

**EFFECT OF FUNGICIDE, POLYMER AND POLYMER DYES TREATMENT  
ON STORABILITY OF ONIONS SEEDS**

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**By**

**BASAVARAJ B.O**

**DEPARTMENT OF SEED SCIENCE AND TECHNOLOGY  
COLLEGE OF AGRICULTURE, DHARWAD  
UNIVERSITY OF AGRICULTURAL SCIENCES,  
DHARWAD – 580 005**

**JULY, 2007**

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**4. \_\_\_\_\_  
(RAVI HUNJE)**

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## I. INTRODUCTION

Onion (*Allium cepa* L.) is one of the important commercial vegetable crop of India. It is a condiment cum bulb vegetable belonging to the family Alliaceae. Both immature and mature bulbs are used as vegetable and also as a spice. Onion bulb is strongly concentrated subterranean shoot with thickened fleshy leaves and bulb is composed of carbohydrates (11.0 g), proteins (1.2 g), fibre (0.6 g), moisture (86.4 g) apart from vitamins like vitamin 'A' (0.012 mg), vitamin 'E' (11 mg), thiamine (0.08 mg), riboflavin (0.01 mg) and niacin (0.2 mg) and minerals like phosphorus (39 mg), calcium (27 mg) per 100 g material (Anon., 1978). Onions have wider use in the manufacture of soups, ketchups, onion flakes and food seasoning, besides being used as salad and pickle. The smell and pungency is due to an alkaloid called 'Allyl propyl disulphide'.

The importance of onion in Indian economy can hardly be over emphasized as it occupies 7.4 per cent of total area (0.52 m ha) under vegetables and with a total output of 5.7 per cent of vegetables in the country (49 lakhs tonnes). In India, it is mainly grown in Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Uttar Pradesh, Orissa and Madhya Pradesh. In Karnataka, the area under onion is 104.4 thousand ha with an estimated annual production of 558.4 thousand million tonnes and productivity of 5.6 tonnes per ha. The average yield of onions in India is 12.5 tonnes per ha which is far less against 44 tonnes per ha in Japan (Singhal, 2000).

It is known fact that seed is a basic and crucial input in agriculture and it is the quality of seed that decides the commercial success of a crop variety. Obviously, the bumper harvest could be possible only when the seeds possess high quality standards viz., purity, germination, uniformity in weight and size apart from freedom from pest and diseases. These quality traits are known to be influenced largely by an interplay of environment, cultural, harvest and post-harvest management practices at both field and storage levels. Among these several factors, particularly maintenance of high quality seeds in storage is the most important aspect in many vegetable crops and particularly in onion which is a poor storer. With the development of organised seed production and marketing activities, seed men are quite aware of problems associated with safe seed storage and handling. It is stated that 80 per cent of certified seeds produced in India are kept in storage for atleast one planting season and remaining 20 per cent has to be carried over for subsequent sowings. The substantial quantity of seeds needs to be stored in for atleast first few planting seasons as a safe guard against rain failure and as a precaution against production of poor quality seeds. Onion seed has short life and loses viability normally within a year. Several factors affect the self life of the seeds. Among these, infection with seed borne fungi is one of the factors for quick loss of viability of seed (Urosevic, 1964). Higher rate of infection and production of fungal metabolite in onion seeds during storage causes inhibition in germination and vigour. *Botrytis allii*, *Botrytis cinerea*, *Fusarium* spp. and *Pleaspora herbarum* are usually found on seeds and seedlings whereas *Alternaria porri* only on seeds. These seed borne microflora may easily penetrate in to seed to cause instant death or delayed systemic infection to emerging seedlings (Tylkowska and Dorna, 2001).

The seed deterioration starts right at the field levels immediately after the physiological maturity. The seed has to be stored safely so that the viability and vigour is maintained intact. Deterioration of seed during storage is inevitable and leads to different changes at different levels viz., impairment or shift in metabolic activity, compositional changes, decline or change in enzyme activities, phenotypic, cytological changes apart from quantitative losses. Seed deterioration is inevitable and irreversible process but the rate of seed deterioration could be slowed down either by storing the seeds under controlled conditions or by imposing seed treatment with polymer coating along with seed treatment chemicals. As the controlled condition involves huge cost, seed treatment remains the best alternative approach to maintain the seed quality.

The polymer coat provides protection from the stress imposed by accelerated ageing, which includes fungal invasion. The coat is thin (8  $\mu$  m), simple to apply, diffuses rapidly and non-toxic to the seedling during germination. It improves plant stand and emergence of seeds, helps in accurate application of the chemical, reducing chemicals wastage and helps to make room for including all required ingredients, protectants, nutrients, plant growth promoters, hydrophobic/hydrophilic substance, oxygen suppliers etc. By encasing the seed

within a thin film of biodegradable polymer, the adherence of seed treatment to the seed is improved, ensures dust free handling, making treated seed both useful and environment friendly. Polymer coating makes sowing operation easier due to the smooth flow of seeds.

Seed colouring was unrealistic and uneconomical a decade ago. But now it has provoked the interest among many seed traders and seed companies to enhance their company image and trademark and reduce the adulteration of seed. Developed countries are practicing seed colouring since a decade as it has advantages in improving the appearance of seeds marketability, consumer preference to control storage pests and diseases. For colouring of seeds, suitability of dyes that are available in the market needs to be studied for their effect on the seed quality.

Among the several factors affecting seed storability, seed microflora is mainly responsible for the degradation of protein and other food reserves resulting in reduction of vigour and germination. As seed is an efficient media for survival and dissemination of pathogens, to reduce the losses due to these pathogens and preserve viability, it is advisable to treat the seeds with fungicides and store them in suitable containers in order to preserve them for considerable time without significant reduction in quality.

Containers play a major role in prolonging the self life of a seed during storage as they separate seeds from the surrounding environment. Some containers are moisture pervious and some are impervious. Suitability of various containers for safe storage of seeds for longer period needs to be studied various crop seeds especially the poor storer like onion. Being hygroscopic in nature, the viability and vigour of seeds under storage are known to be regulated by variation in the physico-chemical factors, initial seed quality and packaging material (Doijode, 1988). To combat these factors effectively, storing the seeds in moisture vapour proof containers like polythene bag, aluminium pouch or any sealed containers are found to be more useful in maintaining the desired quality for longer period (Gurmithsingh and Harishing, 1992), unlike these stored in moisture pervious containers like cloth bag and gunny bag (Singh *et al.*, 1988).

Keeping all these factors in view present investigation entitled "Effect of fungicide, polymer and polymer dyes on storability of onion seeds" was carried out with the following objectives.

- i. To study the effect of polymer film coating with fungicide on storability of onion seeds.
- ii. To study the effect of containers on storability of onion seeds.
- iii. To study the effect of different coloured polymers with and without fungicide on storability of onion seeds.

## 2. REVIEW OF LITERATURE

The brief review of literature pertaining to fungicides, polymers, containers and polymer dyes on storability of onion seeds and other related crops is presented in this chapter.

### 2.1 Effect of polymer film coating with fungicide and containers on storability of onion seeds

#### 2.1.1 Influence of polymer coating

Seed ageing and deterioration of seed are irreversible, inexorable and inevitable process, but the rate of seed deterioration could be slowed down either by storing the seeds under controlled condition or by imposing seed treatment with polymer coating along with seed treatment chemicals (Duan and Burries, 1997). As the controlled condition involves, the huge cost, the seed treatment remains the best alternative approach to maintain the seed quality.

Berdahl and Barker (1981) noticed reduction in germination with higher concentrations of polymer in Russian wild rye (*Elymus junceus*) seeds.

Sachs *et al.* (1981) reported that seed pelleting is highly beneficial for enhancing germination, as seed coat becomes impermeable to oxygen.

Evlakova (1985) reported that pelleting of delinted cotton seeds with carboxy methyl cellulose polymer film increased the germination by 24.5 per cent as compared to untreated seeds.

West *et al.* (1985) indicated that continuous cover on polymer coated seeds could provide protection from physical damage during handling and planting. It also protects fluctuations in seed moisture content due to climatic changes.

Baxter and Waters (1986) suggested that coating of seed with hydrophilic polymer like hydralysed starch graft polyarylonitrile to maintain a higher water potential around germinating seeds.

Hwang and Sung (1991) observed that coating with a hydrophilic polymer regulated the rate of water uptake, reduced imbibitional damage and improved the emergence of soybean seeds.

Dadlani *et al.* (1992) reported that polymer coated seeds of rice variety IR-20 recorded higher root length (34.80 mm), shoot length (170.2 mm) and dry weight of seedling (52.80 mg /seedling) compared to uncoated seeds (33.63 mm, 147.6 mm and 48.3 mg/seedling, respectively).

Pelleting of sorghum seeds with hydrophilic polymer in combination with micronutrients and DAP registered maximum germination and vigour in terms of root length, shoot length and vigour index (Selvaraju, 1992).

Jeong and Cho (1995) noticed that increasing concentration of coating materials reduced the germination in tomato and pepper seeds.

Struve and Hopper (1996) reported that cotton seeds coated with Landec polymer recorded slower imbibition rate, reduced the imbibitional damage, lowered the electrical conductivity values and improved the seed germination.

Duan and Burris (1997) reported that the polymer film act as a physical barrier thus reducing the leaching of imbibitors from the seed covering and restricting the oxygen diffusion to the embryo and there by restricting the ageing effect in stored sugar beet seeds.

The groundnut seed coated with hydrophilic polymer @ 20 g per kg of seed increased the germination percentage, but further increase in the concentration of polymer, inhibited the germination and root and shoot growth (Chikkanna *et al.*, 2000).

In soybean, seed coating of polymer @ 24 mg per kg of seed regulated the rate of water uptake, reduced imbibitional damage and improved the germination and seedling emergence in flooded soil conditions (Chalchalis and Smit, 2001).

Ni and Biddle (2001) revealed that the maize seeds coated with polymer retards imbibition during first few hours of hydration, which is attributed to reduced seed membrane damage and seed leakage resulting in less imbibitional chilling injury.

Taylor *et al.* (2001) reported that film coating of polymer and pelleting with catazime and fungicide to onion seeds reduced the plant stand losses due to onion fly from 20 to 60 per cent to one to eight per cent and also recorded higher germination and seedlings vigour.

Larissa *et al.* (2004) found that bean seeds coated with the polymer and fungicide maintained higher germination compared to control after two months of storage.

Wilson and Geneve (2004) reported that corn seeds coated with polymer and fungicide recorded higher germination (98.50%), less number of abnormal seedlings (1.50%) and lower conductivity values (41.6  $\mu$  mhos/g) compared to control (89.0% germination and 51.4  $\mu$  mhos/g EC, respectively).

Baig (2005) reported that seed coating with thiram @ 2 g + polymer @ 5 g per kg of seeds recorded higher germination, vigour index, rate of germination in soybean seeds throughout the storage period.

Kunkur (2005) reported that seed coating with thiram @ 1.5 g + polymer @ 5 g per kg of seeds recorded higher germination, vigour index, rate of germination and seedling dry weight in cotton seeds throughout the storage period.

Maize seeds coated with thiram 2 g per kg and polymer @ 6 ml per kg of seeds recorded higher germination, vigour index, less seed infection compared to control at the end of 12 months of storage period (Anon., 2007a).

Hybrid rice (DRRH-1) seeds coated with synthetic polymers recorded higher germination, seedling dry weight, vigour index, field emergence and less infection throughout storage period (Anon., 2007b).

Sorghum (var. 85V-84) seeds coated with synthetic polymer along with fungicide recorded significantly higher germination, seedling dry weight, vigour index, field emergence and less infection compare to control at the end of nine months of storage (Anon., 2007c).

### 2.1.2 Influence of fungicides

Seed often loses viability during storage, besides many other environmental and genetic factors, seed borne fungi contribute a lot in this process. When seeds are to be stored under ambient conditions, some seed treatment is needed to take care of seed borne fungi during storage with the aim of improving the shelf life of seed.

Kaul (1972) reported that french bean seed treated with captan @ 3 g per kg of seed maintained germination at 90 per cent after 48 months of storage whereas it was 48 per cent with control.

Pillayarasamy *et al.* (1973) reported that the chilli seeds of cv. K-1 treated with different fungicides (Agrosan GN, cereson, lime dust, captan, fyton, thiovit and TMTD at 2 g/kg seeds) and stored in plastic containers produced higher germination over control throughout the storage period. The fungicides *viz.*, TMTD, captan and agrosan GN, were significantly superior to other fungicides.

Baboth (1979) stored the seeds of 3 onion cultivars treated with four micro element solutions in paper bag at room temperature and treated seeds recorded 80 per cent germination and in control seeds it was 53 per cent after 30 months of storage.

Maholay and Sohi (1982) reported that bitter gourd seeds treated with captan @ 2 g per kg of seed maintained 100 per cent germination after 14 months of storage over control (40%).

Muthuswamy *et al.* (1983) noticed that all fungicides tested improved the germination of chilli, but captan (4 g/kg), sulphur dust (4 g/kg), bavistin (2 g/kg), vitavax (carboxin 2 g/kg) and benlate (benomyl, 4 g/kg) were recommended for seed treatment.

Vadivelu and Ramaswamy (1983) revealed that when tomato seeds at seven per cent moisture content treated with captan and thiram, were packed in vapour proof containers and untreated seeds packed in cloth bag as control, the seeds treated with captan and stored in moisture proof package showed the highest (70%) germination as compared to control after 30 months of storage.

Fungicide treated coriander seed maintained higher germination over the untreated seeds during 60 days of storage. The germination potential of coriander seeds gradually decreased with increase in moisture content even after seed treatment (Prasad, 1988).

Gupta *et al.* (1989) reported that when the onion seeds were treated with thiram, captan, captafol, atonik and cytozyme as alone and in combinations, a sudden fall in germination percentage in all treatments.

In chilli treated with captafol, thiram, aureofungin, topsin and vitavax each at 0.3 per cent concentration improved the germination and seedling length (Dhyani *et al.*, 1991).

Ramanathan and Sivaprakasam (1992) observed that chilli seeds treated with fungicide, fungal metabolite and bacterial metabolite maintained higher germination percentage, shoot length, root length, vigour index and field emergence over untreated ones.

Gupta *et al.* (1992) reported that chilli seeds treated with captan @ 2 g per kg of seed and stored in tin container maintained higher germination (86%) after 12 months of storage than the untreated seeds stored in cloth bag (55%).

Gupta and Singh (1993) observed non-significant influence of fungicides on seed germination of brinjal seeds during 18 months of storage.

Reddy and Reddy (1994) reported that seeds of egg plant treated with thiram (2.5 g/kg), delson (3 ml/kg) and captan (2.5 g/kg) did not affect viability. Among the treatments, seed treated with thiram maintained higher germination over other treatments.

Sharma *et al.* (2000) reported that in onion seeds, *Aspergillus* and *Penicillium* caused considerable loss of seed germination and enhanced seed or seedling mortality and these caused 85 to 100 per cent seed mortality. Seed treatment with captan (0.2%) improved the germination significantly compared to untreated.

Gupta and Aneja (2004) found that in soybean seeds treated with thiram @ 2.5 g per kg of seeds, significantly maintained higher germination (46.30%) compared to control (36.90%) after 15 months of storage.

### 2.1.3 Storage containers

The physical properties and storage potential of seeds are influenced to a very great extent by moisture content, in turn the relative humidity and temperature of the atmosphere surrounding the seed. In general, seed stored in moisture impervious sealed containers provide suitable environment for storage, offer protection against contamination and also act as a effective barrier against the escape of seed treatment chemicals than in moisture pervious containers. Vegetable, flower and tree seeds maintained higher viability for two years, when stored in sealed containers at low moisture content (Barton, 1953).

Harrington (1973) found that moisture proof or moisture resistant packages would be more valuable in prolonging the seed viability and vigour.

Saxena *et al.* (1987) stored the seeds of onion, cabbage, radish, cauliflower, okra and pegs in polythene and cloth bag at room temperature for 24 months. The decrease in germination, root length, shoot length and vigour index with the increase in storage period was greatest in the seed stored in cloth bag and was least in polythene bag.

Karivaratharaju *et al.* (1987) reported that the seeds of brinjal cv. MPD-1 with seven per cent moisture content treated with captan gave 80 and 87 per cent germinability in cloth bag and polythene bag (700 gauge), respectively after 21 months of storage.

Jaoqueline and Selvaraj (1988) reported that brinjal seeds treated with combination of thiram @ 1 g per kg and bavistin @ 1 gp per kg of seed and stored in polythene pouch (300 gauge) maintained higher germination (74.1%) and vigour index (1808) compared to aluminium pouch (58.9%, 1331, respectively).

Dojode (1988) reported that bell pepper seed stored in polythene laminated bag with 6.5 per cent moisture content at 5°C maintained the viability up to five years.

Singh and Singh (1990) dried onion seed to 4.1 per cent moisture content and stored in cloth bag (CB), sealed in single (sp), double (DP) and triple (TP) layer polythene pouches and glass bottles (GB). Seed stored in GB retained viability (79%) for 24 months of storage and seed stored in CB, SP, DP and TP gave 40, 70, 72 and 73 per cent germination, respectively.

Onion seeds stored in sealed polythene bag (700 gauge) maintained higher germination (70%) and vigour index, whereas untreated seeds stored in cloth bag showed reduced germination of 35 per cent and vigour index after 10 months of storage (Vijayakumar *et al.*, 1991).

Verma *et al.* (1991) reported that cauliflower and tomato seeds stored in laminated bag recorded higher germination (65.3 and 67.6%, respectively) compared to unsealed polythene bag (52% and 43%, respectively) at the end of 11 months of storage.

The per cent germination of chilli seeds remained above the prescribed certification standards (60%) up to 19 and 10 months, when stored in tin container and cloth bag, respectively (Ramanathan and Sivaprakasam, 1992).

Onion seeds stored with 4 to 6 per cent moisture content maintained satisfactory germination above the minimum seed certification standards for 360 days in aluminium pouches (71%) and plastic bags (70%). Whereas, seed in cloth bag and paper bag maintained germination above the minimum certification standard for 300 days (Shelar *et al.*, 1992).

Patil and Shelar (1993) reported that seed of brinjal and tomato maintained satisfactory germination above the minimum seed certification standards (70%) for 540 days when stored in moisture impervious containers like polythene bag and aluminium foil packs whereas seeds stored in moisture previous containers like cloth bag and paper bag maintained viability above 70 per cent for 420 days.

Pandey *et al.* (1994) reported that onion seeds stored in cloth bag and polythene bag (750 gauge) at room temperature maintained satisfactory germination as per the minimum seed certification standards (70%) upto nine and 24 months, respectively.

Saxena (1994) stored seeds of vegetables like onion, tomato, okra and cabbage with different moisture contents in different packing materials. He reported that, seeds with 6 to 8 per cent moisture content could be stored for a longer period in polythene bags (700 gauge).

Jagadish *et al.* (1994) stored fresh seed of onion cv. Pusa red in sealed tin, craft paper, aluminium pouch (50 mm), aluminium pouch (20 mm.), polythene bag (500 gauge) and paper bag for 18 months in ambient conditions. Both aluminium pouches retained maximum germination after 18 months compared to other containers.

Singh *et al.* (1996) reported that onion seeds treated with thiram and bavistin @ 2 g per kg of seed and stored in polythene bag maintained higher germination after six months of storage with effective control of *Alternaria alternata*, *Rhizopus* spp. and *Fusarium* spp.

Padma and Reddy (2000) reported that onion seeds stored at 5.3 per cent moisture content in polythene bag maintained viability for longer period (19 months) compared to cloth bag (14 months).

Nagaveni (2005) reported in onion seeds treated with bavistin @ 2 g per kg of seed and packed in polythene or aluminium pouch recorded higher germination, vigour index, field emergence and lower EC compared to untreated seeds packed in cloth bag under ambient condition at the end of 12 months of storage.

#### 2.1.4 Seed colouring

Seed colouring was unrealistic and uneconomical a decade ago. But now it has provoked the interest among many seed traders and seed companies to enhance their company image and trademark and reduce the adulteration of seed. Developed countries are practicing seed colouring since a decade as it has advantages in improving the appearance of seeds marketability, consumer preference to control storage pests and diseases.

Ryker (1959) reported that for every seed man, whether he likes it or not, it is likely at some time and to some degree to be involved in seed colouration as it carries with mixed blessings. He also mentioned that smooth coated seeds such as corn and beans were able to take colour readily and quite uniformly whereas, rough seeds such as oats, barley and grasses were difficult to colour where a pigment along with dye would be necessary for uniform colouration.

Tonapi (1989) reported that seed colouring dyes namely methyl red, methyl orange, gentian violet and phenol red were found to inhibit seed germination and produced drastic effects on vigour and viability potential of sorghum seeds, while, the other dyes such as rhodamine B malachite green, fast green, neutral red and methylene blue promoted seed germination, seedling growth and vigour potential. He also emphasised the need for artificial colouring of blended sorghum seeds toward of fungal invasion and to improve marketable value and consumer preference.

Shivanna (1991) studied the effect of seed colouring on storability in relation to quality using different colours with different concentration and fungicide and insecticide treatment in hybrid sorghum (CSH-5). He observed that, germination and vigour index were influenced by coloring of seeds from 2<sup>nd</sup> to 10<sup>th</sup> month of storage. The seeds treated with dye, fungicide and insecticide promoted marginal reduction or complete elimination of fungal infection and insect infestation.

Most seed treatment contain dyes and some companies add their own 'colour brand' dye to seed treatments. The dyes, if used for treating seeds are invariably mixed with fungicide and insecticides to enhance the quality of seed (Agrawal, 1995).

Vishwaprasad *et al.* (2001) reported that maize seeds treated with four dyes *viz.*, Amaranthus red, sunset yellow, methuylene blue and potassium permanganate each at five and ten per cent concentration along with or without fungicide, maintained germination for 10 months above 90 per cent compared to control.

Vanangamudi *et al.* (2003) noticed that pink poly kote @ 3 kg per kg of seeds + fungicide + insecticide was found to be best in registering higher germination (98.00%) and vigour index (82.91) compared to control (93.00% and 60.54, respectively) in maize. The treated seed stored better compared to untreated seeds.

Saraswathi and Krishnasamy (2003) studied effect of seed colouring dyes congo red, methyl orange and titan yellow in cotton and observed the higher germination per cent, root length, shoot length, dry matter production, vigour index with the seeds coated with these colouring agents.

Keshavalu and Krishnasamy (2004) reported that seeds coated with colour obtained from *Hibiscus rosasinesis* and polykote colours showed higher per cent germination, root length, shoot length and seedling vigour index compared to control in cotton seeds.

