EFFECT OF POLYMERCOATING AND SEED TREATMENT CHEMICALS ON SEED STORABILITY AND FIELD PERFORMANCE OF CHICKPEA

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SUSHMA P. P.

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

JUNE, 2013

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INTRODUCTION

Chickpea is popularly cultivated in sub tropical and semi arid to warm temperature region under dry season. It is one of the earliest food legumes cultivated by man and plays an important role in human diet and agricultural systems. Chickpea belongs to the genus *Cicer* and family Fabaceae. “Anatolia” in Turkey was the area where chickpea is believed to have been originated (Van Der Maesen, 1984).

Chickpeas are rich in protein (20-22%), carbohydrate, fibre, minerals (Ca, Mg, Zn, K, Fe and P) and vitamins (thiamine and niacin) (Jukati, 2012). It is a good protein supplement for people with cereal based diet and can complement the diet with several essential amino acids. Being a leguminous crop, chickpea improves soil fertility by fixing atmospheric nitrogen into plant available form (NH_3 and NH_4) through the phenomenon of symbiosis, it has ability to meet 80 per cent of its nitrogen requirement by symbiotic nitrogen fixation. It leaves substantial amount of residual nitrogen for subsequent crops and adds plenty of organic matter to maintain and improve soil health and fertility because of its deep tap root system, chickpea can withstand drought conditions by extracting water from deeper layers of the soil profile.

Chickpea is the second most widely grown legume crop of the world after soybean. During 2011-2012, the global chickpea area was about 13.20 million ha, with production of 11.62 million metric tons and average yield of 804 kg ha-^{1}. India is the largest chickpea producing country with a share of about 68% in the global chickpea production. In India estimated area, production and productivity during 2011-12 was 9.21mha, 8.22 m tonnes and 841 kg ha^{-1} respectively (Anon., 2012). Madhya Pradesh, Utter Pradesh, Rajasthan, Maharashtra, Gujarat, Andra Pradesh and Karnataka are the major chickpea producing states sharing over 95 per cent area (Anon., 2011a).

Among the cultivated species, *Desi* and *Kabuli* types are of practical importance, which covers 85 and 15 per cent of total cultivated area, respectively. Desi types are small seeded, varied coloured with thick seed coat and reticulated surface. The flower colour is purple or pink with anthocyanin pigment in aerial parts and the protein content is around18 to 19 per cent.Whereas in Kabuli type seeds are large, whitish with thin testa and smooth surface. Flowers are white, without anthocyanin pigment in aerial parts and the protein content is around is 20 to 23 per cent.

However, pulse production of our country has remained almost stagnant for the past several years and hence need to meet out the requirement of pulses to growing population. The problem of seed storage assumes importance because seed has to be stored without loss of viability and vigour from the day of harvest to next planting season and also for carryover purpose. It is evident that all pulses are susceptible to storage pests and disease. Chickpea is no exception because of its high protein content, chickpea seed is highly attacked by storage pests and other microflora. The pulse beetle (*Callosobruchus chinensis*) in storage causes considerable damage and affects the quality of seed. Seed coat acts as both physical and chemical barrier to pest infestation and pathogen infection, besides protecting embryo and endosperm. Additionally, the seed coat can restrict the diffusive loss of seed contents. A thin and smooth seed coat seeds are vulnerable to storage pest and pathogens and may increase the concentration and amount of leachate too.

In modern agriculture, success of seed industry and seed programmes depends upon how carefully seeds are stored up to next planting season without loss of seed viability and vigour. “A seed saved is seed produced” an old adage still holds good today. The storage losses of seeds in terms of quality and quantity may range from zero to hundred per cent under unhygienic storage conditions. A greater variations in quality of chickpea seeds are evident in both *kabuli* and *desi* varieties, during storage. Hence the research on “Influence of storage period on seed quality of chickpea varieties” is felt necessary.

Seed viability is a major factor in crop stand establishment and subsequent productivity in many parts of the world. Losses in seed quality occur during field weathering, harvesting and storage due to which seeds get damaged. If seeds are exposed to high temperature and high humidity, the incidence of micro flora is mainly responsible for the degradation of protein and other food reserves resulting in reduction in viability, vigour and germination. Seed is an efficient media for survival and dissemination of pathogens and pests to reduce the losses and preserve the viability for longer time, it is advisable to coat the seeds with polymer, fungicide and insecticide. Seed coating provides an opportunity to package effective quantities of material in such a way that they can influence the seed or soil at the soil seed interface.

