22	19.37	15.01	12.67
L3V1	28.95	28.39	27.70	27.24	24.74	23.39	22.18	20.34	15.82	10.94	9.61
L3V2	28.97	28.09	27.63	27.15	24.51	23.22	21.65	18.31	14.80	10.54	8.99
SEm±	0.04	0.13	0.07	0.09	0.35	0.12	0.05	0.10	0.16	0.11	0.06
CD(5%)	NS	NS	NS	NS	NS	NS	0.13	0.29	0.46	0.31	0.17
C x V											
C1V1	38.82	37.59	36.84	36.40	34.76	35.59	33.04	32.48	31.47	28.81	26.89
C1V2	38.79	37.42	36.78	36.28	33.49	33.41	32.85	31.97	30.95	28.52	25.74
C2V1	25.82	25.61	24.82	24.65	22.77	21.61	21.32	20.55	19.64	18.35	15.02
C2V2	25.90	25.49	24.77	24.52	22.54	21.46	21.17	19.93	17.06	17.37	13.98
C3V1	26.35	26.76	25.35	25.07	23.93	22.76	21.54	19.89	17.46	11.39	9.23
C3V2	26.28	25.02	25.28	25.00	23.80	22.51	21.04	19.24	15.85	9.60	7.59
C4V1	25.27	24.53	24.27	23.68	21.63	20.53	19.12	16.88	10.53	9.09	3.44
C4V2	25.19	24.34	24.89	23.59	21.77	20.34	18.52	14.68	8.73	9.04	2.89
SEm±	0.08	0.15	0.08	0.10	0.41	0.14	0.05	0.12	0.19	0.13	0.07
CD (5%)	NS	NS	NS	NS	NS	NS	0.15	0.34	0.53	0.36	0.20

L x C x V	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1V1	38.94	37.77	36.94	36.48	35.86	34.77	34.67	33.94	32.92	30.23	28.12
L1C1V2	38.90	37.72	36.90	36.33	35.68	34.67	34.33	33.86	32.81	30.16	27.33
L1C2V1	25.98	25.86	24.98	24.67	23.76	22.86	22.54	21.66	20.87	19.67	16.28
L1C2V2	25.96	25.85	24.91	24.56	23.66	22.76	22.32	21.33	20.68	18.66	15.33
L1C3V1	26.47	26.94	25.47	25.32	24.96	23.94	22.63	21.54	19.67	17.66	15.37
L1C3V2	26.40	26.35	25.40	25.21	24.82	23.88	22.33	21.46	18.46	15.46	12.66
L1C4V1	25.42	24.67	24.47	23.81	22.78	21.67	20.88	19.64	16.33	15.06	10.33
L1C4V2	25.33	24.54	24.33	23.74	22.66	21.54	20.46	18.66	15.12	12.12	8.67
L2C1V1	38.81	37.65	36.87	36.38	34.74	33.65	33.33	32.82	31.82	29.16	27.22
L2C1V2	38.78	37.33	36.78	36.26	31.33	33.33	33.16	32.72	31.69	29.08	26.22
L2C2V1	25.82	25.69	24.82	24.82	22.67	21.69	21.34	20.52	19.68	18.66	15.67
L2C2V2	25.80	25.47	24.80	24.67	22.52	21.47	21.21	20.26	19.33	17.64	14.33
L2C3V1	26.33	26.67	25.33	25.23	23.88	22.67	21.33	20.46	17.46	16.52	12.33
L2C3V2	26.27	25.87	25.27	25.18	23.80	22.33	21.12	19.33	15.41	13.33	10.12
L2C4V1	25.24	24.66	24.24	23.71	21.66	20.66	19.66	17.46	15.26	12.06	0.00
L2C4V2	25.18	24.33	24.78	23.62	22.33	20.33	19.26	16.56	11.06	0.00	0.00
L3C1V1	38.72	37.36	36.72	36.33	33.67	32.36	31.12	30.67	29.67	27.06	25.33
L3C1V2	38.68	37.22	36.68	36.24	33.66	32.22	31.06	29.33	28.39	26.33	23.67
L3C2V1	25.67	25.27	24.67	24.46	21.88	20.27	20.09	19.47	18.36	16.72	13.12
L3C2V2	25.94	25.15	24.67	24.33	21.44	20.16	20.00	18.19	17.18	15.81	12.28
L3C3V1	26.25	26.67	25.25	24.67	22.95	21.67	20.67	17.66	15.26	0.00	0.00
L3C3V2	26.18	25.83	25.18	24.62	22.80	21.33	19.67	16.92	13.67	0.00	0.00
L3C4V1	25.16	24.26	24.16	23.52	20.47	19.26	16.84	13.54	0.00	0.00	0.00
L3C4V2	25.06	24.16	24.05	23.41	20.33	19.16	15.86	8.81	0.00	0.00	0.00
Mean	29.05	28.47	27.82	27.40	25.59	24.53	23.59	21.95	19.21	15.89	13.10
SEm±	0.14	0.26	0.14	0.17	0.70	0.24	0.09	0.20	0.32	0.22	0.12
CD (5%)	NS	NS	NS	NS	NS	NS	0.26	0.57	0.91	0.61	0.35

highest speed of germination was noticed in sesamum (26.32) and lowest in groundnut (3.16) at eleven month of storage.

Due to varieties

Speed of germination showed a non-significant difference in first, third, fourth and sixth month of storage for varieties irrespective of locations and crops. Significantly the highest speed of germination was noticed in variety V_1 (28.62) and the lowest was recorded in variety V_2 (28.32) at second month after storage. Similar trend was noticed upto eleven month of storage. After eleventh month of storage variety V_1 of each crop recorded highest speed of germination (13.65) while, variety V_2 recorded lowest speed of germination (12.55).

Interactions

Due to locations and crops (L x C)

Interaction effects of locations and crops showed significant difference from seventh month of storage for speed of germination. Significantly maximum speed of germination was noticed in L_1C_1 (34.50) and minimum was recorded in L_3C_4 (16.35) after seventh month of storage. Similar trend was noticed upto ninth month of storage. After tenth month of storage significantly the highest speed of germination was recorded in L_1C_1 (30.20) and lowest was recorded in L_3C_3 and L_3C_4 (0.00). Speed of germination was significantly maximum in L_1C_1 (27.72) and minimum was in L_2C_4, L_3C_3, L_3C_4 (0.00) after eleven month of storage.

Due to locations and varieties (L x V)

Interaction effects of locations and varieties showed non-significant difference from first to sixth month after storage. Speed of germination was significantly higher in L_1V_1 (25.18) and lower in L_3V_2 (21.65) after seventh month of storage. Similar trend was noticed from eighth to eleven month of storage. After eleventh month of storage significantly the highest speed of germination was recorded in L_1V_1 (17.52) and lowest in L_3V_2 (8.99).

Due to crops and varieties (C x V)

Interaction of crop and varieties showed significant difference on speed of germination from seventh month of storage. Speed of germination was significantly higher in C_1V_1 (33.04) and lower in C_4V_2 (18.52) after seventh month of storage. Similar trend was noticed from eighth month of storage to eleventh month of storage. Significantly higher speed of germination was recorded in C_1V_1 (26.89) and lower speed of germination was recorded in C_4V_2 (2.89).

Due to locations, crops and varieties (L x C x V)

Interaction effect due to locations, crops and varieties was non-significant for speed of germination from first to sixth months of storage. Significantly highest speed of germination was noticed in $L_1C_1V_1$ (34.67) and lowest was noticed in $L_3C_4V_2$ (15.86) followed by $L_3C_4V_1$ (16.84) after seventh month of storage. Similar trend was noticed upto ninth month of storage. After tenth month of storage $L_1C_1V_1$ (30.23) recorded higher speed of germination while, lower speed of germination was recorded in $L_2C_4V_2$, $L_3C_3V_1$, $L_3C_3V_2$, $L_3C_4V_1$ and $L_3C_4V_2$ (0.00). Similarly, significantly the highest speed of germination was noticed in $L_1C_1V_1$ (28.12) and the lowest in $L_2C_4V_1$, $L_2C_4V_2$, $L_3C_3V_1$, $L_3C_3V_2$, $L_3C_4V_1$ and $L_3C_4V_2$ (0.00) at eleven month after storage.

4.3 Field Emergence (%)

The data on field emergence as influenced by locations, crops and varieties and their interaction effects during storage are presented in Table 4.

Irrespective of locations, crop and varieties the mean field emergence declined from 91.23 to 34.66 per cent from initial month to the eleven month after storage.

Due to locations

The locations differed significantly for field emergence throughout the storage period. Significantly the highest field emergence was recorded in seeds stored at Raichur (91.77%) followed by Dharwad (91.54%) and the lowest was recorded in Sirsi (90.38%) location at first month of storage. Similar trend was noticed throughout the storage period. After eleventh

Table 4. Influence of locations, oilseed crops and varieties on field emergence (%) during storage

Treatments	Months of storage										
	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
Location											
L1	91.77	87.52	84.31	79.03	71.99	68.19	63.26	57.99	54.56	46.73	40.60
	(73.55)	(69.36)	(66.74)	(62.78)	(58.16)	(55.83)	(52.90)	(49.78)	(47.71)	(42.53)	(38.03)
L2	91.54	86.93	83.81	77.32	69.71	65.04	59.63	52.72	48.21	40.03	36.96
	(73.30)	(68.88)	(66.36)	(61.62)	(56.72)	(53.91)	(50.71)	(46.36)	(43.33)	(35.00)	(28.57)
L3	90.38	85.84	82.00	77.77	65.46	59.92	51.37	40.00	34.49	32.33	30.43
	(72.09)	(68.95)	(65.06)	(58.68)	(54.14)	(50.86)	(45.68)	(35.00)	(29.59)	(26.76)	(25.63)
SEm±	0.25	0.19	0.19	0.17	0.10	0.19	0.10	0.07	0.16	0.06	0.12
CD (5%)	0.71	0.54	0.54	0.49	0.28	0.54	0.29	0.21	0.44	0.18	0.35
Crop											
C1	93.04	88.23	86.18	82.23	77.06	74.74	74.12	72.41	71.22	69.19	66.29
	(74.73)	(69.93)	(68.17)	(65.05)	(61.34)	(59.85)	(59.40)	(58.30)	(57.54)	(56.27)	(54.50)
C2	92.98	88.14	85.52	76.85	72.97	71.82	70.59	69.68	66.26	63.43	61.36
	(74.65)	(69.85)	(67.63)	(61.28)	(58.68)	(57.94)	(57.15)	(56.58)	(54.49)	(52.77)	(51.56)
C3	92.76	88.04	85.08	73.95	69.03	61.15	53.99	40.14	30.59	21.46	8.84
	(74.41)	(69.75)	(67.26)	(59.29)	(56.20)	(51.46)	(47.22)	(38.91)	(30.46)	(22.74)	(12.09)
C4	86.15	82.66	76.71	72.47	57.15	49.82	33.67	18.72	14.94	4.72	2.17
	(68.14)	(65.39)	(61.17)	(58.37)	(49.11)	(44.88)	(35.20)	(21.06)	(18.36)	(07.27)	(04.83)
SEm±	0.29	0.22	0.22	0.20	0.11	0.22	0.12	0.09	0.18	0.07	0.14
CD (5%)	0.81	0.63	0.62	0.56	0.32	0.62	0.34	0.24	0.51	0.21	0.41
Variety											
V1	91.32	86.93	83.83	71.99	70.33	66.01	60.09	53.08	48.56	42.35	36.33
	(73.07)	(68.86)	(66.38)	(62.03)	(54.13)	(54.52)	(51.00)	(45.54)	(42.50)	(36.51)	(32.39)
V2	91.15	86.60	82.91	69.71	67.77	62.76	56.08	47.40	42.95	37.04	33.00
	(72.90)	(68.60)	(66.73)	(60.02)	(54.54)	(52.55)	(48.52)	(41.88)	(37.92)	(33.02)	(29.11)
Mean	91.23	86.77	83.37	76.37	69.05	64.32	58.09	50.24	45.75	39.70	34.66
	(72.98)	(68.73)	(66.05)	(61.03)	(56.34)	(53.33)	(48.76)	(43.71)	(40.21)	(34.76)	(30.75)
SEm±	0.20	0.16	0.16	0.14	0.08	0.15	0.08	0.06	0.13	0.05	0.10
CD (5%)	NS	NS	0.44	0.40	0.23	0.44	0.24	0.17	0.36	0.15	0.29

Table 4 Contd…

L x C	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1	93.67 (75.44)	88.66 (70.34)	86.45 (68.42)	82.66 (65.37)	78.54 (62.38)	77.55 (61.70)	75.56 (60.35)	73.23 (58.82)	72.48 (58.34)	70.50 (57.08)	68.66 (55.95)
L1C2	93.55 (75.30)	88.58 (70.26)	85.91 (67.97)	80.12 (63.50)	75.65 (60.41)	74.27 (59.50)	72.69 (58.48)	72.27 (58.20)	68.50 (55.84)	65.39 (53.95)	64.58 (53.47)
L1C3	93.23 (74.92)	88.48 (70.13)	85.57 (67.65)	77.62 (61.75)	72.27 (58.20)	66.27 (54.48)	60.65 (51.13)	51.15 (45.65)	45.62 (42.44)	36.89 (37.25)	22.67 (28.22)
L1C4	86.65 (68.55)	84.38 (66.70)	79.32 (62.94)	75.75 (60.48)	61.50 (51.63)	54.66 (47.65)	44.15 (41.62)	35.33 (36.44)	31.67 (34.21)	14.15 (21.82)	6.50 (14.49)
L2C1	93.40 (75.12)	88.61 (70.25)	86.31 (68.26)	82.61 (55.33)	77.08 (61.38)	73.33 (58.96)	74.44 (59.62)	72.56 (58.39)	71.17 (57.51)	69.41 (56.40)	66.33 (54.51)
L2C2	93.33 (75.01)	88.51 (70.16)	85.64 (57.87)	77.25 (61.85)	73.60 (59.06)	73.00 (58.67)	71.00 (57.40)	70.00 (56.77)	67.00 (54.92)	63.22 (52.65)	61.67 (51.73)
L2C3	93.05 (74.72)	88.41 (70.07)	85.44 (67.55)	75.97 (60.63)	69.66 (59.55)	63.50 (52.82)	58.33 (49.72)	47.50 (43.54)	41.50 (40.04)	27.50 (30.96)	3.84 (8.04
L2C4	86.40 (68.34)	82.21 (65.04)	77.64 (61.77)	73.45 (58.97)	58.50 (49.88)	50.33 (45.17)	34.76 (36.04)	20.84 (26.74)	13.17 (20.88)	0.00 (00.00)	0.00 (00.00)
L3C1	92.06 (73.61)	87.42 (69.20)	85.78 (67.82)	81.42 (64.44)	75.56 (60.35)	73.34 (58.90)	72.32 (58.24)	71.44 (57.68)	70.00 (56.77)	67.65 (55.31)	63.89 (53.04)
L3C2	92.05 (73.62)	87.32 (69.12)	84.82 (67.05)	73.17 (58.83)	69.66 (56.56)	68.20 (55.66)	68.07 (55.58)	66.78 (54.79)	63.28 (52.71)	61.67 (51.73)	57.83 (49.49)
L3C3	92.01 (73.58)	87.23 (69.04)	84.22 (66.57)	68.26 (55.79)	65.17 (56.83)	53.68 (47.09)	43.00 (40.95)	21.76 (27.55)	4.67 (08.89)	0.00 (00.00)	0.00 (00.00)
L3C4	85.41 (67.53)	81.40 (64.43)	73.17 (58.79)	68.21 (55.66)	51.47 (45.82)	44.47 (41.80)	22.09 (27.94)	0.00 (00.00)	0.00 (00.00)	0.00 (00.00)	0.00 (00.00)
SEm±	0.50	0.38	0.38	0.34	0.19	0.38	0.21	0.15	0.31	0.13	0.25
CD (5%)	NS	NS	1.08	0.97	0.55	1.07	0.59	0.43	0.89	0.36	0.71

Table 4 Contd…

L x V	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1V1	91.84	87.56	84.66	79.75	70.76	69.39	64.60	60.54	57.68	50.67	43.54
	(73.63)	(69.40)	(66.01)	(63.27)	(58.66)	(56.57)	(53.71)	(51.29)	(49.56)	(45.15)	(40.30)
L1V2	91.70	87.49	83.97	78.32	71.22	66.99	61.92	55.45	51.45	42.80	37.67
	(73.48)	(69.32)	(66.48)	(62.29)	(57.66)	(55.10)	(52.08)	(48.26)	(45.85)	(39.90)	(35.77)
L2V1	91.61	87.22	84.38	78.60	71.20	67.08	61.96	56.42	51.70	43.64	34.42
	(73.37)	(69.10)	(66.77)	(62.48)	(57.53)	(55.15)	(52.12)	(48.79)	(45.75)	(37.35)	(30.88)
L2V2	91.48	86.64	83.23	76.03	66.41	63.00	57.30	49.03	44.72	36.43	31.50
	(73.23)	(68.66)	(65.95)	(60.75)	(55.91)	(52.66)	(49.30)	(43.93)	(40.92)	(32.65)	(26.26)
L3V1	90.51	86.01	82.45	75.42	67.23	61.56	53.72	42.29	36.31	32.75	31.02
	(72.20)	(68.07)	(65.36)	(60.34)	(55.22)	(51.84)	(47.18)	(36.56)	(32.20)	(27.01)	(25.98)
L3V2	90.26	86.68	81.54	70.10	63.69	58.28	49.02	37.71	32.67	31.91	29.84
	(72.00)	(67.82)	(64.75)	(57.02)	(53.06)	(49.88)	(44.18)	(33.45)	(26.98)	(26.51)	(25.29)
SEm±	0.35	0.27	0.27	0.24	0.14	0.27	0.15	0.11	0.22	0.29	0.18
CD (5%)	NS	NS	NS	0.69	0.39	NS	0.42	0.33	0.63	0.87	0.50
C x V											
C1V1	93.08	86.25	86.27	82.25	78.13	76.45	75.00	73.51	72.05	70.00	67.36
	(74.77)	(69.96)	(68.24)	(65.07)	(62.11)	(60.96)	(59.99)	(59.01)	(58.07)	(56.77)	(55.15)
C1V2	93.00	88.20	86.09	82.20	75.98	73.03	73.21	71.30	70.38	68.37	65.23
	(74.68)	(69.91)	(68.09)	(65.03)	(60.64)	(58.74)	(58.82)	(57.59)	(57.01)	(55.76)	(53.86)
C2V1	93.05	88.15	86.67	78.82	74.06	72.94	71.71	70.60	67.67	64.52	62.83
	(74.74)	(69.87)	(67.71)	(62.60)	(59.39)	(58.65)	(57.85)	(57.12)	(55.33)	(53.42)	(52.43)
C2V2	92.90	88.12	85.44	74.88	71.87	70.70	69.46	68.76	64.85	62.33	59.89
	(74.56)	(69.82)	(67.55)	(59.97)	(57.97)	(57.24)	(56.45)	(56.01)	(53.64)	(52.12)	(50.69)
C3V1	92.81	88.06	85.24	76.77	70.37	62.89	56.21	45.88	36.85	28.66	12.11
	(74.46)	(69.77)	(67.30)	(61.18)	(57.01)	(52.49)	(48.58)	(42.48)	(36.15)	(27.30)	(16.14)
C3V2	92.71	88.01	85.91	71.13	67.69	59.41	51.77	34.41	24.33	14.26	5.56
	(74.35)	(69.72)	(67.13)	(57.60)	(55.38)	(50.43)	(46.00)	(35.34)	(24.76)	(18.17)	(08.03)
C4V1	86.34	83.25	78.21	73.85	58.75	51.75	37.45	22.33	17.66	6.22	3.00
	(68.30)	(65.83)	(62.19)	(59.26)	(50.03)	(45.99)	(37.58)	(23.53)	(20.46)	(08.53)	(05.82)
C4V2	85.96	82.08	75.20	71.09	55.55	47.88	29.88	15.11	12.22	3.21	1.33
	(67.97)	(64.95)	(60.14)	(57.49)	(48.18)	(43.76)	(32.81)	(18.59)	(16.26)	(06.02)	(03.84)
SEm±	0.41	0.31	0.31	0.28	0.16	0.31	0.17	0.12	0.25	0.10	0.20
CD (5%)	NS	NS	0.88	0.79	0.45	NS	0.48	0.35	0.72	0.29	0.58

Table 4 Contd…

L x C x V	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1V1	93.67	88.67	86.52	82.67	79.40	78.34	76.45	74.33	73.82	71.67	69.99
	(74.44)	(70.36)	(68.48)	(65.38)	(62.99)	(62.24)	(60.95)	(59.54)	(59.20)	(57.82)	(56.76)
L1C1V2	93.67	88.64	86.38	82.64	77.61	76.76	74.67	72.12	71.13	69.33	67.33
	(75.44)	(70.32)	(68.36)	(65.36)	(61.78)	(61.16)	(59.76)	(58.11)	(57.48)	(56.35)	(55.14)
L1C2V1	93.64	88.60	85.98	80.67	76.64	74.88	73.66	72.88	69.66	66.66	66.49
	(75.41)	(70.32)	(68.07)	(63.90)	(61.08)	(59.90)	(59.10)	(58.59)	(56.56)	(54.71)	(54.62)
L1C2V2	96.46	88.56	85.84	79.56	74.66	73.66	71.72	71.66	67.33	64.12	62.68
	(75.19)	(70.21)	(67.87)	(63.10)	(59.75)	(59.10)	(57.85)	(57.81)	(55.12)	(53.18)	(52.32)
L1C3V1	93.33	88.50	85.72	78.82	72.66	67.66	62.63	56.63	52.56	45.66	28.67
	(75.04)	(70.16)	(67.77)	(62.58)	(58.45)	(55.32)	(52.30)	(58.79)	(46.45)	(42.49)	(32.36)
L1C3V2	93.12	88.45	85.42	76.42	71.88	64.88	58.66	45.67	38.67	28.12	16.67
	(74.80)	(70.11)	(67.53)	(60.93)	(67.95)	(53.64)	(49.97)	(42.50)	(38.44)	(32.01)	(24.09)
L1C4V1	86.74	84.46	80.42	76.82	62.33	56.67	45.66	38.33	34.66	18.67	9.00
	(68.63)	(66.76)	(67.71)	(61.20)	(52.12)	(48.81)	(42.49)	(38.24)	(36.05)	(25.59)	(17.45)
L1C4V2	86.56	84.30	78.22	74.60	60.66	52.64	42.64	32.33	28.67	9.62	4.00
	(68.48)	(66.63)	(62.16)	(59.76)	(51.14)	(46.50)	(40.75)	(34.64)	(32.36)	(18.06)	(11.53)
L2C1V1	93.46	88.63	86.40	82.63	78.33	76.66	75.33	73.66	72.12	70.00	67.33
	(75.19)	(70.27)	(68.34)	(65.35)	(62.23)	(61.09)	(60.20)	(59.10)	(58.11)	(56.77)	(55.12)
L2C1V2	93.33	88.58	86.22	82.58	75.82	70.00	73.55	71.46	70.22	68.82	65.33
	(75.04)	(70.23)	(68.19)	(65.31)	(60.52)	(56.84)	(59.03)	(57.69)	(56.90)	(56.03)	(53.91)
L2C2V1	93.42	88.52	85.92	79.82	74.51	73.66	71.33	70.66	67.67	64.22	62.67
	(75.15)	(70.17)	(67.94)	(63.29)	(59.76)	(59.10)	(57.60)	(57.18)	(55.33)	(53.24)	(52.32)
L2C2V2	93.23	88.49	85.76	74.67	72.52	72.33	70.67	69.33	66.33	62.22	60.67
	(74.89)	(70.15)	(67.81)	(59.16)	(58.36)	(58.24)	(57.19)	(56.35)	(54.51)	(52.05)	(51.14)
L2C3V1	93.08	88.43	85.66	76.98	70.55	65.67	60.33	52.67	48.67	40.33	7.67
	(74.76)	(70.09)	(67.73)	(61.31)	(56.97)	(54.11)	(50.94)	(46.51)	(44.22)	(39.41)	(16.07)
L2C3V2	93.02	88.38	85.22	74.96	68.98	61.33	56.33	42.33	34.33	14.67	0.00
	(74.69)	(70.05)	(67.37)	(59.95)	(56.13)	(51.33)	(48.62)	(40.57)	(35.85)	(22.51)	(00.00)
L2C4V1	86.46	83.30	77.55	74.98	60.66	52.33	40.86	28.67	18.33	0.00	0.00
	(68.40)	(65.86)	(63.09)	(59.97)	(51.14)	(46.32)	(39.72)	(32.36)	(25.34)	(00.00)	(00.00)
L2C4V2	86.33	81.12	75.72	71.92	56.33	48.33	28.66	30.00	8.00	0.00	0.00
	(68.29)	(64.22)	(60.46)	(57.98)	(48.62)	(44.03)	(32.35)	(21.12)	(16.42)	(00.00)	(00.00)
L3C1V1	92.12	87.46	85.89	81.45	76.67	74.36	73.22	72.55	70.22	68.33	64.75
	(73.69)	(69.24)	(67.91)	(64.47)	(61.05)	(59.56)	(58.81)	(58.39)	(56.90)	(55.73)	(53.56)
L3C1V2	92.00	87.38	85.67	81.38	74.44	72.32	71.42	70.33	69.79	66.96	63.02
	(73.56)	(69.17)	(67.73)	(64.42)	(59.61)	(58.23)	(57.66)	(56.97)	(56.63)	(54.89)	(52.53)

Table 4 Contd…

	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L3C2V1	92.08	87.34	84.92	75.96	70.86	70.27	70.13	68.26	65.67	62.67	59.33
	(73.66)	(69.14)	(67.13)	(60.62)	(57.32)	(56.94)	(56.85)	(55.69)	(54.11)	(52.32)	(50.36)
L3C2V2	92.02	87.30	84.72	70.42	68.44	66.12	66.00	65.29	60.90	60.66	56.33
	(73.59)	(69.10)	(66.97)	(59.03)	(55.80)	(54.38)	(54.31)	(53.88)	(51.30)	(51.14)	(48.62)
L3C3V1	92.02	87.26	84.33	74.32	68.12	55.33	45.67	28.33	9.33	0.00	0.00
	(73.59)	(69.07)	(66.66)	(59.66)	(55.60)	(48.04)	(42.50)	(32.15)	(17.77)	(00.00)	(00.00)
L3C3V2	92.00	87.20	84.10	62.00	62.22	52.02	40.33	15.22	0.00	0.00	0.00
	(73.57)	(69.01)	(66.48)	(51.92)	(52.05)	(46.14)	(39.41)	(22.95)	(00.00)	(00.00)	(00.00)
L3C4V1	85.82	81.98	74.66	69.74	53.26	46.26	25.84	0.00	0.00	0.00	0.00
	(67.86)	(64.86)	(59.75)	(56.61)	(46.85)	(42.84)	(30.54)	(00.00)	(00.00)	(00.00)	(00.00)
L3C4V2	85.00	80.82	71.67	66.67	49.67	42.67	18.33	0.00	0.00	0.00	0.00
	(67.19)	(64.00)	(57.82)	(54.72)	(44.79)	(40.77)	(25.34)	(00.00)	(00.00)	(00.00)	(00.00)
Mean	91.23	86.77	83.37	76.37	69.05	64.32	58.09	50.24	45.75	39.70	34.66
	(72.98)	(68.73)	(66.05)	(61.03)	(56.34)	(53.33)	(48.76)	(43.71)	(40.21)	(34.76)	(30.75)
SEm±	0.70	0.54	0.54	0.48	0.28	0.53	0.29	0.21	0.44	0.18	0.35
CD (5%)	NS	NS	NS	NS	NS	NS	0.83	0.60	1.25	0.51	1.00

* Figures in parentheses arc sine values.

month of storage seeds stored at Raichur recorded significantly the highest field emergence (40.60%) followed by Dharwad (32.96%) and the lowest was recorded on seeds stored at Sirsi (30.43%).