Geetharani *et al.* (2006) studied the influence of hydrophilic polymer coating with and without pesticides and DAP on seed and seedling quality characteristics of chilli cv. K2. The results showed that slurry coating of seed with polykote (3g/kg of seed) along with carbendizim (2 g/kg of seed) and halogen mixture (3 g/kg seed) enhanced the germination and vigour index values by 24 per cent, whereas the pathogen infection was lessened by 1 per cent compared to uncoated seeds.

Shobha (2006) reported that among the synthetic dyes amido black, brilliant green, basic fuchsin and crystal violet at 1.0 per cent along with thiram @ 2 g per kg recorded higher field emergence, germination and vigour index in soybean compared to untreated control at the end of eight months of storage.

Navi *et al.* (2006) reported that hybrid sorghum seeds coated with green colour dye along with insecticide recorded higher seed germination and vigour index compare to control throughout of storage period.

### 3. MATERIAL AND METHODS

In the present study, two experiments were carried out viz., 'Effect of polymer film coating with fungicide and containers on storability of onion seeds' and 'Effect of various coloured polymers with fungicide on storability of onion seeds'. The materials used and methods adopted during the conduct of the experiments are described here under.

#### 3.1 Experiment-I : Effect of polymer film coating with fungicide and containers on storability of onion seeds

##### 3.1.1 Source of seeds

Freshly harvested onion seeds of Bellary red variety produced summer season of 2006 were obtained from the Agricultural Research Station, Bagalkot, University of Agricultural Sciences, Dharwad. After through cleaning and grading the seeds were dried to moisture content of 6.5 per cent and used for storage study.

##### 3.1.2 Climatic conditions

The mean meteorological data from July 2006 to June 2007 were collected from the meteorological observatory. Main Agricultural Research Station, Dharwad and presented in Table 1 and depicted in Fig. 1. During the investigation period, the mean maximum temperature of 37.1°C was noticed during April and the mean minimum temperature of 12.80C during December. The relative humidity during storage period varied from 45 to 87 per cent.

##### 3.1.3 Treatment details

The details of treatment are given below.

Factor – I : Seed treatment

- P<sub>1</sub> : Control (without seed treatment)
- P<sub>2</sub> : Polymer coating @ 6 ml per kg of seeds
- P<sub>3</sub> : Polymer coating @ 9 ml per kg of seeds
- P<sub>4</sub> : Polymer coating @ 12 ml per kg of seeds
- P<sub>5</sub> : Thiram @ 2 g + polymer coating @ 6 ml per kg of seeds
- P<sub>6</sub> : Thiram @ 2 g + polymer coating @ 9 ml per kg of seeds
- P<sub>7</sub> : Thiram @ 2 g + polymer coating @ 12 ml per kg of seeds

Factor – II : Containers (C)

- C<sub>1</sub> : Polythene bag (700 gauge)
- C<sub>2</sub> : Aluminium pouch

Treatment combinations : 7 x 2 = 14

P <sub>1</sub> C <sub>1</sub>	P <sub>5</sub> C <sub>1</sub>
P <sub>1</sub> C <sub>2</sub>	P <sub>5</sub> C <sub>2</sub>
P <sub>2</sub> C <sub>1</sub>	P <sub>6</sub> C <sub>1</sub>
P <sub>2</sub> C <sub>2</sub>	P <sub>6</sub> C <sub>2</sub>
P <sub>3</sub> C <sub>1</sub>	P <sub>7</sub> C <sub>1</sub>
P <sub>3</sub> C <sub>2</sub>	P <sub>7</sub> C <sub>2</sub>
P <sub>4</sub> C <sub>1</sub>	
P <sub>4</sub> C <sub>2</sub>	

##### 3.1.4 Method of seed treatment

**Table 1. Monthly meteorological data for the experimental years (2006-07) at Main Agricultural Research Station, Dharwad**

Months	Temperature ( <sup>0</sup> C)		Relative humidity (%)
	Mean maximum	Mean minimum	
<b>July - 2006</b>	26.6	20.4	87
<b>August</b>	26.3	19.6	85
<b>September</b>	29.2	19.2	77
<b>October</b>	30.0	19.1	67
<b>November</b>	29.2	18.1	70
<b>December</b>	29.1	12.8	61
<b>January- 2007</b>	30.4	14.0	52
<b>February</b>	31.9	15.7	62
<b>March</b>	35.3	19.7	45
<b>April</b>	37.1	20.3	49
<b>May</b>	35.1	20.9	61
<b>June</b>	29.7	21.3	80

One kilogram of seeds were taken in a polythene bag, initially they were treated with thiram @ 2 g per kg of seeds as per the treatment combinations and the polymer @ 6, 9 and 12 ml was added in the polythene bag. The polythene bag was closed tightly and shaken till the seeds are uniformly coated, later the treated seeds were spread on a sheet under the shade and dried completely.

### 3.1.5 Method of storage

The seeds after treatments were dried back to their 6.5 per cent moisture content and stored in polythene and aluminium pouches in laboratory of National Seed Project, University of Agricultural Sciences, Dharwad under ambient conditions for 10 months.

### 3.1.6 Design of experiment

The design of the experiment adopted was Completely Randomized Block Design with four replications.

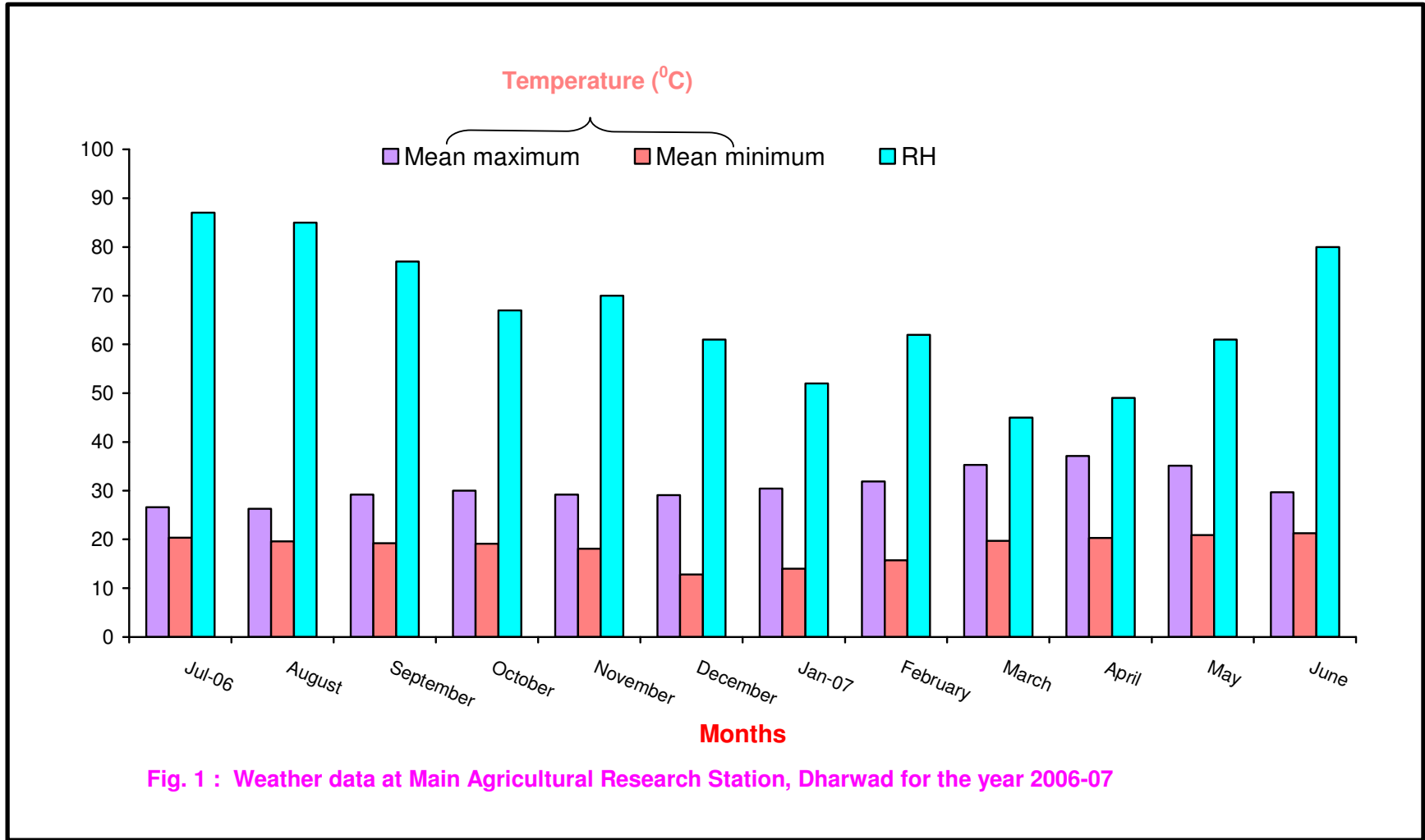
## 3.2. Collections of experimental data

### 3.2.1 Sampling procedure

The seeds were drawn at random from the bags at bimonthly intervals for analyzing the seed quality parameters as detailed below.

### 3.2.2 Germination (%)

Germination test was conducted in four replications of 100 seeds each by adopting between paper method as described by ISTA (Anon., 1999). A temperature of  $25 \pm 1^{\circ}\text{C}$  and relative humidity of 95 per cent was maintained during germination test. The final germination



**Fig. 1 : Weather data at Main Agricultural Research Station, Dharwad for the year 2006-07**

counts were made 12<sup>th</sup> day of germination test for normal seedlings and the germination was expressed in percentage.

### 3.2.3 Rate of germination

The daily germination count was made up to final count. The germination rate index (GRI) was calculated using the following formula and expressed in number.

$$\text{GRI} = G_1/T_1 + G_2/T_2 + \dots + G_n / T_n$$

Where,

$G_1, G_2, \dots, G_n$  are the number of seeds germinated at

$T_1, T_2, \dots, T_n$  are the days of germination test.

### 3.2.4 Shoot length (cm)

From the germination test, 10 normal seedlings were selected randomly in each treatment from all the replications on 12<sup>th</sup> day. The shoot length was measured from the base of the primary leaf to the base of the hypocotyls and the mean shoot length was expressed in centimeter.

### 3.2.5 Root length (cm)

Ten normal seedlings used for shoot length measurement were also used for the measurement of root length. The root length was measured from the tip of the primary root to base of hypocotyl and the mean root length was expressed in centimeter.

### 3.2.6 Seedlings dry weight (mg)

Ten normal seedlings selected for measuring shoot and root length were put in the butter paper pocket and kept in an oven maintained at  $85 \pm 1^\circ\text{C}$  for 24 hours. After drying, the seedlings were kept in a desiccator for cooling. The mean dry weight of seedlings was recorded and expressed in milligrammes per seedling (Anon., 2000).

### 3.2.7 Vigour index

The vigour index (VI) was calculated by adopting the method suggested by Abdul-Baki and Anderson (1973) and expressed in number.

$$\text{Vigour index} = \text{Germination (\%)} \times (\text{Shoot} + \text{Root length in cm})$$

### 3.2.8 Electrical conductivity of seed leachate ( $\text{dSm}^{-1}$ )

Five grammes seeds from each treatment of four replications were weighed and surface sterilized by using 0.1 per cent mercury chloride solution and then rinsed with water for three times. These seeds were soaked in 25 ml distilled water in a beaker and kept in an incubator maintained at  $25 \pm 1^\circ\text{C}$  temperature. After 24 hours of soaking, the solution was decanted and volume was made upto 25 ml by adding distilled water. The electrical conductivity was recorded using the digital conductivity meter and expressed in deciscimens per meter ( $\text{dSm}^{-1}$ ).

### 3.2.9 Moisture content of seed (%)

The moisture content of the seeds was determined by the hot air oven method as per ISTA procedures (Anon., 2000). Five grammes of coarsely ground seed material from each treatment in four replications was dried in a hot air oven maintained at a temperature of  $103 \pm 1^\circ\text{C}$  for a period of 17 hours. Then the samples were cooled in a desiccator and moisture content was determined by using the formula given below and expressed in percentage.

### 3.2.10 Seed health

Detection and identification of seed mycoflora was done by blotter paper method (TP) as per ISTA procedures (Anon., 1999). Twenty five seeds each from four replications were placed equidistantly in sterile glass petridishes of 15 cm diameter containing three moist blotter paper (Whatman No. 1). Then the petridishes were incubated at  $20^\circ\text{C}$  for eight days

with 12 hours light and 12 hours dark cycles. After incubation, seeds were examined under stereobinocular microscope for the presence of infection. The infected seeds are identified and expressed as percentage of total infection.

### 3.2.11 Field emergence (%)

Hundred seeds in four replications were sown in the field. The field emergence counts were made on 20<sup>th</sup> day after sowing. The seedlings with two centimeter growth above the soil surface were considered for recording field emergence and it was expressed in percentage.

## 3.3 Experiment II : Effect of various coloured polymers with fungicide on storability of onion seeds

### 3.3.1 Source of seed

Freshly harvested onion seeds of Bellary red variety producing summer 2006 were obtained from the Agricultural Research Station, Bagalkot, University of Agricultural Sciences, Dharwad. After thorough cleaning and grading the seeds were dried to moisture content of 6.5 per cent and used for storage study.

### 3.3.2 Source of dyes

The different polymers (polykote) were obtained from M/s. Little's Oriental Balm and Pharmaceuticals Ltd., Chennai.

### 3.3.3 Treatment details

The details of treatments are given below.

D<sub>1</sub> : Control (without treatment)

D<sub>2</sub> : Polymer blue @ 12 ml per kg of seeds

D<sub>3</sub> : Polymer red @ 12 ml per kg of seeds

D<sub>4</sub> : Polymer green @ 12 ml per kg of seeds

D<sub>5</sub> : Polymer pink @ 12 ml per kg of seeds

D<sub>6</sub> : Polymer yellow @ 12 ml per kg of seeds

D<sub>7</sub> : Polymer clear @ 12 ml per kg of seeds

D<sub>8</sub> : Thiram @ 2 g + Polymer blue @ 12 ml per kg of seeds

D<sub>9</sub> : Thiram @ 2 g + Polymer red @ 12 ml per kg of seeds

D<sub>10</sub> : Thiram @ 2 g + Polymer green @ 12 ml per kg of seeds

D<sub>11</sub> : Thiram @ 2 g + Polymer pink @ 12 ml per kg of seeds

D<sub>12</sub> : Thiram @ 2 g + Polymer yellow @ 12 ml per kg of seeds

D<sub>13</sub> : Thiram @ 2 g + Polymer clear @ 12 ml per kg of seeds

D<sub>14</sub> : Thiram @ 2 g per kg of seeds

### 3.3.4 Method of seed treatment

One kilogram of seeds were taken in a polythene bag, initially they were treated separately with thiram @ 2 g per kg of seeds as per the treatment combinations and added the Polymer dyes @ 12 ml were added in the polythene bag. The polythene bag was closed tightly and shaken till the seeds are uniformly coated. Later the treated seeds were spread on a sheet under the shade and dried completely.

### 3.3.5 Method of storage

The seeds after treating as per treatment were dried back to their original moisture content and stored in polythene bag in the laboratory of the National Seed Project, University of Agricultural Sciences, Dharwad under ambient conditions.

### 3.3.6 Design of experiment

The design of the experiment adopted was Completely Randomized Block Design with four replications.

### 3.3.7 Collection of experimental data

Data on seed quality parameters, viz., germination (%), rate of germination, shoot length (cm), root length (cm), field emergence, seedling dry weight, vigour index, electrical conductivity of seed leachate ( $\text{dSm}^{-1}$ ), seed moisture content (%) and seed infection (%) was recorded as per procedures explained in experiment I (3.2).

## 3.4 Statistical analysis

The data obtained from the various experiments were statistically analyzed by using appropriate ANOVA. The critical differences between the treatments were worked out at five per cent significance (Sundararaj *et al.*, 1972). The data on percentages were transformed into arc sine root percentage and transformed data was used for statistical analysis.

## 4. EXPERIMENTAL RESULTS

The results of experiment conducted to study the 'Effect of polymer film coating with fungicide and containers on storability of onion seeds' are presented in this chapter.

4.1 Experiment – I : Effect of polymer film coating with fungicide and containers on storability of onion seeds

### 4.1.1 Germination (%)

The results of seed germination (%) as influenced by seed treatments, containers and their interactions are presented in the Table 2 and Fig. 2.

The germination percentage of onion seeds declined progressively with the enhanced storage period. On an average the germination percentage recorded at the beginning and at the end of storage period was 97.62 and 73.90 per cent, respectively.

Significant differences in germination percentage due to seed treatments were observed throughout storage period except initial month. The polymer coating alone or in combination with fungicide or alone recorded significantly higher germination percentage compared to untreated seeds. Significantly higher germination was recorded with seeds coated with polymer @ 12 ml per kg of seed along with thiram @ 2 g per kg of seed at the end of storage period (98.76), followed by P<sub>6</sub> (74.37%). Significantly lower seed germination was recorded throughout the storage period with untreated control (P<sub>1</sub>) which recorded a germination percentage of 70.10 at the end of 10<sup>th</sup> month of storage.

The germination percentage seeds stored in aluminium pouch recorded significantly higher germination percentage over polythene bag throughout the storage period. The germination percentage recorded with aluminium pouch and polythene bag at the end of 10<sup>th</sup> month of storage was 73.88 and 72.81 per cent, respectively.

Interaction effects due to containers and seed treatments were significant throughout the storage period except at initial month of storage. Significantly higher germination percentage was recorded in P<sub>7</sub>C<sub>2</sub> (78.75) and lower germination percentage was noticed in P<sub>1</sub>C<sub>1</sub> (70.10) at the end of 10<sup>th</sup> month of storage period.

### 4.1.2 Field emergence (%)

The results of field emergence as influenced by seed treatments, containers and their interactions are presented in the Table 3.

The field emergence of onion seeds declined progressively with enhanced storage period. On an average, the field emergence percentage recorded at the beginning and at the end of storage period was 90.73 and 64.17 per cent respectively.

Significant difference in field emergence due to seed treatment was observed throughout storage period except initial month. The polymer coating alone or in combination with fungicide recorded significantly higher field emergence compared to untreated control. Significantly higher field emergence was recorded in (P<sub>7</sub>) both at initial (91.53) and at the end of storage period (67.80%). Significantly lower field emergence was recorded throughout the storage period in untreated control (P<sub>1</sub>) which recorded a field emergence of 59.80 per cent at the end of 10<sup>th</sup> month of storage period.

The seeds stored in aluminium pouch (C<sub>2</sub>) recorded significantly higher field emergence over polythene bag (C<sub>1</sub>) throughout the storage period. The field emergence percentage recorded with C<sub>2</sub> and C<sub>1</sub> at the end of 10<sup>th</sup> month of storage was 64.68 and 63.36 per cent respectively.

The interaction effects due to containers and seed treatments differed significant except initial month of storage. Higher and lower field emergence was noticed in P<sub>2</sub>C<sub>2</sub> (68.33%) and P<sub>1</sub>C<sub>1</sub> (58.40%) at the end of 10<sup>th</sup> month of storage.

### 4.1.3 Rate of germination

The results of rate of germination as influenced by seed treatments, containers and their interactions are presented in the Table 4.

Significant differences in rate of germination due to seed treatments with polymer and fungicide were observed throughout the storage period. The polymer coating alone or in combination with fungicide recorded significantly higher rate of germination compared to

**Table 2. Effect of polymer film coating with fungicide and containers on germination percentage of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
P <sub>1</sub> - Control	95.93 (78.18)*	90.27 (71.76)	86.02 (68.03)	83.73 (66.19)	77.64 (61.75)	70.10 (56.79)
P <sub>2</sub> - Polymer coating @ 6 ml /kg of seed	97.42 (80.72)	92.379 (74.32)	87.68 (69.38)	85.14 (67.29)	80.25 (63.58)	72.49 (58.31)
P <sub>3</sub> - Polymer coating @ 9 ml /kg of seed	97.53 (80.90)	93.51 (75.23)	88.68 (70.27)	85.93 (69.00)	80.57 (63.79)	74.22 (59.47)
P <sub>4</sub> - Polymer coating @ 12 ml /kg of seed	97.70 (81.28)	93.79 (75.46)	89.08 (70.43)	86.02 (68.87)	80.66 (63.87)	74.37 (59.54)
P <sub>5</sub> - Polymer coating @ 6 ml + thiram @ 2 g /kg of seed	98.02 (81.87)	93.41 (75.11)	88.60 (70.21)	86.75 (68.01)	81.42 (63.72)	73.62 (59.08)
P <sub>6</sub> - Polymer coating @ 9 ml + thiram @ 2 g /kg of seed	98.03 (81.86)	94.78 (76.39)	89.23 (70.81)	87.54 (69.30)	81.30 (64.23)	74.37 (59.54)
P <sub>7</sub> - Polymer coating @ 12 ml + thiram @ 2 g /kg of seed	98.76 (83.20)	95.62 (77.89)	90.28 (71.76)	88.08 (69.73)	83.36 (65.12)	77.12 (61.34)
S.Em <sub>±</sub>	0.12	0.11	0.20	0.60	0.62	0.40
CD at 5%	NS	0.31	0.57	1.73	1.79	1.15
<b>Containers (C)</b>						
C <sub>1</sub> - Polythene bag (700 gauge)	97.61 (80.91)	92.47 (75.11)	87.34 (69.12)	85.10 (67.21)	79.20 (62.87)	72.81 (58.56)
C <sub>2</sub> - Aluminium pouch	97.65 (80.89)	93.71 (75.46)	88.96 (72.12)	86.48 (68.30)	80.65 (63.87)	73.88 (59.21)
S.Em <sub>±</sub>	0.06	0.5	0.10	0.32	0.49	0.21
CD at 5%	NS	0.14	0.28	0.90	1.40	0.60

Contd...