To preserve the seed material, several measures have been employed from time to time like mixing of inert dusts, use of organochlorine and organophasphrous insecticides. There is a need to manage the pest using effective practices having less mammalian toxicity, longer persistency and no adverse effect on seed quality parameters. A strong reduction in the amounts of pesticides being used can be achieved by applying the crop protection agents directly to seed instead of spraying them in the field and can be incorporated in a film coat layer for better efficiency. Seed coating materials were reported to improve the germination and increase the seedling emergence at changing soil moisture especially in the suboptimal range (Mucke, 1987). The nutrient environment could be created by adding variety of substances to the seed to enhance the seed quality. Seed coating is a technique of seed encapsulation with organic, inorganic nutrients, water absorbents and pesticides. Increase in germination can be seen in polycoated seeds, it is due to increase in the rate of imbibitions where the fine particles in the coating act as a 'wick' or moisture attracting material or perhaps to improve soil seed contact. Coating with hydrophilic polymer regulates the water uptake, reduce imbibitional damage and improve the emergence of soybean seeds (Hwang and sung, 1991).

The polymercoat provides protection from the stress imposed by accelerated ageing, fungal infection and pest infestation. It improves emergence of seedlings and plant stand in the field. Accurate application of chemicals reduces the wastage, polymercoat helps to make room for including all required ingredients, protectants, nutrients, plant growth promoters, hydrophobic / hydrophilic substances, oxygen suppliers etc. by encasing the seed within a thin film of biodegradable polymer, the adherence of seed treatment chemicals to the seed it ensures dust free handling and make treated seed both useful and environment friendly. Polymer coating makes sowing operation easier due to the smooth flow of seeds. Addition of colorant helps in visual monitoring of placement accuracy, enhance the appearance, marketability and consumer preference. The polymer film coat may act as a physical barrier, which has been reported to reduce the leaching of inhibitors from the seed coverings and may restrict oxygen diffusion to the embryo (Vanangamudi *et al.*, 2003).

The detailed information on these aspects of chickpea is lacking and thus deserves the attention of understanding that would be of much practical significance to improve the seed production. Hence, an investigation was initiated to know the "Effect of polymercoat and seed treatment chemicals on seed storability and field performance of chickpea" with the following objectives.

i. To study influence of storage period on seed quality of chickpea varieties.

ii. To study effect of polymercoat and seed treatment chemicals on chickpea seed quality during storage.

iii. To study the influence of polymercoat and seed treatment chemicals on field performance of chickpea.

REVIEW OF LITERATURE

The literature pertaining to the influence of storage period on seed quality of chickpea varieties and effect of polymercoat and seed treatment chemicals on seed storability and field performance of chickpea are presented in this chapter. Since the reviews related to these aspects in chickpea are scarce, hence research works carried out in other related crops are also included in this chapter.

2.1 Influence of storage period on seed quality of chickpea varieties

In storage the viability and vigour of seed varies from variety to variety as the genetic factors influence the storability of seed and field performance in many field crops. The seeds of different cultivars possess different physical structure and chemical composition. These factors determine the longevity of seed in the storage. The literature pertaining to the influence of storage period on seed quality of chickpea varieties traits is reviewed and presented below.

Viability and vigour of seed varied between varieties as the genetic factors influence the storability of seed. The seeds of different cultivars possess different physical, physiological and chemical composition which influences the longevity of seed during storage (Delouche, 1973).

Gupta *et al*. (1976) stored the seeds of 25 soybean varieties and screened them for loss of viability during storage. Among the varieties Punjab-1, JS-2, JS-152 and Monetta maintained more than 70 per cent germination even after one year of storage.

Tewari and Gupta (1981) noticed in sunflower that seeds of Peredvik varieties maintained higher seed quality parameters at the end of eight months of storage than variety Sunrise under cold room condition. Similarly among the seed grades larger seeds proved better in maintenance of viability and vigour than the smaller or mixed seeds.

Vanangamudi (1988) stored soybean seeds for 16 months and observed varietal differences in seed longevity. Seeds of cultivars *viz*., Hill, Co-l, Nirnsoy 7, DS 74-37 and PB-1 have better storage potential. Whereas, Bragg has poor storability. He also observed that small seeds retained their viability longer than large seeds.

Mohanrao (1993) studied on five soybean genotypes with four grades of seed size, the results of experiment revealed that small seeds of all the varieties maintained higher germination and field emergence in all months of storage period. While, the seedling vigour parameters were maximum in big seeds of all the varieties.