Due to crops

Irrespective of locations and varieties the field emergence percentage differed significantly due to crops throughout the storage period. Significantly the highest field emergence was noticed in sesamum, sunflower, soybean (93.04, 92.98, 92.76%) respectively but were on par with each other while, the lowest was recorded in groundnut (86.15%) after first month of storage. While after third month of storage sesamum recorded the highest field emergence (86.18%) and the lowest was recorded in groundnut (76.71%). Similar trend was noticed from fourth month onwards upto eleven months of storage. Significantly more field emergence percentage was observed in sesamum (66.29%) and less in groundnut (2.17%) at the end of eleventh month of storage.

Due to varieties

Field emergence percentage showed significant effect throughout storage period except after first and second month of storage. Significantly maximum (83.33%) field emergence was noticed in variety V_1 and minimum (82.91%) was noticed in variety V_2 after third month of storage. Similar trend was noticed upto eleven month of storage. After eleventh month of storage significantly higher field emergence was noticed in variety V_1 (36.33%) and lower was noticed in variety V_2 (33.00%).

Interactions

Due to locations and crops (L x C)

Field emergence differed significantly due to interaction of locations and crops throughout the storage period except after first and second month of storage. Significantly the highest field emergence percentage was recorded in L_1C_1, L_1C_2, L_1C_3, L_2C_1, L_2C_2, L_2C_3 and L_3C_1 (86.45, 85.91, 85.57, 86.31, 85.65, 85.44 and 85.78%) respectively and were on par with

each other while, the lowest field emergence percentage was recorded in L_3C_4 (73.17%) after third month of storage. After fourth month of storage significantly the highest field emergence percentage was recorded in L_1C_1 (82.66%) and lowest in L_3C_4 (68.21%). Similar trend was noticed from fifth month of storage to eleventh month of storage. Significantly the highest field emergence was recorded in L_1C_1 (68.66%) and lowest was recorded in L_2C_4, L_3C_3 and L_3C_4 (0.00%) after eleventh month of storage.

Due to locations and varieties (L x V)

The field emergence showed significant effect in all month of storage except in first second and third month of storage. Significantly the highest field emergence was noticed in L_1V_1 (79.75%) and lowest in L_3V_2 (70.10%) after fourth month of storage. Similar trend was noticed from fourth month of storage to eleventh month of storage. Significantly the highest field emergence was noticed in L_1V_1 (43.54%) and the lowest in L_3V_2 (29.84%) after eleventh month of storage.

Due to crops and varieties (C x V)

The field emergence differed significantly due to crops and varieties from third month of storage. Significantly higher field emergence was noticed in C_1V_1, C_1V_2, C_2V_1 and C_2V_2 (86.27, 86.09, 86.67, 85.44%) respectively and were on par with each other and lower was in C_4V_2 (75.20%) after third month of storage at similar trend was noticed upto eleventh month of storage. After eleventh month of storage significantly the highest field emergence was recorded in C_1V_1 (67.36%) and lowest (1.33%) was noticed in C_4V_2.

Due to locations, crops and varieties

Field emergence percentage showed non-significant difference throughout the storage period except in seventh, eighth, ninth, tenth and eleventh month of storage. Significantly higher field emergence was noticed in $L_1C_1V_1$ (74.33%) while, lower (0.00%) field emergence was noticed in $L_3C_4V_2$ at eighth month of storage. Similar trend noticed from ninth month of storage to eleven month of storage. Significantly higher (69.99%) field emergence was recorded in $L_1C_1V_1$ and lower (0.00%) in $L_2C_3V_2$, $L_2C_4V_1$, $L_2C_4V_2$, $L_3C_3V_1$, $L_3C_3V_2$, $L_3C_4V_1$ and $L_3C_4V_2$ after eleventh month of storage.

4.4 Root Length (cm)

The data on root length (cm) during storage as influenced by locations, crops and varieties and their interactions are presented in Table 5.

Irrespective of locations, crops and varieties the mean root length (cm) declined from 15.87 to 4.60 cm in first month to eleven month of storage respectively.

Due to locations

Locations differed significantly throughout the storage period for root length parameter. Significantly maximum root length was noticed in seeds stored at Raichur (16.07 cm) followed by Dharwad (15.78 cm) and minimum was recorded in seeds stored at Sirsi (15.56 cm) at first month after storage. Similar trend was noticed from second month of storage to eleven month of storage. At eleventh month after storage seeds stored at Raichur recorded significantly higher root length (6.81 cm), while seeds stored at Sirsi recorded lower root length (2.64 cm).

Due to crops

Root length showed significant differences among crops in all the months of storage period irrespective of locations and varieties. Among crops, soybean recorded higher root length compared to other crops upto eight month of storage, but from ninth month of storage sunflower recorded higher root length compared to other crops. Soybean 18.56 to 4.22 cm and sunflower recorded 17.65 to 7.66 cm, groundnut 16.43 to 1.72 cm and sesamum recorded root length of 10.83 to 4.80 cm from first month of storage to eleven month of storage, respectively.

Table 5. Influence of locations, oilseed crops and varieties on root length (cm) during storage

Treatments	Months of storage										
	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
Location											
L1	16.07	14.99	14.26	1307	12.35	12.18	11.91	11.01	9.35	8.04	6.81
L2	15.78	14.92	14.11	12.71	11.81	11.59	11.38	10.23	8.17	6.15	4.36
L3	15.56	14.50	12.97	11.48	10.68	10.49	10.25	9.60	5.66	3.55	2.64
SEm±	0.07	0.07	0.07	0.07	0.05	0.15	0.05	0.15	0.10	0.06	0.04
CD (5%)	0.19	0.20	0.19	0.18	0.15	0.44	0.15	0.45	0.27	0.17	0.13
Crop											
C1	10.83	10.54	10.16	8.96	7.88	7.69	7.40	7.26	6.92	5.93	4.80
C2	17.65	16.44	15.49	14.17	13.13	13.02	12.81	12.31	10.41	9.75	7.66
C3	18.56	17.35	16.12	14.88	14.48	14.18	14.09	13.13	8.39	4.99	4.22
C4	16.43	14.86	13.36	11.68	10.97	10.78	10.41	8.41	5.19	3.00	1.72
SEm±	0.08	0.08	0.08	0.07	0.06	0.18	0.06	0.06	0.11	0.07	0.05
CD (5%)	0.22	0.23	0.22	0.21	0.17	0.51	0.17	0.17	0.32	0.21	0.15
Variety											
V1	15.87	14.80	13.80	12.44	11.64	11.43	11.22	10.38	7.88	6.29	4.70
V2	15.86	14.80	13.77	12.40	11.58	11.41	11.14	10.17	7.57	5.55	4.50
Mean	15.87	14.80	13.78	12.42	11.61	11.42	11.18	10.28	7.73	5.92	4.60
SEm±	0.06	0.06	0.05	0.05	0.04	0.13	0.04	0.04	0.08	0.05	0.04
CD (5%)	NS	NS	NS	NS	NS	NS	NS	0.20	0.22	0.14	0.10

Table 5 Contd…

L x C	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1	10.93	10.64	10.43	9.37	8.18	7.99	7.75	7.56	7.18	6.17	5.06
L1C2	17.85	16.56	15.89	14.59	13.65	13.66	13.39	12.79	11.46	10.50	9.50
L1C3	18.80	17.46	16.55	15.28	15.05	14.90	14.70	14.17	10.34	9.00	7.50
L1C4	16.70	15.31	14.17	13.06	12.50	12.17	11.79	9.50	8.44	6.50	5.17
L2C1	10.86	10.59	10.29	9.22	8.06	7.91	7.50	7.41	6.89	5.99	4.84
L2C2	17.79	16.49	15.77	14.46	13.50	13.35	13.22	13.40	10.50	10.17	7.45
L2C3	18.75	17.39	16.42	15.10	14.90	14.49	14.54	12.88	8.16	5.97	5.17
L2C4	16.53	15.21	13.97	12.06	10.77	10.62	10.26	8.23	7.12	2.50	0.00
L3C1	10.69	10.40	9.76	8.28	7.40	7.16	6.96	6.82	6.70	5.62	4.50
L3C2	17.32	16.30	14.80	13.49	12.23	12.06	11.81	11.75	9.27	8.60	6.05
L3C3	18.15	17.21	15.38	14.26	13.48	13.16	13.04	12.34	6.68	0.00	0.00
L3C4	16.06	14.08	11.96	9.91	9.63	9.56	9.19	7.50	0.00	0.00	0.00
SEm±	0.14	0.14	0.13	0.13	0.11	0.31	0.10	0.10	0.19	0.12	0.09
CD (5%)	NS	0.41	0.38	0.37	0.30	NS	0.29	0.29	0.55	0.34	0.25
L x V											
L1V1	16.08	15.00	14.29	13.11	12.38	12.18	11.93	11.13	9.50	8.25	6.86
L1V2	16.06	14.98	14.23	13.04	12.31	12.18	11.89	10.88	9.21	7.83	6.75
L2V1	15.97	14.96	14.16	12.75	11.83	11.64	11.46	10.33	8.38	6.94	4.47
L2V2	15.99	14.88	14.07	12.67	11.79	11.55	11.28	10.12	7.95	5.37	4.25
L3V1	15.57	14.45	12.94	11.46	10.72	10.48	10.27	9.68	5.77	3.67	2.77
L3V2	15.55	14.54	13.01	11.51	10.65	10.49	10.24	9.51	5.55	3.44	2.50
SEm±	0.10	0.10	0.09	0.09	0.08	0.22	0.07	0.07	0.14	0.08	0.06
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.24	NS
C x V											
C1V1	10.86	10.57	10.25	9.03	7.95	7.73	7.50	7.33	7.00	6.09	4.93
C1V2	10.79	10.51	10.07	8.88	7.81	7.65	7.31	7.19	6.84	5.76	4.67
C2V1	17.67	16.47	15.55	14.21	13.27	13.14	12.88	12.38	10.49	9.95	7.88
C2V2	17.64	16.43	15.42	14.13	12.98	12.91	12.74	12.24	10.33	9.55	7.44
C3V1	18.59	17.38	16.25	14.90	14.58	14.26	14.15	13.56	9.05	5.33	4.33
C3V2	18.53	17.32	15.98	14.85	14.38	14.10	14.03	12.70	7.73	4.65	4.11
C4V1	16.36	14.80	13.13	11.61	10.77	10.59	10.35	8.26	5.15	3.78	1.67
C4V2	16.49	14.93	13.59	11.75	11.16	10.97	10.48	8.55	5.22	2.22	1.78
SEm±	0.11	0.12	0.11	0.11	0.09	0.25	0.08	0.08	0.16	0.10	0.07
CD (5%)	NS	NS	NS	NS	0.25	NS	NS	0.24	0.45	0.28	0.21

Table 5 Contd…

L x C x V	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1V1	10.98	10.65	10.50	9.46	8.26	8.00	7.82	7.66	7.33	6.33	5.12
L1C1V2	10.88	10.62	10.36	9.28	8.10	7.98	7.67	7.46	7.03	6.00	5.00
L1C2V1	17.86	16.58	15.96	14.65	13.82	13.76	13.45	12.86	11.49	10.67	9.67
L1C2V2	17.83	16.54	15.82	14.52	13.48	13.56	13.33	12.72	11.43	10.33	9.33
L1C3V1	18.82	17.48	16.70	15.33	15.10	14.94	14.72	14.67	10.96	9.67	7.66
L1C3V2	18.77	17.43	16.40	15.23	15.00	14.86	14.68	13.67	9.72	8.33	7.33
L1C4V1	16.64	15.28	14.00	13.00	12.33	12.00	11.72	9.33	8.22	6.33	5.00
L1C4V2	16.75	15.33	14.33	13.12	12.67	12.33	11.86	9.67	8.66	6.67	5.33
L2C1V1	10.88	10.61	10.38	9.30	8.12	7.96	7.67	7.42	6.96	6.12	5.00
L2C1V2	10.84	10.56	10.20	9.14	8.00	7.86	7.33	7.40	6.82	5.86	4.67
L2C2V1	17.80	16.50	15.80	14.56	13.67	13.54	13.32	12.46	10.67	10.33	7.56
L2C2V2	17.77	16.47	15.74	14.33	13.33	13.16	13.12	12.33	10.33	10.00	7.33
L2C3V1	18.76	17.41	16.64	15.12	14.96	14.63	14.66	13.33	8.66	6.31	5.33
L2C3V2	18.73	17.36	16.20	15.08	14.84	14.35	14.42	12.43	7.66	5.62	5.00
L2C4V1	16.44	15.30	13.82	12.00	10.56	10.42	10.20	8.12	7.23	5.00	0.00
L2C4V2	16.61	15.12	14.12	12.12	10.98	10.82	10.32	8.33	7.00	0.00	0.00
L3C1V1	10.72	10.44	9.87	8.34	7.46	7.22	7.00	6.92	6.72	5.82	4.67
L3C1V2	10.66	10.36	9.65	8.22	7.33	7.10	6.92	6.72	6.67	5.42	4.33
L3C2V1	17.34	16.32	14.90	13.42	12.33	12.12	11.86	11.82	8.82	8.86	6.42
L3C2V2	17.30	16.28	14.70	13.55	12.12	12.00	11.76	11.67	9.72	8.33	5.67
L3C3V1	18.20	17.24	15.42	14.26	13.67	13.22	13.08	12.67	7.54	0.00	0.00
L3C3V2	18.10	17.18	15.34	14.25	13.30	13.10	13.00	12.00	5.82	0.00	0.00
L3C4V1	16.00	13.82	11.58	9.82	9.42	9.36	9.12	7.33	0.00	0.00	0.00
L3C4V2	16.12	14.33	12.33	10.00	9.84	9.76	9.26	7.66	0.00	0.00	0.00
Mean	15.87	14.80	13.78	12.42	11.61	11.42	11.18	10.28	7.73	5.92	4.60
SEm±	0.19	0.20	0.19	0.18	0.15	0.44	0.14	0.15	0.27	0.170	0.13
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.48	NS

Due to varieties

Root length differed significantly due to varieties only from eighth month of storage to eleven month of storage. Significantly higher root length was recorded in variety V_1 (10.38, 7.88, 6.29, 4.70 cm), while lowest was recorded in variety V_2 (10.17, 7.57, 5.55, 4.50 cm) at eighth, ninth, tenth and eleventh months of storage respectively.

Interactions

Due to locations and crops (L x C)

Root length differed significantly throughout the storage period except at first and sixth month after storage due to interaction effects of locations and crops. Higher root length was recorded in L_1C_3 (17.46 cm) which was on par with L_2C_3 (17.39 cm) and lower shoot length was recorded in L_3C_1 (10.40 cm) at second month of storage. Similar trend was noticed in subsequent months of storage upto eighth month of storage. After ninth month of storage significantly highest root length was noticed in L_1C_2 (11.46 cm) and lowest in L_3C_4 (0.00 cm). Similar trend was noticed upto eleven month of storage. Significantly highest root length was noticed in L_1C_2 (9.50 cm) and lowest in L_2C_4, L_3C_3 and L_3C_4 (0.00 cm) after eleventh month of storage.

Due to locations and varieties (L x V)

Interaction effects of locations and varieties showed non-significant differences for root length throughout the storage period except in tenth month of storage. Significantly the highest root length was recorded in L_1V_2 (8.25 cm) and the lowest in L_3V_2 (3.44 cm) which was on par with L_3V_1 (3.67 cm) after tenth month of storage.

Due to crops and varieties (L x V)

Interaction effects of crops and varieties showed significant difference after fifth, eighth, ninth, tenth and eleventh month of storage. After fifth month of storage significantly the highest root length was recorded in C_3V_1 (14.58 cm) and the lowest in C_1V_2 (7.81 cm). Similar trend was noticed upto eighth month of storage. After ninth month of storage, significantly maximum root length was recorded in C_2V_1 (10.49 cm) which was on par with C_2V_2 (10.33 cm). While, minimum root length was recorded in C_4V_1 (5.15 cm) which was on par with C_4V_2 (5.22 cm). Similar trend was noticed from ninth month to eleven month of storage. Significantly highest root length was recorded in C_2V_1 (7.88 cm) and lowest recorded in C_4V_1 (1.67 cm) in eleventh month of storage.

Due to locations, crops and varieties (C x L x V)

Root length differed significantly only after tenth month of storage due to interaction effects of locations, crops and varieties. Significantly higher root length was noticed in $L_1C_2V_1$ (10.67 cm) which was on par with $L_1C_2V_2$ (10.33 cm) and $L_2C_2V_1$ (10.33 cm) and lower was recorded in $L_2C_4V_2$, $L_3C_3V_1$, $L_3C_3V_2$ $L_3C_4V_1$ and $L_3C_4V_2$ (0.00 cm) after tenth month of storage. After eleventh month of storage non-significant differences were noticed for root length.

4.5 Shoot Length (cm)

The data on shoot length (cm) during storage as influenced by locations, crops, varieties and their interactions are presented in Table 6.

Irrespective of locations, crops and varieties, the mean shoot length (cm) declined from 12.12 to 3.00 cm in first month of storage and eleven month of storage respectively.

Due to locations

Locations differed significantly throughout the storage period for shoot length parameter. Significantly maximum shoot length was noticed in the seeds stored at Raichur (12.33 cm) followed by Dharwad (12.21 cm) and minimum in seeds stored at Sirsi (11.81 cm)

Table 6. Influence of locations, oilseed crops and varieties on shoot length (cm) during storage

Treatments	Months of storage										
	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
Location											
L1	12.33	11.15	10.50	9.34	8.72	8.53	7.96	7.39	5.75	4.90	4.17
L2	12.21	11.15	10.35	8.95	8.31	7.90	7.55	7.00	4.97	3.81	3.06
L3	11.81	10.69	9.44	8.21	7.53	7.17	6.68	6.08	3.32	2.06	1.78
SEm±	0.11	0.11	0.10	0.05	0.10	0.07	0.06	0.08	0.07	0.05	0.03
CD (5%)	0.29	0.31	0.28	0.14	0.28	0.20	0.17	0.24	0.18	0.16	0.10
Crop											
C1	6.80	6.52	6.12	4.95	4.88	4.73	4.50	4.27	3.89	3.72	3.49
C2	15.63	14.44	13.47	12.12	10.95	10.45	9.43	9.41	7.04	5.75	4.96
C3	16.60	15.33	14.12	12.89	11.73	11.50	11.33	9.93	5.45	3.42	2.81
C4	9.44	7.69	6.67	5.37	5.19	4.78	4.33	3.69	2.33	1.47	0.75
SEm±	0.12	0.13	0.12	0.06	0.11	0.08	0.07	0.10	0.08	0.66	0.04
CD (5%)	0.35	0.36	0.33	0.17	0.32	0.23	0.20	0.27	0.21	0.18	0.11
Variety											
V1	12.12	11.03	10.13	8.87	8.21	7.93	7.45	6.88	4.79	3.82	3.09
V2	12.12	10.96	10.07	8.79	8.17	7.80	7.35	6.77	4.57	3.36	2.91
Mean	12.12	10.99	10.10	8.83	8.19	7.87	7.40	6.82	4.68	3.59	3.00
SEm±	0.09	0.09	0.08	0.04	0.08	0.06	0.05	0.07	0.05	0.04	0.03
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	0.15	0.13	0.08

Table 6 Contd…

L x C	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1	6.88	6.63	6.42	5.36	5.33	5.20	5.01	4.77	4.25	4.06	3.98
L1C2	15.83	14.56	13.87	12.63	11.49	11.25	10.11	9.80	8.50	6.50	5.50
L1C3	16.94	15.44	14.54	13.27	12.21	12.06	11.80	10.50	6.50	5.86	4.93
L1C4	9.66	7.97	7.16	6.10	5.86	5.60	4.93	4.50	3.75	3.17	2.25
L2C1	6.84	6.56	6.28	5.22	5.15	4.95	4.74	4.57	4.20	4.00	3.50
L2C2	15.77	14.47	13.75	12.42	11.25	10.41	9.74	9.50	6.85	5.59	5.25
L2C3	16.72	15.37	14.41	13.09	11.93	11.64	11.50	9.78	5.59	4.41	3.50
L2C4	9.51	8.20	6.95	5.06	4.91	4.59	4.22	4.17	3.25	1.25	0.00
L3C1	6.67	6.36	5.66	4.27	4.17	4.04	3.75	3.47	3.23	3.09	2.99
L3C2	15.30	14.30	12.79	11.31	10.11	9.69	8.43	8.93	5.79	5.16	4.12
L3C3	16.13	15.19	13.42	12.31	11.04	10.81	10.69	9.50	4.28	0.00	0.00
L3C4	9.15	6.89	5.91	4.94	4.81	4.17	3.84	2.41	0.00	0.00	0.00
SEm±	0.21	0.22	0.20	0.10	0.20	0.14	0.12	0.17	0.13	0.11	0.07
CD (5%)	NS	NS	NS	0.29	NS	NS	0.35	0.47	0.37	0.31	0.19
L x V											
L1V1	12.29	11.25	10.53	9.36	8.74	8.56	8.02	7.45	5.81	4.95	4.17
L1V2	12.37	11.05	10.47	9.31	8.71	8.49	7.90	7.34	5.70	4.85	4.16
L2V1	12.20	11.15	10.39	8.98	8.34	8.03	7.60	7.05	5.00	4.31	3.21
L2V2	12.22	11.15	10.31	8.91	8.28	7.77	7.50	6.95	4.94	3.31	2.92
L3V1	11.88	10.69	9.46	8.26	7.56	7.21	6.71	6.13	3.58	2.21	1.89
L3V2	11.74	10.69	9.43	8.16	7.51	7.14	6.64	6.03	3.06	1.92	1.66
SEm±	0.15	0.15	0.14	0.07	0.14	0.10	0.09	0.12	0.09	0.08	0.05
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	0.26	0.22	0.14
C x V											
C1V1	6.82	6.54	6.17	5.03	4.94	4.79	4.58	4.35	4.01	3.79	3.56
C1V2	6.77	6.49	6.07	4.87	4.83	4.67	4.42	4.18	3.77	3.64	3.42
C2V1	15.65	14.47	13.53	12.19	11.04	10.65	9.52	9.53	7.32	6.06	5.24
C2V2	15.62	14.42	13.41	12.04	10.86	10.25	9.33	9.29	6.77	5.44	4.67
C3V1	16.57	15.36	14.25	12.93	11.77	11.63	11.47	10.07	5.68	3.61	2.89
C3V2	16.62	15.30	14.00	12.84	11.68	11.38	11.19	9.78	5.23	3.24	2.73
C4V1	9.46	7.73	6.55	5.32	5.09	4.66	4.22	3.55	2.17	1.83	0.67
C4V2	9.43	7.64	6.79	5.42	5.29	4.91	4.44	3.83	2.50	1.11	0.83
SEm±	0.17	0.18	0.16	0.08	0.16	0.12	0.10	0.14	0.11	0.09	0.05
CD (5%)	NS	NS	NS	NS	NS	0.33	NS	NS	0.30	0.25	0.16

Table 6 Contd…

L x C x V	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1V1	6.90	6.66	6.48	5.44	5.36	5.28	5.09	4.86	4.38	4.12	4.00
L1C1V2	6.86	6.60	6.36	5.28	5.30	5.12	4.92	4.67	4.12	4.00	3.96
L1C2V1	15.84	14.58	13.94	12.63	11.56	11.32	10.22	9.92	8.67	6.67	5.67
L1C2V2	15.82	14.54	13.80	12.62	11.42	11.18	10.00	9.67	8.33	6.33	5.33
L1C3V1	16.80	15.46	14.70	13.30	12.24	12.12	11.92	10.67	6.67	6.00	5.00
L1C3V2	17.08	15.41	14.38	13.23	12.18	12.00	11.67	10.33	6.33	5.73	4.86
L1C4V1	9.62	8.28	7.00	6.08	5.80	5.52	4.86	4.33	3.50	3.00	2.00
L1C4V2	9.73	7.66	7.32	6.12	5.92	5.67	5.00	4.67	4.00	3.33	2.50
L2C1V1	6.86	6.57	6.36	5.30	5.20	5.00	4.82	4.67	4.33	4.08	3.67
L2C1V2	6.82	6.54	6.20	5.14	5.10	4.90	4.67	4.46	4.06	3.92	3.33
L2C2V1	15.78	14.50	13.78	12.53	11.33	10.82	9.80	9.67	6.83	5.85	5.50
L2C2V2	15.76	14.44	13.72	12.30	11.16	10.00	9.67	9.33	6.86	5.33	5.00
L2C3V1	16.74	15.39	14.62	13.10	12.00	11.82	11.67	9.88	5.82	4.82	3.67
L2C3V2	16.70	15.34	14.20	13.08	11.86	11.46	11.33	9.67	5.36	4.00	3.33
L2C4V1	9.42	8.12	6.80	5.00	4.82	4.46	4.12	4.00	3.00	2.50	0.00
L2C4V2	9.59	8.28	7.10	5.12	5.00	4.72	4.32	4.33	3.50	0.00	0.00
L3C1V1	6.70	6.40	5.67	4.34	4.26	4.08	3.82	3.52	3.33	3.18	3.00
L3C1V2	6.64	6.32	5.65	4.20	4.08	4.00	3.67	3.42	3.12	3.00	2.98
L3C2V1	15.32	14.32	12.88	11.42	10.22	9.82	8.54	9.00	6.45	5.66	4.56
L3C2V2	15.28	14.28	12.70	11.20	10.00	9.56	8.32	8.86	5.12	4.67	3.67
L3C3V1	16.18	15.22	13.42	12.40	11.08	10.94	10.82	9.67	4.55	0.00	0.00
L3C3V2	16.08	15.16	13.41	12.22	11.00	10.67	10.56	9.33	4.00	0.00	0.00
L3C4V1	9.33	6.80	5.85	4.88	4.66	4.00	3.67	2.32	0.00	0.00	0.00
L3C4V2	8.97	6.98	5.96	5.00	4.96	4.33	4.01	2.50	0.00	0.00	0.00
Mean	12.12	10.99	10.10	8.83	8.19	7.87	7.40	6.82	4.68	3.59	3.00
SEm±	0.30	0.31	0.28	0.14	0.28	0.20	0.17	0.24	0.18	0.15	0.10
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.44	NS

after first month of storage. Similar trend was noticed in later months of storage. After eleven month of storage significantly higher shoot length was recorded in seeds stored at Raichur (4.17 cm) followed by Dharwad (3.06 cm) while, lower shoot length was recorded in Sirsi (1.78 cm).