Interactions (Px C)	Storage months					
	Initial	2	4	6	8	10
P <sub>1</sub> C <sub>1</sub>	95.28 (82.29)*	91.27 (72.74)	87.03 (69.87)	82.42 (65.70)	72.00 (58.05)	70.10 (56.79)
P <sub>1</sub> C <sub>2</sub>	96.57 (79.22)	91.26 (72.75)	87.18 (69.95)	83.00 (65.65)	79.77 (63.22)	70.31 (56.93)
P <sub>2</sub> C <sub>1</sub>	96.87 (79.70)	92.26 (73.78)	88.18 (69.82)	83.57 (66.03)	75.51 (60.33)	72.15 (58.00)
P <sub>2</sub> C <sub>2</sub>	97.58 (80.72)	93.26 (74.83)	89.02 (70.63)	86.00 (68.87)	80.79 (63.94)	74.75 (59.80)
P <sub>3</sub> C <sub>1</sub>	97.25 (80.37)	73.52 (75.23)	88.18 (69.82)	86.516 (87.44)	80.14 (63.51)	72.50 (58.37)

P <sub>3</sub> C <sub>2</sub>	97.83 (81.47)	93.76 (75.46)	89.18 (70.72)	67.17 (68.87)	81.00 (64.56)	75.20 (60.13)
P <sub>4</sub> C <sub>1</sub>	97.26 (80.37)	94.07 (75.82)	88.99 (70.80)	86.87 (68.70)	80.54 (63.76)	73.25 (58.82)
P <sub>4</sub> C <sub>2</sub>	98.87 (83.71)	94.25 (76.06)	89.17 (70.73)	88.86 (70.45)	81.81 (64.52)	78.36 (62.24)
P <sub>5</sub> C <sub>1</sub>	97.81 (81.47)	92.76 (74.32)	88.02 (69.73)	85.05 (67.21)	80.00 (63.43)	72.25 (58.18)
P <sub>5</sub> C <sub>2</sub>	98.26 (82.29)	94.07 (75.82)	88.18 (70.73)	86.72 (68.21)	80.85 (64.01)	72.75 (58.50)
P <sub>6</sub> C <sub>1</sub>	97.53 (80.72)	94.51 (76.44)	89.23 (70.81)	86.25 (68.19)	80.85 (64.00)	74.00 (59.34)
P <sub>6</sub> C <sub>2</sub>	98.51 (82.97)	95.06 (77.08)	89.23 (70.81)	88.58 (70.18)	81.40 (64.45)	74.75 (59.80)
P <sub>7</sub> C <sub>1</sub>	98.55 (80.71)	95.18 (77.21)	89.63 (71.28)	86.51 (68.44)	82.19 (64.90)	75.50 (60.33)
P <sub>7</sub> C <sub>2</sub>	98.97 (83.15)	96.05 (78.06)	90.92 (72.00)	89.92 (72.00)	82.53 (65.27)	78.75 (62.51)
<b>Mean</b>	<b>97.63</b> <b>(80.90)</b>	<b>93.59</b> <b>(75.23)</b>	<b>88.65</b> <b>(70.27)</b>	<b>86.31</b> <b>(68.38)</b>	<b>80.43</b> <b>(63.73)</b>	<b>73.90</b> <b>(58.21)</b>
S.Em <sub>±</sub>	0.18	0.19	0.28	0.86	0.89	0.57
CD at 5%	NS	0.55	0.81	2.49	2.57	1.65

NS- Non significant \* Figures in parenthesis are arcsine transformed values

untreated seeds. Higher rate of germination was recorded with polymer coating @ 12 ml + thiram @ 2 g per kg of seeds (P<sub>7</sub>) both at initial (45.62) and at the end of storage period (24.50), followed by polymer coating @ 9 ml + thiram @ 2 g per kg of seeds (P<sub>6</sub>) which recorded the rate of germination of 23.62 at end of storage. Significantly lower rate of germination was recorded throughout the storage period with control (P<sub>1</sub>), which recorded the rate of germination of 19.00 at the end of 10<sup>th</sup> month of storage.

The rate of germination differed significantly with the containers throughout the storage period. The rate of germination recorded with aluminium pouch (C<sub>2</sub>) and polythene bag (C<sub>1</sub>) was 23.18 and 22.00, respectively.

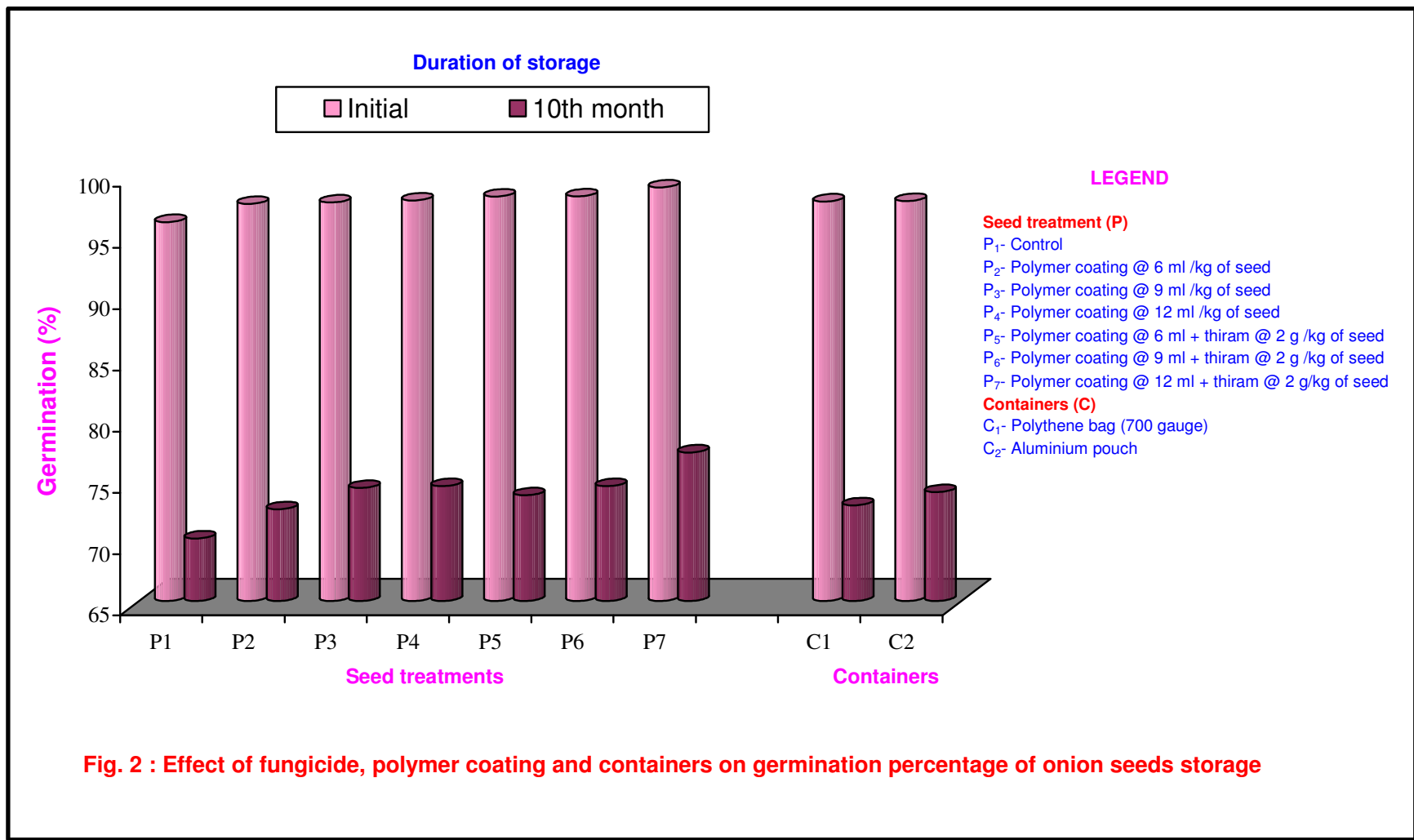
The integration effects due to containers and treatments showed significant variation throughout the storage period. Higher rate of germination was recorded with P<sub>7</sub>C<sub>2</sub> (24.75) and lower rate of germination was recorded with P<sub>1</sub>C<sub>1</sub> (19.75) at the end of 10<sup>th</sup> month of storage period.

#### 4.1.4 Shoot length (cm)

The results of shoot length as influenced by seed treatments, containers and their interactions are presented in the Table 5.

The shoot length of onion seedling declined with the enhanced storage period. On an average, the shoot length recorded at the beginning and end of storage period was 8.59 and 7.46 cm, respectively.

Significant differences in shoot length due to seed coating with polymer alone or along with fungicide treatment were observed throughout storage period. The polymer coating alone are in combination with fungicide recorded significantly higher shoot length compared to untreated control. Significantly higher shoot length was recorded with the polymer @ 12 ml + thiram 2 g per kg of seeds (P<sub>7</sub>) both at initial (8.75 cm) and at the end of storage



**Fig. 2 : Effect of fungicide, polymer coating and containers on germination percentage of onion seeds storage**

**Fig. 2 : Effect of fungicide, polymer coating and containers on germination percentage of onion seeds storage**

**Table 3. Effect of polymer film coating with fungicide and containers on field emergence of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
P <sub>1</sub> - Control	90.12 (71.66)*	86.75 (68.62)	83.62 (66.11)	77.50 (61.68)	69.81 (66.66)	59.80 (50.65)
P <sub>2</sub> - Polymer coating @ 6 ml /kg of seed	90.45 (71.97)	87.62 (69.16)	84.87 (67.09)	79.12 (62.80)	72.37 (59.24)	63.00 (52.54)
P <sub>3</sub> - Polymer coating @ 9 ml /kg of seed	90.62 (72.14)	87.63 (69.38)	85.6 (67.70)	79.62 (63.15)	73.62 (59.08)	63.29 (52.65)
P <sub>4</sub> - Polymer coating @ 12 ml /kg of seed	90.67 (72.14)	87.75 (69.72)	86.00 (68.03)	81.12 (64.23)	75.70 (60.47)	65.70 (54.15)
P <sub>5</sub> - Polymer coating @ 6 ml + thiram @ 2 g /kg of seed	90.62 (71.89)	87.85 (69.37)	85.62 (67.70)	79.36 (62.94)	73.12 (58.76)	63.83 (53.01)
P <sub>6</sub> - Polymer coating @ 9 ml + thiram @ 2 g /kg of seed	91.08 (72.03)	87.87 (69.38)	85.87 (67.86)	82.12 (64.97)	74.80 (59.87)	65.33 (53.91)
P <sub>7</sub> - Polymer coating @ 12 ml + thiram @ 2 g /kg of seed	91.53 (72.06)	88.62 (69.93)	86.37 (68.38)	82.37 (65.12)	78.25 (62.17)	67.80 (55.43)
S.Em±	0.44	0.39	0.40	0.21	0.42	0.40
CD at 5%	NS	1.12	1.15	0.60	1.21	1.15
<b>Containers (C)</b>						
C <sub>1</sub> - Polythene bag (700 gauge)	90.69 (71.92)	87.71 (69.21)	85.35 (68.39)	79.03 (62.73)	72.50 (58.37)	63.36 (52.74)
C <sub>2</sub> - Aluminium pouch	90.78 (72.04)	88.75 (76.36)	86.50 (64.44)	80.11 (63.51)	74.03 (59.34)	64.68 (53.49)
S.Em±	0.24	0.21	0.21	0.11	0.22	0.21
CD at 5%	NS	0.43	0.44	0.31	0.63	0.60

Contd.....

Interactions (PxC)	Storage months					
	Initial	2	4	6	8	10
P <sub>1</sub> C <sub>1</sub>	90.00 (71.54)	86.50 (68.41)	82.75 (66.67)	77.00 (61.34)	68.75 (55.98)	58.40 (49.84)
P <sub>1</sub> C <sub>2</sub>	90.25 (71.77)	8.00 (68.83)	83.00 (65.65)	77.25 (61.48)	69.25 (56.29)	61.33 (51.53)
P <sub>2</sub> C <sub>1</sub>	90.25 (71.92)	87.00 (69.70)	84.50 (66.82)	78.02 (62.03)	71.00 (57.42)	61.58 (51.65)
P <sub>2</sub> C <sub>2</sub>	90.45 (71.50)	88.00 (69.73)	85.50 (67.62)	79.01 (62.73)	72.25 (58.18)	64.00 (53.13)

P <sub>3</sub> C <sub>1</sub>	90.50 (72.01)	87.50 (69.30)	85.00 (67.21)	80.25 (63.58)	74.00 (59.34)	65.25 (53.85)
P <sub>3</sub> C <sub>2</sub>	90.50 (72.01)	88.00 (69.73)	86.50 (68.44)	80.75 (63.94)	75.25 (60.13)	66.16 (54.39)
P <sub>4</sub> C <sub>1</sub>	90.60 (72.26)	87.25 (69.04)	86.25 (68.19)	81.50 (64.52)	76.16 (60.73)	68.00 (55.55)
P <sub>4</sub> C <sub>2</sub>	90.75 (72.52)	88.26 (69.91)	86.75 (68.61)	82.00 (64.90)	78.00 (62.03)	58.58 (49.87)
P <sub>5</sub> C <sub>1</sub>	90.50 (71.77)	87.25 (69.04)	85.25 (67.37)	78.50 (62.38)	71.75 (57.86)	63.75 (52.95)
P <sub>5</sub> C <sub>2</sub>	90.75 (72.01)	88.00 (69.73)	85.75 (67.78)	79.25 (62.87)	73.00 (59.69)	63.70 (54.75)
P <sub>6</sub> C <sub>1</sub>	91.00 (72.01)	88.00 (69.73)	85.50 (67.62)	80.75 (65.94)	74.75 (59.80)	65.0 (83.73)
P <sub>6</sub> C <sub>2</sub>	91.16 (72.26)	88.50 (70.18)	86.00 (68.03)	81.00 (64.26)	75.00 (60.00)	65.58 (54.03)
P <sub>7</sub> C <sub>1</sub>	91.33 (71.86)	88.25 (69.04)	85.50 (67.62)	81.25 (64.30)	77.50 (61.69)	67.80 (55.43)
P <sub>7</sub> C <sub>2</sub>	91.83 (72.20)	89.00 (70.43)	87.75 (79.47)	82.50 (65.50)	79.00 (62.73)	58.33 (55.73)
<b>Mean</b>	<b>90.73</b> <b>(71.98)</b>	<b>87.73</b> <b>(69.47)</b>	<b>85.42</b> <b>(57.54)</b>	<b>80.07</b> <b>(63.43)</b>	<b>77.87</b> <b>(61.89)</b>	<b>64.17</b> <b>(53.19)</b>
S.Em $\pm$	0.63	0.56	0.57	0.30	0.60	0.57
CD at 5%	NS	1.62	1.65	0.86	1.73	1.65

\*Figures in the parenthesis are arcsine transformed values

period (8.13 cm) followed by the polymer @ 9 ml + thiram 2 g per kg of seeds (P<sub>6</sub>) which recorded 8.10 cm shoot length at the end of storage period. Significantly lower shoot length was recorded throughout the storage period with untreated seeds (P<sub>1</sub>), which recorded the shoot length of 6.50 cm at the end of 10<sup>th</sup> month of storage.

Containers exhibited significant variation on the shoot length throughout the storage period. The shoot length recorded with aluminium pouch and polythene bag at the end of storage period was 7.78 cm and 7.57 cm, respectively.

The interactions effect due to containers and treatments differed significant except at initial month of storage. Significantly higher shoot length was recorded in P<sub>7</sub>C<sub>2</sub> (8.20 cm) and lower shoot length was noticed in P<sub>1</sub>C<sub>1</sub> (6.50 cm) at the end of 10<sup>th</sup> month of storage.

#### 4.1.5 Root length (cm)

The results of root length as influenced by seed treatments, containers and their interactions are presented in the Table 6.

The root length of onion seedlings declined with enhanced storage period. On an average, the root length recorded at the beginning and end of the storage period was 8.14 cm and 6.62 cm, respectively. Significant differences in root length due to fungicide treatment and polymer coating at different concentration was observed throughout storage period. The polymer coating alone are in combination with fungicide recorded significantly higher root length compared to untreated control. Significantly higher root length was recorded with polymer @ 12 ml + thiram @ 2 g per kg of seeds (P<sub>7</sub>) both at initial (8.28 cm) and at the end of storage period (7.15 cm), followed by polymer @9 ml + thiram @ 2 g per kg of seeds (P<sub>6</sub>) which recorded a root length of 6.90 cm at the end of storage period. Significantly lower root

**Table 4. Effect of polymer film coating with fungicide and containers on rate of germination of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
	P <sub>1</sub> - Control	45.00	42.50	36.62	33.00	26.25
P <sub>2</sub> - Polymer coating @ 6 ml /kg of seed	45.12	43.00	38.27	35.00	28.25	21.50
P <sub>3</sub> - Polymer coating @ 9 ml /kg of seed	45.37	43.12	38.25	35.50	28.50	21.50
P <sub>4</sub> - Polymer coating @ 12 ml /kg of seed	45.37	43.62	38.62	36.00	28.62	21.62
P <sub>5</sub> - Polymer coating @ 6 ml + thiram @ 2 g /kg of seed	45.37	44.60	39.66	37.25	30.25	23.42
P <sub>6</sub> - Polymer coating @ 9 ml + thiram @ 2 g /kg of seed	45.37	44.12	39.78	37.25	30.32	23.62
P <sub>7</sub> - Polymer coating @ 12 ml + thiram @ 2 g/kg of seed	45.62	44.37	39.80	38.12	30.62	24.50
S.Em <sub>±</sub>	0.06	0.40	0.10	0.40	0.36	0.34
CD at 5%	NS	1.15	0.17	1.15	1.04	0.98
<b>Containers (C)</b>						
C <sub>1</sub> - Polythene bag (700 gauge)	45.13	43.39	38.20	35.50	28.57	22.00
C <sub>2</sub> - Aluminium pouch	45.15	44.57	39.25	36.39	29.67	23.18
S.Em <sub>±</sub>	0.05	0.21	0.05	0.21	0.19	0.18
CD at 5%	NS	0.60	0.14	0.60	0.55	0.52
<b>Interactions (PxC)</b>						
P <sub>1</sub> C <sub>1</sub>	45.00	42.00	37.00	34.25	28.50	19.75
P <sub>1</sub> C <sub>2</sub>	45.25	42.25	38.25	35.75	28.75	20.00
P <sub>2</sub> C <sub>1</sub>	44.50	42.25	38.25	34.75	29.00	20.75
P <sub>2</sub> C <sub>2</sub>	45.75	43.25	39.50	35.25	29.25	21.50
P <sub>3</sub> C <sub>1</sub>	45.00	42.75	39.25	35.25	29.25	21.75
P <sub>3</sub> C <sub>2</sub>	45.75	44.00	39.25	36.25	29.75	22.25
P <sub>4</sub> C <sub>1</sub>	45.00	43.25	39.50	35.25	29.25	21.75
P <sub>4</sub> C <sub>2</sub>	45.75	44.25	39.75	36.75	30.25	23.25
P <sub>5</sub> C <sub>1</sub>	45.25	43.50	39.41	36.25	29.25	21.25
P <sub>5</sub> C <sub>2</sub>	45.50	43.75	39.75	37.25	30.25	23.00
P <sub>6</sub> C <sub>1</sub>	45.50	44.00	39.58	36.25	29.75	23.00
P <sub>6</sub> C <sub>2</sub>	45.37	44.25	39.91	37.25	30.50	24.25
P <sub>7</sub> C <sub>1</sub>	45.25	44.25	39.75	37.00	30.00	24.25
P <sub>7</sub> C <sub>2</sub>	45.50	44.50	40.00	37.25	31.25	24.75
<b>Mean</b>	<b>45.31</b>	<b>43.48</b>	<b>39.22</b>	<b>36.08</b>	<b>29.62</b>	<b>22.08</b>
S.Em <sub>±</sub>	0.09	0.57	0.13	0.57	0.57	0.58
CD at 5%	NS	1.65	0.37	1.65	1.65	1.67

NS- Non significant

**Table 5. Effect of polymer film coating with fungicide and containers on shoot length (cm) of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
P <sub>1</sub> - Control	8.30	7.30	7.20	7.10	6.90	6.50
P <sub>2</sub> - Polymer coating @ 6 ml /kg of seed	8.48	7.63	8.40	7.80	7.80	7.50
P <sub>3</sub> - Polymer coating @ 9 ml /kg of seed	8.55	7.75	8.50	8.00	7.99	7.55
P <sub>4</sub> - Polymer coating @ 12 ml /kg of seed	8.66	7.83	8.50	8.14	8.12	8.05
P <sub>5</sub> - Polymer coating @ 6 ml + thiram @ 2 g /kg of seed	8.66	7.86	8.55	8.21	8.20	8.10
P <sub>6</sub> - Polymer coating @ 9 ml + thiram @ 2 g /kg of seed	8.68	8.00	8.60	8.25	8.25	8.10
P <sub>7</sub> - Polymer coating @ 12 ml + thiram @ 2 g/kg of seed	8.75	8.11	8.75	8.35	8.26	8.13
S.Em±	0.03	0.05	0.04	0.05	0.06	0.08
CD at 5%	NS	0.14	0.11	0.14	0.17	0.23
<b>Containers (C)</b>						
C <sub>1</sub> - Polythene bag (700 gauge)	8.59	7.57	8.29	7.92	7.94	7.57
C <sub>2</sub> - Aluminium pouch	8.60	7.84	8.40	8.10	8.05	7.78
S.Em±	0.01	0.04	0.02	0.04	0.03	0.04
CD at 5%	NS	0.11	0.05	0.11	0.08	0.11
<b>Interactions (PxC)</b>						
P <sub>1</sub> C <sub>1</sub>	8.30	7.30	7.20	7.20	7.10	6.50
P <sub>1</sub> C <sub>2</sub>	8.40	7.33	7.60	7.30	7.30	6.80
P <sub>2</sub> C <sub>1</sub>	8.40	7.60	8.30	7.30	7.30	7.20
P <sub>2</sub> C <sub>2</sub>	8.50	7.63	8.40	8.06	8.07	7.30
P <sub>3</sub> C <sub>1</sub>	8.56	7.63	8.00	8.10	8.11	7.70
P <sub>3</sub> C <sub>2</sub>	8.60	7.63	8.50	8.20	8.20	7.90
P <sub>4</sub> C <sub>1</sub>	8.70	8.06	8.60	8.30	8.30	7.80
P <sub>4</sub> C <sub>2</sub>	8.80	8.16	8.70	8.30	8.314	8.01
P <sub>5</sub> C <sub>1</sub>	8.60	7.66	8.50	8.10	8.10	8.00
P <sub>5</sub> C <sub>2</sub>	8.63	7.73	8.70	8.30	8.32	8.00
P <sub>6</sub> C <sub>1</sub>	8.66	7.83	8.70	8.30	8.30	8.00
P <sub>6</sub> C <sub>2</sub>	8.70	7.86	8.80	8.40	8.40	8.10
P <sub>7</sub> C <sub>1</sub>	8.70	8.36	8.80	8.40	8.41	8.00
P <sub>7</sub> C <sub>2</sub>	8.76	8.50	8.90	8.60	8.60	8.20
<b>Mean</b>	<b>8.59</b>	<b>7.78</b>	<b>8.38</b>	<b>7.98</b>	<b>8.025</b>	<b>7.46</b>
S.Em±	0.11	0.07	0.05	0.08	0.09	0.11
CD at 5%	NS	0.20	0.14	0.23	0.26	0.31

NS- Non significant

length was recorded throughout storage period with untreated seeds ( $P_1$ ), which recorded the root length of 6.00 cm at the end of 10<sup>th</sup> month of storage.