Ahamed *et al*. (1994) reported in Sunflower cv. Morden that the storability of 4.75 mm size graded seed was only for nine months, while the seeds of 5.00 mm size stored for about one year. They have also reported higher germination in bolder seeds indicating that bold seeds during storage deteriorate slower than small seeds.

Kumar *et al*. (1997) reported that germination and seedling vigour decreased in all the varieties of peas with the increased duration of storage.

Kharb *et al*. (1998) observed that the soybean genotypes T-49, M0-40, PK-262, PK 416 and Durya deteriorated at faster rate and considered them as poor storer. Whereas, Kalitur, JS-8021, JS-8759, JS-8918 Punjab-1, KB-92, NRC-2, MACS-335 and Pusa-20 as good storer as these genotypes maintained the germination percentage above the certification standards (70%) after nine months of storage.

Singh *et al*. (1998) reported that at ambient temperature vigour and viability of 12 genotypes of rice bean declined gradually during 3 to 3.5 years of storage.

Among the three groundnut varieties tested, TMV-2 stored for more than 12 months followed by JL-24 and ICGS-11 with or without seed treatment (Vasundhara and Bommegowda, 1999).

Arati *et al*. (2000) found that performance of Annegeri-1(*Desi*) was better compared to ICCV-2 (*Kabuli*) for seed quality parameters variety A-1 recorded higher germination (68.71%), seedling length (20.48cm), seedling vigour index (1406) and field emergence (51.00 %)at the end of 14 months of storage.

Kurdikeri *et al*. (2003) observed significant varietal differences for germination in groundnut. Among six genotypes of groundnut stored in cloth bag under ambient conditions of Dharwad, cv.

DH-330, JL-24, TMV-2 and ICGS-76 maintained satisfactory germination (70%) as per the minimum seed certification standards up to 15 months. While, Mardur local and DH-40 maintained germination upto 11 and 9 months, respectively.

Gnyandev (2009) studied storage potential of chickpea varieties among the varieties *Desi* type varieties maintained satisfactory germination upto 8-9 months while *Kabuli* types upto 7-8 months during 12 months of storage period.

Kapoor *et al.* (2010) studied that sequence and relationship process of deterioration over a short period in the five chickpea varieties *viz*., three desi varieties (Pusa256, Pusa212 and BGD 72) and two *kabuli* (Pusa267 and K551). Ageing on seed viability, seedling vigour and biochemical process were explored. They found that differential responses exhibited among the varieties with respect to ageing and they concluded that Pusa256 is the best variety followed by K551 among all 5 varieties and Pusa 212 is the highly sensitive variety with respect to ageing.

2.1.1 Influence of Seed coat on storability

Singh *et al*. (1980) reported the seed coat thickness in "desi" (small seeded) was found to be 115 to 205µ (av. 144µ) whereas in "kabuli" (large seeded) was 37 to 106 µ (av.58.5 µ). Further they concluded that "desi" type stored better compared to "kabuli" type.

The differences in seed coat content of "desi" and "kabuli" types were attributed to differences in seed coat anatomy and they influence on storability of seeds (Kumar and Singh, 1989).

Gill and Cubero (1993) observed differences in the seed coats of *Cicer arietinum* and reported that seed coats are thicker in "desi" types compared to "kabuli" types. "desi" type seeds store better under normal conditions compared to "kabuli" type seeds.

Sood *et al*. (1997) evaluated the Chickpea seeds of desi type (Gaurav, C-235 and H82-2) and Kabuli type (L-44, L-550 and Gora Hisari) for hard to cook defect during storage by measuring physicochemical and biochemical changes. Results revealed that, *desi* types possessed higher seed coat thickness than *kabuli* types. Gaurav among desi and L-44 among kabuli cultivars were found to be superior because of higher 100 seed weight and thick seed coat.

Kumar *et al*. (1998) evaluated seventeen desi chickpea genotypes for physical characters which determine the seed quality. Among the bold seeded varieties Gaurav, KGP 143-1, and Kap 173-4 were found to be very good physical and phsico-chemical characters whereas, among small seeded types GNG-146 had better water absorption and swelling capacity.

2.1.2 Influence of Bruchid infestation on storability

Siddiqui (1972) reported that the loss caused by *Callasobruchus chinensis* was to the extent of 68.3, 97.5, 81.0 and 30.0 per cent in gardenpea, cowpea, mungbean and chickpea, respectively after three months of storage.