Due to crops

Shoot length showed significant differences among oilseed crops in all the months of storage period irrespective of locations and varieties. Among oilseed crops, soybean recorded higher shoot length than all other crops upto eighth month of storage whereas from ninth month onwards sunflower recorded higher shoot length compared to other crops. Soybean recorded shoot length of 16.60 to 2.81 cm, sunflower recorded (15.63 to 4.96 cm), groundnut (9.44 to 0.75 cm) and sesamum recorded (6.80 to 3.49 cm) from first month to eleven month of storage respectively.

Due to varieties

Shoot length differed significantly due to varieties only after eighth month of storage to eleven month of storage. Significantly higher shoot length was recorded in variety V_1 (4.79, 3.82, 3.09 cm) while variety V_2 recorded lower shoot length (4.57, 3.36, 2.91 cm) after nine, ten and eleven months of storage respectively.

Interactions

Due to locations and crops (L x C)

Interaction effects of locations and crops showed significant difference for shoot length in fourth, seventh, eighth, ninth, tenth and eleventh months of storage. The highest shoot length was recorded in L_1C_3 (13.27 cm) and was on par with L_2C_3 (13.09 cm) and lowest in L_3C_1 (4.27 cm) after fourth month of storage. Similar trend was noticed upto eleventh month of storage. After eleventh month of storage L_1C_2 (5.50 cm) recorded higher shoot length followed by L_2C_2 (5.25 cm) and lower shoot length was recorded in L_2C_4, L_3C_3 and L_3C_4 (0.00 cm).

Due to locations and varieties (L x V)

Interaction effects of locations and varieties showed significant differences for shoot length only from ninth month onwards. Significantly highest shoot length was noticed in L_1V_1 (5.81 cm) and lowest in L_3V_2 (3.06 cm) after ninth month of storage. Similar trend was noticed at tenth and eleventh month after storage. While, after eleventh month of storage L_1V_1 recorded significantly highest shoot length (4.17 cm), which was on par with L_1V_2 (4.16 cm), while L_3V_2 recorded lowest shoot length (1.66 cm).

Due to crops and varieties (C x V)

Interaction effect of crops and varieties showed significant difference for shoot length after sixth, ninth, tenth and eleventh months of storage. Significantly higher shoot length was recorded in C_3V_1 (11.63 cm) and lowest in C_1V_2 (4.67 cm) which was on par with C_4V_1 (4.66 cm) at sixth month after storage whereas, at ninth month of storage significantly highest shoot length was noticed in C_2V_1 (7.32 cm) and lowest in C_4V_2 (2.17 cm). Similar trend was noticed after tenth and eleventh month of storage. After eleventh month of storage significantly highest shoot length was recorded in C_2V_1 (5.24 cm) and lowest in C_4V_1 (0.67 cm) followed by C_4V_2 (0.83 cm).

Due to locations, crops and varieties (L x C x V)

Interaction effect due to locations, crop and varieties were non significant for shoot length in all the months of storage except in tenth month of storage. Higher shoot length was recorded in $L_1C_2V_1$ (6.67 cm) which was on par with $L_1C_2V_2$ (6.33 cm) and lower shoot length was noticed in $L_2C_4V_2$, $L_3C_3V_1$, $L_3C_3V_2$, $L_3C_4V_1$ and $L_3C_4V_2$ (0.00 cm) in tenth month of storage.

4.6 Seedling Dry Weight (g)

The data on seedling dry weight (g) during storage as influenced by locations, crops and varieties and their interaction effects are presented in Table 7.

Table 7. Influence of locations, oilseed crops and varieties on seedling dry weight (g/10 seedlings) during storage

Treatments	Months of storage										
	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
Location											
L1	1.981	1.919	1.629	1.346	1.072	1.029	0.984	0.947	0.870	0.847	0.753
L2	1.965	1.884	1.581	1.291	1.029	1.007	0.965	0.898	0.819	0.571	0.395
L3	1.923	1.819	1.497	1.216	0.949	0.911	0.869	0.732	0.229	0.122	0.103
SEm±	0.005	0.003	0.003	0.004	0.005	0.003	0.002	0.003	0.003	0.004	0.003
CD (5%)	0.015	0.009	0.009	0.012	0.013	0.009	0.007	0.009	0.007	0.010	0.008
Crop											
C1	0.062	0.058	0.053	0.049	0.044	0.039	0.034	0.029	0.023	0.028	0.014
C2	1.123	1.053	1.008	0.960	0.894	0.829	0.782	0.710	0.703	0.662	0.611
C3	1.124	1.120	1.044	1.039	1.033	1.030	1.025	0.967	0.641	0.489	0.387
C4	5.517	5.265	4.172	3.090	2.095	2.033	1.917	1.730	1.190	0.873	0.523
SEm±	0.006	0.004	0.003	0.005	0.005	0.004	0.003	0.004	0.004	0.004	0.003
CD (5%)	0.017	0.010	0.010	0.014	0.015	0.011	0.008	0.011	0.008	0.012	0.009
Variety											
V1	1.952	1.864	1.562	1.276	1.025	0.998	0.956	0.875	0.671	0.621	0.425
V2	1.961	1.885	1.572	1.293	1.008	0.967	0.923	0.843	0.608	0.405	0.343
Mean	1.956	1.874	1.569	1.284	1.017	0.983	0.939	0.859	0.639	0.513	0.384
SEm±	0.004	0.003	0.002	0.003	0.004	0.003	0.002	0.003	0.002	0.003	0.002
CD (5%)	NS	0.007	0.007	0.010	0.011	0.008	0.005	0.008	0.006	0.008	0.006

L x C	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1	0.070	0.067	0.062	0.058	0.054	0.049	0.044	0.040	0.034	0.055	0.024
L1C2	1.127	1.081	1.063	1.027	0.954	0.900	0.878	0.823	0.815	0.799	0.756
L1C3	1.131	1.127	1.066	1.060	1.053	1.050	1.042	1.034	0.777	0.752	0.664
L1C4	5.595	5.400	4.325	3.240	2.225	2.120	1.970	1.890	1.855	1.780	1.570
L2C1	0.062	0.060	0.054	0.050	0.043	0.038	0.035	0.030	0.024	0.020	0.012
L2C2	1.122	1.054	1.042	0.969	0.925	0.875	0.845	0.797	0.791	0.706	0.671
L2C3	1.126	1.122	1.048	1.044	1.038	1.036	1.032	0.975	0.748	0.715	0.497
L2C4	5.550	5.300	4.180	3.100	2.110	2.080	1.950	1.790	1.715	0.840	0.000
L3C1	0.054	0.048	0.042	0.038	0.035	0.029	0.023	0.018	0.012	0.009	0.005
L3C2	1.119	1.023	0.917	0.884	0.803	0.711	0.623	0.509	0.504	0.479	0.406
L3C3	1.116	1.111	1.018	1.014	1.009	1.005	1.002	0.892	0.400	0.00	0.000
L3C4	5.405	5.095	4.010	2.930	1.950	1.900	1.830	1.510	0.000	0.00	0.000
SEm±	0.010	0.006	0.006	0.008	0.009	0.007	0.005	0.007	0.005	0.007	0.005
CD (5%)	0.029	0.017	0.017	0.024	0.026	0.018	0.014	0.018	0.014	0.020	0.015
L x V											
L1V1	1.976	1.916	1.624	1.335	1.083	1.052	1.006	0.969	0.919	0.904	0.826
L1V2	1.985	1.923	1.633	1.358	1.060	1.007	0.959	0.924	0.822	0.789	0.681
L2V1	1.962	1.878	1.583	1.293	1.049	1.028	0.999	0.923	0.851	0.834	0.344
L2V2	1.968	1.890	1.579	1.288	1.000	0.986	0.932	0.873	0.787	0.308	0.246
L3V1	1.916	1.798	1.480	1.200	0.944	0.915	0.862	0.733	0.244	0.126	0.104
L3V2	1.930	1.841	1.514	1.233	0.955	0.908	0.877	0.731	0.214	0.118	0.101
SEm±	0.007	0.004	0.004	0.006	0.007	0.005	0.003	0.005	0.004	0.005	0.004
CD(5%)	NS	0.012	0.012	0.017	0.018	0.013	0.010	0.013	0.010	0.015	0.011
C x V											
C1V1	0.066	0.061	0.055	0.051	0.048	0.041	0.036	0.031	0.025	0.038	0.015
C1V2	0.058	0.056	0.051	0.047	0.040	0.036	0.032	0.027	0.021	0.018	0.012
C2V1	1.124	1.052	1.024	0.987	0.951	0.897	0.852	0.792	0.787	0.743	0.689
C2V2	1.121	1.054	0.992	0.933	0.837	0.760	0.712	0.627	0.620	0.581	0.533
C3V1	1.127	1.122	1.048	1.043	1.039	1.036	1.029	0.990	0.723	0.557	0.435
C3V2	1.122	1.118	1.040	1.035	1.028	1.024	1.021	0.944	0.559	0.421	0.339
C4V1	5.490	5.220	4.123	3.023	2.063	2.020	1.907	1.687	1.150	1.147	0.560
C4V2	5.543	5.310	4.220	3.157	2.127	2.047	1.927	1.773	1.230	0.600	0.487
SEm±	0.008	0.005	0.005	0.007	0.008	0.005	0.004	0.005	0.004	0.006	0.004
D (5%)	0.041	0.014	0.014	0.019	0.021	0.015	0.011	0.015	0.012	0.017	0.013

Table 7 Contd…											
L x C x V	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1V1	0.074	0.070	0.064	0.060	0.056	0.052	0.048	0.042	0.036	0.084	0.026
L1C1V2	0.066	0.064	0.060	0.056	0.052	0.045	0.040	0.038	0.032	0.026	0.022
L1C2V1	1.128	1.083	1.076	1.038	1.026	0.998	0.976	0.936	0.934	0.916	0.856
L1C2V2	1.126	1.080	1.050	1.016	0.882	0.801	0.780	0.710	0.696	0.682	0.656
L1C3V1	1.132	1.129	1.068	1.062	1.060	1.051	1.046	1.038	0.884	0.856	0.742
L1C3V2	1.130	1.126	1.064	1.058	1.046	1.042	1.038	1.030	0.669	0.649	0.586
L1C4V1	5.570	5.380	4.290	3.180	2.190	2.100	1.960	1.860	1.820	1.760	1.680
L1C4V2	5.620	5.420	4.360	3.300	2.260	2.140	1.980	1.920	1.890	1.800	1.460
L2C1V1	0.066	0.062	0.057	0.052	0.049	0.040	0.036	0.032	0.026	0.021	0.014
L2C1V2	0.057	0.058	0.052	0.048	0.036	0.036	0.033	0.027	0.022	0.020	0.010
L2C2V1	1.124	1.046	1.060	1.020	1.000	0.950	0.940	0.908	0.900	0.820	0.800
L2C2V2	1.120	1.062	1.025	0.918	0.850	0.800	0.750	0.686	0.682	0.596	0.542
L2C3V1	1.129	1.124	1.056	1.051	1.046	1.042	1.038	1.032	0.850	0.815	0.562
L2C3V2	1.124	1.120	1.040	1.036	1.030	1.028	1.026	0.918	0.645	0.615	0.432
L2C4V1	5.530	5.280	4.160	3.050	2.100	2.080	1.980	1.720	1.630	1.680	0.000
L2C4V2	5.570	5.320	4.200	3.150	2.120	2.080	1.920	1.860	1.800	0.00	0.000
L3C1V1	0.057	0.050	0.044	0.040	0.038	0.030	0.024	0.020	0.014	0.010	0.006
L3C1V2	0.050	0.046	0.040	0.036	0.032	0.028	0.022	0.016	0.010	0.008	0.004
L3C2V1	1.120	1.026	0.935	0.902	0.828	0.742	0.640	0.532	0.526	0.492	0.412
L3C2V2	1.118	1.020	0.900	0.865	0.778	0.680	0.605	0.486	0.482	0.466	0.400
L3C3V1	1.119	1.114	1.020	1.016	1.010	1.008	1.004	0.900	0.435	0.000	0.000
L3C3V2	1.113	1.109	1.016	1.012	1.008	1.002	1.000	0.883	0.364	0.000	0.000
L3C4V1	5.370	5.000	3.920	2.840	1.900	1.880	1.780	1.480	0.00	0.000	0.000
L3C4V2	5.440	5.190	4.100	3.020	2.000	1.920	1.880	1.540	0.00	0.000	0.000
Mean	1.956	1.874	1.569	1.284	1.017	0.983	0.939	0.859	0.639	0.513	0.384
SEm±	0.014	0.009	0.008	0.012	0.013	0.009	0.007	0.009	0.007	0.010	0.008
CD (5%)	NS	0.024	0.002	0.034	NS	0.026	0.019	0.026	0.020	0.028	0.022

Irrespective of locations, crops and varieties the mean seedling dry weight (cm) declined from 1.956 to 0.384 g in first month of storage to eleven month of storage respectively.

Due to locations

Locations differed significantly throughout the storage period for seedling dry weight parameter. Significantly the highest seedling dry weight was recorded in seeds stored at Raichur (1.981 g) followed by Dharwad (1.965 g) and the lowest (1.923 g) was recorded in seeds stored at Sirsi at first month of storage. Similar trend was noticed in all the month of storage. After eleventh month of storage, significantly the highest seedling dry weight was recorded in seeds stored at Raichur (0.753 g) and the lowest was recorded in seeds stored at Sirsi (0.103 g).

Due to crops

The seedling dry weight differed significantly throughout the storage period. Among crops, groundnut recorded significantly higher seedling dry weight (5.517 g) followed by soybean (1.124 g) which was on par with sunflower (1.123 g) and lower seedling dry weight was recorded in sesamum (0.062 g) after first month of storage. But with the advancement of storage period groundnut and soybean declined in seedling dry weight. Sesamum recorded 0.062 to 0.014 g, sunflower 1.123 to 0.611 g while, soybean recorded 1.124 to 0.387 g and groundnut 5.517 to 0.523 g seedling dry weight from initial month of storage to eleven month of storage.

Due to varieties

Irrespective of crops and locations seedling dry weight differed significantly due to varieties throughout the storage period except in first month of storage. Irrespective of locations and crops the variety V_2 of each crop recorded significantly higher seedling dry weight (1.885 g) while variety V_1 recorded lower seedling dry weight (1.864 g) at second month of storage. Similar trend was noticed upto fourth month of storage. After fifth month of storage variety V_1 recorded significantly the highest seedling dry weight (1.025 g), while lowest was in variety V_2 (1.008 g). Similar trend was noticed upto eleven month of storage. Significantly highest seedling dry weight was noticed in variety V_1 (0.425 g) and lowest was noticed in variety V_2 (0.343 g) at the end of storage period.

Interactions

Due to locations and crops (L x C)

Seedling dry weight differed significantly throughout the storage period due to interaction of locations and crops. Significantly higher seedling dry weight was noticed in L_1C_4 (5.595 g) followed by L_2C_4 (5.550 g) and L_3C_4 (5.405 g) and lower was recorded in L_3C_1 (0.054 g) at first month of storage. Similar trend was noticed upto eighth month of storage. After ninth month of storage significantly the highest seedling dry weight was recorded in L_1C_4 (1.855 g) followed by L_2C_4 (1.715 g) and the lowest was recorded in L_3C_4 (0.00 g) and in tenth month of storage highest seedling dry weight was noticed in L_1C_4 (1.780 g) and lowest was recorded in L_3C_3 and L_3C_4 (0.00 g). Significantly the highest seedling dry weight was noticed in L_1C_4 (1.570 g) and the lowest in L_2C_4, L_3C_3 and L_3C_4 (0.00 g) at the end of storage period.

Due to locations and varieties

Seedling dry weight differed significantly throughout the storage period except in first month of storage. Higher seedling dry weight was noticed in L_1V_2 (1.923 g) followed by L_1V_1 (1.916 g) and lower in L_3V_1 (1.798 g) at second month of storage. Similar trend was noticed upto fourth month of storage. After fifth month L_1V_1 recorded significantly highest (1.083 g) seedling dry weight followed by L_1V_2 (1.060 g) and lowest in L_3V_1 (0.944 g) which was on par with L_3V_2 (0.955 g) and after sixth month of storage significantly highest seedling dry weight was recorded in L_1V_1 (1.052 g) and lowest in L_3V_2 (0.908 g). Similar trend was noticed upto eleven month of storage. Significantly highest seedling dry weight was noticed in L_1V_1 (0.826 g) and lowest in L_3V_2 (0.104 g) and was on par with L_3V_1 (0.101 g) at the eleven month of storage.

Due to crops and varieties

Seedling dry weight differed significantly throughout the storage period due to interaction effect of crop and variety. Significantly the highest seedling dry weight was noticed in C_4V_2 (5.543 g) which was on par with C_4V_1 (5.490 g) followed by C_3V_1 (1.127 g) C_2V_1 (1.121 g) and lowest was recorded in C_1V_2 (0.058 g) at first month of storage. Similar trend was noticed upto eighth month of storage. After ninth month of storage C_4V_2 (1.230 g) recorded higher seedling dry weight followed by C_4V_1 (1.150 g) but C_3V_1 declined more (0.723 g) than C_2V_1 (0.787 g), while after tenth month C_4V_2 (0.600 g) declined more than C_4V_1 (1.147 g). After eleventh month of storage significantly highest seedling dry weight was recorded in C_2V_1 (0.689 g) and lowest was recorded in C_1V_2 (0.012 g) which was on par with C_1V_1 (0.015 g).

Due to locations, crops and varieties (L x C x V)

Seedling dry weight differed significantly throughout the storage period except after first and fifth month of storage. Significantly the highest seedling dry weight was noticed in $L_1C_4V_2$ (5.420 g) and the lowest was recorded in $L_3C_1V_2$ (0.046 g) followed by $L_3C_1V_1$ (0.050 g) at the end of second month of storage. Similar trend was noticed upto eighth month of storage. But after ninth month of storage highest seedling dry weight was noticed in $L_1C_4V_2$ (1.890 g) followed by $L_1C_4V_1$ (1.820 g) and lowest was recorded in $L_3C_4V_1$ and $L_3C_4V_2$ (0.00 g). After tenth month of storage highest seedling dry weight was recorded $L_1C_4V_2$ (1.800 g) and lowest was in $L_2C_4V_2$, $L_3C_3V_1$, $L_3C_3V_2$ and $L_3C_4V_2$ (0.00 g) significantly highest seedling dry weight was noticed in $L_1C_4V_1$ (1.680 g) and lowest was recorded in $L_2C_4V_1$, $L_2C_4V_2$, $L_3C_3V_1$, $L_3C_3V_2$, $L_3C_4V_1$ and $L_3C_4V_2$ (0.00 g) after eleven month of storage.

4.7 Seedling Vigour Index

The data on vigour index during storage as influenced by storage locations, crops and varieties and their interaction effects are presented in Table 8.

Irrespective of locations, crops and varieties, the mean seedling vigour index declined from 2669 to 431 in first month of storage to eleven month of storage respectively.

Due to locations

Vigour index of seedlings differed significantly due to storage locations throughout the storage period. The seeds stored at Raichur recorded significantly maximum vigour index (2718) followed by Dharwad (2701) and seeds stored at Sirsi recorded significantly minimum vigour index (2590) at first month of storage. Similar trend was recorded in later months of storage. After eleven month of storage significantly higher vigour index was recorded in Raichur (566) followed by Dharwad (422) and lower vigour index was recorded in seeds stored at Sirsi (305).

Due to crops

Vigour index differed significantly among oilseed crops throughout the storage period. Vigour index was significantly highest in soybean (3381) followed by sunflower (3207), groundnut (2392) and lowest in sesamum (1697) at first month of storage. Similar trend was noticed from second month upto seven month of storage. After eighth month of storage significantly highest vigour index was recorded in sunflower (1642) followed by soybean (1440), sesamum (970) and lowest in groundnut (562). Wherein after ninth month of storage significantly highest vigour index was noticed in sunflower (1308) followed by sesamum (882), soybean (703) while, lowest was in groundnut (284). Similar trend was noticed after tenth and eleventh month of storage. Significantly more vigour index was noticed in sunflower (849) followed by sesamum (648) and less was recorded in groundnut (37) after eleventh month of storage.

Due to varieties

Irrespective of crops and locations vigour index differed significantly due to varieties from fourth month of storage. Variety V_1 recorded higher vigour index (1896), while lower vigour index was recorded in variety V_2 (1846) after fourth month of storage. Similar trend was noticed from fifth month to eleventh month of storage. Significantly the highest vigour

Table 8. Influence of locations, oilseed crops and varieties on vigour index during storage

Treatments	Months of storage										
	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
Location											
L1	2718	2444	2278	2007	1796	1702	1547	1337	1047	793	566
L2	2701	2418	2240	1925	1670	1552	1431	1172	805	614	422
L3	2590	2331	2019	1681	1446	1323	1128	952	531	397	305
SEm±	12.12	6.53	8.79	3.76	3.15	2.50	3.30	2.83	2.03	2.18	1.97
CD (5%)	34.49	18.57	25.02	10.69	8.98	7.10	9.38	8.04	5.78	6.20	5.60
Crop											
C1	1697	1607	1533	1309	1148	1063	998	970	882	759	648
C2	3207	2908	2716	2375	2066	1937	1729	1642	1308	1109	849
C3	3381	3081	2814	2437	2127	1981	1825	1440	703	398	191
C4	2392	1994	1653	1364	1208	1120	922	562	284	140	37
SEm±	14.00	7.54	10.15	4.34	3.64	2.88	3.81	3.26	2.34	2.52	2.27
CD (5%)	39.84	21.44	28.89	12.35	10.36	8.20	10.83	9.28	6.67	7.16	6.46
Variety											
V1	2670	2396	2193	1896	1670	1554	1397	1204	840	641	449
V2	2669	2399	2165	1846	1605	1497	1340	1103	748	562	413
Mean	2669	2398	2179	1871	1637	1525	1369	1153	794	601	431
SEm±	9.90	5.33	7.18	3.07	2.58	2.04	2.69	2.31	1.66	1.78	1.61
CD (5%)	NS	NS	NS	8.73	7.33	5.80	7.66	6.56	4.72	5.06	4.57

Table 8 Contd…

L x C	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1	1723	1632	1591	1390	1237	1157	1104	1038	953	833	729
L1C2	3262	2943	2795	2502	2212	2121	1879	1754	1532	1252	1030
L1C3	3443	3107	2909	2537	2297	2177	2004	1692	1091	741	395
L1C4	2445	2094	1819	1600	1441	1352	1201	863	612	348	112
L2C1	1715	1622	1563	1361	1190	1100	1020	979	898	805	637
L2C2	3248	2927	2769	2451	2118	1948	1783	1653	1278	1127	873
L2C3	3432	3093	2880	2496	2191	2062	1914	1457	805	454	177
L2C4	2409	2030	1749	1393	1182	1099	1008	597	239	71	0
L3C1	1653	1567	1446	1177	1018	933	870	894	794	639	578
L3C2	3111	2856	2585	2172	1869	1742	1527	1518	1115	948	643
L3C3	3269	3043	2654	2277	1894	1706	1556	1171	214	0	0
L3C4	2325	1860	1391	1098	1002	911	558	227	0	0	0
SEm±	24.25	13.05	17.58	7.52	6.31	4.99	6.59	5.65	4.06	4.36	3.93
CD (5%)	NS	37.14	50.04	21.38	17.95	14.20	18.76	16.08	11.55	12.40	11.19
L x V											
L1V1	2719	2443	2293	2037	1819	1725	1575	1377	1093	837	592
L1V2	2717	2443	2264	1978	1774	1678	1518	1297	1000	750	540
L2V1	2700	2425	2264	1946	1702	1584	1460	1222	857	665	445
L2V2	2701	2410	2219	1904	1637	1520	1402	1122	753	563	399
L3V1	2591	2320	2024	1704	1487	1354	1156	1013	571	420	311
L3V2	2588	2342	2014	1657	1404	1292	1099	892	490	373	299
SEm±	17.15	9.23	12.43	5.31	4.46	3.53	4.66	3.99	2.87	3.08	2.78
CD (5%)	NS	NS	NS	NS	12.69	10.04	NS	11.37	8.17	8.77	7.91
C x V											
C1V1	1703	1612	1548	1325	1175	1084	1026	1008	902	783	648
C1V2	1691	1601	1519	1293	1122	1042	970	933	862	734	648
C2V1	3210	2913	2725	2408	2110	1974	1764	1674	1357	1159	890
C2V2	3204	2903	2707	2341	2022	1900	1694	1609	1259	1058	807
C3V1	3390	3094	2844	2472	2172	2033	1864	1558	813	449	217
C3V2	3372	3067	2785	2401	2082	1930	1786	1321	593	347	164
C4V1	2377	1966	1655	1378	1223	1126	934	573	290	171	43
C4V2	2408	2023	1651	1350	1194	1115	911	551	277	108	32
SEm±	19.80	10.66	14.36	6.14	5.15	4.08	5.38	4.61	3.32	3.56	3.21
CD (5%)	NS	30.32	NS	17.46	14.66	11.59	15.32	13.13	9.43	10.13	9.14

Table 8. Contd…

L x C x V	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1V1	1727	1634	1604	1407	1258	1177	1136	1068	981	853	735
L1C1V2	1719	1629	1578	1373	1216	1136	1072	1008	925	813	722
L1C2V1	3264	2947	2810	2528	2249	2153	1915	1791	1570	1297	1058
L1C2V2	3260	2938	2779	2475	2174	2089	1841	1717	1493	1206	1001
L1C3V1	3449	3112	2942	2600	2314	2209	2041	1790	1210	825	447
L1C3V2	3437	3101	2875	2474	2279	2145	1967	1594	971	657	342
L1C4V1	2436	2082	1814	1611	1456	1360	1208	857	612	373	128
L1C4V2	2453	2106	1823	1590	1425	1343	1194	869	611	323	95
L2C1V1	1719	1626	1580	1377	1216	1123	1053	999	919	827	669
L2C1V2	1710	1617	1545	1344	1163	1077	986	960	877	783	605
L2C2V1	3251	2932	2775	2487	2166	2013	1818	1689	1319	1170	905
L2C2V2	3244	2922	2762	2414	2069	1883	1748	1617	1237	1083	841
L2C3V1	3435	3099	2927	2511	2219	2095	1957	1582	931	522	204
L2C3V2	3429	3087	2833	2481	2162	2028	1872	1331	678	385	150
L2C4V1	2396	2044	1764	1410	1209	1106	1011	616	257	141	0
L2C4V2	2422	2015	1734	1376	1155	1092	1005	578	221	0	0
L3C1V1	1663	1576	1459	1190	1050	953	889	957	805	670	539
L3C1V2	1643	1558	1433	1163	986	913	851	830	783	607	616
L3C2V1	3115	2860	2589	2209	1914	1757	1559	1543	1182	1011	706
L3C2V2	3107	2851	2580	2134	1823	1727	1494	1492	1048	884	580
L3C3V1	3287	3072	2662	2306	1982	1795	1593	1303	298	0	0
L3C3V2	3251	3014	2646	2247	1805	1616	1519	1038	130	0	0
L3C4V1	2300	1772	1386	1112	1003	911	583	247	0	0	0
L3C4V2	2350	1947	1395	1084	1001	911	533	206	0	0	0
Mean	2669	2398	2179	1871	1637	1525	1369	1153	794	601	431
SEm±	34.29	18.45	24.87	10.63	8.92	7.06	9.33	7.99	5.74	6.16	5.56
CD (5%)	NS	52.52	NS	30.24	25.39	20.08	NS	2.27	16.34	17.54	16.83

index was recorded in variety V_1 (449) and lowest recorded in variety V_2 (413) after eleven month of storage.