The aluminium pouch ( $C_2$ ) was significantly superior in root length over polythene bag ( $C_1$ ) throughout the storage. The root length recorded with the aluminium pouch and polythene bag (700 gauge) at the end of storage period was 6.87 cm and 6.60 cm, respectively.

The interaction effects between treatments and containers differed significantly except at initial month of storage. Significantly higher root length was recorded in  $P_7C_2$  (7.20 cm) and lower root length was noticed in  $P_1C_1$  (6.10 cm) at the end of 10<sup>th</sup> month of storage.

#### 4.1.6 Dry weight of seedlings (mg)

The results of dry weight of seedlings as influenced by seed treatments, containers and their interactions are presented in the Table 7.

The dry weight of seedlings declined with enhanced storage period. On an average, the dry weight of seedlings recorded at the beginning and end of the storage period was 30.01 mg and 20.19 mg, respectively. Significant differences in dry weight of seedling due to seed treatment with polymer along with fungicide was observed throughout storage period. The polymer coating alone in combination with fungicide recorded significantly higher dry weight of seedlings compared to untreated control. Significantly higher dry weight of seedling was recorded with polymer coating @ 12 ml + thiram @ 2 g per kg of seeds both at initial (30.19 mg) and at the end of storage period (22.05 mg), followed by polymer coating @ 9 ml + thiram @ 2 g per kg of seeds which recorded 20.98 mg dry weight of seedlings at the end of storage period. Significantly lower dry weight of seedling was recorded throughout the storage with the untreated seeds ( $P_1$ ), which recorded a dry weight of seedling of 16.07 mg at the end of 10<sup>th</sup> month of storage period.

Significant variation in dry weight of seedling due to containers was observed throughout the storage period. Higher seedling dry weight was recorded with aluminium pouch ( $C_2$ ) than polythene bag ( $C_1$ ), which recorded a dry weight of seedlings of 21.34 mg and 20.03 mg, respectively at the end of storage period.

The interaction effects due to seed treatments and containers were observed throughout the storage period. Higher seedlings dry weight was recorded in  $P_7C_2$  (22.18 mg) and lower seedling dry weight was recorded in  $P_1C_1$  (17.47 mg) at the end of 10<sup>th</sup> month of storage.

#### 4.1.7 Vigour index

The results of vigour index as influenced by seed treatments, containers and their interactions are presented in the Table 8 and depicted in Fig. 3.

The vigour index declined with enhanced storage period. On an average, the vigour index recorded at the beginning and end of the storage period was 1615 and 1160, respectively. Significant differences in vigour index due to polymer coating alone or along with fungicide was observed throughout the storage period. The polymer coating alone or in combination with fungicide recorded significantly higher vigour index compared to untreated control. Significantly higher vigour index was recorded with polymer coating @ 12 ml + thiram @ 2 g per kg of seeds ( $P_7$ ) both at initial (1663) and at end of storage period (1291), followed by polymer coating @ 9 ml + thiram @ 2 g per kg of seeds ( $P_6$ ) which recorded a vigour index of 1219 at the end of storage period.

Significantly lower seed vigour index was recorded throughout the storage period with the untreated seeds ( $P_1$ ), which recorded the vigour index of 995 at the end of 10<sup>th</sup> month of storage.

Significant variation was observed in vigour index due to containers. Aluminium pouch ( $C_2$ ) found significantly superior over polythene bag ( $C_1$ ) in all the months of storage. The vigour index recorded with  $C_2$  and  $C_1$  at the end of storage period was 1168 and 1100, respectively.

The interaction between seed treatments and containers differed significantly except at initial month of storage. Significantly higher vigour index was noticed in  $P_7C_2$  (1333) and lower vigour index was noticed in  $P_1C_1$  (925) at the end of 10<sup>th</sup> month of storage.

**Table 6. Effect of polymer film coating with fungicide and containers on root length (cm) of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
P <sub>1</sub> - Control	8.03	7.20	6.85	6.80	6.50	6.00
P <sub>2</sub> - Polymer coating @ 6 ml /kg of seed	8.11	7.60	7.45	7.25	6.73	6.40
P <sub>3</sub> - Polymer coating @ 9 ml /kg of seed	8.12	7.73	7.80	7.30	6.75	6.50
P <sub>4</sub> - Polymer coating @ 12 ml /kg of seed	8.14	7.95	7.95	7.40	6.85	6.50
P <sub>5</sub> - Polymer coating @ 6 ml + thiram @ 2 g /kg of seed	8.15	7.80	7.65	7.50	7.06	6.70
P <sub>6</sub> - Polymer coating @ 9 ml + thiram @ 2 g /kg of seed	8.16	8.00	8.10	7.60	7.15	6.90
P <sub>7</sub> - Polymer coating @ 12 ml + thiram @ 2 g/kg of seed	8.28	8.10	8.20	7.75	7.40	7.15
S.Em±	0.02	0.04	0.05	0.03	0.04	0.06
CD at 5%	NS	0.11	0.14	0.09	0.11	0.17
<b>Containers (C)</b>						
C <sub>1</sub> - Polythene bag (700 gauge)	8.12	7.70	7.70	7.20	6.69	6.60
C <sub>2</sub> - Aluminium pouch	8.16	7.81	7.92	7.38	6.96	6.87
S.Em±	0.11	0.03	0.05	0.02	0.03	0.05
CD at 5%	NS	0.08	0.14	0.05	0.08	0.14
<b>Interactions (PxC)</b>						
P <sub>1</sub> C <sub>1</sub>	8.03	7.20	6.80	6.85	6.55	6.10
P <sub>1</sub> C <sub>2</sub>	8.04	7.35	6.90	6.90	6.60	6.20
P <sub>2</sub> C <sub>1</sub>	8.03	7.50	7.10	7.00	6.46	6.10
P <sub>2</sub> C <sub>2</sub>	8.07	7.90	7.80	7.50	6.70	6.30
P <sub>3</sub> C <sub>1</sub>	8.08	7.56	7.40	7.10	7.00	6.50
P <sub>3</sub> C <sub>2</sub>	8.20	8.00	8.10	7.50	7.00	6.80
P <sub>4</sub> C <sub>1</sub>	8.10	8.00	8.10	7.70	6.50	6.60
P <sub>4</sub> C <sub>2</sub>	8.30	8.00	8.20	7.80	7.00	6.90
P <sub>5</sub> C <sub>1</sub>	8.05	7.70	7.50	7.40	7.00	6.50
P <sub>5</sub> C <sub>2</sub>	8.20	7.90	7.80	7.40	7.13	6.60
P <sub>6</sub> C <sub>1</sub>	8.15	7.90	7.90	7.50	7.10	6.90
P <sub>6</sub> C <sub>2</sub>	8.21	8.00	8.00	7.70	7.20	7.00
P <sub>7</sub> C <sub>1</sub>	8.25	8.00	8.20	7.70	7.30	7.10
P <sub>7</sub> C <sub>2</sub>	8.31	8.22	8.20	7.90	7.50	7.20
<b>Mean</b>	<b>8.14</b>	<b>7.77</b>	<b>7.71</b>	<b>7.35</b>	<b>6.92</b>	<b>6.62</b>
S.Em±	0.03	0.05	0.08	0.05	0.06	0.09
CD at 5%	NS	0.14	0.23	0.14	0.17	0.26

NS- Non significant

#### 4.1.8 Electrical conductivity of seed leachate (dSm-1)

The results of electrical conductivity as influenced by seed treatments, containers and their interactions are presented in the Table 9.

**Table 7. Effect of polymer film coating with fungicide and containers on seedlings dry weight (mg) of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
P <sub>1</sub> - Control	29.72	27.64	23.19	21.72	20.37	16.07
P <sub>2</sub> - Polymer coating @ 6 ml /kg of seed	29.98	28.04	24.58	22.49	21.10	19.80
P <sub>3</sub> - Polymer coating @ 9 ml /kg of seed	29.99	28.08	24.76	22.88	21.40	19.90
P <sub>4</sub> - Polymer coating @ 12 ml /kg of seed	30.04	28.18	24.84	23.00	21.60	20.36
P <sub>5</sub> - Polymer coating @ 6 ml + thiram @ 2 g /kg of seed	30.00	29.24	25.50	23.58	22.20	20.91
P <sub>6</sub> - Polymer coating @ 9 ml + thiram @ 2 g /kg of seed	30.15	29.95	25.22	23.33	22.25	20.98
P <sub>7</sub> - Polymer coating @ 12 ml + thiram @ 2 g/kg of seed	30.19	30.19	25.76	23.60	22.73	22.05
S.Em±	0.04	0.40	0.38	0.37	0.40	0.37
CD at 5%	NS	1.15	1.10	1.07	1.15	1.07
<b>Containers (C)</b>						
C <sub>1</sub> - Polythene bag (700gauge)	29.98	27.28	24.78	22.87	21.48	20.03
C <sub>2</sub> - Aluminium pouch	30.00	28.33	25.84	23.92	22.58	21.34
S.Em±	0.02	0.21	0.20	0.19	0.21	0.22
CD at 5%	NS	0.60	0.57	0.55	0.60	0.63
<b>Interactions (Px C)</b>						
P <sub>1</sub> C <sub>1</sub>	29.71	27.82	24.31	21.92	20.09	17.47
P <sub>1</sub> C <sub>2</sub>	29.73	27.79	24.36	22.11	20.65	18.76
P <sub>2</sub> C <sub>1</sub>	29.89	27.69	24.44	22.23	21.23	18.99
P <sub>2</sub> C <sub>2</sub>	30.07	27.86	24.55	22.30	21.30	19.84
P <sub>3</sub> C <sub>1</sub>	29.91	27.88	24.77	22.87	21.60	20.07
P <sub>3</sub> C <sub>2</sub>	30.09	28.02	24.97	22.89	21.80	20.23
P <sub>4</sub> C <sub>1</sub>	29.89	28.05	24.70	22.76	21.87	20.16
P <sub>4</sub> C <sub>2</sub>	30.19	28.50	25.01	23.71	21.96	20.55
P <sub>5</sub> C <sub>1</sub>	29.91	28.30	25.11	22.94	21.53	20.76
P <sub>5</sub> C <sub>2</sub>	30.08	28.66	25.16	23.17	21.97	21.20
P <sub>6</sub> C <sub>1</sub>	30.10	28.76	25.14	23.25	22.03	21.30
P <sub>6</sub> C <sub>2</sub>	30.16	29.05	25.24	23.42	22.10	21.50
P <sub>7</sub> C <sub>1</sub>	30.20	29.14	25.43	23.58	22.15	21.87
P <sub>7</sub> C <sub>2</sub>	30.22	29.34	25.58	23.63	22.32	22.18
<b>Mean</b>	30.01	28.30	24.81	22.90	21.53	20.19
S.Em±	0.50	0.56	0.53	0.52	0.56	0.53
CD at 5%	NS	1.62	1.53	1.50	1.62	1.53

NS- Non significant

The electrical conductivity of seed leachate increased to enhanced storage period. On an average, the electrical conductivity of seed leachate recorded at the beginning and end of the storage period was 0.513 dSm<sup>-1</sup> and 0.662 dSm<sup>-1</sup>, respectively. Significant differences

**Table 8. Effect of polymer film coating with fungicide and containers on vigour index of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
P <sub>1</sub> - Control	1571	1294	1287	1190	1091	995
P <sub>2</sub> - Polymer coating @ 6 ml /kg of seed	1599	1442	1369	1316	1225	1126
P <sub>3</sub> - Polymer coating @ 9 ml /kg of seed	1618	1452	1411	1345	1236	1137
P <sub>4</sub> - Polymer coating @ 12 ml /kg of seed	1624	1481	1413	1361	1275	1148
P <sub>5</sub> - Polymer coating @ 6 ml + thiram @ 2 g /kg of seed	1604	1482	1408	1370	1292	1206
P <sub>6</sub> - Polymer coating @ 9 ml +thiram @ 2 g /kg of seed	1625	1505	1423	1403	1353	1219
P <sub>7</sub> - Polymer coating @ 12 ml + thiram @ 2 g/kg of seed	1663	1506	1490	1445	1414	1291
S.Em±	41	42	40	40	39	38
CD at 5%	118	121	115	116	112	110
<b>Containers (C)</b>						
C <sub>1</sub> - Polythene bag (700 gauge)	1618	1451	1305	1334	1205	1100
C <sub>2</sub> - Aluminium pouch	1618	1552	1404	1361	1283	1168
S.Em±	22	22	21	21	18	19
CD at 5%	NS	63	60	60	52	55
<b>Interactions (PxC)</b>						
P <sub>1</sub> C <sub>1</sub>	1570	1242	1282	1145	1058	925
P <sub>1</sub> C <sub>2</sub>	1572	1347	1292	1230	1116	978
P <sub>2</sub> C <sub>1</sub>	1581	1345	1320	1229	1183	1066
P <sub>2</sub> C <sub>2</sub>	1590	1469	1453	1302	1287	1107
P <sub>3</sub> C <sub>1</sub>	1582	1436	1349	1230	1125	1189
P <sub>3</sub> C <sub>2</sub>	1590	1469	1428	1399	1312	1191
P <sub>4</sub> C <sub>1</sub>	1609	1475	1394	1342	1272	1222
P <sub>4</sub> C <sub>2</sub>	1618	1487	1506	1462	1344	1275
P <sub>5</sub> C <sub>1</sub>	1628	1493	1364	1229	1306	1093
P <sub>5</sub> C <sub>2</sub>	1632	1501	1446	1335	1359	1182
P <sub>6</sub> C <sub>1</sub>	1646	1495	1428	1388	1339	1207
P <sub>6</sub> C <sub>2</sub>	1658	1510	1534	1405	1359	1232
P <sub>7</sub> C <sub>1</sub>	1666	1520	1467	1419	1398	1249
P <sub>7</sub> C <sub>2</sub>	1668	1539	1534	1472	1489	1333
<b>Mean</b>	<b>1615</b>	<b>1452</b>	<b>1400</b>	<b>1347</b>	<b>1269</b>	<b>1160</b>
S.Em±	58	60	57	57	56	58
CD at 5%	NS	173	165	165	162	167

NS- Non significant

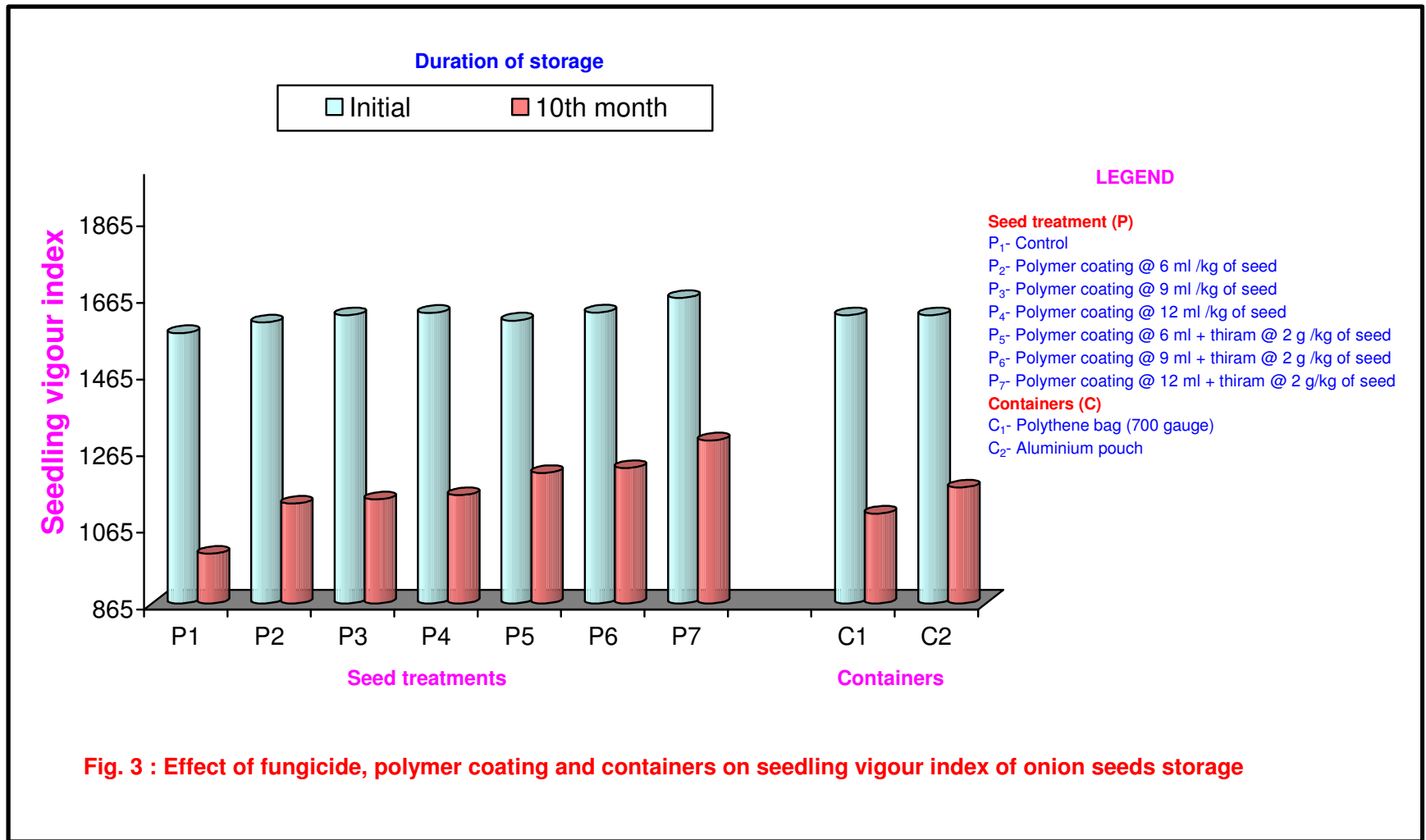


Fig. 3 : Effect of fungicide, polymer coating and containers on seedling vigour index of onion seeds storage

**Table 9. Effect of polymer film coating with fungicide and containers on electrical conductivity of seed leachate ( $\text{dSm}^{-1}$ ) of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
P <sub>1</sub> - Control	0.519	0.586	0.628	0.655	0.680	0.710
P <sub>2</sub> - Polymer coating @ 6 ml /kg of seed	0.517	0.564	0.596	0.620	0.653	0.685
P <sub>3</sub> - Polymer coating @ 9 ml /kg of seed	0.513	0.563	0.594	0.618	0.652	0.677
P <sub>4</sub> - Polymer coating @ 12 ml /kg of seed	5.512	0.563	0.593	0.615	0.650	0.654
P <sub>5</sub> - Polymer coating @ 6 ml + thiram @ 2 g /kg of seed	5.513	0.541	0.566	0.600	0.633	0.658
P <sub>6</sub> - Polymer coating @ 9 ml + thiram @ 2 g /kg of seed	5.510	0.539	0.567	0.595	0.630	0.656
P <sub>7</sub> - Polymer coating @ 12 ml + thiram @ 2 g/kg of seed	0.507	0.518	0.566	0.590	0.625	0.630
S.Em $\pm$	0.005	0.009	0.010	0.006	0.005	0.006
CD at 5%	NS	0.026	0.028	0.017	0.014	0.017
<b>Containers (C)</b>						
C <sub>1</sub> - Polythene bag (700 gauge)	0.513	0.546	0.618	0.623	0.658	0.685
C <sub>2</sub> - Aluminium pouch	0.513	0.530	0.579	0.606	0.630	0.652
S.Em $\pm$	0.003	0.004	0.010	0.003	0.003	0.004
CD at 5%	NS	0.011	0.028	0.009	0.009	0.011
<b>Interactions (PxC)</b>						
P <sub>1</sub> C <sub>1</sub>	0.522	0.546	0.672	0.621	0.650	0.705
P <sub>1</sub> C <sub>2</sub>	0.519	0.541	0.588	0.614	0.646	0.677
P <sub>2</sub> C <sub>1</sub>	0.518	0.545	0.585	0.613	0.637	0.687
P <sub>2</sub> C <sub>2</sub>	0.516	0.544	0.583	0.610	0.634	0.681
P <sub>3</sub> C <sub>1</sub>	0.516	0.545	0.585	0.611	0.632	0.662
P <sub>3</sub> C <sub>2</sub>	0.514	0.537	0.584	0.608	0.630	0.656
P <sub>4</sub> C <sub>1</sub>	0.514	0.544	0.585	0.610	0.630	0.652
P <sub>4</sub> C <sub>2</sub>	0.512	0.541	0.561	0.605	0.629	0.658
P <sub>5</sub> C <sub>1</sub>	0.512	0.551	0.578	0.607	0.630	0.654
P <sub>5</sub> C <sub>2</sub>	0.511	0.538	0.577	0.605	0.629	0.649
P <sub>6</sub> C <sub>1</sub>	0.509	0.535	0.580	0.603	0.629	0.648
P <sub>6</sub> C <sub>2</sub>	0.505	0.531	0.575	0.601	0.627	0.669
P <sub>7</sub> C <sub>1</sub>	0.508	0.538	0.585	0.598	0.626	0.638
P <sub>7</sub> C <sub>2</sub>	0.505	0.520	0.558	0.593	0.625	0.633
<b>Mean</b>	<b>0.513</b>	<b>0.538</b>	<b>0.585</b>	<b>0.607</b>	<b>0.632</b>	<b>0.662</b>
S.Em $\pm$	0.007	0.012	0.020	0.009	0.007	0.009
CD at 5%	NS	NS	0.57	0.023	0.020	0.026

NS- Non significant

were recorded due to seed treatment with polymer coating along with fungicide throughout the storage period. The polymer coating alone in combination with fungicide recorded significantly higher electrical conductivity compared to untreated control. There was significant variation in polymer coating @ 12 ml + thiram @ 2 g per kg of seeds ( $P_7$ ) showed superiority over all the treatments. Among the treatments, lower electrical conductivity of seed leachate was recorded in  $P_7$  ( $0.507 \text{ dSm}^{-1}$ ) and higher EC recorded in  $P_1$  ( $0.519 \text{ dSm}^{-1}$ ) at the initial period of storage. At the end of storage period, the electrical conductivity recorded with these treatments was  $0.630 \text{ dSm}^{-1}$  and  $0.710 \text{ dSm}^{-1}$  respectively.