Gupta *et al*. (1981) reported the decreased viability, hundred seed weight after six months after storage period. About 84 per cent of seed damage, 55 per cent weight loss and 98 per cent germination loss due to pulse beetle were seen in bengalgram.

Vimala and Pushpamma (1983) found progressive increase in the loss of seed viability with increase in the level of infestation by *Collasobruchus chinensis*. It was the highest for redgram followed by blackgram and bengalgram seeds.

Singal (1987) reported that no genotype of chickpea was completely resistant to bruchid infestation but M83-114, 1784-71, 1783-31, 1784-8 and M-8-1 were susceptible.

Modgil and Mehta (1995) studied physical and chemical properties of bengal gram seeds stored for six months. They noticed 41 per cent decrease in weight and density after 6 months. The chemical changes noticed were increased moisture, crude fat, crude protein, crude fiber and uric acid but decrease in true protein and methionine content due to pulse beetle *Collasobruchus chinensis* infestation.

Biradarpatil *et al.* (1995) observed significant reduction in 100 seed weight, germination and vigour with increased number of holes of the bengalgram seeds infested with bruchid compared to normal seeds (uninfested).

2.1.3 Chickpea varietal charectoristics

Bahrenfus and Fehr (1984) observed differences in two soybean cultivars *viz*., Cumberland and Harper based on flower colour, pubescence, pod colour *etc* Harper cultivar has purple flower tawny pubescence, brown pods at maturity and higher seed yield compared to Cumberland but both cultivars were similar in days to maturity and plant height.

Forty four chickpea cultivars collected from different locations of Uttar Pradesh, exhibited variation with regard to seeds per pod (1-3) , foliage colour (green, purple and half green), plant height (20-35 cm) and number of branches per plant (4-10) (Anon., 1992).

Upadhayay *et al.* (2002) classified 1956 accessions of chickpea of which 1465 were desi, 433 kabuli and 88 intermediate types. All the three types differed significantly for flower colour, plant colour, dots on seed testa, testa texture, plant width, days to maturity, 50 per cent flowering, pods per plant, 100 seed weight and plot yield.

Lokare *et al*. (2007) studied for genetic divergence for seed yield and quality traits in 60 “kabuli” chickpea genotypes. Significantly wide range of variation for 100 seed weight and moderate variation was observed for protein content and cooking time among the genotypes.

Vadez *et al.* (2007) evaluated “desi” and “kabuli” genotypes for salinity stress tolerance, they observed yield potential was more in “desi” type compared to “kabuli” type in the saline stress condition from this they concluded that “desi” genotypes had higher salinity tolerance than “kabuli” genotypes.

Chandrashekhar (2008) recorded significant differences in days to 50 per cent flowering, pod length, pod shape and number of seeds per pod and found that they were found most reliable characters for classifying French bean genotypes.

Gnyandev (2009) reported that “desi” cv. BGD103 the large seed size than Annegeri-1, Bheema, ICCV-2. He found that BGD 103 recorded significantly highest seed yield and seed quality parameters compared to all other varieties.

Gaur *et al*. (2010) reported “desi” type chickpeas seeds are small angular with rough surface and have thick seed coat with brown, yellow, green and black various shades and combinations. Flowers are pink colour in nature. Whereas “kabuli” type chickpeas are white with rams head shape, thin seed coat, smooth seed surface, and white flowers.

Tripathi *et al*. (2012) evaluated 44 Kabuli type and 42 Desi type, for their phenological, physicochemical and cooking quality traits. They observed significant differences among the genotypes for days to 50 per cent flowering (34-81days), days to maturity (85-122 days), number of pods per plant (13-66), number of seeds per plant (15-85), 100-seed weight (10.5-58.6 g), seed yield (561-1852 kg/ha), seed volume (0.1-0.52ml/seed) except in hydration capacity (0.11-0.68 g water/seed), hydration index (0.80-1.21), swelling capacity (0.11- 0.7 ml/seed), and cooking time (38-125 min).

2.2 Effect of polymercoat and seed treatment chemicals on chickpea seed quality during storage

Storage of seeds at least for next sowing season is an essential part of seed programme. Many times the seed is to be stored for many years as buffer stock. The seed quality deterioration starts right at the field level immediately after the physiological maturity. The seed has to be stored safely so that the viability and vigour are maintained.