Interactions

Due to locations and crops (L x C)

The vigour index differed significantly due to interaction of locations and crops throughout the storage period except in first month of storage. Significantly highest vigour index (3107) was in L_1C_3 followed by L_2C_3 (3093) and lowest was recorded in L_3C_1 (1567) at second month of storage. Similar trend was noticed upto seventh month of storage. After eighth month of storage significantly highest vigour index was noticed in L_1C_2 (1754) followed by L_1C_3 (1692) and L_2C_2 (1653) and lowest was noticed in L_3C_4 (227). After ninth month of

storage significantly higher vigour index was noticed in L_1C_2 (1532) and lowest in L_2C_4 (239), L_3C_3 (214) and L_3C_4 (0000). Similar trend was noticed upto tenth and eleventh month of storage. Significantly highest vigour index was recorded in L_1C_2 (1030) while, lowest (0000) in L_2C_4, L_3C_3, L_3C_4 at eleventh month of storage.

Due to Locations and varieties (L x V)

Interaction effects of location and varieties showed non-significant differences except in fifth, sixth, eighth, ninth, tenth and eleventh month of storage. Significantly higher vigour index (2443) was noticed in L_1V_1 and L_1V_2 respectively and lowest vigour index was noticed in L_3V_1 (2326) at second month of storage. After fifth month of storage significantly higher vigour index was noticed in L_1V_1 (1819) while, L_3V_2 recorded lower vigour index (1404). Similar trend was noticed after sixth, tenth and eleventh month of storage. After eleventh month of storage significantly higher vigour index was recorded in L_1V_1 (592) and lower vigour index was recorded in L_3V_2 (299).

Due to crops and varieties (C x V)

The vigour index differed significantly throughout the storage period except after first and third month of storage. Significantly the highest vigour index was recorded in C_3V_1 (3090) which was on par with C_3V_2 (1607) after second month of storage and lowest was recorded in C_1V_2 (1601) after second month of storage. Similar trend was noticed upto sixth month of storage. After eighth month of storage significantly higher vigour index was noticed in C_2V_1 (1674) and lower vigour index was noticed in C_4V_2 (551). Similar trend was recorded upto eleven month of storage. Significantly the highest vigour index was recorded in C_2V_1 (890) and lowest in C_4V_2 (32) at eleven month of storage.

Due to locations, crops and varieties (L x C x V)

Interaction effects of locations, crops and varieties showed significant differences for vigour index throughout storage period except in first, third and seventh month after storage. The highest vigour index was recorded in $L_1C_3V_1$ (3112) which was on par with $L_1C_3V_2$ (3101), $L_2C_3V_1$ (3099) and $L_2C_3V_2$ (3087) in second month of storage and lowest in $L_3C_1V_1$ (1576) which was on par with $L_3C_1V_2$ (1558). After fourth month of storage significantly maximum vigour index was recorded in $L_1C_3V_1$ (2600) and minimum was recorded in $L_3C_4V_2$ (1084). Similar trend was recorded upto eighth month of storage. After nine month of storage significantly highest vigour index was recorded in L_1V_1 (1570) zero vigour index was recorded in $L_3C_4V_1$ and $L_3C_4V_2$. After tenth month of storage, significantly highest vigour index was noticed in $L_1C_2V_1$ (1297) and zero vigour index was noticed in $L_2C_4V_2$, $L_3C_3V_1$, $L_3C_3V_2$, $L_3C_4V_1$ and $L_3C_4V_2$. Significantly higher vigour index was noticed in $L_1C_2V_1$ (1058) lower (0000) vigour index in $L_2C_4V_1$, $L_2C_4V_2$, $L_3C_3V_1$, $L_3C_3V_2$, $L_3C_4V_1$ and $L_3C_4V_2$ after eleventh month o storage.

4.8 Electrical Conductivity (dSm^{-1})

The data an electrical conductivity as influenced by locations, crops and varieties and their interactions during storage are presented in Table 9.

Irrespective of locations, crops, varieties the mean electrical conductivity increased from 0.163 to 1.115 dSm^{-1} from initial month to eleven month after storage.

Due to locations

The EC was found to differ significantly due to locations throughout the storage period. Significantly the lowest EC was observed in seeds stored at Raichur (0.159 dSm^{-1}) followed by Dharwad (0.162 dSm^{-1}) and the highest was observed in seeds stored at Sirsi (0.167 dSm^{-1}) at first month of storage. Similar trend was observed in later months of storage. At eleventh month after storage the lowest EC was noticed in seeds stored at Raichur (1.039 dSm^{-1}) followed by Dharwad (1.102 dSm^{-1}) and the highest was noticed in seeds stored at Sirsi (1.204 dSm^{-1}).

Due to crops

EC differed significantly throughout the storage period among oilseed crops. Significantly lowest EC was recorded in sesamum (0.156 dSm^{-1}) which was on par with sunflower (0.159 dSm^{-1}) and the highest was recorded in groundnut (0.171 dSm^{-1}) and

Table 9. Influence of locations, oilseed crops and varieties on electrical conductivity (dSm^{-1}) during storage

Treatments	Months of storage										
	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
Location											
L1	0.159	0.197	0.224	0.245	0.278	0.349	0.424	0.558	0.741	0.847	1.039
L2	0.162	0.209	0.237	0.254	0.298	0.357	0.450	0.621	0.810	0.938	1.102
L3	0.167	0.219	0.251	0.276	0.320	0.423	0.507	0.735	0.880	1.039	1.204
SEm±	0.003	0.002	0.003	0.002	0.003	0.003	0.005	0.006	0.003	0.003	0.005
CD (5%)	0.010	0.006	0.010	0.007	0.009	0.009	0.014	0.017	0.007	0.008	0.013
Crop											
C1	0.156	0.164	0.189	0.198	0.215	0.238	0.248	0.321	0.354	0.387	0.702
C2	0.159	0.179	0.218	0.246	0.280	0.354	0.453	0.592	0.748	0.871	0.953
C3	0.164	0.218	0.236	0.248	0.293	0.385	0.508	0.719	0.982	1.108	1.314
C4	0.171	0.271	0.306	0.342	0.406	0.529	0.633	0.920	1.156	1.397	1.491
SEm±	0.004	0.003	0.004	0.003	0.004	0.004	0.006	0.007	0.003	0.003	0.005
CD (5%)	0.011	0.007	0.011	0.008	0.010	0.010	0.017	0.020	0.009	0.009	0.015
Variety											
V1	0.162	0.206	0.231	0.254	0.293	0.365	0.444	0.604	0.786	0.907	1.094
V2	0.164	0.210	0.244	0.263	0.304	0.388	0.477	0.672	0.834	0.975	1.136
Mean	0.163	0.208	0.237	0.259	0.299	0.376	0.460	0.638	0.810	0.941	1.115
SEm±	0.003	0.002	0.003	0.002	0.003	0.003	0.004	0.005	0.002	0.002	0.004
CD (5%)	NS	NS	0.008	0.006	0.007	0.007	0.012	0.014	0.006	0.007	0.011

L x C	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1	0.153	0.162	0.184	0.189	0.208	0.224	0.238	0.305	0.337	0.366	0.589
L1C2	0.156	0.172	0.203	0.229	0.257	0.335	0.438	0.547	0.682	0.777	0.884
L1C3	0.160	0.213	0.219	0.235	0.275	0.348	0.461	0.662	0.907	1.015	1.256
L1C4	0.166	0.240	0.288	0.327	0.370	0.490	0.559	0.717	1.037	1.228	1.426
L2C1	0.155	0.164	0.190	0.198	0.215	0.232	0.245	0.318	0.352	0.390	0.682
L2C2	0.158	0.179	0.219	0.238	0.287	0.348	0.451	0.560	0.752	0.877	0.937
L2C3	0.163	0.216	0.239	0.247	0.298	0.363	0.481	0.701	0.944	1.073	1.314
L2C4	0.171	0.275	0.302	0.335	0.392	0.484	0.622	0.904	1.191	1.410	1.474
L3C1	0.159	0.167	0.194	0.207	0.223	0.258	0.259	0.339	0.372	0.406	0.836
L3C2	0.164	0.186	0.232	0.271	0.296	0.378	0.469	0.671	0.810	0.959	1.037
L3C3	0.169	0.226	0.250	0.262	0.304	0.444	0.582	0.793	1.095	1.236	1.370
L3C4	0.177	0.297	0.327	0.365	0.457	0.612	0.718	1.138	1.241	1.553	1.573
SEm±	0.007	0.005	0.007	0.005	0.006	0.006	0.010	0.012	0.005	0.006	0.009
CD (5%)	NS	0.013	NS	NS	0.017	0.018	0.029	0.035	0.015	0.017	0.026
L x V											
L1V1	0.158	0.195	0.218	0.241	0.270	0.337	0.401	0.540	0.704	0.809	1.021
L1V2	0.160	0.198	0.229	0.249	0.285	0.362	0.448	0.576	0.778	0.884	1.056
L2V1	0.161	0.208	0.231	0.250	0.294	0.342	0.440	0.575	0.785	0.885	1.082
L2V2	0.163	0.209	0.244	0.258	0.301	0.371	0.460	0.667	0.835	0.990	1.122
L3V1	0.166	0.216	0.243	0.270	0316	0.416	0.491	0.696	0.869	1.026	1.179
L3V2	0.168	0.222	0.259	0.282	0.324	0.430	0.523	0.775	0.840	1.051	1.229
SEm±	0.005	0.003	0.005	0.004	0.004	0.004	0.007	0.009	0.004	0.004	0.007
CD (5%)	NS	NS	NS	NS	NS	NS	NS	0.025	0.010	0.011	0.018
C x V											
C1V1	0.155	0.164	0.187	0.194	0.211	0.231	0.238	0.307	0.344	0.379	0.689
C1V2	0.157	0.165	0.191	0.202	0.219	0.244	0.257	0.334	0.364	0.396	0.716
C2V1	0.158	0.177	0.214	0.239	0.273	0.339	0.444	0.569	0.732	0.847	0.915
C2V2	0.161	0.181	0.222	0.253	0.287	0.369	0.462	0.616	0.764	0.895	0.990
C3V1	0.162	0.215	0.231	0.245	0.288	0372	0.487	0.680	0.945	1.027	1.290
C3V2	0.165	0.222	0.242	0.250	0.297	0.399	0.530	0.758	1.018	1.189	1.337
C4V1	0.171	0.269	0.290	0.338	0.402	0.519	0.607	0.858	1.123	1.375	1.483
C4V2	0.172	0.273	0.321	0.347	0.411	0.539	0.654	0.981	1.190	1.420	1.499
SEm±	0.006	0.004	0.006	0.004	0.005	0.005	0.008	0.010	0.004	0.005	0.008
CD (5%)	NS	NS	NS	NS	NS	NS	NS	0.028	0.012	0.013	0.021

Table 9 Contd…											
L x C x V	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1V1	0.152	0.162	0.182	0.186	0.202	0.216	0.231	0.298	0.326	0.355	0.586
L1C1V2	0.154	0.163	0.186	0.192	0.214	0.231	0.246	0.312	0.348	0.376	0.592
L1C2V1	0.155	0.170	0.200	0.226	0.246	0.315	0.426	0.542	0.670	0.742	0.856
L1C2V2	0.157	0.174	0.206	0.232	0.268	0.355	0.450	0.552	0.694	0.812	0.912
L1C3V1	0.158	0.210	0.213	0.232	0.269	0.329	0.442	0.638	0.862	0.918	1.234
L1C3V2	0.162	0.215	0.226	0.238	0.282	0.368	0.480	0.686	0.952	1.112	1.279
L1C4V1	0.168	0.239	0.276	0.320	0.364	0.489	0.504	0.682	0.956	1.220	1.410
L1C4V2	0.165	0.242	0.300	0.334	0.376	0.492	0.614	0.752	1.118	1.236	1.442
L2C1V1	0.154	0.164	0.188	0.196	0.212	0.226	0.238	0.300	0.342	0.382	0.668
L2C1V2	0.156	0.163	0.192	0.200	0.218	0.238	0.253	0.336	0.362	0.398	0.696
L2C2V1	0.157	0.178	0.218	0.230	0.282	0.329	0.442	0.552	0.726	0.862	0.926
L2C2V2	0.159	0.180	0.220	0.246	0.292	0.367	0.460	0.567	0.778	0.892	0.948
L2C3V1	0.161	0.216	0.236	0.244	0.294	0.348	0.468	0.675	0.894	0.936	1.268
L2C3V2	0.164	0.217	0.241	0.249	0.302	0.378	0.495	0.728	0.993	1.210	1.361
L2C4V1	0.170	0.273	0.282	0.331	0.389	0.466	0.612	0.772	1.176	1.360	1.466
L2C4V2	0.172	0.278	0.322	0.339	0.394	0.502	0.632	1.036	1.206	1.460	1.482
L3C1V1	0.158	0.166	0.192	0.200	0.220	0.252	0.246	0.322	0.363	0.400	0.812
L3C1V2	0.160	0.168	0.196	0.214	0.226	0.264	0.272	0.355	0.382	0.412	0.860
L3C2V1	0.162	0.184	0.225	0.260	0.290	0.373	0.463	0.613	0.800	0.936	0.964
L3C2V2	0.166	0.188	0.240	0.282	0.302	0.384	0.475	0.728	0.820	0.982	1.110
L3C3V1	0.168	0.220	0.243	0.260	0.302	0.438	0.550	0.788	1.079	1.226	1.368
L3C3V2	0.170	0.230	0.258	0.264	0.306	0.450	0.615	0.859	1.110	1.246	1.372
L3C4V1	0.176	0.295	0.312	0.362	0.452	0.602	0.706	1.120	1.236	1.544	1.573
L3C4V2	0.178	0.300	0.342	0.368	0.462	0.622	0.730	1.156	1.146	1.563	1.573
Mean	0.163	0.208	0.237	0.259	0.299	0.376	0.460	0.638	0.810	0.941	1.115
SEm±	0.010	0.006	0.010	0.007	0.009	0.009	0.014	0.017	0.007	0.008	0.013
CD (5%)	NS	NS	NS	NS	NS	NS	NS	0.050	0.021	0.023	0.037

soybean (0.164 dSm^{-1}) which were on par with each other at first month after storage. Similar trend was noticed throughout the storage period. After eleven month of storage the lowest EC was observed in sesamum (0.702 dSm^{-1}) and highest was observed in groundnut (1.491 dSm^{-1}).

Due to varieties

Irrespective of crops and locations EC showed significant differences for varieties from third month of storage. Significantly the lowest (0.231 dSm^{-1}) EC was noticed in variety V_1 and highest was noticed in variety V_2 (0.244 dSm^{-1}) after third month of storage and similar trend was noticed from fourth month of storage to eleven month of storage. Significantly the lowest EC was recorded in variety V_1 of each crop (1.094 dSm^{-1}) while the highest was recorded in variety V_2 (1.136 dSm^{-1}) after the end of eleven month of storage.

Interactions

Due to locations and crops (L x C)

EC differed significantly through out the storage period for location and crops except in first, third and fourth month of storage. In the second month after storage significantly the lowest EC was recorded in L_1C_1, L_2C_1, L_3C_1 (0.162, 0.164, 0.167 dSm^{-1}) respectively which, was on par with each other and the highest EC was recorded in L_3C_4 (0.297 dSm^{-1}). Similar trend was noticed throughout the storage period. Significantly the lowest EC was observed in L_1C_1 (0.589 dSm^{-1}) and the highest was observed in L_3C_4 (1.573 dSm^{-1}) after eleven month of storage.

Due to locations and varieties (L x V)

EC of seed leachate differed significantly due to interaction between location and variety only after eighth month of storage. Significantly the lowest EC was recorded in L_1V_1 (0.540 dSm^{-1}) and the highest in L_3V_2 (0.775 dSm^{-1}) after eighth month of storage. Similar trend was noticed from ninth month of storage to eleventh month of storage. Significantly the lowest EC was recorded in L_1V_1 (1.021 dSm^{-1}) while L_3V_2 (1.229 dSm^{-1}) recorded highest EC after eleven month of storage.

Due to crops and varieties (C x V)

EC of seed leachate differed significantly due to interactions of crops and varieties only after eighth month of storage. Significantly the lowest EC was recorded in C_1V_1 (0.307 dSm^{-1}) and the highest was recorded in C_4V_2 (0.981 dSm^{-1}) after eighth month of storage. Similar trend was recorded from ninth month to eleventh month after storage. Significantly the lowest EC was recorded in C_1V_1 (0.689 dSm^{-1}) and the highest was in C_4V_2 (1.499 dSm^{-1}) after eleventh month of storage.

Due to locations, crops and varieties (L x C x V)

EC of seed leachate differed significantly due to interactions of locations, crops and varieties only from eight month after storage. Significantly the lowest EC was recorded in $L_1C_1V_1$ (0.298 dSm^{-1}) and highest EC was recorded in $L_3C_4V_2$ (1.156 dSm^{-1}) after eighth month and similar trend was noticed from ninth month to eleven month after storage. After eleventh month of storage the lowest EC was recorded in $L_1C_1V_2$ (0.586 dSm^{-1}) and the highest EC was recorded in $L_3C_4V_1$ and $L_3C_4V_2$ (1.573 dSm^{-1}).

4.9 Moisture content (%)

The data on moisture content as influenced by locations, crops and varieties and their interaction effects during storage are presented in Table 10.

Irrespective of locations, crops and varieties the mean moisture content declined from 10.19 to 9.85 per cent from initial month to eleventh month of storage.

Due to locations

Irrespective of crops and varieties moisture content differed significantly throughout the storage period among locations. Fluctuation in moisture content was noticed in all location but it was significantly low in seeds stored at Raichur (10.13%) followed by Dharwad (10.18%) and high in seeds stored at Sirsi (10.27%) at first month of storage. Similar trend

Table 10. Influence of locations, oilseed crops and varieties on moisture content (%) during storage

Treatments	Months of storage										
	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
Location											
L1	10.13	10.08	10.17	9.83	9.72	9.74	9.61	9.69	9.50	9.68	9.72
L2	10.18	10.15	10.23	10.01	9.76	9.78	9.66	9.72	9.56	9.72	9.78
L3	10.27	10.23	10.32	10.16	10.06	10.08	9.88	9.93	9.79	9.93	10.05
SEm±	0.005	0.007	0.020	0.024	0.006	0.006	0.005	0.009	0.007	0.005	0.007
CD (5%)	0.014	0.020	0.058	0.068	0.017	0.017	0.014	0.026	0.020	0.014	0.019
Crop											
C1	10.16	10.00	10.18	9.97	9.81	9.82	9.65	9.73	9.57	9.72	9.80
C2	10.19	10.14	10.21	9.94	9.82	9.84	9.69	9.75	9.60	9.75	9.84
C3	10.21	10.16	10.26	10.02	9.86	9.88	9.75	9.79	9.63	9.79	9.85
C4	10.21	10.18	10.32	10.07	9.90	9.91	9.78	9.84	9.68	9.84	9.90
SEm±	0.006	0.008	0.024	0.028	0.007	0.007	0.006	0.011	0.008	0.006	0.008
CD (5%)	0.016	0.022	0.067	0.078	0.019	0.020	0.016	0.030	0.023	0.016	0.022
Variety											
V1	10.19	10.14	10.24	9.98	9.84	9.86	9.70	9.77	9.61	9.76	9.84
V2	10.20	10.15	10.25	10.02	9.86	9.87	9.73	9.79	9.63	9.80	9.85
Mean	10.19	10.14	10.24	10.00	9.85	9.87	9.72	9.78	9.62	9.78	9.85
SEm±	0.004	0.006	0.017	0.048	0.005	0.005	0.004	0.007	0.006	0.004	0.006
CD (5%)	0.011	NS	NS	NS	0.013	0.014	0.011	0.021	0.017	0.011	NS