There was a significant variation between the containers with respect to electrical conductivity of seed leachate throughout the storage period. At the end of storage period, electrical conductivity of seed leachate was  $0.652 \text{ dSm}^{-1}$  and  $0.685 \text{ dSm}^{-1}$  in  $C_2$  and  $C_1$ , respectively.

Interaction effects due to seed treatments and containers on electrical conductivity of seed leachate was non-significant at initial two months of storage and after fourth month significantly lower EC value was noticed in polymer coated with fungicide treated seeds  $0.633 \text{ dSm}^{-1}$  untreated seeds ( $0.705 \text{ dSm}^{-1}$ ) at the end of storage.

#### 4.1.9 Moisture content (%)

The results of moisture content as influenced by seed treatments, containers and their interactions are presented in the Table 10.

The seed moisture varied with different months of storage. The seed moisture increased from 6.5 per cent at initial to 7.80 per cent at eighth months of storage and further decreased to 6.8 per cent at the tenth month of storage. Significantly lower moisture content was recorded in  $P_7$  (6.48%) followed by  $P_6$  (6.55%) and significantly higher moisture content recorded in untreated seeds (7.10%) at the end of 10<sup>th</sup> month of storage period.

Significant differences were observed between container for seed moisture content. Lower seed moisture content was recorded in aluminium pouch (6.75%) as compared to polythene bag (6.90%) at the end of 10<sup>th</sup> month of storage period.

Interaction between the containers and seed treatments were found significant throughout the storage period. Significantly lower moisture content was recorded in  $P_7C_2$  (6.47%) higher moisture was recorded in  $P_1C_1$  (7.62%) at the end of 10<sup>th</sup> month of storage.

#### 4.1.10 Seed infection (%)

The results of seed infection as influenced by seed treatments, containers and their interactions are presented in the Table 11 and depicted in Fig. 4.

The seed infection per cent increased progressively with the enhanced storage period. On an average, the seed infection per cent recorded at the beginning and at the end of storage period was 3.26 and 13.46 per cent, respectively. Significant differences in seed infection per cent due to seed treatments was observed after the second month of storage periods onwards.

Significantly lower seed infection was recorded in ( $P_7$ ) at the end of storage period (2.08%). Significantly higher seed infection was recorded throughout storage with untreated seeds ( $P_1$ ) which recorded 10.29 per cent infection at the end of 10<sup>th</sup> month of storage.

Significant variations were recorded containers throughout the storage. Significantly lower seed infection was observed in aluminium pouch (6.01%) compared to polythene bag (7.20%) at the end of 10<sup>th</sup> month of storage period.

The interaction effects due to containers and seed treatments were significant throughout the storage period. Significantly lower seed infection was recorded with  $P_7C_2$  (1.24%) and higher seed infection was recorded in  $P_1C_1$  (12.83%) at the end of storage period.

## 4.2 Experiment – II : Effect of fungicide and polymer dyes on storability of onion seeds

The results pertaining to the 'Effect of fungicide and polymer dyes on onion seed storability are present in this chapter.

**Table 10. Effect of polymer film coating with fungicide and containers on moisture content of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
P <sub>1</sub> - Control	6.52	7.09	7.60	7.95	7.26	7.10
P <sub>2</sub> - Polymer coating @ 6 ml /kg of seed	6.51	6.96	7.30	7.57	7.02	6.85
P <sub>3</sub> - Polymer coating @ 9 ml /kg of seed	6.51	6.92	7.22	7.53	7.00	6.72
P <sub>4</sub> - Polymer coating @ 12 ml /kg of seed	6.50	6.86	7.16	7.31	6.95	6.70
P <sub>5</sub> - Polymer coating @ 6 ml + thiram @ 2 g /kg of seed	6.50	6.85	7.12	7.13	6.93	6.62
P <sub>6</sub> - Polymer coating @ 9 ml + thiram @ 2 g /kg of seed	6.49	6.60	7.10	7.09	6.90	6.55
P <sub>7</sub> - Polymer coating @ 12 ml + thiram @ 2 g/kg of seed	6.46	6.51	6.99	7.05	6.84	6.48
S.Em <sub>±</sub>	0.02	0.01	0.02	0.01	0.03	0.04
CD at 5%	NS	0.03	0.05	0.03	0.09	0.12
<b>Containers (C)</b>						
C <sub>1</sub> - Polythene bag (700 gauge)	6.51	6.93	7.30	7.38	7.01	6.90
C <sub>2</sub> - Aluminium pouch	6.50	6.78	7.20	7.30	6.96	6.75
S.Em <sub>±</sub>	0.01	0.02	0.03	0.02	0.01	0.02
CD at 5%	NS	0.05	0.08	0.05	0.02	0.05
<b>Interactions (PxC)</b>						
P <sub>1</sub> C <sub>1</sub>	6.55	7.15	7.90	8.10	7.65	7.62
P <sub>1</sub> C <sub>2</sub>	6.53	7.03	7.80	8.04	7.30	6.87
P <sub>2</sub> C <sub>1</sub>	6.53	6.98	7.30	7.66	7.12	6.84
P <sub>2</sub> C <sub>2</sub>	6.52	6.90	7.23	7.56	7.06	6.84
P <sub>3</sub> C <sub>1</sub>	6.51	6.95	7.30	7.43	7.05	6.77
P <sub>3</sub> C <sub>2</sub>	6.50	6.90	7.20	7.40	7.02	6.76
P <sub>4</sub> C <sub>1</sub>	6.50	6.81	7.01	7.20	7.00	6.72
P <sub>4</sub> C <sub>2</sub>	6.50	6.80	7.01	7.15	6.98	6.72
P <sub>5</sub> C <sub>1</sub>	6.51	6.90	7.13	7.20	6.96	6.71
P <sub>5</sub> C <sub>2</sub>	6.50	6.80	7.10	7.12	6.92	6.68
P <sub>6</sub> C <sub>1</sub>	6.49	6.80	7.10	7.10	6.88	6.64
P <sub>6</sub> C <sub>2</sub>	6.48	6.79	6.95	7.09	6.85	6.57
P <sub>7</sub> C <sub>1</sub>	6.46	6.60	7.11	7.05	6.83	6.50
P <sub>7</sub> C <sub>2</sub>	6.43	6.55	6.90	7.03	6.73	6.47
<b>Mean</b>	<b>6.50</b>	<b>6.85</b>	<b>7.30</b>	<b>7.38</b>	<b>7.10</b>	<b>6.65</b>
S.Em <sub>±</sub>	0.03	0.03	0.05	0.03	0.04	0.05
CD at 5%	NS	0.08	0.14	0.08	0.11	0.14

NS- Non significant

**Table 11. Effect of polymer film coating with fungicide and containers on seed infection (%) of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
P <sub>1</sub> - Control	1.14 (5.98)*	1.75 (7.55)	4.08 (11.55)	5.01 (12.86)	7.41 (5.21)	10.29 (18.56)
P <sub>2</sub> - Polymer coating @ 6 ml /kg of seed	0.37 (3.45)	1.50 (7.00)	1.68 (7.38)	3.39 (10.54)	5.411 (3.42)	6.79 (13.75)
P <sub>3</sub> - Polymer coating @ 9 ml /kg of seed	0.07 (1.13)	0.75 (4.95)	1.71 (7.47)	3.06 (10.02)	4.41 (2.25)	6.79 (13.75)
P <sub>4</sub> - Polymer coating @ 12 ml /kg of seed	0.64 (3.69)	0.80 (8.09)	1.60 (6.55)	2.84 (8.92)	4.41 (11.05)	6.20 (14.40)
P <sub>5</sub> - Polymer coating @ 6 ml + thiram @ 2 g /kg of seed	0.51 (4.07)	0.30 (3.12)	0.97 (5.61)	1.72 (7.18)	2.91 (9.70)	5.04 (12.95)
P <sub>6</sub> - Polymer coating @ 9 ml + thiram @ 2 g /kg of seed	0.22 (2.65)	0.17 (2.31)	0.65 (4.56)	1.08 (8.87)	2.29 (8.62)	4.91 (12.72)
P <sub>7</sub> - Polymer coating @ 12 ml + thiram @ 2 g/kg of seed	0.04 (1.14)	0.10 (1.83)	0.18 (2.21)	0.42 (3.62)	1.17 (6.11)	2.08 (8.10)
S.Em±	0.16	0.11	0.32	0.30	0.38	0.29
CD at 5%	0.46	0.31	0.92	0.86	1.10	0.83
<b>Containers (C)</b>						
C <sub>1</sub> - Polythene bag (700 gauge)	0.45 (3.27)	0.94 (5.09)	2.64 (9.28)	4.69 (12.38)	5.15 (13.05)	7.20 (15.56)
C <sub>2</sub> - Aluminium pouch	0.40 (3.16)	0.59 (4.03)	1.47 (6.30)	2.31 (8.04)	3.89 (10.80)	6.01 (13.68)
S.Em±	0.09	0.05	0.17	0.16	0.20	0.16
CD at 5%	NS	0.14	0.49	0.46	0.57	0.46

Contd.....

Interactions (Px C)	Storage months					
	Initial	2	4	6	8	10
P <sub>1</sub> C <sub>1</sub>	1.58 (7.20)	2.35 (8.81)	5.03 (12.94)	6.16 (14.36)	8.91 (17.36)	12.83 (20.98)
P <sub>1</sub> C <sub>2</sub>	1.25 (6.41)	1.75 (7.59)	3.13 (10.46)	4.96 (12.85)	7.66 (16.06)	11.91 (20.18)
P <sub>2</sub> C <sub>1</sub>	0.70 (4.76)	1.20 (6.28)	2.86 (9.70)	3.86 (11.31)	5.91 (14.06)	7.75 (16.15)

P <sub>2</sub> C <sub>2</sub>	0.50 (4.05)	1.25 (6.41)	1.78 (7.60)	3.46 (10.70)	5.16 (13.11)	6.66 (14.99)
P <sub>3</sub> C <sub>1</sub>	0.25 (2.85)	1.01 (5.76)	1.58 (7.15)	2.66 (9.31)	3.91 (11.38)	6.75 (13.86)
P <sub>3</sub> C <sub>2</sub>	0.10 (1.77)	0.60 (4.43)	0.85 (5.28)	1.28 (6.45)	2.66 (9.35)	5.91 (14.06)
P <sub>4</sub> C <sub>1</sub>	0.05 (1.98)	0.35 (3.38)	0.45 (3.84)	0.88 (5.39)	1.91 (7.88)	3.91 (11.38)
P <sub>4</sub> C <sub>2</sub>	0.03 (0.98)	0.25 (2.85)	0.35 (3.39)	0.72 (4.88)	1.16 (6.03)	1.66 (7.33)
P <sub>5</sub> C <sub>1</sub>	0.60 (4.54)	0.80 (5.12)	1.96 (9.70)	3.91 (11.38)	5.91 (14.06)	7.16 (15.51)
P <sub>5</sub> C <sub>2</sub>	0.40 (3.60)	0.70 (4.78)	1.46 (7.99)	2.86 (9.70)	4.91 (12.79)	6.41 (14.65)
P <sub>6</sub> C <sub>1</sub>	0.30 (3.10)	0.25 (2.85)	1.23 (6.95)	2.66 (9.35)	3.66 (11.01)	5.16 (12.73)
P <sub>6</sub> C <sub>2</sub>	0.15 (2.198)	0.11 (1.95)	0.71 (6.36)	0.76 (5.01)	2.16 (8.40)	3.39 (10.83)
P <sub>7</sub> C <sub>1</sub>	0.05 (1.29)	0.09 (14.71)	0.26 (2.85)	0.63 (4.56)	1.58 (7.20)	2.91 (9.71)
P <sub>7</sub> C <sub>2</sub>	0.03 (0.98)	0.09 (81.77)	0.10 (1.47)	0.21 (2.66)	0.76 (5.01)	1.24 (6.40)
<b>Mean</b>	3.26	4.55	6.47	8.85	10.98	13.46
S.Em <sub>±</sub>	<b>0.24</b>	0.16	6.41	0.43	0.53	0.42
CD at 5%	NS	0.46	1.33	1.24	1.53	1.21

NS- Non significant \*Figures in the parenthesis are arcsine transformed values

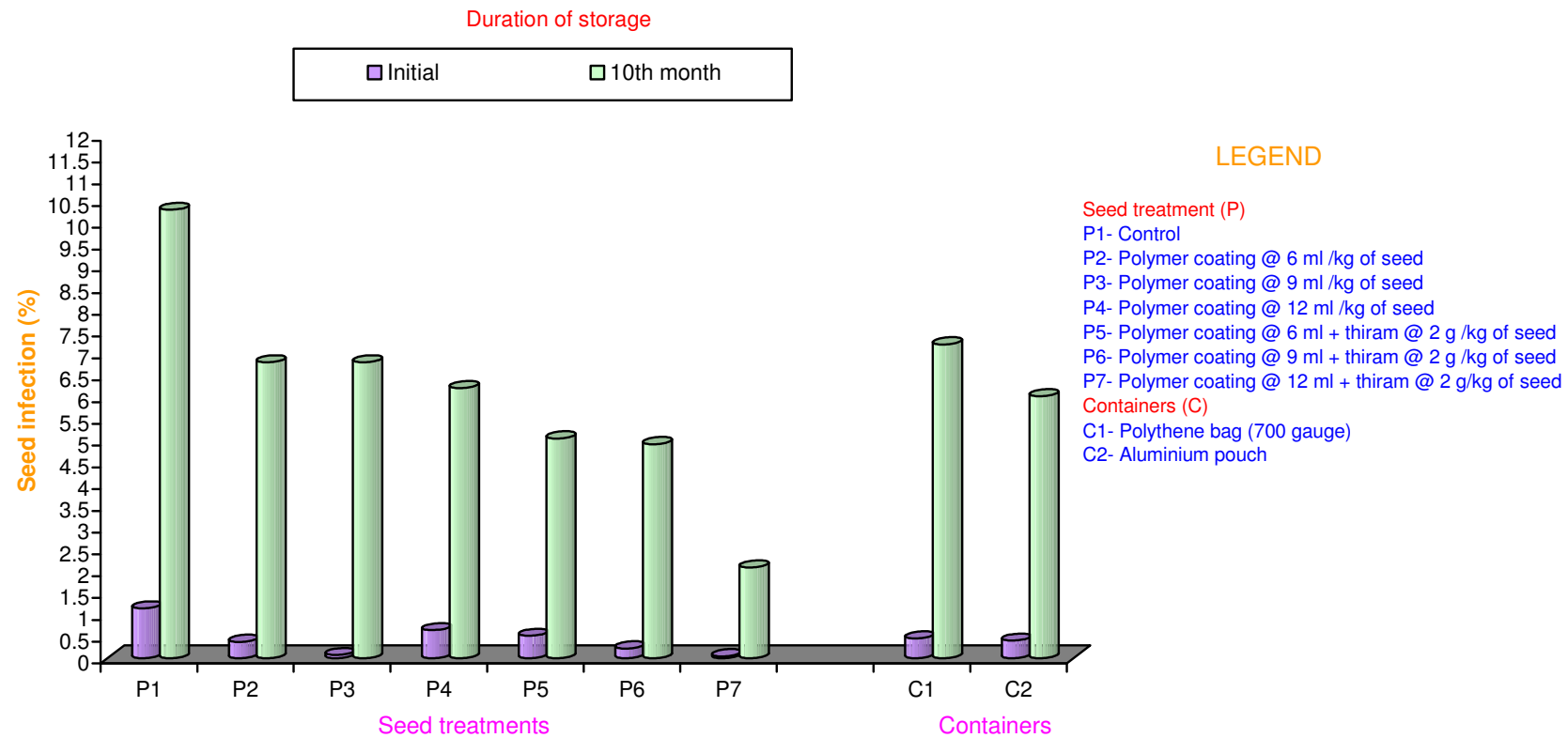
#### 4.2.1 Germination (%)

The data on germination percentage as influenced by polymer dyes and fungicide treatments during storage are presented in Table 12 and depicted in Fig. 5.

Significant differences due to seed treatments were observed in germination percentage. Irrespective of seed treatments, the germination of onion seeds declined progressively with increase in the storage period. On an average, the seed germination was 95.80 per cent at the initial stage and it declined to 74.92 per cent at the end of 10<sup>th</sup> months of storage.

Among the treatments, polymer yellow @ 12 ml per kg with thiram @ 2 g per kg of seeds (D<sub>12</sub>) recorded higher germination percentage throughout storage period, followed by polymer green @ 12 ml with thiram @ 2 g per kg of seeds (D<sub>10</sub>) which were on par with each other at the end of 10<sup>th</sup> months of storage. While, untreated control (D<sub>1</sub>) recorded lower germination. The germination percentage recorded with these treatments at the end of 10<sup>th</sup> months of storage was 78.33, 77.68 and 69.50, respectively.

The other seed treatments except fungicide treatment alone exhibited better storability by recording significantly higher germination percentage throughout the storage period over untreated control. The germination percentage recorded at the end of 10<sup>th</sup> month of storage with D<sub>8</sub>, D<sub>9</sub>, D<sub>11</sub> and D<sub>13</sub> was 75.60, 75.06, 75.00 and 74.25, respectively. Among the polymer dyes, the polymer yellow recorded higher germination throughout the storage, whereas polymer clear (white) recorded lowest germination percentage throughout the storage. The same trend was observed when treated with fungicide along with polymer dyes. The germination was higher with the polymer dyes + fungicide combination than the polymer dyes alone throughout the storage period.



**Fig. 4 : Effect of fungicide, polymer coating and containers on seed infection of onion seeds storage**

**Fig. 4 : Effect of fungicide, polymer coating and containers on seed infection of onion seeds storage**

#### 4.2.2 Field emergence (%)

The data on field emergence as influenced by polymer dyes and fungicide treatments during storage period are presented in Table 13.

Significant differences due to seed treatments were observed for field emergence throughout the storage period. Irrespective of seed treatments, the field emergence of onion seeds declined progressively with increase in the storage period. On an average, the field emergence was 88.70 per cent at initial of the experiment and it declined to 58.57 per cent at the end of 10<sup>th</sup> month of storage.

Among the treatments polymer yellow @ 12 ml per kg with thiram @ 2 g per kg of seeds (D<sub>12</sub>) recorded higher field emergence throughout the storage period followed by polymer green @ 12 ml per kg + thiram @ 2 g per kg of seeds (D<sub>10</sub>) which were on par with each other at the end of 10<sup>th</sup> month of storage over D<sub>1</sub>. The field emergence recorded with these treatments at the end of 10<sup>th</sup> months of storage was 63.75, 62.00 and 52.00 per cent respectively.

The other seed treatments except fungicide treatment alone exhibited better storability by recording significantly higher field emergence percentage throughout the storage period over untreated control. The field emergence recorded at the end of 10<sup>th</sup> month of storage with D<sub>8</sub>, D<sub>9</sub>, D<sub>11</sub> and D<sub>13</sub> was 60.00, 59.35, 58.75 and 58.00 per cent respectively. Among the polymer dyes, the polymer yellow recorded higher field emergence throughout the storage, whereas polymer clear (white) recorded lowest germination percentage throughout the storage. The same trend was observed when treated with fungicide along with polymer dyes. The germination was higher with the polymer dyes + fungicide combination than the polymer dyes alone throughout the storage period.

#### 4.2.3 Rate of germination

The data on rate of germination as influenced by polymer dyes and fungicide treatments during storage period are presented in Table 14.

Irrespective of seed treatments, the mean rate of germination decreased from 44.13 to 20.9 by the end of storage period. The seed treated with fungicide and polymer dyes exhibited superiority in rate of germination throughout the storage period over untreated control. Significantly higher rate of germination (22.60) was recorded with polymer yellow followed by polymer green (22.30) which were on par with each other and lower rate of germination (17.80) was recorded with untreated control at the end of storage period.

The other seed treatments except fungicide alone also showed significant difference in rate of germination over control. Among the polymer dyes, the polymer yellow recorded higher rate of germination throughout the storage, whereas polymer clear (white) recorded lowest rate of germination throughout the storage. The same trend was observed when treated with fungicide along with polymer dyes. The rate of germination was higher with the polymer dyes + fungicide combination than the polymer dyes alone throughout the storage period.

#### 4.2.4 Shoot length (cm)

The data on shoot length as influenced by polymer dyes and fungicide treatments during storage period are presented in Table 15.

The shoot length of onion seedlings declined progressively with the increase in storage period. On an average it was 8.65 cm at the initial month of storage and declined to 7.35 cm at the end of 10<sup>th</sup> month of storage period.

Among the treatments, seed treated with polymer yellow @ 12 ml per kg of seed along with thiram 2 g per kg of seeds (D<sub>12</sub>) recorded significantly higher shoot length followed by polymer green @ 12 ml per kg of seed with thiram @ 2 g per kg of seeds (D<sub>10</sub>) which were on par with each other at the end of ten months of storage, while, untreated control (D<sub>1</sub>) recorded the lowest shoot length. The shoot length recorded with these treatments at the end of 10<sup>th</sup> months of storage was 7.95, 7.80 and 6.95 cm, respectively.