Table 10 Contd…

L x C	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1	10.09	10.03	10.11	9.76	9.68	9.70	9.55	9.66	9.45	9.62	9.67
L1C2	10.13	10.10	10.15	9.82	9.69	9.72	9.59	9.67	9.49	9.67	9.69
L1C3	10.15	10.10	10.16	9.86	9.74	9.75	9.64	9.70	9.52	9.70	9.74
L1C4	10.16	10.12	10.28	9.89	9.78	9.80	9.68	9.73	9.53	9.74	9.77
L2C1	10.13	10.08	10.18	10.02	9.73	9.74	9.62	9.67	9.52	9.67	9.73
L2C2	10.19	10.11	10.20	9.86	9.75	9.76	9.63	9.69	9.54	9.69	9.78
L2C3	10.19	10.13	10.27	10.05	9.77	9.79	9.67	9.72	9.56	9.73	9.78
L2C4	10.10	10.15	10.29	10.13	9.81	9.82	9.72	9.79	9.64	9.79	9.82
L3C1	10.25	10.19	10.27	10.13	10.02	10.04	9.78	9.87	9.73	9.88	10.02
L3C2	10.27	10.20	10.29	10.15	10.04	10.05	9.84	9.89	9.77	9.90	10.05
L3C3	10.29	10.25	10.35	10.17	10.08	10.11	9.94	9.95	9.82	9.95	10.04
L3C4	10.29	10.26	10.39	10.19	10.11	10.12	9.95	10.00	9.86	10.00	10.11
SEm±	0.010	0.014	0.041	0.048	0.012	0.012	0.010	0.018	0.014	0.010	0.014
CD (5%)	NS	NS	NS	NS	NS	NS	0.028	NS	NS	NS	NS
L x V											
L1V1	10.12	10.08	10.17	9.82	9.71	9.73	9.61	9.68	9.49	9.67	9.71
L1V2	10.14	10.09	10.18	9.84	9.73	9.75	9.62	9.70	9.50	9.69	9.73
L2V1	10.19	10.11	10.23	9.96	9.76	9.77	9.65	9.70	9.55	9.70	9.76
L2V2	10.18	10.12	10.24	10.07	9.77	9.78	9.67	9.73	9.57	9.74	9.79
L3V1	10.27	10.22	10.31	10.15	10.05	10.07	9.86	9.92	9.78	9.92	10.05
L3V2	10.28	10.23	10.34	10.17	10.08	10.09	9.90	9.94	9.81	9.94	10.05
SEm±	0.007	0.010	0.029	0.034	0.008	0.009	0.007	0.013	0.010	0.007	0.010
CD (5%)	NS	NS	NS	NS	NS	NS	0.020	NS	NS	NS	NS
C x V											
C1V1	10.15	10.09	10.18	9.96	9.80	9.82	9.65	9.72	9.56	9.71	9.79
C1V2	10.17	10.10	10.19	9.98	9.82	9.83	9.65	9.74	9.58	9.73	9.81
C2V1	10.19	10.13	10.21	9.88	9.81	9.83	9.67	9.74	9.59	9.74	9.83
C2V2	10.20	10.14	10.22	10.01	9.83	9.85	9.70	9.76	9.61	9.76	9.84
C3V1	10.20	10.15	10.25	10.01	9.85	9.87	9.72	9.78	9.62	9.78	9.85
C3V2	10.21	10.16	10.26	10.03	9.88	9.89	9.77	9.80	9.64	9.80	9.85
C4V1	10.21	10.17	10.31	10.06	9.89	9.90	9.77	9.82	9.66	9.82	9.89
C4V2	10.22	10.18	10.33	10.08	9.91	9.93	9.79	8.86	9.69	9.86	9.91
SEm±	0.008	0.011	0.033	0.039	0.009	0.010	0.008	0.015	0.012	0.008	0.011
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 10 Contd…											
L x C x V	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1V1	10.08	10.02	10.10	9.75	9.67	9.69	9.55	9.64	9.44	9.61	9.66
L1C1V2	10.10	10.03	10.11	9.77	9.68	9.70	9.55	9.67	9.47	9.63	9.67
L1C2V1	10.12	10.08	10.14	9.82	9.68	9.71	9.58	9.66	9.48	9.66	9.68
L1C2V2	10.14	10.11	10.15	9.82	9.69	9.72	9.60	9.68	9.50	9.68	9.69
L1C3V1	10.14	10.10	10.16	9.84	9.72	9.74	9.62	9.69	9.51	9.69	9.72
L1C3V2	10.15	10.09	10.16	9.85	9.76	9.76	9.65	9.71	9.52	9.71	9.76
L1C4V1	10.15	10.12	10.28	9.88	9.76	9.78	9.67	9.72	9.53	9.72	9.76
L1C4V2	10.16	10.11	10.28	9.90	9.79	9.82	9.68	9.74	9.53	9.75	9.78
L2C1V1	10.12	10.08	10.18	10.00	9.72	9.73	9.61	9.67	9.51	9.66	9.72
L2C1V2	10.14	10.08	10.17	10.03	9.74	9.74	9.63	9.68	9.53	9.68	9.74
L2C2V1	10.18	10.10	10.20	9.69	9.74	9.75	9.62	9.68	9.53	9.68	9.76
L2C2V2	10.19	10.12	10.20	10.04	9.75	9.76	9.64	9.70	9.54	9.70	9.79
L2C3V1	10.18	10.12	10.26	10.04	9.76	9.78	9.66	9.71	9.56	9.71	9.76
L2C3V2	10.20	10.13	10.27	10.06	9.78	9.80	9.67	9.73	9.56	9.74	9.80
L2C4V1	10.19	10.14	10.28	10.11	9.80	9.81	9.71	9.76	9.61	9.76	9.81
L2C4V2	10.20	10.16	10.30	10.14	9.82	9.83	9.73	9.81	9.66	9.82	9.83
L3C1V1	10.24	10.18	10.26	10.12	10.00	10.03	9.78	9.86	9.72	9.86	10.00
L3C1V2	10.26	10.20	10.28	10.14	10.03	10.04	9.78	9.88	9.74	9.89	10.03
L3C2V1	10.26	10.20	10.28	10.13	10.02	10.04	9.82	9.88	9.75	9.88	10.04
L3C2V2	10.27	10.20	10.30	10.16	10.05	10.16	9.86	9.90	9.78	9.91	10.05
L3C3V1	10.28	10.24	10.33	10.16	10.06	10.10	9.88	9.94	9.80	9.94	10.07
L3C3V2	10.29	10.26	10.36	10.18	10.10	10.12	10.00	9.95	9.84	9.96	10.00
L3C4V1	10.28	10.26	10.38	10.18	10.10	10.11	9.94	9.98	9.84	9.98	10.10
L3C4V2	10.30	10.16	10.40	10.20	10.12	10.13	9.96	10.02	9.88	10.00	10.12
Mean	10.19	10.14	10.24	10.00	9.85	9.87	9.72	9.78	9.62	9.78	9.85
SEm±	0.014	0.019	0.057	0.067	0.016	0.017	0.014	0.027	0.020	0.014	0.019
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

was noticed throughout the storage period. Significantly the highest moisture content was noticed in seeds stored at Sirsi (10.05%) and the lowest was in seeds stored at Raichur (9.72%) after eleventh month of storage.

Due to crops

Moisture content differed throughout the storage period among different oilseed crops. The moisture content was significantly maximum in groundnut and soybean (10.21%) and were on par with each other while, minimum was in sesamum and sunflower (10.16 and 10.19%) respectively but were on par with each other after first month of storage. Similar trend was noticed from second month to eleventh month of storage. Significantly low moisture

content percentage was recorded in V_1 (9.84%) and more (9.85%) in V_2 after eleventh month of storage.

Due to varieties

Moisture content differed significantly throughout the storage period except after second, third, fourth and eleventh month of storage. Significantly the lowest moisture content percentage was noticed in V_1 (10.19%) and the highest in variety V_2 (10.20%) after first month of storage. Similar trend was noticed from fifth month of storage to tenth month of storage. After eleven month of storage numerically higher (9.85%) moisture content was noticed in V_1 and lower (9.84%) was noticed in V_2.

Interactions

Due to locations and crops (L x C)

The moisture content was found to differ non-significantly throughout the storage period except after seventh month of storage due to locations and crops. Similarly highest moisture content (9.95%) was noticed in L_3C_4 which was on par with L_3C_3 (9.94%) and the lowest moisture content (9.55%) was noticed in L_1C_1 after seventh month of storage. Numerically higher (10.11%) moisture content noticed in L_3C_4 and lower (9.67%) was noticed in L_1C_1 after eleven month of storage.

Due to locations and varieties (L x V)

Moisture content due to interaction effects of locations and varieties showed a non significant effect throughout the storage period except after seventh month of storage. Significantly the lowest moisture content (9.61%) was noticed in L_1V_1 which was on par with L_1V_2 (9.62%). Significantly the highest moisture content was noticed in L_3V_2 (9.90%) after seventh month of storage. After eleventh month of storage higher (10.05%) moisture content was noticed in L_3V_1, L_3V_2 and lower (9.71%) in L_1V_1.

Due to crops and varieties (C x V)

Interaction effects due to crops and varieties showed a non significant difference throughout the storage period for moisture content.

Due to locations, crops and varieties (L x C x V)

Interaction effects due to locations, crops and varieties showed non-significant difference in moisture content throughout the storage period.

4.10 Seed Infection (%)

The data on per cent seed infection during storage as influenced by locations, crops and varieties and their interaction effects are presented in Table 11.

Irrespective of locations, crops and varieties, the mean seed infection percentage increased from 9.91 to 24.58 from initial month to eleven month after storage.

Due to locations

The seed infection found to differ significantly due to locations throughout the storage period. Significantly lowest seed infection was observed in seeds stored at Raichur (6.67%) followed by Dharwad (9.83%) and highest was recorded in seeds stored at Sirsi (13.22%). Similar trend was recorded throughout the storage period. At eleventh month after storage the lowest infection was noticed in seeds stored at Raichur (20.75%) followed by Dharwad (24.18%) and the highest was noticed in seeds stored at Sirsi (28.83%).

Due to crops

Seed infection per cent differed significantly throughout the storage period among oil seed crops.

At first month of storage infection was not observed in sesamum (0.00%) and highest infection was recorded in groundnut (20.25%). Similar trend was noticed throughout the storage period. At eleventh month of storage sesamum record lowest (14.33%) infection and highest (34.61%) infection was noticed in groundnut

Table 11. Influence of locations, oilseed crops and varieties on seed infection (%) during storage

Treatments	Months of storage										
	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
Location											
L1	6.67	7.71	9.58	11.96	13.71	14.62	16.16	17.17	18.09	19.25	20.75
L2	9.83	11.75	14.40	16.23	17.19	18.83	20.37	20.85	21.66	23.00	24.18
L3	13.22	15.95	18.83	20.61	21.97	22.91	25.00	25.54	26.46	27.87	28.83
SEm±	0.07	0.03	0.04	0.04	0.09	0.05	0.10	0.09	0.06	0.06	0.09
CD (5%)	0.21	0.08	0.11	0.12	0.25	0.14	0.28	0.24	0.17	0.16	0.24
Crop											
C1	0.00	1.44	3.89	6.47	7.24	7.87	8.11	8.61	10.94	13.44	14.33
C2	3.83	5.61	9.53	11.93	12.89	13.87	15.22	15.77	16.33	18.00	19.33
C3	15.55	17.61	20.28	21.50	22.67	24.03	27.22	28.06	28.40	29.05	30.05
C4	20.25	22.55	23.39	25.16	27.69	29.39	31.50	32.30	32.61	33.00	34.61
SEm±	0.09	0.03	0.05	0.05	0.10	0.06	0.11	0.10	0.07	0.07	0.10
CD (5%)	0.24	0.09	0.13	0.13	0.29	0.16	0.32	0.28	0.20	0.20	0.28
Variety											
V1	9.36	11.50	13.85	15.97	17.22	18.43	19.97	20.76	21.53	22.91	24.04
V2	10.46	12.11	14.70	16.56	18.03	19.15	21.05	21.61	22.62	23.83	25.12
Mean	9.91	11.80	14.27	16.27	17.62	18.79	20.51	21.18	22.07	23.37	24.58
SEm±	0.06	0.02	0.03	0.03	0.08	0.04	0.08	0.07	0.05	0.05	0.07
CD (5%)	0.17	0.07	0.09	0.09	0.23	0.12	0.23	0.20	0.14	0.14	0.20

Table 11 Contd…

L x C	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1	0.00	0.00	0.00	4.33	4.83	5.17	5.83	6.50	9.17	11.00	12.00
L1C2	0.00	0.00	5.00	8.83	10.17	10.17	10.83	11.50	12.00	14.00	16.00
L1C3	11.00	12.84	15.00	15.67	17.16	18.67	21.66	23.34	23.55	24.00	24.93
L1C4	15.69	18.00	18.33	19.00	22.67	24.50	26.33	27.34	27.67	28.00	30.00
L2C1	0.00	0.00	4.33	6.60	7.17	7.94	8.17	8.33	10.50	13.00	14.00
L2C2	2.17	5.33	8.94	10.66	11.67	13.94	15.00	15.16	16.00	18.00	18.00
L2C3	16.67	19.00	21.17	22.67	22.50	24.44	27.17	27.83	28.16	28.67	29.73
L2C4	20.50	22.67	23.16	25.00	27.45	29.00	31.16	32.06	32.00	32.33	34.00
L3C1	0.00	4.33	7.33	8.50	9.73	10.50	10.33	11.00	13.17	16.33	17.00
L3C2	9.33	11.50	14.67	16.30	16.83	17.50	19.83	20.67	21.00	22.00	23.00
L3C3	19.00	21.00	24.67	26.16	28.36	30.00	32.83	33.00	33.50	34.50	35.50
L3C4	24.56	27.00	28.67	31.50	32.97	34.67	37.00	37.50	38.17	38.66	39.83
SEm±	0.15	0.06	0.08	0.08	0.18	0.10	0.20	0.17	0.12	0.12	0.17
CD (5%)	0.42	0.16	0.23	0.23	0.50	0.28	0.56	0.48	0.34	0.35	0.48
L x V											
L1V1	6.25	7.50	9.33	11.58	13.16	14.25	15.58	16.92	17.67	18.91	20.21
L1V2	7.10	7.92	9.83	12.33	14.25	15.00	16.75	17.42	18.52	19.58	21.25
L2V1	9.17	11.08	13.80	15.91	16.89	18.47	20.00	20.53	21.33	22.58	23.83
L2V2	10.50	12.41	15.00	16.55	17.50	19.19	20.75	21.16	22.00	23.41	24.53
L3V1	12.66	15.91	18.41	20.41	21.61	22.58	24.33	24.83	25.58	27.25	28.08
L3V2	13.78	16.00	19.25	20.81	22.33	23.25	25.67	26.25	27.33	28.50	29.58
SEm±	0.10	0.04	0.06	0.06	0.12	0.07	0.14	0.12	0.09	0.09	0.12
CD (5%)	NS	0.11	0.16	0.16	NS	NS	NS	0.34	0.24	0.25	0.34
C x V											
C1V1	0.00	1.33	3.55	6.22	7.04	7.77	7.81	8.55	10.55	13.00	13.77
C1V2	0.00	1.55	4.22	6.73	7.44	7.96	8.33	8.66	11.33	13.88	14.88
C2V1	2.89	5.55	9.18	11.77	12.44	13.66	14.88	15.33	15.88	17.55	18.77
C2V2	15.00	5.66	9.89	12.09	13.33	14.07	15.55	16.22	16.77	18.44	19.88
C3V1	16.01	17.22	19.66	21.33	22.44	23.63	26.44	27.33	27.66	28.55	29.39
C3V2	19.55	18.00	20.89	21.66	22.91	24.44	28.00	28.78	29.14	29.55	30.70
C4V1	20.95	21.89	23.00	24.55	26.97	28.66	30.66	31.82	32.00	32.55	34.22
C4V2	21.20	23.22	23.78	25.77	28.42	30.11	32.33	32.78	33.22	33.44	35.00
SEm±	0.34	0.05	0.07	0.07	0.14	0.08	0.16	0.14	0.10	0.10	0.14
CD (5%)	1.02	0.13	0.18	0.19	0.41	0.23	0.46	0.40	0.28	NS	NS

Table 11 Contd…											
L x C x V	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1V1	0.00	0.00	0.00	4.00	4.66	5.00	5.66	6.33	8.67	10.66	11.33
L1C1V2	0.00	0.00	0.00	4.67	5.00	5.33	6.00	6.66	9.66	11.33	12.66
L1C2V1	0.00	0.00	4.66	8.66	9.33	10.00	10.66	11.33	11.66	13.67	15.33
L1C2V2	0.00	0.00	5.33	9.00	11.00	10.33	11.00	11.67	12.53	14.33	16.66
L1C3V1	10.33	12.68	14.66	15.00	16.66	18.33	20.66	22.67	23	23.66	24.52
L1C3V2	11.66	13.00	15.33	16.33	17.66	19.00	22.66	24.00	24.10	24.33	25.33
L1C4V1	14.66	17.33	18.00	18.66	22.00	23.66	25.33	27.00	27.33	27.66	29.66
L1C4V2	16.73	18.66	18.67	19.33	23.33	25.83	27.33	27.67	28	28.33	30.33
L2C1V1	0.00	0.00	4.00	6.33	7.00	7.66	8.00	8.33	10.33	12.33	13.66
L2C1V2	0.00	0.00	4.66	6.86	7.33	8.22	8.33	8.33	10.66	13.66	14.33
L2C2V1	0.00	4.00	8.56	10.66	11.33	13.66	14.33	14.66	15.66	17.33	18.66
L2C2V2	4.33	6.66	9.33	10.67	12.00	14.22	15.66	15.66	16.33	18.66	19.33
L2C3V1	16.00	18.33	20.00	22.33	22.66	24.22	27.00	27.33	27.66	28.33	29.33
L2C3V2	17.33	19.66	22.33	23.00	22.33	24.66	27.33	28.33	28.66	29.00	30.12
L2C4V1	20.66	22.00	22.66	24.33	26.57	28.33	30.66	31.79	31.67	32.33	33.66
L2C4V2	20.33	23.33	23.66	25.66	28.33	29.66	31.66	32.33	32.33	32.35	34.33
L3C1V1	0.00	4.00	6.66	8.33	9.46	10.66	10.00	10.66	12.66	16	16.33
L3C1V2	0.00	4.66	8.00	8.66	10.00	10.33	10.66	11.33	13.67	16.66	17.66
L3C2V1	8.66	12.66	14.33	16.00	16.66	17.33	19.66	20.00	20.33	21.66	22.33
L3C2V2	10.00	10.33	15.00	16.60	17.00	17.67	20.00	21.33	21.66	22.33	23.66
L3C3V1	18.66	20.66	24.33	26.66	28.00	28.33	31.66	32.00	32.33	33.67	34.38
L3C3V2	19.33	21.33	25.00	25.66	28.73	29.66	34.00	34.00	34.66	35.33	36.66
L3C4V1	23.33	26.33	28.33	30.66	32.33	34.00	36.00	36.66	37.00	37.66	39.33
L3C4V2	25.79	27.66	29.00	32.33	33.60	35.33	38.00	38.33	39.33	39.66	40.33
Mean	9.91	11.80	14.27	16.27	17.62	18.79	20.51	21.18	22.07	23.37	24.58
SEm±	0.21	0.08	0.11	0.11	0.25	0.14	0.28	0.24	0.17	0.17	0.24
CD (5%)	0.59	0.23	0.32	0.32	NS	0.40	0.79	0.68	0.48	0.50	NS

Due to varieties

Seed infection showed significant differences for varieties throughout the storage period. Significantly lowest (9.36%) infection was noticed in variety V_1 and highest (10.46%) was noticed in variety V_2 at first month of storage. Similar trend was observed upto eleventh month of storage. Significantly the lowest seed infection (24.04%) was recorded in variety V_1 while variety V_2 recorded (25.12%) seed infection after the end of eleven month of storage.

Due to locations and crops (L x C)

Seed infection differed significantly throughout the storage period for location and crops. No infection was observed upto three months of storage in sesamum stored at Raichur, upto two months at Dharwad, upto one month at Sirsi. Significantly lowest infection was observed in sesamum seed stored at Raichur (4.33%) and highest (31.50%) was recorded in groundnut seeds stored at Sirsi after fourth month of storage. Similar trend was observed throughout the storage period. At eleventh month of storage lowest (12.00%) infection was noticed in sesamum seeds stored at Raichur and highest (39.83%) was noticed in groundnut seeds stored at Sirsi.

Due to locations and varieties

Interaction effects of locations and variety showed non-significant difference in first, fifth, sixth and seventh month of storage. At the end of second month lowest (7.50%) infection was noticed in variety V_1 of each crop stored at Raichur and highest (16.00%) infection was recorded in variety V_2 stored at Sirsi. Similar trend was noticed throughout the storage period. Significantly lowest (20.21%) infection was noticed in variety V_1 stored at Raichur and while variety V_2 stored at Sirsi recorded highest (29.58%) infection at eleventh month of storage.

Due to crops and varieties

Interaction effects of crops and varieties showed significant difference throughout the storage period except last ten and eleventh months of storage. At first month of storage varieties DS-1 and E-8 of sesamum recorded zero per cent infection while, groundnut variety TAG-24 recorded highest infection (20.95%). Similar trend was noticed throughout the storage period. Numerically lesser (13.77%) infection was recorded in DS-1 variety of sesamum and higher (35.00%) was recorded in TAG-24 variety of groundnut at eleventh month of storage.

Due to locations, crops and varieties (L x C x V)

Interaction of locations, crops and varieties showed significant differences for seed infection throughout storage period except in fifth and eleventh month of storage. No infection was observed upto three months in both the varieties of sesamum DS-1 and E-8, for stored at Raichur, for two months at Dharwad and for one month at Sirsi. Whereas, sunflower varieties KBSH-1 and RFSH-1 recorded zero infection at Raichur for first two months of storage and variety KBSH-1 of sunflower stored at Dharwad recorded no infection at first month of storage. At fourth month of storage DS-1 variety of sesamum stored at Raichur significantly recorded lesser (4.00%) infection and higher (32.33%) was recorded in variety TAG-24 of groundnut stored at Sirsi. Similar trend was noticed throughout the storage period. Numerically minimum (11.33%) infection was noticed in DS-1 variety of sesamum stored at Raichur and maximum (40.33%) was recorded in TAG-24 variety of groundnut stored at Sirsi at eleventh month of storage.

4.11 Oil Content (%)

The data on oil content percentage during storage as influenced by different storage locations, crops and varieties and their interaction effects are presented in Table 12.

Irrespective of locations, crops and varieties, the mean oil content percentage decreased from 40.17 to 36.47 per cent during first month of storage to end of eleventh month of storage respectively.

Table 12. Influence of locations, oilseed crops and varieties on oil content (%) during storage

Treatments	Months of storage										
	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
Location											
L1	40.30	40.02	39.82	39.63	39.50	39.33	38.84	37.86	37.15	37.00	36.71
L2	40.24	40.01	39.67	39.59	39.43	39.30	38.25	37.76	37.00	36.56	36.43
L3	39.97	39.61	39.21	39.09	39.11	39.03	37.99	37.50	36.62	36.49	36.27
SEm±	0.08	0.13	0.13	0.11	0.12	0.07	0.09	0.07	0.09	0.09	0.08
CD (5%)	0.23	NS	0.36	0.30	NS	0.20	0.25	0.19	0.25	0.24	0.23
Crop											
C1	51.19	51.41	51.13	50.89	49.84	50.27	49.70	49.30	46.54	46.82	46.61
C2	41.51	41.13	40.82	40.16	40.71	40.55	39.74	39.54	35.51	38.19	37.96
C3	20.67	20.06	19.75	19.76	20.22	19.67	16.80	17.22	18.14	15.02	14.86
C4	47.32	46.90	46.57	46.92	46.61	46.39	47.20	44.77	47.51	46.71	46.44
SEm±	0.10	0.15	0.15	0.12	0.14	0.08	0.10	0.08	0.10	0.10	0.09
CD (5%)	0.27	0.43	0.42	0.34	0.39	0.23	0.29	0.22	0.29	0.28	0.26
Variety											
V1	40.32	39.96	39.66	39.51	39.55	39.31	38.55	37.55	36.89	36.84	36.68
V2	40.03	39.79	39.48	39.36	39.13	39.13	38.17	37.86	37.14	36.53	36.26
Mean	40.17	39.88	39.57	39.43	39.34	39.22	38.26	37.71	36.93	36.68	36.47
SEm±	0.07	0.11	0.11	0.09	0.10	0.06	0.07	0.06	0.07	0.17	0.07
CD (5%)	0.19	NS	NS	NS	0.28	0.17	0.21	0.16	0.21	0.20	0.19

L x C	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1	51.40	51.61	51.41	51.18	50.10	50.40	49.91	49.39	47.05	47.10	46.70
L1C2	41.38	41.48	41.28	40.36	40.34	40.50	40.54	39.90	35.69	38.33	38.13
L1C3	20.75	19.98	19.82	19.89	20.38	19.75	17.36	17.31	18.34	15.63	15.44
L1C4	47.66	46.99	46.79	47.08	47.18	46.66	47.53	44.83	47.53	46.93	46.59
L2C1	51.44	51.54	51.16	51.10	49.76	50.43	49.66	49.31	46.89	46.64	46.60
L2C2	41.78	41.16	40.98	40.41	41.03	40.78	39.30	39.70	35.50	38.23	38.02
L2C3	20.65	20.16	19.76	19.88	20.16	19.60	16.73	17.21	18.11	14.92	14.84
L2C4	47.16	47.18	46.78	46.98	46.75	46.40	47.30	44.82	47.46	46.46	46.24
L3C1	50.74	51.09	50.81	50.39	49.65	49.99	49.54	49.20	45.68	46.70	46.52
L3C2	41.36	40.75	40.21	39.71	40.75	40.36	39.38	39.03	35.28	38.02	37.74
L3C3	20.60	20.05	19.66	19.53	20.11	19.65	16.30	17.13	17.98	14.50	14.30
L3C4	47.14	46.55	46.15	46.71	45.91	46.11	46.76	44.66	47.55	46.75	46.50
SEm±	0.17	0.26	0.26	0.210	0.24	0.14	0.18	0.14	0.18	0.17	0.16
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
L x V											
L1V1	40.57	40.07	39.89	39.75	39.86	39.57	39.09	37.83	36.89	37.17	36.96
L1V2	40.03	39.96	39.76	39.51	39.14	39.09	38.58	37.88	37.41	36.82	36.46
L2V1	40.29	40.07	39.79	39.57	39.53	39.28	38.40	37.54	36.86	36.71	36.65
L2V2	40.20	39.95	39.55	39.61	39.32	39.32	38.09	37.98	37.14	36.41	36.20
L3V1	40.09	39.75	39.30	39.20	39.27	39.08	38.16	37.28	36.37	36.63	36.43
L3V2	39.85	39.47	39.12	38.97	38.94	38.98	37.83	37.73	36.89	36.35	36.11
SEm±	0.12	0.19	0.18	0.15	0.17	0.10	0.13	0.10	0.13	0.12	0.11
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C x V											
C1V1	51.45	51.47	51.15	51.29	50.03	50.44	49.93	49.32	46.43	46.79	46.68
C1V2	50.93	51.86	51.11	50.48	49.65	50.10	49.48	49.28	46.65	46.84	46.54
C2V1	40.96	40.88	40.52	39.55	40.34	39.96	39.52	39.18	34.92	38.02	37.82
C2V2	42.05	41.38	41.13	40.78	41.07	41.13	39.96	39.91	36.09	38.36	38.11
C3V1	20.64	20.00	19.68	19.73	20.16	19.64	16.58	17.16	17.96	14.92	14.81
C3V2	20.69	20.13	19.82	19.80	20.26	19.69	17.01	17.28	18.33	15.11	14.91
C4V1	48.22	47.63	47.29	47.45	47.68	47.20	48.18	44.56	47.53	47.63	47.42
C4V2	46.42	46.18	45.85	46.39	45.54	45.58	46.22	44.98	47.50	45.80	45.47
SEm±	0.14	0.22	0.21	0.17	0.20	0.12	0.15	0.11	0.12	0.14	0.13
CD (5%)	0.38	0.61	0.59	0.48	0.55	0.33	0.41	0.31	0.42	0.40	0.37

Table 12 Contd…											
L x C x V	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
L1C1V1	51.80	51.73	51.53	51.38	50.25	50.80	50.23	49.63	46.83	47.25	47.00
L1C1V2	51.00	51.50	51.30	50.98	49.95	50.00	49.60	49.15	47.28	46.95	46.40
L1C2V1	41.18	41.14	40.93	40.08	40.83	40.16	40.68	39.70	35.18	38.15	37.95
L1C2V2	41.58	41.83	41.63	40.65	39.85	40.83	40.40	40.10	36.20	38.50	38.30
L1C3V1	20.83	19.84	19.72	20.01	20.33	19.83	17.05	17.25	18.30	15.42	15.23
L1C3V2	20.68	20.13	19.93	19.78	20.43	19.68	17.68	17.38	18.38	15.85	15.65
L1C4V1	48.48	47.60	47.40	47.53	48.03	47.48	48.43	44.75	47.25	47.88	47.68
L1C4V2	46.85	46.38	46.18	46.62	46.33	45.85	46.63	44.90	47.80	45.98	45.50
L2C1V1	51.43	51.40	51.28	51.25	49.93	50.40	49.91	49.23	47.22	46.61	46.73
L2C1V2	51.45	51.68	51.05	50.95	49.60	50.45	49.40	49.40	46.55	46.68	46.48
L2C2V1	40.90	41.03	40.83	39.68	40.40	39.90	38.78	39.33	34.90	38.03	37.83
L2C2V2	42.95	41.30	41.13	41.15	41.65	41.65	39.83	40.08	36.20	38.43	38.23
L2C3V1	20.55	20.08	19.68	19.88	20.03	19.55	16.55	17.15	17.88	15.03	15.08
L2C3V2	20.65	20.25	19.85	19.88	20.30	19.65	16.90	17.28	18.35	14.81	14.60
L2C4V1	48.28	47.78	47.38	47.48	47.76	47.28	48.38	44.48	47.45	47.18	46.98
L2C4V2	46.04	46.58	46.18	46.48	45.73	45.53	46.23	45.18	47.48	45.74	45.50
L3C1V1	51.13	50.95	50.65	51.25	49.90	50.13	49.65	49.10	45.23	46.51	46.30
L3C1V2	50.35	51.23	50.98	49.53	49.40	49.85	49.42	49.30	46.13	46.90	46.75
L3C2V1	40.80	40.48	39.80	38.90	39.80	39.80	39.10	38.50	34.68	37.88	37.68
L3C2V2	41.93	41.03	40.63	49.53	41.70	40.93	39.65	39.55	35.89	38.15	37.80
L3C3V1	20.55	20.08	19.65	19.30	20.13	19.55	16.15	17.08	17.70	14.33	14.13
L3C3V2	20.75	20.03	19.68	19.75	20.10	19.75	16.45	17.18	18.25	14.68	14.48
L3C4V1	47.90	47.50	47.10	47.35	47.25	46.85	47.73	44.45	47.88	47.83	47.60
L3C4V2	46.38	45.60	45.20	46.08	44.58	45.38	45.80	44.88	47.21	45.68	45.40
Mean	40.17	39.88	39.57	39.43	39.34	39.22	38.26	37.71	36.93	36.68	36.47
SEm±	0.23	0.37	0.36	0.30	0.34	0.20	0.25	0.19	0.26	0.24	0.23
CD (5%)	NS	NS	NS	NS	0.95	NS	NS	NS	NS	NS	NS

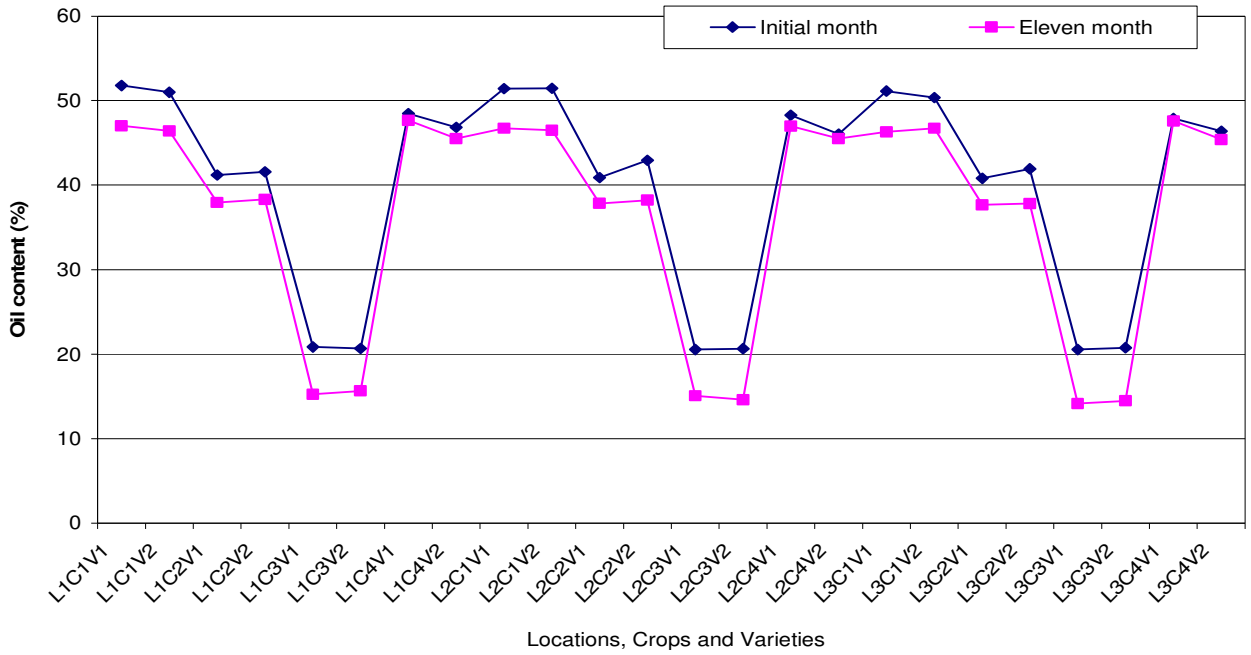

Fig. 4. Influence of locations, crops and varieties on oil content during storage

Fig. 4. Influence of locations, crops and varieties on oil content during storage

Due to locations

Locations differed significantly throughout the storage period except in second and fifth month of storage for per cent oil content. Higher oil content percentage was noticed in seeds stored at Raichur (40.30%) which was on par with seeds stored at Dharwad (40.24%) and lower oil content percentage was noticed in seeds stored at Sirsi (39.97%) at first month of storage. Similar trend was noticed throughout the storage upto eleventh month of storage. Significantly higher oil content was noticed in seeds stored at Raichur (36.71%) which was on par with seeds stored at Dharwad (36.43%) while lower oil content percentage was noticed in seeds stored at Sirsi (36.27%) at eleventh month of storage.

Due to crops

Per cent oil content showed significant difference among oilseed crops in all the months of storage period. Among oilseed crops, sesamum recorded significantly the highest oil content (51.19%) followed by groundnut (47.32%), sunflower (41.51%) while, soybean (20.67%) recorded significantly the lowest oil content percentage at first month of storage. Similar trend was noticed upto eleventh month of storage. After eleventh month of storage higher oil content was noticed in sesamum (46.61%) which was on par with groundnut (46.44%) and lower oil content was noticed in soybean (14.86%).

Due to varieties

Per cent oil content differed significantly due to varieties in all months of storage except in second, third and fourth months of storage. After first month of storage significantly the highest oil content was noticed in variety V_1 (40.32%) while, the lowest was recorded in variety V_2 (40.03%). Similar trend was recorded throughout the storage period. Significantly higher oil content was noticed in variety V_1 (36.68%) and lower oil content was noticed in variety V_2 (36.26%) at eleventh month of storage.

Interactions

Due to locations and crops (L x C)

Interaction effects of locations and crops showed non-significant differences throughout the storage period for per cent oil content. However, it was relatively more (51.40%) in L_1C_1 and less (20.60% and 20.65%) in L_3C_3 and L_2C_3 respectively in first month of storage. Similar trend was noticed throughout the storage period. At the end of 11 months of storage numerically oil content was more (46.70%) in L_1C_1 and less (14.84%) in L_2C_3.

Due to locations and crops (L x V)

Interaction effects of locations and varieties showed non significant differences throughout the storage period for per cent oil content. However it was numerically more (40.57%) in L_1V_1 and less (39.85%) in L_3V_2 after first month of storage. Similar trend was recorded throughout storage period for per cent oil content. At the end of 11 months of storage oil content was more (36.96%) in L_1V_1 and less (36.11%) in L_3V_2.

Due to crops and varieties (C x V)

Interaction effects between crops and varieties showed significant differences throughout the storage period. Significantly maximum oil content was recorded in C_1V_1 (51.45%) followed by C_1V_2 (50.93%). While, it was minimum in C_3V_1 (20.64%) followed by C_3V_2 (20.69) in first month of storage. Similar trend was noticed upto eleven month of storage. After eleventh month of storage C_1V_1 recorded more (46.68%), oil content which was on par with C_1V_2 (46.54%) and while C_3V_1 recorded less (14.81%) oil content which was on par with C_3V_2 (14.91%).

Due to locations, crops and varieties (C x L x V)

Per cent oil content differed significantly due to interaction effects of locations, crops and varieties only in fifth month of storage. Higher oil content per cent was noticed in $L_1C_1V_1$ (50.25%) which was on par with $L_1C_1V_2$ (49.95%), $L_2C_1V_1$ (49.93%), $L_2C_1V_2$ (49.60%), $L_3C_1V_1$ (49.90%) and $L_3C_1V_2$ (49.40%) and lower oil content was noticed in $L_2C_3V_1$ (20.03%), which was on par with $L_1C_3V_1$ (20.33%), $L_1C_3V_2$ (20.43%), $L_2C_3V_2$ (20.30%), $L_3C_3V_1$ (20.13%) and $L_3C_3V_2$ (20.10%) at fifth month of storage.

V. DISCUSSION

In any crop success of seed production ends with safe storage of seeds. Now-a-days much importance is being given to storage of seeds as “Seeds saved is seed produced”. Not all kinds of seeds store equally well, as storability is mainly under genetic control but modified by the environment in which the seeds are stored. Apart from genetic factor, storage potential also varies among genera, species, and varieties and even it extends to seed lots (Delouche, 1973). Further among different crop seeds, oilseeds are considered to be very poor storers followed by starch rich cereals which are classified as medium storers while, protein rich seeds of pulses as good storers.

Loss of seed viability due to ageing and deteriorative changes in storage is characterized as inexorable, irreversible, and inevitable but the rate of deterioration can be slowed down by storing the seeds under controlled conditions at lower relative humidity and temperature. But storage under controlled conditions seems to be very costly in developing countries like India. Hence, storage of seeds in natural places (locations) where, ambient temperature and relative humidity are relatively low seems to be better to maintain seed quality which will be less costly compared to controlled conditions seed storage.

Keeping these in view, an experiment was conducted to ascertain the storage potential of two-varieties of four important oil seed crops namely sesamum sunflower, soybean and groundnut stored under ambient conditions at three locations namely Raichur, Dharwad and Sirsi for eleven months from June 2005 to May 2006.

Required quantity of seed samples were drawn monthly and observations on germination percentage, speed of germination, field emergence, root length, shoot length, seedling dry weight, vigour index, electrical conductivity of seed leachate, moisture content, seed infection and oil content percentage were taken and the results obtained are discussed in this chapter.

Due to locations

Much emphasis has been given towards importance of storage of seed in such provinces where ambient relative humidity and temperature are within safe upper limits. Seed stored in low relative humidity and temperature generally store for longer period (Agrawal, 1976). Storage of seeds in places where ambient temperature and relative humidity do not exceed 30°C and 70 per cent respectively in most of the months is considered to be most ideal and most economic to store seeds for one planting season (Agrawal, 1976; Bhattacharya and Chatterjee, 1980 and Kulkarni and Vyakarnahal, 1987).

The storage potential of seeds as judged by the seed germination declined with the advancement of storage period irrespective of crops and varieties in all the locations from 95.34 to 46.63 per cent from initial month of storage to eleven month of storage (Table 2). The seeds stored at Raichur higher germination compared to seed stored at Dharwad and Sirsi. The relative differences in germination noticed among storage locations could be attributed to the differential natural ageing phenomenon and differential influence of ambient temperature and relative humidity prevailed and invasion of storage fungi during the storage period (Agrawal, 1976 and Agrawal, 1980).

The gradual reduction in speed of germination was noticed in all the oil seed crops throughout the storage period in all the three locations. The reduction in speed of germination was less in seeds stored at Raichur compared to other two locations. This reduction was observed due to gradual loss of seed viability and vigour with increasing storage period. Similar findings have been reported by Kumar *et al.* (1997) in peas and Verma *et al.* (2003) in Brassica.

Field emergence was also found to decrease with the advancement of storage period and was more in the seeds stored at Raichur compared to other two locations. This may be attributed to slow reduction of viability of seeds stored at Raichur which may be due

to lower ambient temperature and relative humidity prevailed during entire storage period. Similar influence of location on field emergence have also been reported by Kalappa (1997), Prasadrao *et al.* (2001) in sunflower and Narayanaswamy (2003) in groundnut.

Likewise root length, shoot length, seedling dry weight, vigour index, oil content percentage decreased with increase in the storage period in all three locations of storage. However, these parameters were relatively higher in the seeds stored at Raichur as compared to Dharwad and Sirsi. Higher seed quality parameters noticed at Raichur location may be attributed to the congenial ambient storage temperature (<30°C) and relative humidity (<70%) prevailed throughout the storage period. Similar differences in seedling vigour attributes due to storage locations have been reported by Dhanasekaran and Vadivelu (1994) in groundnut, Sharma *et al.* (1998) in soybean, Sharma and Singh (1997) in different oilseed crops and Prasadrao *et al.* (2001) and Kalappa (2002) in sunflower and Narayanaswamy (2003) in groundnut.

The electrical conductivity values are taken as indices of membrane integrity and are inversely related to seed quality. The electrical conductivity of seed leachates will be always higher in aged seeds owing to loss of membrane integrity of cell and cell organelles due to autoxidation of membrane bound phospholipids of cell membranes (Koostra and Harrington, 1969 and Abdul-Baki and Anderson, 1970), due to enzymic degradation (Saxena *et al*., 1998; Francis and Coolbear 1988), due to fungi (Mathur and Sinha, 1978).

The results of the present study indicated that the electrical conductivity was more in the seeds stored at Sirsi throughout the storage period as compared to Raichur and Dharwad. The higher EC values recorded in seeds stored at Sirsi location may be related to higher seed deterioration owing to greater influence of prevailing high relative humidity and temperature in most of the storage months. Similarly, Dhanasekaran and Vadivelu (1994), Narayanaswamy (2003) and Deshpande (2003) in groundnut. Anuja Gupta and Aneja (2004) in Soybean, Kalappa (2002) in sunflower have reported differential EC values owing to location effects on seed quality during storage.

The seeds being hygroscopic, the moisture content of seed fluctuate inconcomitant with the prevailing temperature and relative humidity of the locality. In the present study, the moisture content of seed also found to differ significantly among storage locations showing higher moisture content in different months of storage at Sirsi and Dharwad. But seed stored at Raichur continued to show lower moisture contents during different months of storage owing to low relative humidity and higher temperature in most of the months due to which higher germination was noticed in the present study. Bhattacharya and Chatterjee (1980) in West Bengal and Kallappa (1997) in Karnataka also recorded higher moisture content in seeds stored at places where relative humidity temperature were higher in most of the months than those stored at lower relative humidity and temperature resulting in lower viability of seeds.

Several storage fungi are known to invade seeds during storage and their occurrence is dependent on seed moisture content, prevailing relative humidity and temperature. Generally storage fungi are saprophytic and will be very active at higher seed moisture content (12%), relative humidity (>70%) and temperature (25-30°C) and cause much damage to seeds both in quality and quantity. In the present study it was evident that invasion of fungi was less in the seeds stored at Raichur compared to other two locations (Table 11). Pathological investigations made by Christensen and Kauffmann (1969) and Christensen (1971) in sunflower, Agrawal and Gupta (1989) in soybean also showed higher frequency of storage fungi in stored seeds and was ascribed to favourable atmosphere prevailed for the growth of storage fungi.

With advancement of storage oil content found to decrease in all the locations. Per cent oil content was more in the seeds stored at Raichur compared to other two locations.
The lowest oil percentage was recorded at Sirsi and it may be related to enzymic and non-enzymic autoxidation of lipids which occurs at higher storage temperature, relative humidity and higher seed moisture content. Similar decrease in oil content was noticed by McNeal (1966), Verma and Gupta (1975), in sunflower, Dhanasekaran and Vadivelu (1994),

Narayanaswamy (2003) in groundnut, Arulnandhy and Senanayake (1991) in soybean. Decrease in oil content was positively related with increase in lipase activity on account of fungi infection (Saraswat and Mathur (1985), Saxena *et al.* (1998), Taung and McDonald (1995).

In the present study, it is noticed that all the seed quality parameters of different oilseed crops irrespective of varieties were better when stored at Raichur followed by Dharwad and were poor in the seeds stored at Sirsi. Irrespective of crops and varieties the better seed quality parameters noticed under Raichur location may be attributed to the congenial ambient storage temperature (25-30°C) and less (70%) relative humidity prevailed throughout the storage period except in July, August, September months of storage. The results were in conformity with reports of Kulkarni and Vyakarnahal (1987), Kalappa (1997) who also reported that storage of seeds at Raichur is better than storage at Dharwad or at Sirsi owing to higher humidity and temperature.

Due to crops

Variations in storage potential among kinds of seeds have been well documented in several crops and is related mainly to genetic factor besides differences in physical or chemical composition of seeds (Delouche, 1973 and Diojoide, 1988, Kurdikeri, 1996 and Manomani, 2002).

The results of the present study revealed that storage potential of different oilseed crops as judged by germination percentage was found to differ significantly among oil seed crops in all the months of storage. Germination was maximum (96.74%) in sesamum followed by sunflower (96.67%), soybean (96.58%) and minimum in groundnut (92.39%) in the first month of storage (Table 2 and Fig.1). From second month onwards the germination percentage decreased gradually in all the oilseed crops and at the end of eleven month of storage also sesamum maintained higher germination (78.50%) compared to sunflower (68.49%), soybean (17.37%) and was lower in groundnut (5.09%). The differences noticed in storability as judged by germination values among different oilseed crops may be related to genetic factor and influence of prevailing temperature and relative humidity of storage places. Delouche (1973), Sharma and Singh (1997) and Kurdikeri *et al.*(2000) have also reported relative differences in storage potential of oilseed crops to genetic and environmental factors.

Among oilseed crops, satisfactory germination as per the minimum seed certification standards was maintained upto 10 months in sesamum and sunflower, seven months in soybean and six months in groundnut. Poor storability noticed in soybean and groundnut seeds may be accounted for their structural differences, delicacy of seed coat and peripheral embryo besides higher fungi invasion. Similar differences in storability among oilseed crops have been reported by Kurdikeri *et al.* (2000).

The mean field emergence decreased from initial month (91.23%) to the end of eleven month (34.66%) irrespective of locations, crops and varieties. Among oil seed crops sesamum showed maximum (93.04 to 66.29%) field emergence followed by sunflower (92.98 to 61.36%), soybean (92.76 to 8.84%) and was minimum (86.15 to 2.17%) in groundnut after first and eleven month of storage respectively.

Similarly, speed of germination, seedling vigour index, shoot length and root length were found to decrease from first month of storage to end of eleven month of storage in all the crops irrespective of locations and varieties.

The decline in speed of germination, field emergence, seedling dry weight, vigour index, shoot length and root length noticed among the crops may be due to their genetic differences age induced deterioration, inherent differences in seed structure and composition. It has been postulated by Delouche (1973) and Manomani (2002) in soybean that with increase in storage period accompanying decline in seed vigour is expected and is manifested through decrease in seed and seedling vigour parameters. Further decline in seeds and seedling vigour parameters was also related to decrease in both quantity and

quality of food reserves like sugars, amino acids, oil content, protein etc in different crops (Agrawal, 1980 and Anuja Gupta and Aneja, 2004).

Generally, the electrical conductivity of seed leachate is inversely related to seed quality, thus higher the electrical conductivity lower the seed quality and vice versa. In aged seeds or partially deteriorated seed, the electrical conductivity will be higher, owing to decrease in membrane integrity on account of detrimental changes in biomembranes occurring in stored seeds (Koostra and Harrington, 1969) or due to fungal invasion (Roberts, 1972).

In the present study, the mean EC was found to increase from (0.163 to 1.115 dSm^{-1}) from first month to the end of eleven month of storage irrespective of crops. This also supports the hypothesis of inverse relation of EC with seed quality as evident with decreased germination, speed of germination, field emergence and other seedling vigour parameters. Shanmugavel *et al.* (1995) and Vieira *et al.* (1999) also related decline of seed quality parameters with the amount of electrolytes leakage.

Among oilseed crops, EC was higher in groundnut (0.171 to 1.491 dSm^{-1}) followed by soybean (0.164 to 1.314 dSm^{-1}), sunflower (0.159 to 0.953 dSm^{-1}) and lower (0.156 to 0.702 dSm^{-1}) at first month and after eleventh month of storage respectively. Higher leachates recorded in groundnut followed by soybean and sunflower may be due to the fact that these big seeds contain greater amount of food reserves like storage soluble sugars, phenols, amino acids, oil content and free fatty acids which leach out with increase in storage period due to loss of membrane integrity and due to peroxidation of unsaturated fatty acids in comparison to small seeds like sesamum. The present results are in conformity with the reports of Kalappa (2002) in sunflower, Narayanaswamy (2003) in groundnut, Singh and Dadlani (2003) and Anuja Gupta and Aneja (2004) in soybean and Basra *et al*. (2004) in cotton.

Seeds are hygroscopic in nature and as such loose or gain moisture content inconcomitant with the changes in prevailing atmospheric relative humidity and temperature. In the present study also, moisture fluctuation has been noticed in all the oilseed crops during storage from first month to end of eleven month of storage. The mean moisture content was found to vary from 10.19 to 9.85 per cent, irrespective of crops from first month to eleven month of storage respectively. Similar variation in seed moisture during storage in relation to prevailing temperature and relative humidity were reported by Narayanaswamy (1993) in groundnut and Sharma and Singh (1997) in different crop species.

In the present study, irrespective of locations, crops and varieties the mean per cent seed infection was found to increase from 9.91 to 24.58 per cent from first month of storage to eleven month of storage. Among oilseed crops, highest infection of fungi was noticed in groundnut seeds (20.25 to 34.61%) followed by soybean (15.55 to 30.05%), sunflower (3.83 to 19.33%) and lowest was recorded in sesamum (0.00 to 14.33%) after first month of storage to eleven month of storage. It may be due to greater reserved food material readily available in larger seeds (Prasad *et al*., 1988, Saxena and Karan, 1991, Basavegowda *et al*., 2003) due to higher moisture content and relative humidity that favoured growth of pathogens (Narayanaswamy, 2003 and Krishnappa *et al.,* 2003).

In the present study, irrespective of locations and varieties the mean oil content was found to decrease from (40.17%) in first month to (36.47%) eleven month of storage. Among oil seed crops, oil content percentage was higher in sesamum (51.19%), followed by groundnut (47.32%), sunflower (41.51%) and lower in soybean (20.67%) after first month of storage but decreased correspondingly, to 46.61 per cent in sesamum; 46.44 per cent in groundnut; 37.96 per cent in sunflower and 14.86 per cent in soybean at the end of eleven month of storage.

Similar decrease in oil content with increase in storage period have been reported by Verma *et al.* (2003) in mustard, Narayanaswamy (2003) in groundnut, Anuja Gupta and Aneja (2004) in soybean. The decrease in oil content has been related to peroxidation of lipid by peroxidase enzyme (Verma *et al*., 2003 in mustard, Anuja Gupta and Aneja, 2004 in

soybean), non -enzymic lipid autoxidation (Koostra and Harrington, 1969) and also to fungi invasion (Christensen and Kauffmann, 1969, Verma and Gupta, 1975, Mathur and Sinha, 1978, Williams and McDonald, 1983, Saraswat and Mathur, 1985, Vaidya and Dharemvir (1989), Narayanaswamy *et al*., 1993 and Verma *et al.* 2003).

Due to varieties

The storage potential of seeds and seed quality during storage varies among genera, species and varieties as it is mainly under genetic control, but modified by the environment (Agrawal, 1974; Desai, 1986 and Bhatia *et al.,* 2002). Apart from genetic factor, the storability of different varieties is also regulated by initial seed quality, physical and chemical composition of seed (Doijoide, 1988), as different cultivars possess different physical structure and chemical composition which determine the longevity of seed in storage.

The results of the present study also revealed that irrespective of locations and crops germination percentage decreased in V_1 from 95.38 to 42.73 per cent and in V_2 from 95.31 to 40.54 per cent from initial month to eleven month of storage respectively. The decrease in germination during storage between varieties was mainly due to age induced phenomenon which is inevitable inexorable and irreversible and also this might be due to varietal variations. Similar observations have been made by Diwakar *et al.* (2002) in sesamum, Sharma and Singh (1997) in different oilseed crops, Balamurugan *et al.* (1989), Kalappa (1997), Bhaskar (1988) in sunflower, Kurdikeri *et al.* (2003) in groundnut and Venkatareddy *et al.* (1992) and Anuja Gupta and Aneja (2004) in soybean.

With the advancement of storage period root length, shoot length, seedling length, vigour index, speed of germination, field emergence and seedling dry weight were found to decrease in both the varieties of different oilseed crops. The decline in these parameters in all the varieties may be attributed to the age induced decline in germination during storage. The results are in conformity with those of Tewari and Gupta (1981) in sunflower, Arulnandhy and Senanayake (1991), Kalavathi *et al.* (1994), Kurdikeri *et al.* (1996), Anuja Gupta and Aneja (2004) in soybean, Krishnappa *et al.* (2001), Kurdikeri *et al.* (2003) in groundnut and Diwakar *et al.* (2002) in sesamum.

In the present study the EC was found to increase from 0.162 to 1.094 dSm^{-1} in V_1 from first month to the end of eleven month of storage while in V_2 it increased from 0.164 to 1.136 dSm^{-1}.

Varietal differences in seed moisture content was noticed in the present study throughout the storage period except in second, third and eleven month of storage which may be due to differences in physico-chemical properties of seeds.

The variations noticed in both EC and moisture content in the varieties irrespective of crops and locations may be related to varietal differences in anatomical structure, permeability of membrane and differences in seed coat composition. Similar variation in moisture content and EC values were noticed by Vyas *et al.* (1990), Anuja Gupta and Aneja (2004) in soybean cultivars.