The other treatments except fungicide treatment alone exhibited better storability by recording significantly higher shoot length throughout the storage period over control. The shoot length recorded at the end of 10<sup>th</sup> months of storage with D<sub>8</sub>, D<sub>9</sub>, D<sub>11</sub> and D<sub>13</sub> was 7.70, 7.65, 7.62 and 7.30 cm, respectively. Among the polymer dyes, the polymer yellow recorded

**Table 12. Effect of polymer dyes and fungicide treatments on germination (%) of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
D <sub>1</sub> - Control	94.60 (76.56)*	87.30 (69.12)	82.35 (65.12)	78.30 (62.34)	74.50 (59.67)	69.50 (56.48)
D <sub>2</sub> - Polymer blue @12 ml /kg of seed	95.00 (77.08)	89.60 (69.38)	87.68 (69.38)	85.00 (67.21)	78.69 (62.44)	74.25 (59.47)
D <sub>3</sub> - Polymer red @ 12 ml /kg of seed	94.67 (76.56)	88.00 (69.73)	85.50 (67.62)	82.25 (65.05)	77.30 (61.55)	74.00 (59.34)
D <sub>4</sub> - Polymer green @ 12 ml /kg of seed	95.33 (77.43)	91.00 (72.54)	88.00 (69.73)	85.50 (67.62)	79.50 (63.08)	75.00 (60.00)
D <sub>5</sub> - Polymer pink @ 12 ml /kg of seed	95.00 (77.08)	92.10 (73.68)	85.00 (67.21)	82.00 (64.90)	76.00 (60.67)	73.10 (59.76)
D <sub>6</sub> - Polymer yellow @ 12 ml /kg of seed	95.60 (77.89)	88.02 (69.73)	89.10 (70.72)	86.33 (68.38)	80.00 (63.43)	75.50 (60.33)
D <sub>7</sub> - Polymer clear @ 12 ml /kg of seed	95.00 (77.08)	88.00 (69.73)	84.30 (66.66)	81.35 (64.38)	75.60 (60.40)	72.13 (58.12)
D <sub>8</sub> - Polymer blue @12 ml + thiram @ 2 g/kg of seed	95.33 (77.49)	91.33 (72.84)	88.00 (68.73)	87.67 (69.38)	79.00 (62.73)	75.60 (60.40)
D <sub>9</sub> - Polymer red @ 12 ml + thiram @ 2 g/kg of seed	95.00 (77.08)	91.00 (72.54)	88.00 (68.73)	87.00 (68.87)	78.25 (62.17)	75.06 (60.00)
D <sub>10</sub> - Polymer green @ 12 ml + thiram @ 2 g/kg of seed	95.60 (77.89)	92.60 (74.21)	89.20 (70.81)	88.00 (69.73)	80.25 (63.58)	77.68 (61.75)
D <sub>11</sub> - Polymer pink @ 12 ml + thiram @ 2 g/kg of seed	95.00 (77.08)	91.00 (72.54)	87.50 (69.30)	86.25 (68.19)	78.00 (62.03)	75.00 (60.00)
D <sub>12</sub> - Polymer yellow @ 12 ml +thiram @ 2 g/kg of seed	95.67 (77.89)	93.00 (74.66)	90.00 (71.57)	89.00 (70.63)	81.50 (64.52)	78.33 (62.34)
D <sub>13</sub> - Polymer clear @ 12 ml + thiram @ 2 g/kg of seed	95.21 (77.34)	90.31 (71.85)	87.00 (68.87)	86.00 (68.03)	77.15 (61.41)	74.25 (59.47)
D <sub>14</sub> - Thiram @ 2 g/kg of seed	95.00 (77.08)	88.00 (69.73)	83.00 (65.65)	79.00 (62.73)	75.08 (60.00)	70.00 (56.79)
<b>Mean</b>	<b>95.80</b> <b>(78.17)</b>	<b>91.10</b> <b>(72.64)</b>	<b>87.00</b> <b>(69.87)</b>	<b>85.33</b> <b>(67.45)</b>	<b>81.34</b> <b>(64.38)</b>	<b>74.92</b> <b>(59.82)</b>
S.Em±	0.68	0.63	0.54	0.66	0.95	0.49
CD at 5%	NS	1.82	1.56	1.91	2.75	1.41

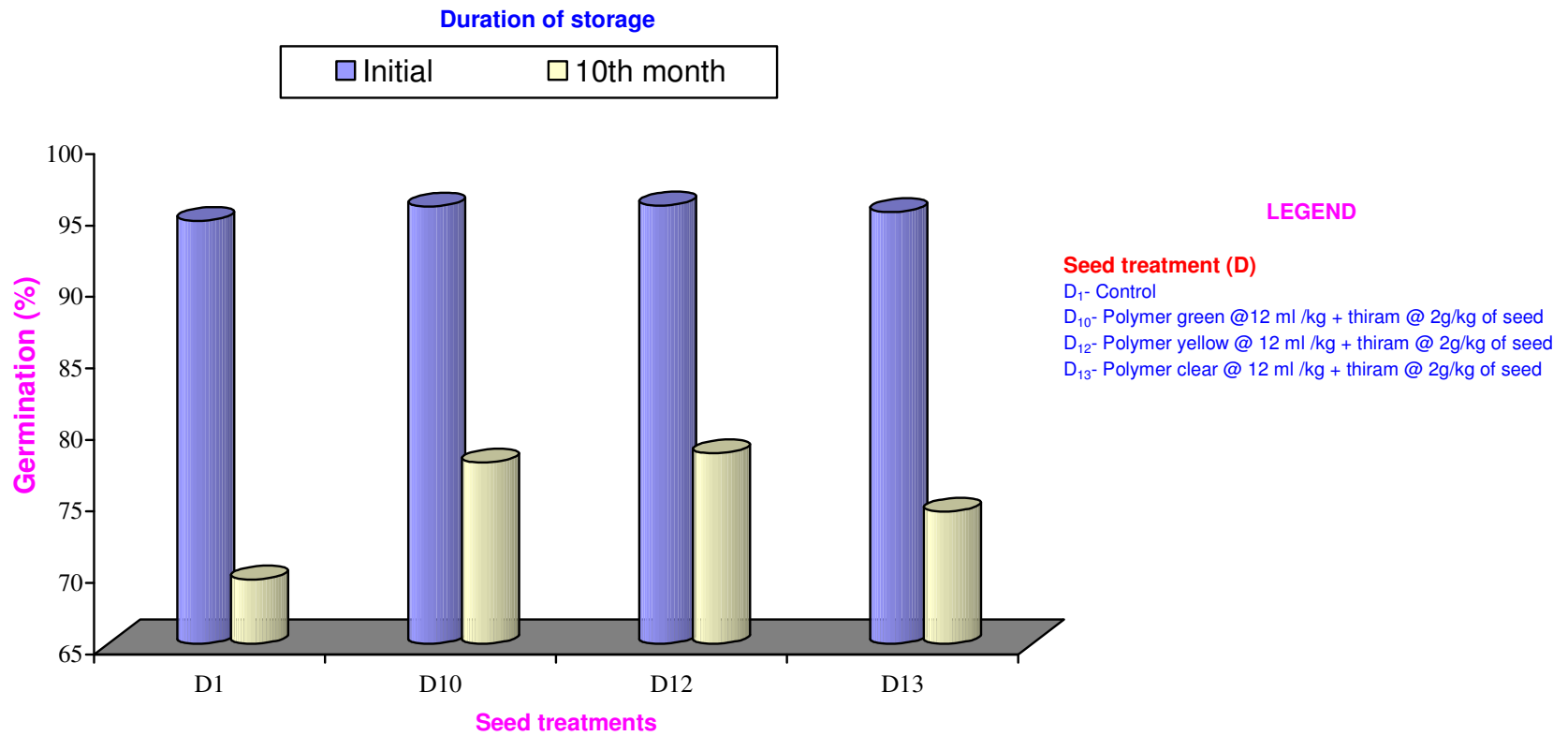
NS- Non significant

\* Figures in parenthesis are arcsine transformed values

higher shoot length throughout the storage, whereas polymer clear (white) recorded lowest shoot length throughout the storage. The same trend was observed when treated with fungicide along with polymer dyes. The shoot length was higher with the polymer dyes + fungicide combination than the polymer dyes alone throughout the storage period.

#### 4.2.5 Root length (cm)

The root length of onion seedlings as influenced by the polymer dyes and fungicide at different months of storage period are presented in Table 16.



**Fig. 5 : Effect of fungicide and polymer dyes on germination percentage of onion seeds storage**

**Fig. 5 : Effect of fungicide and polymer dyes on germination percentage of onion seeds storage**

**Table 13. Effect of polymer dyes and fungicide treatments on field emergence (%) of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
D <sub>1</sub> - Control	88.00 (69.73)	85.35 (67.45)	81.00 (64.16)	76.30 (60.97)	60.00 (50.77)	52.00 (46.15)
D <sub>2</sub> - Polymer blue @12 ml /kg of seed	89.30 (70.91)	87.50 (69.30)	85.60 (67.70)	79.33 (62.24)	65.25 (53.85)	59.25 (50.30)
D <sub>3</sub> - Polymer red @ 12 ml /kg of seed	88.60 (70.27)	87.00 (69.87)	85.51 (67.62)	77.20 (62.94)	64.20 (53.25)	58.00 (49.60)
D <sub>4</sub> - Polymer green @ 12 ml /kg of seed	89.50 (71.09)	88.00 (69.73)	86.25 (68.19)	82.60 (65.27)	67.84 (55.43)	60.50 (51.06)
D <sub>5</sub> - Polymer pink @ 12 ml /kg of seed	88.07 (69.73)	86.60 (68.62)	84.60 (63.89)	77.10 (61.41)	64.00 (53.13)	57.25 (49.14)
D <sub>6</sub> - Polymer yellow @ 12 ml /kg of seed	89.67 (71.19)	88.67 (70.27)	86.70 (68.61)	83.00 (65.65)	68.50 (55.86)	61.25 (51.47)
D <sub>7</sub> - Polymer clear @ 12 ml /kg of seed	88.00 (69.73)	86.00 (68.03)	84.50 (66.82)	77.00 (61.34)	63.35 (52.74)	56.75 (48.85)
D <sub>8</sub> - Polymer blue @12 ml + thiram @ 2 g/ kg of seed	89.60 (71.19)	88.00 (68.73)	87.00 (69.87)	80.60 (63.87)	66.50 (54.63)	60.00 (50.77)
D <sub>9</sub> - Polymer red @ 12 ml + thiram @ 2 g/ kg of seed	88.75 (76.36)	87.50 (69.30)	86.60 (68.53)	80.50 (63.79)	65.25 (53.85)	59.35 (50.36)
D <sub>10</sub> - Polymer green @ 12 ml + thiram @ 2 g/ kg of seed	90.00 (71.57)	88.50 (70.18)	87.50 (69.30)	85.00 (67.21)	69.50 (56.48)	62.00 (51.94)
D <sub>11</sub> - Polymer pink @ 12 ml + thiram @ 2 g/ kg of seed	88.33 (70.00)	87.00 (69.87)	85.10 (67.29)	79.25 (62.87)	65.00 (53.73)	58.75 (50.01)
D <sub>12</sub> - Polymer yellow @ 12 ml + thiram @ 2 g/ kg of seed	91.05 (72.54)	89.00 (70.63)	88.00 (69.73)	85.30 (67.45)	70.15 (56.85)	63.75 (52.95)
D <sub>13</sub> - Polymer clear @ 12 ml + thiram @ 2 g/ kg of seed	88.30 (70.00)	87.00 (69.87)	85.05 (67.21)	79.00 (62.73)	65.00 (53.73)	58.00 (49.60)
D <sub>14</sub> - Thiram @ 2 g/kg of seed	88.25 (69.91)	86.00 (68.03)	83.01 (65.65)	76.00 (60.67)	61.00 (51.35)	53.25 (46.83)
<b>Mean</b>	<b>88.70</b> <b>(76.36)</b>	<b>86.73</b> <b>(68.61)</b>	<b>84.43</b> <b>(66.74)</b>	<b>80.05</b> <b>(63.43)</b>	<b>68.01</b> <b>(55.55)</b>	<b>58.57</b> <b>(50.01)</b>
S.Em±	0.67	0.58	<b>0.57</b>	<b>0.56</b>	<b>0.60</b>	<b>0.58</b>
CD at 5%	NS	1.67	1.65	1.62	1.73	1.67

NS- Non significant

\* Figures in the parenthesis arcsine transformed values

**Table 14. Effect of polymer dyes and fungicide treatments on rate of germination of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
D <sub>1</sub> - Control	43.00	41.60	36.00	32.60	27.60	17.80
D <sub>2</sub> - Polymer blue @12 ml /kg of seed	43.80	43.15	40.11	35.05	28.78	20.65
D <sub>3</sub> - Polymer red @ 12 ml /kg of seed	43.60	43.10	39.10	34.62	27.80	19.60
D <sub>4</sub> - Polymer green @ 12 ml /kg of seed	44.10	43.20	41.00	35.15	29.50	21.00
D <sub>5</sub> - Polymer pink @ 12 ml /kg of seed	43.80	43.00	38.80	34.80	28.30	19.65
D <sub>6</sub> - Polymer yellow @ 12 ml /kg of seed	44.40	43.60	41.00	35.25	29.80	21.45
D <sub>7</sub> - Polymer clear @ 12 ml /kg of seed	43.90	43.15	38.75	35.15	27.80	20.90
D <sub>8</sub> - Polymer blue @12 ml + thiram @ 2 g/ kg of seed	44.60	43.80	40.44	36.10	29.70	21.80
D <sub>9</sub> - Polymer red @ 12 ml + thiram @ 2 g/ kg of seed	44.10	43.60	39.50	35.10	29.10	21.60
D <sub>10</sub> - Polymer green @ 12 ml +thiram @ 2 g/kg of seed	44.80	44.00	41.35	36.80	29.90	22.30
D <sub>11</sub> - Polymer pink @ 12 ml + thiram @ 2 g/ kg of seed	44.30	43.20	39.65	36.15	29.00	21.90
D <sub>12</sub> - Polymer yellow @ 12 ml +thiram @ 2 g/ kg of seed	44.90	44.20	41.90	36.85	30.50	22.60
D <sub>13</sub> - Polymer clear @ 12 ml + thiram @ 2 g/ kg of seed	44.50	43.20	39.50	35.50	28.80	21.50
D <sub>14</sub> - Thiram @ 2 g/kg of seed	43.10	43.00	37.45	33.82	27.60	20.20
<b>Mean</b>	<b>44.13</b>	<b>43.40</b>	<b>39.80</b>	<b>35.21</b>	<b>28.85</b>	<b>20.95</b>
S.Em±	0.39	0.46	0.39	0.44	0.46	0.35
CD at 5%	1.12	1.33	1.12	1.27	1.33	1.01

**Table 15. Effect of polymer dyes and fungicide treatments on shoot length (cm) of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
D <sub>1</sub> - Control	8.51	8.13	7.91	7.51	7.30	6.95
D <sub>2</sub> - Polymer blue @12 ml /kg of seed	8.60	8.60	8.40	8.05	7.80	7.50
D <sub>3</sub> - Polymer red @ 12 ml /kg of seed	8.61	8.50	8.38	8.03	7.66	7.40
D <sub>4</sub> - Polymer green @ 12 ml /kg of seed	8.70	8.64	8.50	8.10	7.85	7.60
D <sub>5</sub> - Polymer pink @ 12 ml /kg of seed	8.60	8.50	8.36	8.00	7.65	7.40
D <sub>6</sub> - Polymer yellow @ 12 ml /kg of seed	8.72	8.68	8.56	8.12	7.87	7.65
D <sub>7</sub> - Polymer clear @ 12 ml /kg of seed	8.60	8.52	8.30	8.00	7.50	7.20
D <sub>8</sub> - Polymer blue @12 ml + thiram @ 2 g /kg of seed	8.71	8.78	8.60	8.20	7.86	7.70
D <sub>9</sub> - Polymer red @ 12 ml + thiram @ 2 g/ kg of seed	8.70	8.75	7.53	8.18	7.78	7.65
D <sub>10</sub> - Polymer green @ 12 ml + thiram @ 2 g /kg of seed	8.80	8.85	8.65	8.35	8.12	7.80
D <sub>11</sub> - Polymer pink @ 12 ml + thiram @ 2 g/ kg of seed	8.80	8.73	8.50	8.10	7.76	7.62
D <sub>12</sub> - Polymer yellow @ 12 ml + thiram @ 2 g/ kg of seed	8.81	8.90	8.68	8.40	8.15	7.95
D <sub>13</sub> - Polymer clear @ 12 ml + thiram @ 2 g/ kg of seed	8.80	8.73	8.42	8.09	7.75	7.30
D <sub>14</sub> - Thiram @ 2 g/kg of seed	8.60	8.46	8.41	7.80	7.34	7.16
<b>Mean</b>	<b>8.65</b>	<b>8.62</b>	<b>8.40</b>	<b>8.06</b>	<b>7.76</b>	<b>7.35</b>
S.Em±	0.05	0.06	0.05	0.07	0.04	0.04
CD at 5%	NS	0.17	0.14	0.20	0.11	0.11

**Table 16. Effect of polymer dyes and fungicide treatments on root length (cm) of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
D <sub>1</sub> - Control	8.50	8.53	8.30	7.80	7.25	6.80
D <sub>2</sub> - Polymer blue @12 ml /kg of seed	8.60	8.61	8.50	8.10	7.70	7.46
D <sub>3</sub> - Polymer red @ 12 ml /kg of seed	8.60	8.60	8.49	8.01	7.60	7.32
D <sub>4</sub> - Polymer green @ 12 ml /kg of seed	8.70	8.71	8.60	8.15	7.80	7.52
D <sub>5</sub> - Polymer pink @ 12 ml /kg of seed	8.60	8.60	8.45	8.00	7.40	7.25
D <sub>6</sub> - Polymer yellow @ 12 ml /kg of seed	8.70	8.73	8.61	8.20	7.90	7.60
D <sub>7</sub> - Polymer clear @ 12 ml /kg of seed	8.60	8.70	8.40	8.00	7.45	7.20
D <sub>8</sub> - Polymer blue @12 ml + thiram @ 2 g /kg of seed	8.80	8.80	8.69	8.30	7.79	7.70
D <sub>9</sub> - Polymer red @ 12 ml + thiram @ 2 g/ kg of seed	8.80	8.79	8.61	8.29	7.71	7.69
D <sub>10</sub> - Polymer green @ 12 ml + thiram @ 2 g /kg of seed	8.81	8.82	8.75	8.45	8.10	7.75
D <sub>11</sub> - Polymer pink @ 12 ml + thiram @ 2 g/ kg of seed	8.80	8.70	8.61	8.25	7.50	7.65
D <sub>12</sub> - Polymer yellow @ 12 ml + thiram @ 2 g/ kg of seed	8.83	8.86	8.79	8.51	8.15	7.85
D <sub>13</sub> - Polymer clear @ 12 ml + thiram @ 2 g/ kg of seed	8.80	8.69	8.50	8.20	7.48	7.60
D <sub>14</sub> - Thiram @ 2 g/kg of seed	8.50	8.53	8.30	7.9	7.30	7.00
<b>Mean</b>	<b>8.71</b>	<b>8.69</b>	<b>8.57</b>	<b>8.14</b>	<b>7.68</b>	<b>7.26</b>
S.Em±	0.03	0.04	0.05	0.04	0.05	0.06
CD at 5%	NS	0.11	0.14	0.11	0.14	0.17

NS- Non significant

Significant differences in root length were observed due to seed treatments. The root length declined progressively with increase in the period of storage. On an average root length recorded was 8.71 cm which was declined to 7.26 cm at the end of 10<sup>th</sup> month of storage period.

Among all the treatments, D<sub>12</sub> (thiram @ 2 g + polymer yellow @ 12 ml/kg of seeds) recorded significantly higher root length (7.85 cm) followed by D<sub>10</sub> (7.75 cm) and D<sub>8</sub> (7.70 cm), which were on par with each other at the end of storage period. The lower root length was recorded with untreated control throughout the storage period and at the end of the 10<sup>th</sup> month of storage, the root length recorded (D<sub>1</sub>) was 6.80 cm.

The other treatments were also significantly superior over untreated control. The root length recorded at the end of storage period with D<sub>8</sub>, D<sub>9</sub>, D<sub>11</sub> and D<sub>13</sub> was 7.70, 7.69, 7.65 and 7.60 cm respectively. Among the polymer dyes, the polymer yellow recorded higher root length throughout the storage, whereas polymer clear (white) recorded lowest root length throughout the storage. The same trend was observed when treated with fungicide along with polymer dyes. The root length was higher with the polymer dyes + fungicide combination than the polymer dyes alone throughout the storage period.

#### 4.2.6 Dry weight of seedling (mg)

The dry weight of seedlings as influenced by different polymer dyes with fungicide during storage are presented in Table 17.

Dry weight of seedlings decreased with the increase in storage period. Irrespective of the treatments, the mean dry weight of seedlings decreased from 29.91 mg (initial) to 18.00 mg at the end of storage period.

Among the different treatment combinations, D<sub>12</sub> (thiram @ 2 g /kg + polymer yellow @ 12 ml/kg of seeds) recorded significantly higher dry weight (19.66 mg) followed by D<sub>10</sub> (19.33 mg) and D<sub>8</sub> (18.66), which were on par with each other at the end of storage period. The lower dry weight of seedling was recorded with untreated control throughout the storage period and at the end of the 10<sup>th</sup> month of storage. Dry weight of seedling recorded with D<sub>1</sub> was 15.73 mg. Among the polymer dyes, the polymer yellow recorded higher dry weight of seedlings throughout the storage, whereas polymer clear (white) recorded lowest dry weight of seedlings throughout the storage. The same trend was observed when treated with fungicide along with polymer dyes. The dry weight of seedlings was higher with the polymer dyes + fungicide combination than the polymer dyes alone throughout the storage period.

#### 4.2.7 Vigour index

The vigour index as influenced by seed treatment with polymer dyes and fungicide at different months of storage period are presented in Table 18 and depicted in Fig. 6.

There was a significant difference for vigour index due to seed treatment during the entire period except for the initial month of storage. Gradual decline in the vigour index of seedlings was observed from initial month of storage to end of storage period. On an average it declined from 1649 to 1146 at the end of storage period.

The seed treatments recorded significantly higher vigour index over untreated control throughout the storage period. The treatment D<sub>12</sub> recorded higher vigour index of 1392 over all other treatments at the end of storage period. The lower vigour index was observed with untreated control D<sub>1</sub> (935) at the end of 10<sup>th</sup> months of storage. The vigour index recorded at the end of 10<sup>th</sup> month of storage with D<sub>8</sub>, D<sub>9</sub>, D<sub>11</sub> and D<sub>13</sub> was 1306, 1249, 1243 and 1181, respectively. Among the polymer dyes, the polymer yellow recorded higher vigour index throughout the storage, whereas polymer clear (white) recorded lowest vigour index throughout the storage. The same trend was observed when treated with fungicide along with polymer dyes. The vigour index was higher with the polymer dyes + fungicide combination than the polymer dyes alone throughout the storage period.

#### 4.2.8 Electrical conductivity of seed leachate (dSm<sup>-1</sup>)

The data on electrical conductivity as influenced by polymer dyes and fungicide during storage are presented in Table 19.