In present study, the seed infection was found to increase from 9.36 to 24.04 per cent from first month to end of eleven month of storage in V_1 and from 10.46 to 25.12 per cent in V_2. The differences noticed in fungi invasion might be due to differential responses of genotypes to different field and storage environment (Pierre and Malaurie, 1972, Agrawal and Singh, 1974).

In general per cent storage fungi infection found to increase with the increase in storage period in all the varieties of different oilseed crops. The differences in fungi invasion was noticed in different varieties of oilseed crops, perhaps it may be due to favourable relative humidity, temperature and moisture content of seeds that favoured fungal invasion or it may be also due to relative differences in food reserves availability for both the fungi. Similarly Tungeswara (1996) in sunflower, Vamadevappa (1998) in soybean, and Siddiqui (1998),

Narayanaswamy (2003), Krishnappa *et al.* (2003) and Basavegowda *et al.* (2003) in groundnut also noticed different levels of fungi invasion in stored seeds.

Irrespective of crops and locations the oil content decreased from 40.32 to 36.38 per cent in V_1 and from 40.03 to 36.26 per cent in V_2 in first to eleventh month of storage. Substantial decrease in oil content between varieties as noticed in the present investigation may be related to age induced depletion phenomenon, improper storage environment or may due to higher activity of storage fungi. Similar reports were made by Verma *et al.* (2003) in mustard, Anuja Gupta and Aneja (2004) in soybean. It has postulated that high temperature and high seed moisture content leads to enzymic lipid peroxidation and oil content decreases (Basra *et al.* 2004, McNeal, 1966 and Verma and Gupta, 1975). Narayanaswamy (2003) opined decrease in oil content was also due to storage fungi which increases free fatty acid leading to rancidity of oil and decreases oil content. The above findings are in accordance with the studies of Saraswat and Matur (1985), Saxena and Mohana (1998), Nargund (2003) and Krishnappa *et al.* (2003) in different oilseed crops.

Interactions

Interaction between locations and crops (L x C)

The interaction effects between locations and oil seed crops (Table 2 and Fig. 2))revealed that seeds of sesamum and sunflower stored at Raichur recorded significantly higher germination percentage, field emergence, speed of germination, oil content with decreased electrical conductivity throughout storage. In general the seeds of all the oilseed crops stored at Raichur showed significantly higher speed of germination, field emergence, shoot length, root length, seedling dry weight, vigour index, lower fungi invasion and EC values throughout the storage period compared to seeds stored at Dharwad and Sirsi. This may be attributed slower deteriorative changes owing to congenial ambient storage temperature (<30°C) and relative humidity (<70%) prevailed throughout the storage period as reported by Kalappa (1997), Prasadrao *et al.* (2001), Sharma and Singh (1997), Chitra Devi and Dadlani (2003).

Seeds of sesamum stored at Raichur maintained satisfactory germination upto eleven months, at Dharwad upto ten months and at Sirsi upto nine months of storage. The seeds of sunflower stored at Raichur and Dharwad maintained satisfactory germination upto ten months and at Sirsi upto nine months. Whereas, seeds of soybean stored at Raichur and Dharwad maintained satisfactory germination upto seven months and at Sirsi upto six months. The seeds of groundnut maintained satisfactory germination upto seven months at Raichur, for six months at Dharwad and upto four months at Sirsi.

The results of present study clearly confirm the present validity period of nine months prescribed for certified seeds of sesamum and sunflower may be retained as these two oilseed crops found to maintain satisfactory germination as per the minimum seed certification standards more than nine months when stored in all the three locations under ambient conditions while, for soybean and groundnut seeds the present prescribed validity period needs to be revised and fixed only upto six months since these two crops could store only upto six months in all the three locations.

Similar suggestions for revision of present norms of minimum seed certification standards based on actual storage potential have been made by several researchers. In groundnut Chowdhury *et al.* (2003), Narayanaswamy (2003) and Kurdikeri *et al.* (2003) and in soybean Singh and Maurya (1972), Srivastava and Sareen (1972, 1974), Boakye-Boateng and Hume (1975), Arulnandhy and Senanayake (1991), Sharma *et al* (1998), Anuja Gupta and Aneja (2004), Kurdikeri *et al.* (2000), Ponnam Singh (1998) and Manomani (2002) have similarly reported that these two oilseed crops were poor in storability and lost viability within nine months.

In case of sunflower, Balamurugan *et al.* (1989) and Kalappa (2002) and in sesamum Madanagopal and Dharmalingam (1993) noticed higher germination for even after nine months and confirm to the minimum seed certification standards and thus do not need any revision of validity period.

Further, revision of validity period for oilseed crops may be made specific to each locations as location effects are quite evident in the present study and corroborate with the results of Prasadrao *et al.* (2001) and Kalappa (2002) in sunflower, Dhanasekaran and Vadivelu (1994), Chowdhury *et al.* (2003), Narayanaswamy (2003) in groundnut, Sharma *et al.* (1998) in soybean who also clearly indicated the need for location specific revision of validity period.

Interaction between location and varieties (L x V)

The interaction effects between locations and varieties showed remarkable differences on various seed quality parameters during storage. The variety DS-1 of sesamum, KBSH-1 of sunflower, JS-9305 of soybean and GPBD-4 of groundnut stored at Raichur recorded better seed quality parameters throughout the storage period. These varieties at Raichur showed significantly higher germination percentage, speed of germination, field emergence, shoot length, root length, vigour index, seedling dry weight, oil content with decreased electrical conductivity and fungi infection compared to the other variety of different oilseed crops stored at Dharwad and Sirsi. This difference in the germination potential and seedling vigour parameters of the same variety at different locations may be due to genotypic differences, seed size difference, physical and chemical properties of seed as reported by Kalavathi (1994) in soybean. The varietal differences in storage potential at different storage locations have been related also to initial seed quality, seed moisture content, prevailing relative humidity, temperature, fungi invasion besides genetic factors. Similar reports were also made by Kalappa (1997) in sunflower, Verma *et al.* (2003) in Brassica, Chowdhury *et al.* (2003), Narayanaswamy (2003) in groundnut and Sharma *et al.* (1998) in soybean varieties stored in different locations.

Due to crops and varieties (C x V)

The interaction between crops and varieties, revealed that variety DS-1 and E-8 of sesamum followed by variety KBSH-1 of sunflower, maintained significantly higher germination percentage, shoot length, root length, speed of germination, field emergence, vigour index, seedling dry weight, oil content percentage with decreased electrical conductivity and fungi infection throughout the storage period compared to both the varieties of soybean and groundnut. The variations noticed on seed quality during storage among oil seed crops and varieties may be attributed to genetic and varietal characters (Delouche, 1973, Agrawal, 1980, Prasadrao *et al*., 2001, Kurdikeri *et al*., 1996 and 2003).
Variety DS-1 and E-8 of sesamum maintained satisfactory germination upto ten months, variety KBSH-1 and RFSH-1 of sunflower maintained upto ten and nine months respectively, whereas varieties of soybean JS-9305 and JS-335 maintained upto seven months and varieties GPBD-4 and TAG-24 of groundnut maintained upto six and five months respectively. Similar differences in storage potential between varieties have been reported in soybean by Venkatareddy *et al.* (1992), Kalavati *et al.* (1994), Gurmit Singh and Gill (1996), Kharb *et al.* (1998), Kurdikeri *et al.* (1996), Vamadevappa (1998), Anuja Gupta and Aneja (2004) in groundnut by Basavaraju (1996), Golasangi (1997), Krishnappa *et al.* (2001) and Kurdikeri *et al.* (2003), in sunflower by Bhaskar (1988) and Tungeswara (1996) and in sesamum by Diwakar *et al.* (2002).

Based on the results generated it may be pleaded that the present validity period of nine months fixed for soybean and groundnut needs to be fixed upto 6 months only whereas, for sesamum and sunflower the present nine months of validity may be continued.

Due to locations, crops and varieties (L x C x V)

The three way interactions of locations, crops and varieties (Table 2 and Fig. 3) revealed that variety DS-1 and E-8 of sesamum followed by variety KBSH-1 of sunflower stored at Raichur recorded significantly higher germination percentage, speed of germination, field emergence, shoot length, root length, seedling dry weight and vigour index, and oil content percentage (Table 12 and Fig. 4) with significantly lower electrical conductivity and fungi infection through out the storage period compared to other interaction combinations of

varieties, crops and locations. The differences in storability and seedling vigour parameters noticed may be due to genetic, species and varietal characters and also due to storage places and their prevailing temperature and relative humidity. The present study results are in conformity with Kurdikeri *et al.* (2000), Agrawal (1976), Agrawal (1980) and Prasadrao *et al.* (2001) in different varieties of oilseed crops stored at different locations.

Satisfactory germination as per seed standards was maintained upto eleven months in varieties DS-1 and E-8 of sesamum stored at Raichur, upto ten months at Dharwad and nine month at Sirsi. The sunflower varieties KBSH-1 and RFSH-1 stored at Raichur maintained upto eleven and ten months respectively, at Dharwad upto ten months, at Sirsi upto nine months. Whereas, soybean varieties JS-9305 and JS-335 stored at Raichur maintained satisfactory germination upto eight and seven months respectively, at Dharwad upto seven and six months respectively and upto six and five months respectively at Sirsi. The groundnut varieties GPBD-4 and TAG-24 maintained satisfactory germination at Raichur upto seven months, at Dharwad upto seven and six months respectively, at Sirsi only for five and four months respectively.

In the present study, sesamum and sunflower maintained satisfactory germination as per the minimum seed certification standards upto ten months of storage. While, groundnut and soybean retained viability only for six and seven months of storage respectively.
In our country the validity period for all the certified seeds of oilseed crops has been fixed initially upto nine months. But the results of the present study clearly indicated that groundnut and soybean seeds have not retained their germination capacity upto nine months. Hence for these two crops, the present seed standards need to be revised and validity period may be fixed only upto six months and for sunflower and sesamum the present validity period of 9 months may be retained. In a similar way Kurdikeri *et al*. (2000) for different crops, Basavegowda and Kenchanagouder (2000), Chowdhury *et al.* (2003), Narayanaswamy (2003) for groundnut, Kalappa (2002) for sunflower, Sharma *et al.* (1998) for soybean have opined to revise the minimum seed certification standard based on the actual storage potential of seeds.

Seeds revision would definitely help the farmers to sow the quality seeds which safe guard the farmers from the deserters of sowing low quality seeds.

Practical application of the results

Based on the results generated in the present study following practical applications are pointed out.

Storage of oilseed crops under ambient conditions at Raichur (Zone-2) and Dharwad (zone-8) is found to be better than at Sirsi (Zone-9) location.

The present validity period of nine months is appropriate for sesamum and sunflower but for soybean and groundnut, it may be fixed only for six months.

Future line of work

1. The present storage study may also be extended to different varieties of other oilseed crops stored in different locations of Karnataka and validity period may be fixed based on actual storage potential.

2. The present study may also be conducted on other crop seeds like cereals and pulses.

3. There is a need to ascertain storability of seeds stored in different containers for evaluation of validity period norms.

4. The storage studies may be continued involving seed treatment with botanicals and chemicals for evaluation of validity period norms.

VI. SUMMARY

The results generated from storage studies entitled “Evaluation of validity period of different oilseed crops stored at different locations” conducted during 2005-06 are summarized below.

- The seeds stored at Raichur recorded higher seed quality parameters throughout storage compared to Dharwad and Sirsi. Significantly lower seed quality parameters were noticed in seeds stored at Sirsi during storage.
- Among oilseed crops, sesamum and sunflower seeds recorded higher seed quality parameters throughout the storage period compared to soybean and groundnut. Sesamum and sunflower maintained satisfactory germination (80.50% and 71.05%) respectively upto ten months of storage, while soybean and groundnut (71.61%) maintained only for seven and six month of storage respectively with better seedling vigour and with low electrical conductivity and fungal activity.
- Varieties found to differ significantly in storage potential. The seed germination (74.69%), speed of germination, field emergence, shoot length, root length, seedling dry weight, vigour index and oil content were maximum with low EC and fungal activity. DS-1 of sesamum, KBSH-1 of sunflower, JS-9305 of soybean and GPBD-4 groundnut were better in storability compared to E-8 of sesamum, RFSH-1 of sunflower JS-335 of soybean and TAG-24 of groundnut upto end of storage period.
- The interaction effects between locations and crops indicated that seeds of sesamum stored at Raichur recorded significantly higher seed germination, speed of germination, field emergence, shoot length, root length, vigour index, seedling dry weight, oil content with decrease electrical conductivity and seed infection compared to other oilseed crops stored at different locations.

Seeds of sesamum stored at Raichur maintained satisfactory germination upto eleven month of storage, whereas at Dharwad upto ten months and nine months at Sirsi.

Seeds of sunflower stored at Raichur and Dharwad maintained satisfactory germination upto ten months and upto nine months at Sirsi.

Whereas, seeds of soybean stored at Raichur and Dharwad maintained satisfactory germination upto seven month and six months at Sirsi. Seeds of groundnut maintained satisfactory germination upto seven months at Raichur, for six months at Dharwad and upto four months at Sirsi.

- Among interactions of locatsand varieties, variety DS-1 of sesamum, KBSH-1 of sunflower, JS-9305 of soybean and GPBD-4 of groundnut stored at Raichur recorded significantly higher values for all seed quality parameters than seeds stored at Dharwad and Sirsi compared to variety E-8 of sesamum, RFSH-1 of sunflower, JS-335 of soybean and TAG-24 of groundnut stored at Raichur, Dharwad and Sirsi.
- Among interaction between crops and varieties DS-1 and E-8 of sesamum followed by variety KBSH-1 of sunflower, showed significantly higher seed quality parameters compared to both the varieties of soybean and groundnut, throughout the storage period.

Variety DS-1 and E-8 of sesamum maintained satisfactory germination upto ten months, variety KBSH-1 and RFSH-1 of sunflower maintained upto ten and nine months respectively whereas, varieties of soybean JS-9305 and JS-335 maintained upto seven months and varieties GPBD-4 and TAG-24 of groundnut maintained upto six and five months respectively.

The three way interactions of locations, crops and varieties showed that DS-1 and E-8 of sesamum and KBSH-1 variety of sunflower stored at Raichur recorded significantly higher germination percentage, speed of germination, field emergence, shoot length, root length, seedling dry weight, vigour index, oil content percentage with significantly lower electrical conductivity and fungi infection throughout the storage period compared to other interaction combination of crops, location and varieties

Satisfactory germination as per seed standards was maintained upto eleven months in varieties DS-1 and E-8 of sesamum stored at Raichur, upto ten months at Dharwad and nine months at Sirsi. The sunflower varieties KBSH-1 and RFSH-1 stored at Raichur maintained upto eleven and ten months respectively at Dharwad upto ten months, at Sirsi upto nine months. Whereas, soybean varieties JS-9305 and JS-335 stored at Raichur maintained satisfactory germination upto eight and seven months, at Dharwad upto seven and six months respectively and upto six and five months respectively at Sirsi. The groundnut varieties GPBD-4 and TAG-24 maintained satisfactory germination at Raichur upto seven months, at Dharwad upto seven and six months respectively, and at Sirsi only for five and four months respectively.

VII. REFERENCES

ABDUL-BAKI, A.A., 1980, Biochemical aspects of seed vigour. *Horticultural Science*, 15 : 765-770.

ABDUL-BAKI, A.A. AND ANDERSON, J.D., 1970, Viability and leaching of sugar from germinating barley. *Crop Science*, 13 : 630-633.

ABDUL-BAKI, A.A. AND ANDERSON, J.D., 1972, Physiological and biochemical deterioration of seeds Kazolowski (Ed.) In : *Seed Biology* II. Academic Press, New York, London.

ABDUL-BAKI, A.A. AND ANDERSON, J.D., 1973, Vigour determination in soybean by multiple criteria. *Crop Science*, 13 : 630-633.

AGRAWAL, P.K., 1974, Storage studies on maize seeds. *Bulletin of Grain* Technology, 12 : 109-112.

AGRAWAL, P.K., 1976, Identification of suitable seed storage places in India on the basis of temperature and relative humidity conditions. *Seed Research*, 4 (1) : 6-11.

AGRAWAL, P.K., 1980, Relative storability of seeds of ten species under ambient conditions. *Seed Research*, 8 : 94-99.

AGRAWAL, S.C. AND GUPTA, R.K., 1989, Fungal pathogens detected on soybean seeds grown in different localities. *Seed Research*, 17 (2) : 208-210.

AGRAWAL, V.K. AND SINGH, O.U., 1974, Fungi associated with sunflower seeds. *Indian Phytopathology*, 27 : 240-246.

ALMEIDA-, F-DE, A.C. AND MORAIS, J.D., 1997, Effect of conditioning, type of packing and storage atmosphere on physiological quality of groundnut seeds. *Revista de Oleaginosase-Fibrasas*, 22 (2) : 27-33.

ANONYMOUS, 1990, Annual Report, Seed Technology Research project, Andra Pradesh Agricultural University, Rajendranagar, Hyderabad, pp. 16-18.

ANONYMOUS, 1996, International rules for seed testing. *Seed Science and Technology*, 24 : 1-335.

ANONYMOUS, 2003, *Indian Agriculture*, pp. 365-367.

ANUJA GUPTA AND ANEJA, K.R., 2004, Seed deterioration in soybean varieties during storage : Physiological Attributes. *Seed Research*, 32 (1) : 26-32.

ARULNANDHY, V. AND SENANAYAKE, D.A., 1991, Changes in viability, vigour and chemical composition of soybean seeds stored under humid tropical conditions. *Legume Research*, 14 (3) : 135-144.

ATAGA, A.E. AND AKUESHI, C.O., 1996, Fungi associated with sunflower seed in Nigeria. *Seed Research*, 24 (1) : 64-65.

BALAMURUGAN, P., UDAYASOORIAN, C. AND GOPALAN, A., 1989, Studies on the influence of drying methods on storage of sunflower seeds. *Seeds and Farms*, 15 : 21-23.

BASAVEGOWDA, PATIL, M.B., NEGALUR, S.B. AND NARGUND, V.B., 2003, Divesity in seed borne fungal pathogens in groundnut (*Arachis hypogaea* L.) of Karnataka. In : *Proceedings of National Workshop on Groundnut Seed Technology*, Feb. 6-7, pp. 179-180.

BASRA, S.M.A., ASHRAI, M., NIQBAL, KWALIQ AND AHMAD, R., 2004, Physiological and biochemical aspects of pre-sowing heat stress on cotton seed. *Seed Science and Technology*, 32 : 765-774.

BASAVARAJU, G.V., 1996, Contribution of production factors on seed yield and quality of groundnut. In : *Proceedings of National Workshop on Groundnut Seed Technology*, Ed. Basavegowda, *et al.* held at University of Agricultural Sciences Campus, Raichur, during February 6-7, 2003, pp. 63-66.

BASAVARAJU, P., CHALUVARAJU, G., DEEPAK, S.A., AMRUTHESH, K.N. AND SHEKAR SHETTY, H., 2004, Location and transmission of downy mildew Pathogen *Plamospara halsteo* (i) in sunflower seeds. *Seed Research*, 32 (1) : 108-110.

BASAVEGOWDA AND KENCHANAGOUDER, P.V., 2000, Effect of genotype and storage period on seed quality in summer groundnut. *Seed Tech News*, 30 (2) : 22-23.

BASAVEGOWDA AND RAVIKUMAR, G.H., 2001, Influence of pod drying techniques and storage containers on seed quality in rabi/summer groundnut. *Proceedings of National Seminar on Seed Science and Technology* in the New Millenium vistas and vision. August 6-8, 2001, Mysore, India, p. 183.

BASKIN, C. AND DELOUCHE, J.C. AND CABRERA, E.R., 1987, The influence of packaging materials, seed moisture content and storage environment on seed storability and performance of soybean. *Newsletter Association of Official Seed Analyst*, 61 (2) : 15.

BASU, R.N., 1993, Seed invigouration for extended storability. *Seed Research*, pp. 217-230.

BERJAK, P. AND VILLIERS, TA., 1972, Ageing in plant embryos II. Age induced damage and its repair during early germination. *Orw Phytologist*, 71 : 135-144.

BERNAL-LUGU, I. AND LEOPOLD, A.C., 1992, Changes in soluble carbohydrates during seed storage. *Plant Physiology*, 30 : 195-236.

BHASKAR, V., 1988, Study on validation period and time (S) of revalidation in sunflower seeds (*Helianthus annus* (L.) Merr.). *M.Sc. (Agri.) Thesis*, University of Agricultural Sciences, Bangalore,

BHATIA, V.S., TIWARI, S.P. AND SUSHIL PANDEY, 2002, Soybean seed quality scenario in India – A Review. *Seed Research*, 30 (2) : 171-185.

BHATTACHARYA, P. AND SAMUI, R.C. AND SEN, S., 1983, Studies on the germination of stored sunflower seed. *Seed Research*, 11: 162-171.

BHATTACHARYA, N. AND CHATTERJEE, B.N., 1980, A note on the identification of suitable seed storage sites in West Bengal. *Seed Research*, 8 (1) : 85-90.

BINDU, M.K., 1997, Evaluation of groundnut genotypes for storability of vigour. *Seed Tech News*, 27 (3) : 7.

BOAKYE-BOATENG, K.B. AND HUME, D.J., 1975, Effect of storage conditions of germination of soybean (*Glycine max* L.). *Seed Gnyana Agricultural Sciences*, 8 : 109-114.

BRADNOCK, W.T. AND MATHEWS, S., 1970, Assessing field emergence potential of wrinkle seeded peas. *Horticulture Research*, 10 : 50-58.

CHITRA DEVI, KANT, K. AND DADLANI, M., 2003, Effect of size grading and ageing on sinapine leakage, electrical conductivity and germination percentage in the seed of mustard (*Brassica suncea* L.). *Seed Science and Technology*, 31 : 505-509.

CHAKRAVARTHI, B.P., SHEKAWAT, P.S. AND ANILKUMAR, T.B., 1973, Control of damping off and root rot of sesame caused by *Thielavia terricola* var. minor by soil drenching with fungicides and antiobiotics and their efficacy in treatment of seeds. *Indian Phytopathology*, 26 : 646-649.

CHING, T.M. AND SCHOOLCRAFT, I.C., 1968, Physiological and chemical differences in aged seeds. *Crop Science*, 8 : 407-409.

CHOHAN, J.S. AND JASMIT KAUR, 1975, Seed borne mycoflora of sunflower and control of seed borne pathogens. *Indian Journal of Mycology and Plant Pathology*, 6 : 210-211.

CHOWDHURY, MATHUR D.S. LAL AND JAYPRAKASH, 2003, Seed research on groundnut under NSP crops. *Proceedings of National Workshop on Groundnut Seed Technology*, Feb 6-7, pp. 6-19.

CHRISTENSEN, C.M. AND KAUFFMANN, M.H., 1969, Grain storage. University of Minnesota, Press Minneapolis.

CHRISTENSEN, C.M., 1969, Factors affecting invasion of sunflower seeds by storage fungi. *Phytopathology*, 59 (11) : 1699-1702.

CHRISTENSEN, C.M., 1971, Evaluating conditions and storability of sunflower seeds. *Journal of Stored Prod. Research*, 7 : 163-169.

COPELAND, L.O., 1988, Seed germination. In : *Principles of Seed Science and Technology*, Surjeet Publications, Delhi, pp. 55-212.

CROWE, J.H., HOESKSTRA, T.A. AND CROWE, L.M., 1992, An hydrobiosis. *Annual Review of Physiology*, 54 : 579-599.

CURTIS, H.J., 1966, A composite theory of ageing. *Gerntologist*, 6 : 143.

DANGE, S.R.S. AND PATIL, V.J., 1984, Effect of relative humidity, storage period on fungal invasion and viability of groundnut seeds. *Bulletin of Grain Technology*, 22 (3) : 225-231.

DANGE, S.R.S. PATIL, V.J., LADANI, M.G. AND MANVAR, D.K., 1985, Effect of relative humidity, storage period on fungal invasion and germination of groundnut seeds. *Seeds and Farms*, 11 : 39-41.

DELOUCHE, J.C., 1973, Precepts of seed storage (Revised). *South Canada Proceedings*, Mississippi state University, pp. 97-122.

DELOUCHE, J.C., MATTHES, R.K., DOUGHERTY, G.M. AND BOYD, A.H., 1973, Storage of seed in subtropical and tropical regions. *Seed Science and Technology*, 1 : 663-692.

DESAI, D.B., 1986, Problems of seed industry in relation to seed legislation. *Seed Tech News*, 16 (3-4) : 15.

DESHPANDE, V.K. 1988, Effect of dates of harvesting on seed yield, quality and storability in maize (*Zea mays* L.). *M.Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad, Karnataka, India.

DESHPANDE, V.K., SARWAD, R.K. AND SHEKARAGOUDA, M., 2003, Accelerated ageing test – A tool to predict relative storability in groundnut. *Proceedings of National Workshop on Groundnut Seed Technology*, Feb. 6-7, pp. 171-176.

DESWAL, D.P. AND SHEORAN, I.S., 1993, A simple method of seed leakage measurement applicable to single seed of any size. *Seed Science and Technology*, 21 : 179-185.

DEY, G. AND MUKHERJEE, R.K., 1988, Invigouration of dry seeds with physiologically active chemicals inorganic solvents. *Seed Science and Technology*, 16 : 145-153.

DHANASEKARAN, E. AND VADIVELU, K.K., 1994, Effect of agro-ecological conditions of production on storability of groundnut cv. TMV-2 seed. *Seed Tech News*, 24 (4): 11-12.

DIGHE, R.S., ZAADE, V.R., ZODE, N.G. AND ASALMOL, M.N., 1995, Study on seed invigouration with chemicals in sunflower. *Annals of Plant Physiology*, 9 : 55-58.

DIWAKAR, S.K., MADHU VAJPEYI AND SINGH, P.K., 2002, Quality studies of some sesame (*Sesamum indicum* L.) seeds, oil, protein and fatty acids. *Journal of Oilseed Research*, 19 (1) : 71-72.

DOIJOIDE, S.N., 1988, Comparison of storage containers for storage of French bean seeds under ambient conditions. *Seed Research*, 16 : 245-247.