**Table 17. Effect of polymer dyes and fungicide treatments on seedling dry weight (mg) of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
D <sub>1</sub> - Control	29.40	27.73	24.23	22.26	17.63	15.73
D <sub>2</sub> - Polymer blue @12 ml /kg of seed	29.70	28.36	24.90	22.53	19.60	17.83
D <sub>3</sub> - Polymer red @ 12 ml /kg of seed	29.63	28.33	24.80	22.36	19.53	17.16
D <sub>4</sub> - Polymer green @ 12 ml /kg of seed	29.73	28.46	25.40	23.16	20.26	18.50
D <sub>5</sub> - Polymer pink @ 12 ml /kg of seed	29.60	27.90	24.70	22.20	19.50	17.56
D <sub>6</sub> - Polymer yellow @ 12 ml /kg of seed	29.73	28.70	25.53	23.30	20.80	18.73
D <sub>7</sub> - Polymer clear @ 12 ml /kg of seed	29.72	28.07	24.63	22.10	19.26	18.16
D <sub>8</sub> - Polymer blue @12 ml + thiram @ 2 g/ kg of seed	29.76	28.70	25.26	23.53	20.36	18.66
D <sub>9</sub> - Polymer red @ 12 ml + thiram @ 2 g/ kg of seed	29.73	28.50	24.73	23.33	20.23	18.33
D <sub>10</sub> - Polymer green @ 12 ml + thiram @ 2 g/ kg of seed	30.33	29.50	26.50	23.60	21.30	19.33
D <sub>11</sub> - Polymer pink @ 12 ml + thiram @ 2 g/ kg of seed	30.00	28.36	24.30	23.40	19.56	17.50
D <sub>12</sub> - Polymer yellow @ 12 ml +thiram @ 2 g/ kg of seed	30.80	29.80	27.80	23.70	21.53	19.66
D <sub>13</sub> - Polymer clear @ 12 ml + thiram @ 2 g/ kg of seed	30.23	28.26	24.36	23.30	19.13	17.33
D <sub>14</sub> - Thiram @ 2 g/kg of seed	29.66	27.90	24.16	22.53	19.80	16.33
<b>Mean</b>	<b>29.91</b>	<b>28.49</b>	<b>25.16</b>	<b>23.04</b>	<b>20.03</b>	<b>18.00</b>
S.Em <sub>±</sub>	0.19	0.13	<b>0.10</b>	<b>0.12</b>	<b>0.09</b>	<b>0.10</b>
CD at 5%	0.55	0.37	0.28	0.34	0.26	0.28

Electrical conductivity increased as storage period advanced. Irrespective of treatments, the mean electrical conductivity increased from 0.464 dSm<sup>-1</sup> at initial to 0.736 dSm<sup>-1</sup> by the end of storage period.

Among the different treatment combinations, significant variation was recorded after second month of storage. Significantly lower electrical conductivity was recorded in treatment D<sub>12</sub> (0.561 dSm<sup>-1</sup>) followed by D<sub>10</sub> (0.571 dSm<sup>-1</sup>) and D<sub>8</sub> (0.579 dSm<sup>-1</sup>) as compared to untreated control (D<sub>1</sub>) which recorded higher electrical conductivity of 0.885 dSm<sup>-1</sup> at the end of 10<sup>th</sup> month of storage period. Among the polymer dyes, the polymer yellow recorded lower electrical conductivity of seed leachate throughout the storage, whereas polymer clear (white) recorded highest electrical conductivity of seed leachate throughout the storage. The same trend was observed when treated with fungicide along with polymer dyes. The electrical

**Table 18. Effect of polymer dyes and fungicide treatments on seedling vigour index of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
D <sub>1</sub> - Control	1609	1438	1333	1137	1023	935
D <sub>2</sub> - Polymer blue @12 ml /kg of seed	1628	1542	1498	1369	1141	1062
D <sub>3</sub> - Polymer red @ 12 ml /kg of seed	1634	1510	1436	1279	1120	1030
D <sub>4</sub> - Polymer green @ 12 ml /kg of seed	1653	1584	1470	1386	1210	1103
D <sub>5</sub> - Polymer pink @ 12 ml /kg of seed	1634	1516	1436	1199	1087	1023
D <sub>6</sub> - Polymer yellow @ 12 ml /kg of seed	1658	1591	1521	1425	1276	1103
D <sub>7</sub> - Polymer clear @ 12 ml /kg of seed	1639	1528	1591	1257	1089	1037
D <sub>8</sub> - Polymer blue @12 ml + thiram @ 2 g/ kg of seed	1670	1653	1590	1478	1366	1306
D <sub>9</sub> - Polymer red @ 12 ml + thiram @ 2 g/ kg of seed	1658	1648	1474	1471	1385	1249
D <sub>10</sub> - Polymer green @ 12 ml + thiram @ 2 g/ kg of seed	1683	1648	1600	1525	1353	1362
D <sub>11</sub> - Polymer pink @ 12 ml + thiram @ 2 g/ kg of seed	1672	1623	1576	1454	1422	1243
D <sub>12</sub> - Polymer yellow @ 12 ml + thiram @ 2 g/ kg of seed	1683	1654	1602	1537	1441	1392
D <sub>13</sub> - Polymer clear @ 12 ml + thiram @ 2 g/ kg of seed	1652	1648	1542	1439	1273	1181
D <sub>14</sub> - Thiram @ 2 g/kg of seed	1624	1453	1352	1161	1039	1022
<b>Mean</b>	<b>1649</b>	<b>1572</b>	<b>1487</b>	<b>1365</b>	<b>1230</b>	<b>1146</b>
S.Em $\pm$	31	39	22	28	24	20
CD at 5%	89	112	63	81	69	57

conductivity of seed leachate was lower with the polymer dyes + fungicide combination than the polymer dyes alone throughout the storage period.

#### 4.2.9 Moisture content (%)

The data on moisture content of seeds as influenced by polymer dyes and fungicide during storage are presented in Table 20.

The average moisture content of seeds gradually increased from initial months (6.5%) up to 6<sup>th</sup> month of storage (7.5%) and again decreased. At the end of storage the moisture content was 6.5 per cent.

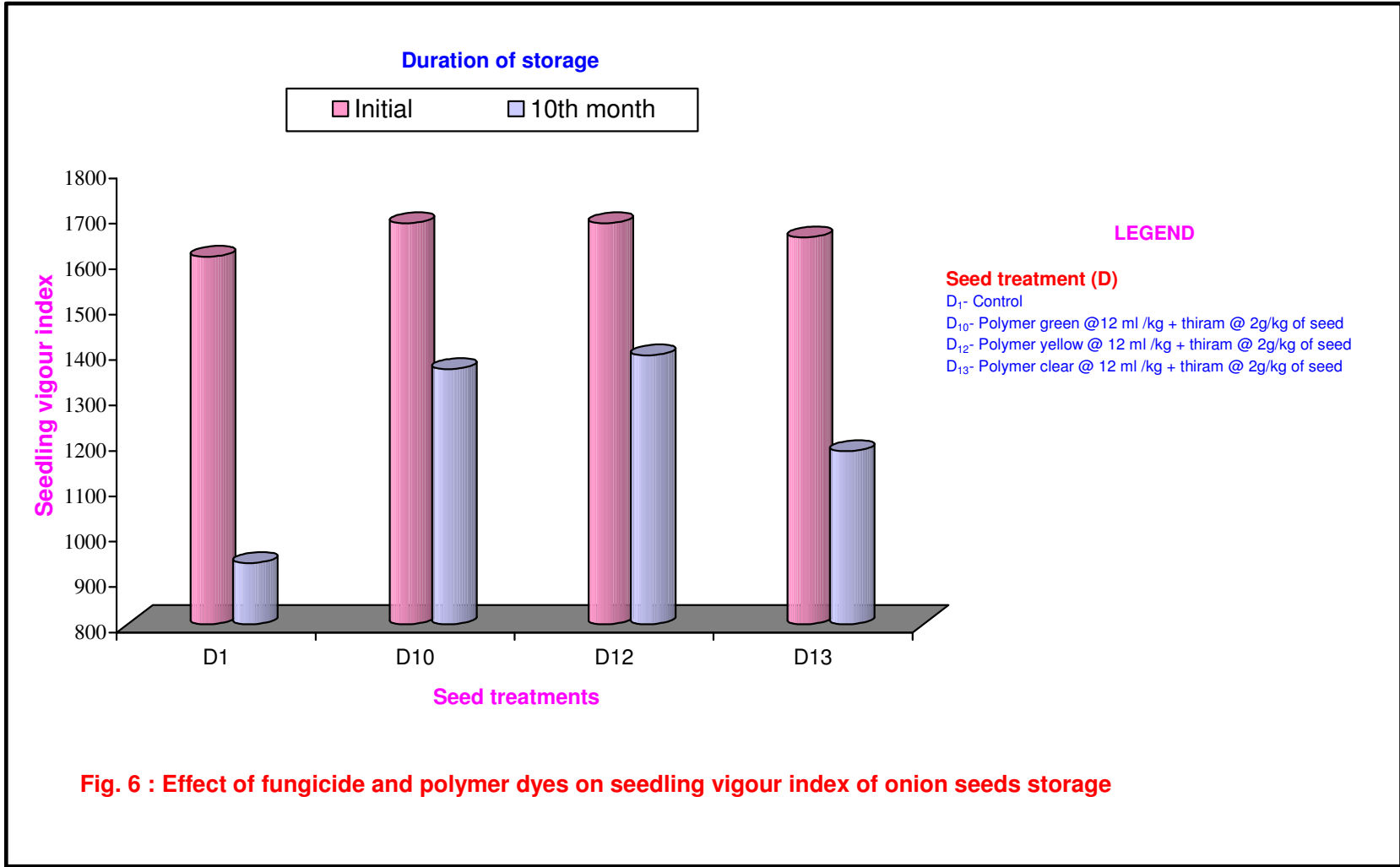


Fig. 6 : Effect of fungicide and polymer dyes on seedling vigour index of onion seeds storage

**Table 19. Effect of polymer dyes and fungicide treatments on electrical conductivity of seed leachate ( $\text{dSm}^{-1}$ ) of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
D <sub>1</sub> - Control	0.510	0.568	0.627	0.781	0.820	0.885
D <sub>2</sub> - Polymer blue @12 ml /kg of seed	0.501	0.560	0.618	0.675	0.804	0.722
D <sub>3</sub> - Polymer red @ 12 ml /kg of seed	0.503	0.561	0.620	0.681	0.809	0.852
D <sub>4</sub> - Polymer green @ 12 ml /kg of seed	0.453	0.492	0.531	0.570	0.653	0.696
D <sub>5</sub> - Polymer pink @ 12 ml /kg of seed	0.504	0.557	0.616	0.668	0.802	0.867
D <sub>6</sub> - Polymer yellow @ 12 ml /kg of seed	0.444	0.479	0.516	0.553	0.629	0.669
D <sub>7</sub> - Polymer clear @ 12 ml /kg of seed	0.462	0.558	0.615	0.675	0.677	0.871
D <sub>8</sub> - Polymer blue @12 ml + thiram @ 2 g /kg of seed	0.420	0.457	0.476	0.516	0.581	0.579
D <sub>9</sub> - Polymer red @ 12 ml + thiram @ 2 g/ kg of seed	0.501	0.455	0.500	0.534	0.606	0.597
D <sub>10</sub> - Polymer green @ 12 ml + thiram @ 2 g /kg of seed	0.414	0.439	0.465	0.492	0.549	0.571
D <sub>11</sub> - Polymer pink @ 12 ml + thiram @ 2 g/ kg of seed	0.426	0.467	0.485	0.504	0.581	0.642
D <sub>12</sub> - Polymer yellow @ 12 ml +thiram @ 2 g/ kg of seed	0.411	0.435	0.460	0.486	0.541	0.561
D <sub>13</sub> - Polymer clear @ 12 ml + thiram @ 2 g/ kg of seed	0.434	0.503	0.545	0.587	0.565	0.615
D <sub>14</sub> - Thiram @ 2 g/kg of seed	0.507	0.566	0.625	0.687	0.804	0.876
<b>Mean</b>	<b>0.464</b>	<b>0.506</b>	<b>0.550</b>	<b>0.609</b>	<b>0.817</b>	<b>0.736</b>
S.Em $\pm$	0.001	0.021	0.030	0.011	0.040	0.051
CD at 5%	NS	0.060	0.086	0.031	0.115	0.147

NS – Non significant

Among all the treatments, D<sub>12</sub> (thiram @ 2 g + polymer yellow 12 ml per kg of seeds) recorded lower seed moisture content (6.3) followed by D<sub>10</sub> (6.4%) which were on par with each other at the end of storage period. The significantly higher seed moisture content was recorded with untreated control throughout the storage period and at the end of the 10<sup>th</sup> month of storage, the moisture content was recorded with D<sub>1</sub> was 6.9 per cent. Among the polymer dyes, the polymer yellow recorded lower seed moisture content throughout the storage, whereas polymer clear (white) recorded higher seed moisture content throughout the storage. The same trend was observed when treated with fungicide along with polymer dyes. The seed moisture content was higher with the polymer dyes + fungicide combination than the polymer dyes alone throughout the storage period.

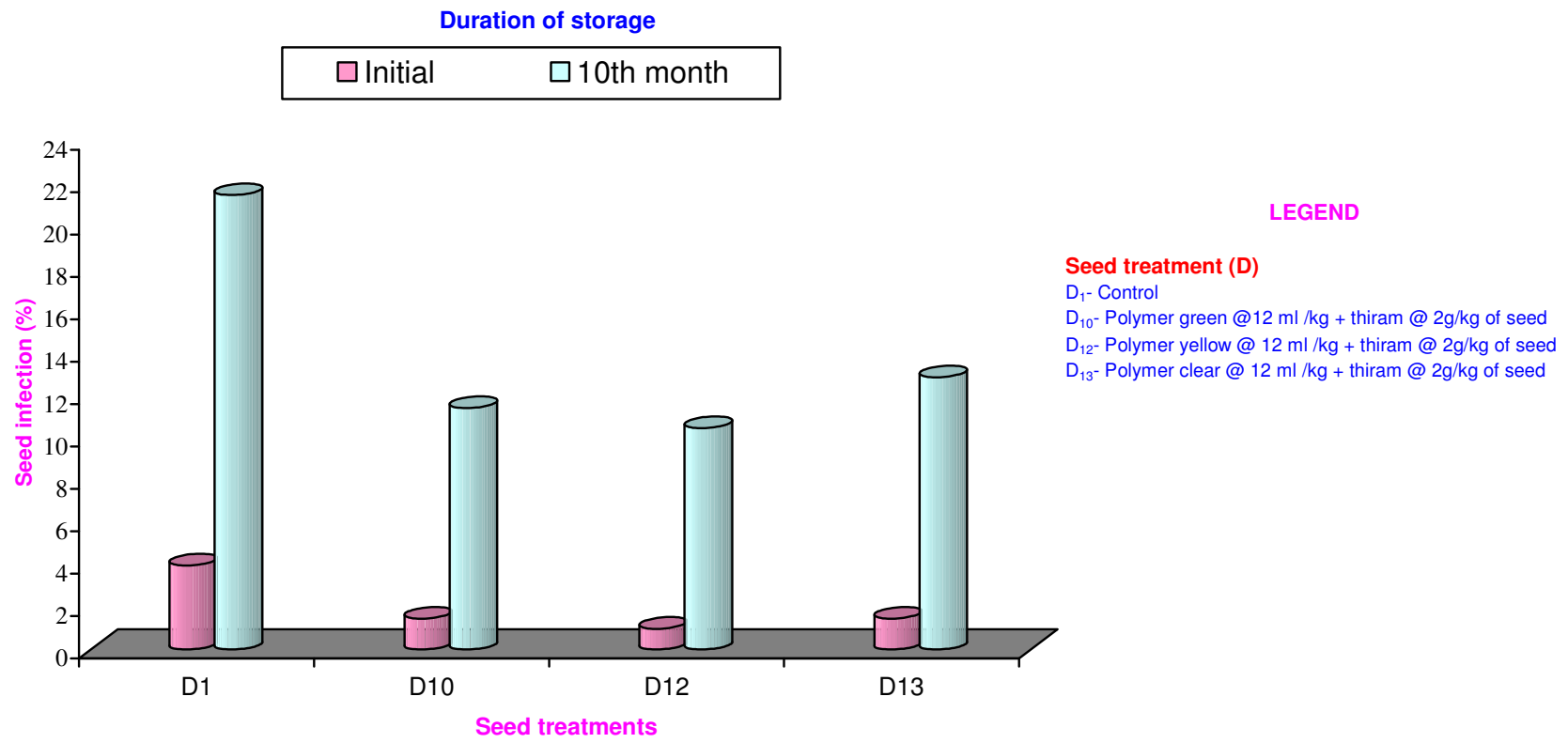
**Table 20. Effect of polymer dyes and fungicide treatments on moisture content of onion seeds during storage**

Treatments	Months of storage					
	Initial	2	4	6	8	10
D <sub>1</sub> - Control	6.5	7.2	7.5	7.6	7.2	6.9
D <sub>2</sub> - Polymer blue @12 ml /kg of seed	6.5	7.1	7.3	7.3	6.9	6.5
D <sub>3</sub> - Polymer red @ 12 ml /kg of seed	6.5	7.1	7.3	7.3	6.9	6.6
D <sub>4</sub> - Polymer green @ 12 ml /kg of seed	6.5	7.0	7.2	7.2	6.8	6.4
D <sub>5</sub> - Polymer pink @ 12 ml /kg of seed	6.5	7.1	7.3	7.3	7.0	6.6
D <sub>6</sub> - Polymer yellow @ 12 ml /kg of seed	6.5	6.9	7.1	7.2	6.8	6.4
D <sub>7</sub> - Polymer clear @ 12 ml /kg of seed	6.5	7.1	7.4	7.4	7.1	6.8
D <sub>8</sub> - Polymer blue @12 ml + thiram @ 2 g/ kg of seed	6.4	7.0	7.1	7.2	6.8	6.4
D <sub>9</sub> - Polymer red @ 12 ml + thiram @ 2 g/ kg of seed	6.4	7.0	7.2	7.3	6.8	6.5
D <sub>10</sub> - Polymer green @ 12 ml + thiram @ 2 g /kg of seed	6.4	6.9	7.0	7.1	6.7	6.4
D <sub>11</sub> - Polymer pink @ 12 ml + thiram @ 2 g /kg of seed	6.5	7.0	7.2	7.3	6.9	6.6
D <sub>12</sub> - Polymer yellow @ 12 ml + thiram @ 2 g/ kg of seed	6.4	6.8	6.9	7.0	6.6	6.3
D <sub>13</sub> - Polymer clear @ 12 ml + thiram @ 2 g/ kg of seed	6.5	7.1	7.3	7.4	7.0	6.7
D <sub>14</sub> - Thiram @ 2 g/kg of seed	6.5	7.1	7.5	7.5	7.1	6.7
<b>Mean</b>	<b>6.5</b>	<b>7.0</b>	<b>7.3</b>	<b>7.5</b>	<b>6.9</b>	<b>6.5</b>
S.Em±	0.05	0.09	0.06	0.06	0.08	0.07
CD at 5%	NS	NS	0.17	0.17	0.23	0.20

Table 21. Effect of polymer dyes and fungicide treatments on seed infection (%) of onion seeds during storage

Table 21. Effect of polymer dyes and fungicide treatments on seed infection (%) of onion seeds during storage

Treatments	Months of storage					
	Initial	2	4	6	8	10
D <sub>1</sub> - Control	3.97 (11.00)	7.83 (16.32)	10.50 (19.30)	14.98 (22.78)	18.65 (25.62)	21.45 (27.60)
D <sub>2</sub> - Polymer blue @12 ml /kg of seed	2.80 (49.70)	6.30 (14.54)	7.99 (16.43)	12.20 (20.5)	15.62 (23.30)	15.19 (22.95)
D <sub>3</sub> - Polymer red @ 12 ml /kg of seed	2.87 (11.35)	6.37 (14.62)	9.95 (18.40)	12.48 (20.70)	16.49 (23.97)	16.97 (24.34)
D <sub>4</sub> - Polymer green @ 12 ml /kg of seed	2.10 (8.33)	5.92 (14.09)	6.97 (15.32)	11.69 (20.00)	14.74 (22.59)	13.40 (21.50)
D <sub>5</sub> - Polymer pink @ 12 ml /kg of seed	2.93 (9.91)	6.30 (14.54)	7.99 (16.43)	12.48 (20.70)	15.63 (23.30)	16.97 (24.34)
D <sub>6</sub> - Polymer yellow @ 12 ml /kg of seed	2.00 (8.13)	5.19 (13.17)	6.87 (15.20)	11.19 (19.55)	13.90 (21.90)	11.46 (19.80)
D <sub>7</sub> - Polymer clear @ 12 ml /kg of seed	2.75 (9.55)	5.98 (14.17)	7.98 (16.43)	12.50 (21.70)	15.97 (23.57)	15.19 (22.95)
D <sub>8</sub> - Polymer blue @12 ml + thiram @ 2 g/ kg of seed	1.59 (7.25)	5.60 (13.70)	6.88 (15.20)	8.93 (17.40)	11.86 (20.16)	11.70 (20.02)
D <sub>9</sub> - Polymer red @ 12 ml + thiram @ 2 g/ kg of seed	1.46 (6.95)	5.60 (13.70)	7.50 (15.85)	9.96 (18.49)	11.85 (20.17)	12.73 (22.02)
D <sub>10</sub> - Polymer green @ 12 ml + thiram @ 2 g/ kg of seed	1.46 (6.95)	4.88 (12.77)	5.95 (14.12)	7.95 (16.39)	10.86 (19.85)	11.40 (19.79)
D <sub>11</sub> - Polymer pink @ 12 ml + thiram @ 2 g/ kg of seed	1.59 (7.25)	5.60 (13.70)	7.53 (15.89)	9.96 (18.41)	11.86 (20.16)	12.71 (22.00)
D <sub>12</sub> - Polymer yellow @ 12 ml + thiram @ 2 g/ kg of seed	0.98 (5.44)	3.87 (11.35)	4.98 (13.90)	6.95 (15.29)	9.99 (18.43)	10.45 (18.81)
D <sub>13</sub> - Polymer clear @ 12 ml + thiram @ 2 g/ kg of seed	1.46 (6.95)	5.92 (14.08)	6.90 (15.30)	9.95 (18.41)	14.74 (22.59)	12.85 (21.02)
D <sub>14</sub> - Thiram @ 2 g/kg of seed	3.87 (11.35)	6.70 (15.12)	9.90 (18.40)	12.48 (12.70)	16.74 (24.16)	19.72 (26.38)
<b>Mean</b>	<b>2.75</b> <b>(8.44)</b>	<b>5.86</b> <b>(13.98)</b>	<b>7.80</b> <b>(16.30)</b>	<b>10.52</b> <b>(18.94)</b>	<b>14.30</b> <b>(22.30)</b>	<b>14.52</b> <b>(22.45)</b>
S.Em±	0.77	0.24	0.22	0.32	0.27	0.04
CD at 5%	0.05	0.69	0.63	0.92	0.79	1.11



**Fig. 7 : Effect of fungicide and polymer dyes on seed infection percentage of onion seeds storage**

**Fig. 7 : Effect of fungicide and polymer dyes on seed infection percentage of onion seeds storage**

#### 4.2.10 Seed infection (%)

The data on seed infection per cent as influenced by polymer dyes and fungicide during storage are presented in Table 21 and depicted in Fig. 7.

Irrespective of seed coating with polymer dyes along with fungicide, the mean per cent seed infection increased from 2.75 per cent at initial to 14.52 per cent at the end of storage period.

Significantly lower seed infection of 10.45 per cent was recorded in D<sub>12</sub> followed by D<sub>10</sub> (11.40%) as compared to untreated control (21.45%), which at the end of 10<sup>th</sup> month of storage. Similarly, other treatments involving fungicide treatment alone or in combination with polymer dyes exhibited superiority in seed health over the treatment without fungicide by recording significantly lower seed infection percentage. Among the polymer dyes, the polymer yellow recorded lower seed infection throughout the storage, whereas polymer clear (white) recorded higher seed infection throughout the storage. The same trend was observed when treated with fungicide along with polymer dyes. The seed infection was higher with the polymer dyes + fungicide combination than the polymer dyes alone throughout the storage period.

## 5. DISCUSSION

The results pertaining to the effect of fungicide, polymer and polymer dyes on onion seed storability are discussed in this chapter.

### 5.1 Experiment-I : Effect of polymer film coating with fungicide and containers on storability of onion seed

Seed ageing and deterioration of seed are irreversible, inexorable and inevitable process, but the rate of seed deterioration could be slowed either by storing the seeds under controlled condition or by imposing seed treatment with polymer coating along with seed treatment chemicals (Duan and Burries, 1997). As the controlled condition involves the huge cost, the seed treatment remains the best alternative approach to maintain the seed quality.

In the present investigation, irrespective of the treatments, the seed quality parameters declined progressively with the increase in storage period. The average germination, shoot length, root length, vigour index, rate of germination and dry weight of seedling at the beginning of the storage period were 97.63 per cent, 8.59 cm, 8.14 cm, 1615, 45.31 and 30.01 mg, which declined to 73.90 per cent, 7.46 cm, 6.62 cm, 1160, 22.08 and 20.19 mg, respectively at the end of 10<sup>th</sup> month of storage. This decrease in seed quality during storage may be attributed to ageing effects, leading to depletion of food reserves and decline in synthetic activity of the embryo apart from death of seeds because of fungal invasion (Gupta *et al.*, 1993). However, the average germination was above the minimum seed certification standards (70.0%) even after 10<sup>th</sup> months of storage.

Among the treatments, the seeds treated with fungicides coupled with polymer coating exhibited superiority in maintaining the seed quality throughout the storage period. The seeds treated with thiram @ 2 g per kg of seed with polymer @ 12 ml per kg of seed (P<sub>7</sub>) recorded significantly higher seed quality parameters followed by seeds treated with thiram @ 2 g per kg of seed with polymer coating @ 9 ml per kg of seed (P<sub>6</sub>), which were on par with each other in most of the quality parameters compared to untreated control (P<sub>1</sub>) and to the treatments with lower doses of polymer coating. The polymer treatment @ 12 ml per kg of seed (P<sub>7</sub>) recorded significantly higher values for root length, vigour index, rate of germination and lower values, for electrical conductivity and seed infection indicating the superiority over control in maintaining the seed quality in storage.

The rate of reduction in germination percentage from the beginning of the storage period till the end of 10<sup>th</sup> month of storage was slower in seeds treated with fungicide and polymer, compared to untreated seed. The rate of reduction in germination percentage during storage in P<sub>7</sub> and P<sub>1</sub> was 77.12 and 70.10 per cent, respectively. These results are conformity with the findings of Taylar *et al.* (2001) in onion, Vanangamudi *et al.* (2003) in maize and Larissa *et al.* (2004) in onion and bean.

The other quality parameters *viz.*, vigour index, rate of germination and dry weight of seedlings recorded at the end of 10<sup>th</sup> month of storage was 1291, 24.50 and 22.05 mg with P<sub>7</sub> and 1148, 21.62 and 20.71 mg with P<sub>4</sub> whereas, untreated control (P<sub>1</sub>) recorded 995, 19.00 and 16.07 mg, respectively at the end of storage period. The polymer keeps the seed intact, as it acts as binding material and covers the minor cracks and aberrations on the seed coat thus blocking the fungal invasion. It may also act as a physical barrier which reduces leaching of inhibitors from seed coverings and restrict oxygen movement and thus reducing the respiration of embryo thereby reducing the ageing effect on seeds (Duan and Burris, 1997). The polymer also prevents moisture content fluctuations during storage (West *et al.*, 1985).

The fungicide covered by polymer enhances the efficiency of fungicide till the end of storage period. It forms a flexible film that adheres and protects the fungicide on the seed and preventing dusting off and loss of fungicide during storage. This, in the present study was reflected by reducing the seed infection by pathogen. The enhanced germination and quality parameters with treated seeds with fungicide and polymer coating is because of the combined favourable effects of these chemicals. The fungicide protected the seed deterioration by reducing the fungal invasion. The effectiveness of fungicides and polymer coating may be due to the compatibility and synergetic effect which reduced the growth of the pathogen and favoured germination and other parameters (Omvir Singh *et al.*, 1973 ; Sindhan and Bose, 1981 and Sundaresh *et al.*, 1987).

The electrical conductivity of seed leachate indicates the membrane integrity and quality of seed and it is negatively correlated with seed quality. In the present study, evidently implicate a progressive but rapid increase in electrical conductivity of seed leachate during storage period. The average electrical conductivity at the initial period was  $0.513 \text{ dSm}^{-1}$  which enhanced to  $0.662 \text{ dSm}^{-1}$  at the end of storage period indicating increased permeability of membrane and decline in the compactness of seeds due to fungicides and polymer coating. The treatments  $P_7$ ,  $P_6$  and  $P_5$  recorded lower electrical conductivity of 0.630, 0.656 and  $0.658 \text{ dSm}^{-1}$  respectively compared to control ( $0.710 \text{ dSm}^{-1}$ ) at the end of the storage period. This may be due to higher incidence of fungi which leads to loss of membrane integrity in the seeds stored without chemical treatments. The polymer coating holds the seeds intact and covers the cracks and aberrations of the seed coat and thus reduces the leaching of electrolytes (Struve and Hopper, 1996).

Storage fungi have been reported to invade and destroy seeds if the seeds are not protected and storage environment is favourable to them, which may lead to loss of viability, development of musty odours and discolouration of seeds. The incidence of storage pathogen increased with increase in storage period (Prasanna, 1994). The per cent infection differed with seed treatments and storage period. The average seed infection percentage at initial stage was 3.26 which increased gradually and rapidly to 13.46 per cent at the end of 10<sup>th</sup> month of storage. The minimum infection was observed in seeds treated with thiram @ 2 g and polymer coating @ 12 ml per kg of seeds ( $P_7$ ) followed by polymer coating @ 9 ml per kg of seed ( $P_6$ ) which recorded 2.08 and 4.91 per cent infection, respectively at the end of storage period. Whereas, the untreated ( $P_1$ ) seeds recorded significantly higher seed infection (10.29) at the end of storage period. This may be due to the fluctuation in the moisture content of seed treated with and without polymers. In the present study, the treatment  $P_7$  recorded lower moisture content (6.48%) compared to untreated seed (7.10%) at the end of storage. The polymer and fungicide treatment act as barriers to the absorption of moisture from the environment and also prevent the loss of quality of seeds by avoiding fungal infection in chemical treated seeds of onion as noticed by Singh (1992), Gupta *et al.* (1993), Murthy and Raveesha (1996) and Vamadevappa (1998).

Containers play a major role in prolonging the self life of seed during storage as they separate seeds from the surrounding environment. Some containers are moisture pervious and some are imperious. In the present study, two moisture impervious containers namely aluminium pouch and polythene bag, which proved better storers in the previous studies (Padma and Reddy, 2000) in onion seed were used for the study. Among these two containers, aluminium pouch found significantly superior in maintaining higher seed quality parameters throughout the storage compared to polythene bag.

The seeds stored in aluminium pouch recorded higher germination (73.88%), rate of germination (23.18), field emergence (64.68%), shoot length (7.78 cm), root length (6.87 cm), vigour index (1169) and seedlings dry weight (21.34 mg) compared to polythene bag (72.81%, 22.00, 63.93%, 7.57 cm, 6.60 cm, 1100 and 20.03 mg, respectively). The superiority of aluminium pouch in maintaining the higher seed quality parameters has been reported earlier by Pandey *et al.* (1994) and Jagadish *et al.* (1994) in onion seeds.

Aluminium pouch recorded lower moisture content (6.75%), electrical conductivity of seed leachate ( $0.652 \text{ dSm}^{-1}$ ) and seed infection (6.01%) at the end of storage period, which intern maintained high quality parameters during storage. These results are in accordance with Nagaveni (2005) in onion seeds.

Interaction effect between seed treatments and containers was found to be significant throughout storage period. Higher germination, rate of germination, field emergence, shoot length, root length, vigour index and dry weight of seedling was recorded in  $P_7C_2$  (78.75%, 24.75, 58.33%, 8.20 cm, 7.20 cm, 1333 and 22.18 mg, respectively) and lower in  $P_1C_1$  (70.10%, 19.75, 58.40%, 6.50 cm, 6.10 cm, 925 and 17.47 mg) respectively, at the end of storage. Significantly lower moisture content, EC value and seed infection was recorded in  $P_7C_2$  (6.47%,  $0.633 \text{ dSm}^{-1}$  and 1.24%, respectively) than  $P_1C_1$  (7.62%,  $0.705 \text{ dSm}^{-1}$  and 12.83%, respectively) at the end of 10<sup>th</sup> month of storage.

The selective influence of containers for polymer coating and polymer + fungicide coating might have resulted in the significant interaction effects.

## 5.2 Experiment – II : Effect of various coloured polymers with fungicide on storability of onion seeds

Seed enhancement implies an improvement in seed quality attributes by any post harvest treatment resulting in improved germinability, better field emergence and longer storability than the corresponding untreated seeds. Several seed coating treatments including seed colouring as post harvest treatment have been applied to improve seed quality /vigour and storability. Seed colouring was unrealistic and uneconomical a decade ago. But now it has provoked the interest among many seed traders and seed companies to enhance their company image and trademark. Developed countries are practicing this, since a decade as it has other advantages in improving the appearance of seeds, marketability, consumer preference, combating storage pests and diseases, enabling to identify carryover seeds and to prevent adulteration.

In order to know the effect of different dyes on storability of onion seeds, seeds were treated with different polymer dyes viz., polymer dyes blue, polymer dyes red, polymer dyes green, polymer dyes pink, polymer dyes yellow and polymer dyes clear (white) each at same concentration and in combination with or without fungicide. The results indicate that, there was significant variation in the seed quality throughout the storage due to difference in colour of the polymers.

Irrespective of the treatments the seed quality parameters declined progressively with the increase in storage period. The average germination, shoot length, root length, vigour index, rate of germination and dry weight of seedling at the beginning of storage were 95.80 per cent, 8.65 cm, 8.71 cm, 1649, 44.13 and 29.91 mg, which declined to 74.92 per cent, 7.35 cm, 7.26 cm, 1146, 20.75 and 18.00 mg respectively at the end of 10<sup>th</sup> months of storage period.

All the polymer dyes alone or in combination with fungicide maintained significantly higher germination throughout the storage period compared to the untreated seeds and fungicide treated seeds. These dyes maintained the germination above the minimum seed certification standard till the end of 10<sup>th</sup> month of storage. Among the treatments, polymer dyes yellow @ 12 ml coupled with thiram @ 2 g per kg of seed recorded higher seed germination (78.33%), field emergence (63.75%), rate of germination (22.60), shoot length (7.95 cm), root length (7.85 cm), vigour index (1392) and seedlings dry weight (19.66 mg) at the end of 10<sup>th</sup> month of storage followed by polymer dyes green @ 12 ml + thiram @ 2 g per kg of seed (77.68%, 62.00%, 22.30, 7.80 cm, 7.75 cm, 1362 and 19.30 mg, respectively). Whereas, these parameters were significantly lower with the untreated control followed by fungicide treatment alone. Similar influence of colouring agents on storability of seeds have been observed by Vishvaprasad (2001) in maize, Shivanna (1991) in sorghum and Keshavulul an Kirshnaswamy (2005) in soybean.

The moisture content (6.3%), electrical conductivity (0.561 dSm<sup>-1</sup>) and seed infection (10.45%) were significantly lower in seed treated with polymer yellow @ 12 ml + thiram @ 2 g per kg of seed followed by polymer green @ 12 ml + thiram @ 2 g per kg of seed of 6.3 per cent 6.4 per cent at the end of 10<sup>th</sup> month of storage.

The variation in the seed quality parameters, among the different polymer dyes may be because of selective influence of these dyes on the seed quality. Similar results were observed earlier by Tonapi (1989) in sorghum, Saraswathi and Krishnaswamy (2003) in maize and Shobha (2006) in soybean.

### Practical utility

For better storability of onion seeds, the seeds should be film coated using polymer @ 12 ml per kg with thiram @ 2 g per kg of seeds.

Storage of onion seeds in aluminium pouch was found beneficial in maintaining higher seed quality in storage.

The seeds can be marketed after colouring with different polymer dyes, as these colours not only are harmless to seed but rather beneficial, as they maintained better seed quality parameters during storage.

## Future line of work

Studies on polymer coating and fungicide treatment at varied concentrations can be taken up in different crops.

Similar studies on polymer coating and fungicide treatment can be taken up in other vegetable crops.

Studies on suitability of different containers for safe storage of different vegetable seeds can be taken up.

## 6. SUMMARY AND CONCLUSIONS

Onion is one of the important vegetable crop which is grown throughout India and world. The seeds are stored after harvest till the next sowing or until further use. The onion seeds are found to be poor storer. Proper seed treatments are used to enhance seed quality and storability. Efficiency of chemicals used to store the seeds can be increased by treating the seeds with polymer, which holds the fungicides and insecticides intact and prevent loss during storage. Seeds coating with colouring agents enhance appearance of seed. Its marketability, company image and controls pest and diseases during storage. Keeping in view of these factors two laboratory experiments were carried out to study the effect of fungicide and polymer coating on storability of onion seeds and influence of fungicide and polymer dyes on storability of onion seeds during 2006-07 at laboratory of National Seed Project, University of Agricultural Sciences, Dharwad. The results of the experiments are summarized here.

### Effect of polymer film coating with fungicide and containers on storability of onion seeds

The seeds treated with fungicide and polymer showed significant superiority on seed quality parameters during storage.

The treatment P<sub>7</sub> (Thiram @ 2 g with polymer @ 12 ml/kg of seed) recorded higher germination followed by P<sub>6</sub> (Thiram 2 g + polymer @ 12 ml per kg of seed) and lowest was recorded in untreated control (P<sub>1</sub>). These treatments recorded the germination percentage of 77.12, 74.37 and 70.10, respectively at the end of storage period.

Significantly higher shoot length (8.13 cm) and root length (7.15 cm) were recorded in seeds treated with Thiram @ 2 g + polymer coating @ 12 ml per kg of seed (P<sub>7</sub>) followed by seeds treated with Thiram @ 2 g + polymer 9 ml per kg of seed (8.10 cm and 6.90 cm, respectively) and the lowest shoot and root length (6.50 cm and 6.00 cm, respectively) were observed in untreated control (P<sub>1</sub>) at the end of storage period.

Significantly higher vigour index (1291), rate of germination (24.50) and dry weight of seedlings (22.05 mg) were recorded in P<sub>7</sub> treatment and these were significantly lower (995, 19.00 and 16.07 mg, respectively) in untreated control at the end of 10<sup>th</sup> month of storage.

Treatment P<sub>7</sub> recorded significantly lower electrical conductivity and seed infection (0.630 dSm<sup>-1</sup> and 2.08% respectively) followed by P<sub>6</sub> and P<sub>5</sub>. Whereas, the untreated control recorded higher values for electrical conductivity and seed infection (0.710 dSm<sup>-1</sup> and 10.29%, respectively) at the end of 10<sup>th</sup> month of storage.

Significantly higher field emergence (67.80%) was recorded in P<sub>7</sub> and significantly lower field emergence recorded (59.80%) in untreated seed (P<sub>1</sub>) at the end of 10<sup>th</sup> month of storage.

Significantly higher germination, shoot length, root length, vigour index, rate of germination and seedlings dry weight were recorded in C<sub>2</sub> (aluminum pouch), which are 73.88%, 7.78 cm, 6.87 cm, 1168m 23.18 and 21.34 mg, respectively, compare to polythene bag (700 gauge). Significantly lower value of moisture content, electrical conductivity and seed infection was recorded with the seeds stored in aluminium pouch (C<sub>2</sub>) (0.652 dSm<sup>-1</sup>, 6.75%, and 6.01%, respectively) compare to C<sub>1</sub> at the end of 10<sup>th</sup> month of storage. Significantly higher field emergence was recorded in C<sub>2</sub> (64.68%), compare to C<sub>1</sub> (63.36%) at the end of 10<sup>th</sup> month of storage.

Interaction effects due to different treatment combination and containers were significant. The seed quality parameters were higher with P<sub>7</sub>C<sub>2</sub> and lower with P<sub>1</sub>C<sub>1</sub> throughout storage period.

### Effect of various coloured polymers with fungicide on storability of onion seeds

All the polymer dyes alone or in combination with fungicides maintained significantly higher seed quality parameters during storage compared to untreated seeds. Thiram @ 2 g coupled with polymer yellow coating @ 12 ml per kg of seed recorded higher germination followed by D<sub>10</sub> (Thiram @ 2 g + polymer green @ 12 ml per kg of seed) and lower germination was recorded in untreated control (D<sub>1</sub>). These treatments recorded germination percentage of 78.33, 77.68 and 69.50, respectively at the end of 10<sup>th</sup> month of storage.

Significantly higher shoot length (7.95 cm) and root length (7.85 cm) were recorded in seeds treated with Thiram @ 2 g + polymer yellow @ 12 ml per kg of seed (D<sub>12</sub>) followed by seeds treated with Thiram @ 2 g + polymer green @ 12 ml per kg of seed (7.80 cm and 7.75 cm, respectively) and lower shoot and root length (6.95 cm and 6.80 cm, respectively) were recorded in untreated control (D<sub>1</sub>) at the end of storage. Significantly higher vigour index (1392), rate of germination (22.60) and seedlings dry weight (19.66 mg) was recorded in D<sub>12</sub> and significantly lower vigour index, rate of germination and seedlings dry weight (935, 17.80 and 15.73 mg, respectively) recorded with untreated control (D<sub>1</sub>) at the end of 10<sup>th</sup> month of storage. Higher field emergence (63.75%) was recorded in D<sub>12</sub> (Thiram @ 2 g + polymer yellow @ 12 ml per kg of seed) compare to control D<sub>1</sub> (52.50%) at the end of 10<sup>th</sup> month of storage.

Significantly lower electrical conductivity (0.561 dSm<sup>-1</sup>), moisture content (6.3%) and seed infection (10.40%) were recorded in D<sub>12</sub> (Thiram @ 2 g + polymer yellow @ 12 ml per kg of seed) compare to control D<sub>1</sub> (0.885 dSm<sup>-1</sup>, 6.9% and 21.45%, respectively) at the end of storage period.

From the results of these investigation, it may be concluded that, for enhancing the storability and to maintain higher seed quality parameters throughout the storage, the seeds of onion are to be treated with Thiram @ 2 g per kg of seed coupled with polymer coating @ 12 ml per kg of seeds. To improve appearance, marketability apart from the better storability, seeds of onion could be coated with synthetic polymer dyes like polymer yellow or green along with fungicide treatment.

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# EFFECT OF FUNGICIDE, POLYMER AND POLYMER DYES TREATMENT ON STORABILITY OF ONIONS SEEDS

BASABARAJ B.O

2007

N.K. BIRADAR PATIL

## ABSTRACT

An experiment was conducted on storability of onion seed cv. Bellary red in the Laboratory of National Seed Project, University of Agricultural Sciences, Dharwad during 2006-07. freshly harvested seeds were stored for a period of 10 months under ambient condition to know the effect of fungicide, polymer and polymer dyes coating on seed quality of onion seeds. Seeds were treated with polymer @ 6ml, 9ml and 12ml, concentration and with and without fungicide (Thiram @ 2g/kg of seeds) and stored in two containers viz., Polythene bag (700 gauge) and aluminum pouch. In an another experiment, seeds were treated with different fungicide (Thiram @ 2g/kg of seed) and stored in polythene bag for 10 months under ambient conditions.

The results revealed that, seed coating with polymer @ 12ml + thiram 2g per kg of seed showed superiority in storing the seeds by recording significantly higher germination percent (77.12%), rate of germination (24.50), field emergence (67.80%), root length (7.15cm), shoot length (8.13cm), vigour index (1291), seedlings dry weight (22.05mg) and lower electrical conductivity of seed leachate ( $0.630 \text{ dSm}^{-1}$ ), moisture content (6.48%) and seed infection (2.08%) as compared to control at the 10<sup>th</sup> month of storage. Seeds stored in aluminum pouch recorded significantly higher seed quality parameters compared to polythene bag.

Seeds treated with different colored polymers coupled with fungicide recorded significantly higher seed quality parameters. Seeds coated with polymer yellow @ 12ml + thiram @ 2g per kg of seeds recorded higher germination (78.33%), field emergence (63.75%), rate of germination (22.60), shoot length (7.95cm), root length (7.85cm), vigour index (1392), seedling dry weight (19.66mg) and lower electrical conductivity of seed leachate ( $0.561 \text{ dSm}^{-1}$ ). Moisture content (6.3%) and seed infection (10.45%) as compared to control at the end of 10<sup>th</sup> months of storage. Other polymers dyes were also superior over untreated control.