DOURADO, A.M. AND ROBERTS, E.H., 1984, Chromosome aberration induced during storage in barley and pea seeds. *Annals of Botany*, 54 : 769-749.

DWIVEDI, S.N., 1990, Changes in the concentration of total phenolic compounds in gram seeds as influenced by fungal invasion during storage. *Indian Phytopathology*, 43 : 96-98.

ELLIS, R.H. AND ROBERTS, E.H., 1981, The quantification of ageing and survival in orthodox seeds. *Seed Science and Technology*, 9 : 373-409.

FARAG, R.S., 1990, Effects of fungal infection and agrochemical on the chemical composition of sesame and soybean seeds and aflatoxin production (a review). *Bulletin of Faculty of Agriculture*, University of Cairo, 41 (1) : 43-61.

FRANCIS, A. AND COOLBEAR, P., 1988, Changes in the fatty acid content of the polar lipid fraction of tomato seeds induced by ageing and/or subsequent low temperature pre-sowing treatment. *Seed Science and Technology*, 16 (7) : 87-95.

GAO-PING PING, QIAO-YANXIANG, LI-YING , P.P., QIAO, Y.X. AND LI, Y., 1996, Effects of storage temperature on soybean seed vigour and physiological relations. *Acta Agriculture*, *Boreali sinica*, 11 (4) : 114-118.

GAVRIELIT-GELMOND, H., 1970, Moisture content and storage of peanut seed. *Proceedings of International Seed Test. Ass*, 36 (1) : 159-171.

GHOSH, B., ADHIKARI, J. AND BANERJEE, N.C., 1981, Changes in some metabolites in rice seeds during ageing. *Seed Science and Technology*, 9 : 469-473.

GOLASANGI, 1997, Effect of drying methods on seed viability and storability in groundnut. *M.Sc. (Agri.) Thesis*, University of Agricultural Sciences, Bangalore.

GURMIT SINGH AND HARI SINGH, 1992, Maintenance of germinability of soybean (*Glycine max* L.) seeds. *Seed Research*, 20 : 49-50.

GURMIT SINGH AND GILL, S.S., 1996, Evaluation of soybean genotypes for seed storability. *Seed Research*, 22 : 137-140.

HARRINGTON, J.F., 1960, Thumb rule for dry seed. *Crops and Seeds*, 13 : 16-17.

HARRISON, J.G. AND PERRY, D.A., 1976, Studies on the mechanism of barley seed deterioration. *Annals of Applied Biology*, 84 : 57-62.

JAMARIA, SHARMA, K.B. AND GUPTA, R.B.L., 1974, Fungi intercepted from sunflower seeds and their control. *Indian Journal of Mycology and Plant Pathology*, 5 : 212-213.

JAWARE GOWDA, S.G. AND BHOLE, N.G., 1989, Prediction of relative germination of seeds stored at different storage system. *Mysore Journal of Agricultural Sciences*, 23 : 168-171.

JUSTICE, O.L. AND BASS, L.N., 1978, *Principles and Practices of Seed Storage*. USDA Agricultural Handbook, No. 506, Washington, pp. 53-60.

KALAPPA, P.K., 2002, Prediction of storage potential of seed lots of sunflower BSH-1. *Seed Tech News*, 32 (1) : 146.

KALAPPA, V.P., 1997, Production of storage potential of seed lots and performance evaluation of different vigour levels in sunflower (*Helianthus annus* L.). *Ph.D. Thesis*, University of Agricultural Sciences, Bangalore.

KALAVATHI, D., RAMAMOORTHY, K. AND SUNDARESWARAN, S., 1994, Relative viability and vigour of different genotypes of soybean (*Glycine max* (L.) Merrill) during storage. *Madras Agricultural Journal*, 81 (11) : 612-615.

KATHMALE, D.R., NAJAN, B.R. AND UBALE, S.S., 2003, Seed viability studies in groundnut. *Proceedings of National Workshop on Groundnut Seed Technology*, Feb. 6-7, pp. 177-178.

KESHAVULU, K. AND KRISHNASAMY, V., 2005, Effect of seed colouring on seed quality and bruchid damage in soybean. *Seed Research*, 33 (2) : 208-210.

KETRING, D.L., 1971, Physiology of oilseeds III. Response of initially high and low germinating Spanish – type peanut seeds to three storage environments. *Agronomy Journal*, 63 : 435-438.

KETRING, D.L., 1973, Ethylene production, germination and vigour of starr variety Spanish type peanut seeds stored at high and low humidities. *Journal of American Peanut Research and Education Ass. Inc.*, 5 (1) : 114-122.

KHARB, R.P.S., DESWAL, D.P. AND DAHIYA, B.S., 1998, Evaluation of soybean and pearlmillet genotypes for seed storability. *Seed Tech News*, 28 (1-4) : 85.

KOOSTRA, P.T. AND HARRINGTON, J.F., 1969, Biochemical effects of age on membrane lipids in *Cucumis sativus* L. seed. In : *Proceedings of International Seed Testing Association*, 34 : 329.

KRISHNAMURTHY, Y.L. AND RAVEESHA, 1996, Histopathology of soybean seed infected with *Aspergillus flavus. Seed Research*, 24 (2) : 129-134.

KRISHNAPPA, N., NARAYANASWAMY, S., BALAKRISHNA, P. AND LOKESH, K., 2003, Influence of storage mycoflora on seed quality of groundnut (*Arachis hypogaea* L.) varieties stored in different packing materials. *Proceedings of National Workshop on Groundnut seed Technology*, Feb. 6-7, pp. 6-19.

KRISHNAPPA, N., NARAYANASWAMY, S., SREENAVASA, R. AND KUMAR, C., 2001, Seed quality as influenced by natural storage and accelerated ageing in groundnut cultivars. *Mysore Journal of Agricultural Sciences*, 35 : 37-43.

KRISHNAVENI, K. AND RAMASAMY, K.R., 1985, Bio-chemical studies in COH-1 maize seed during storage. *Madras Agricultural Journal*, 72 : 500-504.

KRISTOV, K. AND KRISTOVA, P., 1978, Some biological and mutagenic changes in maize seeds during ageing. *Resteniev dnl Nauki*, 15 (8) : 13-23.

KULKARNI, G.N. AND VYAKARNAHAL, B.S., 1987, Identification of suitable seed storage places in Karnataka. *Seed Research*, 15 (1) : 30-33.

KUMAR, S., SINGAL, N.C. AND PRAKASH, S., 1997, Intervarietal variability for seed congevity in pea (*Pisum sativum*). *Indian Journal of Genetics and Plant Breeding*, 57 : 204-209.

KUMAR, K. AND SINGH, J., 1983, Effect of fungicidal seed treatment, duration and types of container on viability of sesame during storage. *Indian Journal of Mycology and Plant Pathology*.

KURDIKERI, M.B., BASAVARAJ, G.T., DANAPUR, H.N., HIREMATH, N.V. AND ASWATHANRAYAN, S.C., 1996, Storability of soybean (*Glycine max* (L.) Merr.) seed under ambient conditions. *Karnataka Journal of Agricultural Sciences*, 9 (3) : 552-554.

KURDIKERI, M.B., GIRIRAJ, K. AND SHEKHAR GOUDA, M., 2003, Storage potential of groundnut seeds under ambient conditions. In : *Proceedings of National Workshop on Groundnut Seed Technology*, Ed. Basavegowda, *et al.* University of Agricultural Sciences, Campus, Raichur during February 6-7, 2003, pp. 168-170.

KURDIKERI, M.B., MERWADE, M.N. AND CHANNAVEERASWAMY, 2000, Maintenance of viability in different crop species under ambient storage. *Seed Research*, 28 (1) : 109-110.

KUSHI, K.K. AND KHARE, M.N., 1979, Seed borne fungi of sesame and their significance. *Seed Research*, 7 (1) : 48-53.

MADANAGOPAL, B. AND DHARMALINGAM, C., 1993, Pre-treatment methods to control seed deterioration in ginelly (*Sesamum indicum*, L.) cv. TMV-3. *Madras Agricultural Journal*, pp. 33-40.

MAGUIRE, J.D., 1962, Speed of germination and in selection evaluating for seedling emergence and vigour. *Crop Science*, 2 : 176-177.

MAJHI, A. AND BANDOPADHYAY, P.K., 1993, Vigour and viability of groundnut seed cv. JL-24 under different storage containers. *Environment and Ecology*, 11 : 930-932.

MANOMANI, V., 2002, Storability of dormant and non-dormant cultivars of groundnut (*Arachis hypogaea* L.). *Seed Research*, 30 (1) : 158-160.

MATHUR, S.K. AND SINHA, S., 1978, Certain biochemical changes in bajra (*Pennisetum typhoides*) seeds during storage. *Seed Research*, 6 (2) : 172-180.

MCNEAL, X., 1966, Conditioning and storage of soybeans Bull. 714, Arkans Agric. Exp. Station, pp. 30.

MENG, X.D., 1993, The relationship between seed deterioration and physiological and biochemical changes in vegetable soybeans. *Soybean Science*, 12 (3): 259-264.

MOHOLKAR, N.D., MATE, S.N. SHELAR, V.R., MANSARE, M.R. AND BHARUD, R.W., 2002, Physico-chemical treatment for extension of storability of seeds of male parent (6D-1) of sunflower Hybrid KBSH-1. *Seed Research*, 32 (1) : 159-160.

MUTHURAJ, R., KANT, K. AND KULSHRESTHA, D.D., 2002, Screening soybean cultivars for seed mycoflora and effect of Thiram treatment thereon. *Seed Research*, 30 (1) : 118-121.

NARAYANASWAMY, S., 1993, Effect of provenance, pre-sowing treatment and storage on seed yield and quality in groundnut. *Ph.D. Thesis*, University of Agricultural Sciences, Bangalore.

NARAYANASWAMY, S., 2003, Effect of packaging and location of storage on groundnut seed. In : *Proceedings of National Workshop on Groundnut Seed Technology*, Ed. Basavegowda, *et al.* University of Agricultural Sciences Campus, Raichur during February 6-7, 2003, pp. 164-167.

NARAYANASWAMY, S. AND SHAMBULINGAPPA, K.G., 1994, Diversity in seed borne fungal pathogens in groundnut. *Journal of Oilseed Research*, 11 (2) : 294-299.

NARAYANASWAMY, S., RAJENDRA PRASAD, S. AND VIJAYMOHA REDDY, 2001, Effect of packaging materials on seed quality in groundnut for bulk seed storage. *Proceedings of National Seminar on Seed Science and Technology* in New Millennium – Vistas and vision. August 6-8, 2001, Mysore, India, p. 196.

NARGUND, V.B., PATIL, M.B. AND DESHPANDE, V.K., 2003, Pod rot of groundnut and its impact on seed properties. *Proceedings of National Workshop on Groundnut Seed Technology*, Feb. 6-7, pp. 164-167.

NAUTIYAL, P.C. AND JOSHI, Y.C., 1991, Storage of rabi/summer groundnut (*Arachis hypogaea* L.) with calcium chloride for prolonged seed viability and vigour. *Tropical Science*, 31 : 21-26.

NKANG, A. AND UMAR, E.O., 1997, Six month storability of five soybean cultivars as influenced by stage of harvest, storage temperature and relative humidity. *Seed Science and Technology*, 25 (1) : 93-99.

NKANG, A., 1988, Some aspects of biochemical basis of viability of loss in stored qukfaylla seeds. *Seeds Science and Technology*, 16 : 247-260.

NORDEN, A.J., 1981, Effect of provenance and storage environment on life span of shelled peanut seed. *Crop Science*, 21 (2) : 263-266.

PADMA, V. AND MURALIMOHAN REDDY, B., 2001, Seed invigoration for extending storability of soybean seed. *Journal of Research Acharya N.G. Ranga Agricultural University*, 29 (4) : 1-5.

PAMMENTER, N.W., ADAMSON, J.H. AND BERIAK, P., 1974, Viability of stored seed : Extension by catholic protection. *Science*, 186 : 1123-1124.

PARMIL SINGH AND KHATRA, G., 1984, Effect of accelerated ageing treatment on germination percentage, germination relative index and vigour index in two groundnut varieties. *Indian Journal of Ecology*, 11 : 117-121.

PATRA, A.K., TRIPATHY, S.K. AND SAMUI, R.C., 2000, Effect of drying and storage methods on seed quality of summer groundnut (*Arachis hypogaea* L.). *Seed Research*, 28 (1) : 32-35.

PERL, M., LURIA, I. AND GELMOND, H., 1978, Biochemical changes in sorghum seeds affected by accelerated ageing. *Journal of Experimental Botany*, 29 (109) : 479-509.

PERRY, D.A., 1969, Seed vigour in peas (*Pisum sativum* L.). In : *Proceedings of International Seed Testing Association*, 34 : 221-232.

PIERRE, J.G. AND MALAURIE, C., 1972, A study of the phytotoxicity of fungicide treatments applied to sunflower seeds in the case of carry over of seed stocks. *Proceedings of the Fifth International Conference of Sunflower*, pp. 25-29.

POLLOCK, B.M. AND ROOS, E.E., 1972, Seed and seedling vigour. In : Seed Biology-II. Ed. Kozlowski, T.T., Academic Press, New York, London, pp. 313-387.

PONNAM SINGH, THAKUR, DAS VAISH, C.P., KATIYAR, R.P. AND GUPTA, P.K., 1998, Studies on packaging materials for storage of soybean seeds under ambient conditions. *Seed Research*, 9 (2) : 75.

POWELL, A.A. AND MATHEWS, S., 1986, Cell membranes and seed leachate conductivity in relation to the quality of seed for sowing. *Journal of Seed Technology*. 10 (2) : 81-100.

PRASADRAO, G.S., MURALIMOHAN REDDY, B., ANKAIAH, R., GOPAL SINGH, SATYANARAYANA, 2001, Place of production and storage effect on the storability of rice, maize and sunflower. *Seed Research*, 29 (1) : 106-108.

PRASAD, B.K., NARAYAN, N. AND KISHORE, A., 1988, Physio-chemical changes in food reserve of coriander seed due to storage moulds. *Indian Phytopathology*, 41 : 386-388.

PRASANNA, K.P.R., 1984, Storage conditions for seed health. *Seed Tech News*, 24 (4) : 71.

PRIESTLEY, D.A., 1986, Seed ageing. Comstock Press, Ithala. NY.

RADHAKRISHNA, R., 1982, The effect of storage conditions on prolonging the viability of vegetable soybean. In : *21st International Horticultural Congress*, Vol-I Hague, Netherlands.

RAJENDRAPRASAD, S., UJJNAIAH, U.S., SATHYANARAYANA REDDY, A. AND JAGADISH, G.V., 1998, Effect of genotypes of groundnut kernels and containers on seed quality during storage. *Seed Tech News*, 28 (4) : 35.

RAMAMOORTHY, K. AND KARIVARATHARAJU, T.V., 1986, Storability and biochemical compositions of ground seed as influenced by packaging and seed treatment. *Indian Agriculture*, 30 : 101-106.

RAO, R.V.V., SUGUNAKAR REDDY, M. AND CHANDRASEKHARA RAO, K., 1996, Effect of fungicidal treatment on the viability of groundnut (*Arachis hypogaea* L.). *Seed in Storage.* Seed Research, 24 (1) : 66-68.

REDDY, M.J., SHEKHARA SHETTY, H., FANELLI, C. AND LACEY, J., 1992, Lipid peroxidation of stored groundnut seeds in relation to water activity and storage temperature. *International Arachis Newsletter*, 11 : 33-34.

RHEENEN, H.A., 1981, Longevity of sesame seed under different storage conditions. *FAO Plant Production and Plant Protection Paper*, 29 : 173-175.

ROBERTS, E.H., 1972, Storage environment and control of viability. In : *Viability of Seeds*, Ed. E.H. Roberts Chapman and Hall Limited, London, pp. 14-18.

ROBERTS, E.H., ABDALLA F.H. AND OWEN, R.S., 1967, Nuclear damage and the ageing of seeds in *Aspects of the Biology of Ageing*, Symposium XXI (Ed. Woolhouse, H.W.) 65, Cambridge University Press.

SANGWAN, R.S. AND DUHAN, J.C., 1998, Quality of sunflower seed during storage. *Seed Tech News*, 28 (1-4) : 27.

SARASWAT, R.P. AND MATHUR, S.K., 1985, Lipase production by seed borne fungi of linseed. *Seed Research*, 13 (2) : 123-124.

SAVITHRI, H., SUGUNAKAR REDDY, M. AND MURALIMOHAN REDDY, S., 1998, Effect of seed treatment with fungicides and insecticides on seed borne fungi, storage insect pest, seed viability and seedling vigour of groundnut. *Seed Research*, 26 (1) : 62-72.

SAXENA AND KARAN, D., 1991, Effect of seed borne – fungi on protein and carbohydrate contents of sesame and sunflower seeds. *Indian Phytopathology*, 44 : 134-136.

SAXENA, N., KARAN, D. AND MOHANA, 1998, Enzymatic studies of seed borne fungi of safflower seeds and their role in seed deterioration during storage. *Seed Tech News*, 28 : 25-26.

SEDENKO, D.M., 1975, Phosphorus compounds and phytase activity in maize seeds stored at different initial moisture content. *Fiziologiya Rastenii*, 22 : 236-240.

SEN, S., 1977, Cellular lesions leading to non-viability of seeds. *Seed Research*, 5 : 79-92.

SHANMUGAVEL, S., ANURADHA VARIER AND MALAVIKA DADLANI, 1995, Physiological attributes associated with seed ageing in soybean (*Glycine max* (L.) Merrill) cultivars. *Seed Research*, 23 (2) : 61-66.

SHARMA, J.K. AND SINGH, H.B., 1997, Relative storability of the seeds of some crop species under ambient conditions. *Seed Research*, 25 (1) : 37-40.

SHARMA, R.C., GILL, S.S. AND HARRAJ DEEPKUR, 1994, Seed health of Raya in relation to storage under different treatments. *Seed Tech News*, 24 (4) : 76.

SHARMA, S.N., GOYAL, K.C., GUPTA, I.J., GUPTA, H.C., KAKRALYA, B.S., SHARMA, S.K., MEHTA, S.M. AND RATHORE, A.K.S., 1998, Packaging material and soybean seed quality during storage. *Seed Research*, 26 (1) : 89-91.

SHEKHARGOUDA, M., KATIYAR, R.P. AND VAISH, C.P., 1998, Storability of sunflower seeds harvested at physiological field maturity. *Seed Tech News*, 28 (4) : 76.

SIDDIQUI, M.R., 1998, Pathology of stored seed. *Seed Tech News*, 28 : 44.

SINGH, A.K., 1987, Effect of storage temperature and relative humidity on seed germinability of soybean. *Seed Research*, 15 (1) : 104-105.

SINGH, D.P., 1992, Fungicidal treatments for control of seed borne fungi and improving germination percentage in different soybean cultivars. *Seed Tech News*, 22 (2) : 35.

SINGH, K.K. AND DADLANI, M., 2003, Effect of packaging on vigour and viability of soybean (*Glycine max* (L.) Merrill) seed during ambient storage. *Seed Research*, 31 (1) : 27-32.

SINGH, J.N. AND MAURYA, M.L., 1972, Effect of storage condition on germination of soybean seeds. *Bulletin Grain Technology*, 10 (3) : 158-167.

SNEDECOR, G. AND COCHRAN, W.G., 1967, *Statistical Methods*. Oxford and IBH Publishing Company, Bombay, pp. 135-197.

SRIVASTAVA, A.K. AND GILL, M.K., 1975, Physiology and biochemistry of seed deterioration in soybean during storage. *Research Advances Plant Science*, p. 50.

SRIVASTAVA, A.K. AND SAREEN, K., 1974, Physiology and biochemistry of deterioration in soybean seeds during storage 1. Mobilization efficiency of nitrogen metabolism. *Seed Research*, 2 : 26-32.

SUNDARAJAN, N., NAGARAJU, S., VENKATARAMAN, S. AND JAGANATH, M.H., 1972, Design and analysis of field experiments. University of Agricultural Sciences, Bangalore.

TAPPEL, A.L., 1973, Lipid peroxidation damage to cell components. *Federal Proceedings*, 32 : 1807-1874.

TAUNG, U. AND McDONALD, MB., 1995, Changes in esterase activity associated with peanut (*Arachis hypogaea* L.) seed deterioration. *Seed Science and Technology*, 23 : 101-111.

TEARI, N., SINGH, P., VAISH, C.P., KATIYAR, R.P. AND KANAUJIA, V.P., 1998, Viability of mustard seeds (*Brassica juncea* L.) stored under ambient conditions of central plain zone of Uttar Pradesh. *Seed Research*, 9 (2) : 75.

TEWARI, M.N. AND GUPTA, P.C., 1981, Effect of genotype seed grade and environment on viability and vigour of sunflower seed in storage. *Seed Research*, 9 (2) : 126-131.

TUNGESWARA, V., 1996, Storability studies in rice and sunflower hybrids and their parental lines. *M.Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad.

VAIDYA ANJALI AND DHAREMVIR, 1989, Changes in the oil in stored groundnut due to *A. niger* and *A flavus*. *Indian Phytopathology*, 42 : 525-529.

VANANGAMUDI, 1988, Storability of soybean seeds as influenced by the variety, seed size and storage container. *Seed Research*, 16 (1) : 81-87.

VAMADEVAPPA, H., 1998, Studies on seed viability and vigour in relation to storage in soybean (*Glycine max* (L.) Merrill). *M.Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad.

VENKATAREDDY, D.M., BOMMEGOWDA, A. AND PARAMESH, 1992, Storability of soybean seeds as influenced by genotypes and containers. *Seed Tech News*, 22 (2) : 41.

VERMA, R.S. AND GUPTA, P.C., 1975, Storage behaviour of soybean varieties vastly differing in seed size. *Seed Research*, 3 (1) : 39-44.

VERMA, S.S., TOMER, R.P.S., URMIL VERMA, 2003, Loss of viability and vigour in Indian mustard seeds stored under Ambient conditions. *Seed Research*, 31 (1) : 98-101.

VIEIRA, R.D., PAIVA-AGUERO, J.A., PERECIN, D. AND BITTENCOURT, S.R.M., 1999, Correlation of electrical conductivity and other vigour tests with field emergence of soybean seedlings. *Seed Science and Technology*, 27 : 67-75.

VILLIERS, T.A., 1971, *Cytological Studies in Dormancy*, I Embryo maturation during dormancy, *New Phytology*, 70 : 751.

VILLIERS, T.A., 1980, Ageing and the longevity of seeds on field conditions. *Seed Ecology*, pp. 265-287.

VYAS, R.P., KUMAR, R., PRAKASH, V. AND KATIYAR, R.P., 1990, Germinability of soybean seeds after harvest in subsequent storage. *Seed Research*, 18 : 44-46.

WEIDENBORNER, M. AND HINDORF, H., 1989, Fungi isolated from protein enriched seeds and pods with special emphasis on the genus *Aspergillus. Seed Science and Technology*, 17 : 383-394.

WILLIAMS, R.J. AND McDONALD, D.D., 1983, Grain molds in the tropics : Problems and importance. *Annual Review of Phytopathology*, 21 : 1531-178.

WILSON, D.O. AND McDONALD, M.B., 1986, The lipid peroxidation model of seed ageing. *Seed Science and Technology*, 14 : 269-300.

ZAD, J., 1978, A note on the mycoflora of sunflower seeds in Iran. *Seed Science and Technology*, 6 : 953-956.

ZHANG, R.P., WANG, Z.Y., GAO, J.F. AND XUE, G., 1993, The effects of pre-treatment with PEG on the lipoxygenase (LOX) activity and protein contents of the soybean (*Glycine max*) hyptocotyl. *Soybean Science*, 12 (4) : 335-339.

ZODE, N.G. AND PATIL, V.N., 1990, Storability of crop seeds as influenced by genotype and season. *Annual Plant Physiology*, 4 (1) : 127-129.

EVALUATION OF VALIDITY PERIOD OF DIFFERENT OILSEED CROPS STORED AT DIFFERENT LOCATIONS

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ABSTRACT

A study on evaluation of validity period of different varieties of oil seed crops stored at different locations under ambient conditions was carried out for 11 months in the Department of Seed Science and Technology, Agriculture College, University of Agricultural Sciences, Dharwad during 2005-06. The results indicated that among locations, Raichur was found to be best for storage of oilseed crops compared to Dharwad and Sirsi. Among crops, sesamum and sunflower maintained satisfactory germination upto ten months of storage, while soybean and groundnut· maintained only for seven and six month respectively with better seedling vigour and with low electrical conductivity and fungal activity. Among varieties DS-l of sesamum and KBSH-l of sunflower, JS-9305 of soybean and GPBD-4 of groundnut stored for longer periC?d compared to E-8 of sesamum, RFSH-l of sunflower, JS-335 of soybean and TAG-24 of groundnut. The interaction oflocations and crops revealed that sesamum seeds stored at Raichur recorded significantly higher germination compared to other oilseed crops stored at different locations. The interaction of crops and varieties revealed that DS-l and E-8 of sesamum and KBSH-l of sunflower showed significantly higher seed quality parameters compared to both the varieties of soybean and groundnut throughout the storage period. The interactions of locations, crops and varieties indicated that seeds of DS-l and E-8 of sesamum and KBSH-l of sunflower stored at Raichur recorded significantly higher germination and vigour parameters compared to other interaction combinations of crops, locations and varieties. Satisfactory germination as per the Minimum Seed Standards was maintained upto eleven months in varieties DS-l and E-8 of sesamum stored at Raichur, up to ten months at Dharwad and nine months at Sirsi. The sunflower varieties KBSH-l and RFSH-l stored at Raichur maintained up to eleven and ten months respectively, at Dharwad upto ten months and at Sirsi upto nine months. Whereas, soybean varieties JS-9305 and JS-335 stored at Raichur maintained satisfactory germination up to eight and seven months, upto seven and six months respectively at Dharwad and upto six and five months respectively at Sirsi. The groundnut varieties GPBD-4 and T AG-24 maintained satisfactory germination at Raichur upto seven months, at Dharwad upto seven and six months respectively, and at Sirsi only for five and four months respectively.