The storability of the seed is mainly depends on several factors such as genetic, initial seed quality, provenance, storage environment, pest and disease *etc* If any one factor looses it leads to rapid loss of viability and vigour. This intern results in poor establishment of the crop in the field which leads to low productivity. Seed deterioration is an irreversible, inexorable and inevitable 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 the huge cost, seed treatment remains the best alternative approach to maintain the seed quality.

Seed polymer coating is the substance applied to the seed that does not obscure its shape. Seed coating is one of the most economical approaches for improving seed storability and field performance.

The post harvest seed treatment with polymer seed coat, insecticide and fungicide would bring qualitative improvement in the seed, particularly germinability, greater storability and better field performance. This kind of plasticizer polymer form flexible film that prevents dusting off and loss of fungicide during handling and is readily soluble in water (hydrophilic) so as not to impede with normal germination (Sherin and Susan John, 2003). The application of polymer to seed serves as an extra exterior shell in order to give the desired seed characteristics *viz*., quick or delayed water uptake and enhanced germination that would be beneficial for better emergence and establishment in the given condition (Taylor *et al*., 1998). Film coating provides protection from the stress imposed by accelerated ageing, which include fungal invasion. It improves plant stand and emergence of seeds and this technique is recommended for high value agricultural crops (Sherin and Susan John, 2003).

2.2.1 Effect of polymer coating on seed quality during storage

Berdahl and Barker (1980) noticed the reduction in germination with higher concentrations of polymer in Russian wild rye seeds.

Sachs *et al*. (1981) reported that the sweet pepper seed pelleting was highly beneficial for enhancing the germination as seed coats become impermeable to oxygen.

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

West *et al.* (1985) indicated that continuous cover on polymer coated seed 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 sweet corn seeds were coated with hydrophilic polymer like hydrolysed starch graft polyarylonitrile to maintain a high water potential around germinating seeds.

Sathyanarayana Rao and Ranganathaiah (1988) noticed in paddy seed treated with Emisan–6 reduced seed borne fungi (4.55%), increased the field emergence (71.85%) over control (36.00% and 48.66%, respectively).

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

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

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

Devay *et al.* (1995) concluded that, the acid delinted cotton seed along with the polymer coating avoids the additional steps needed for seed neutralization and pesticide seed treatment of acid delinted seed, because the polymer coating is premixed with pesticides.

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 the cotton seeds coated with Landec polymer recorded slower imbibitional rate, reduced the imbibitional damage, lowered the electrical conductivity values and improved the germination.

Taylor *et al.* (1998) reported that, the application of polymer to seed serves as an extra exterior shell in order to give the desired seed characteristics *viz*., quick or delayed water uptake and enhanced germination that would be beneficial for better emergence and establishment in the given condition.

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

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

Chachalis and Smith (2001) suggested that coating of soybean seed with 24 mg of hydrophobic polymer (Vinamul 3650) per seed regulated the rate of water uptake, reduced the imbibitional damage and improved the germination per cent and seedling emergence. The coating with hydrophobic polymer also lowered the solute leakage in aged seeds.

Larissa *et al*. (2004) studied that, the dry bean (*Phaseolus vulgaris* L.) seed coated with the polymers and treated with fungicide, germination of coated and treated seeds was not affected during the storage period. The association of coating and a wettable powder treatment showed a higher germination percentage after two months of storage.

John *et al.* (2005) reported that maize seeds coated with polycoat @ 3 g/kg as slurry coating improved the seed quality. In terms of uniformity in coating the physical appearance of slurry-coated seeds was better in terms of aesthetic value. The rate of imbibition was maximum in polykote slurry coating @ 3 g/kg seed and gave the highest germination percentage (97), root length (19.7 cm), shoot length (18.5 cm), dry matter production (1.031 g/ seedling), vigour index (3776), germination rate (47.6%), and chlorophyll content (1.22 mg/g).

The soybean seeds treated with polykote namely, black, red recorded significant increase in germination percentage over control (Keshavalu and Krishnaswamy, 2005).

Vinitha (2006) noticed that in film coating of tomato seeds showed that 6 g of white red polykote @ 6g kg-1 of seeds registered higher values for germination, root length, shoot length and vigour index than the uncoated seeds respectively.

Chandravathi *et al.* (2008) reported that in pearlmillet, among the seed treatments, hydropriming + polymer coating + Thiram 2.5 g per kg of seed + malathion 5% recorded significantly highest germination (83.45 %), root length (17.40 cm), shoot length (8.21 cm), vigour index (2085), seedling dry weight (78.47 mg), lowest electrical conductivity (0.718 dS/m) and field emergence (81.39%) as compared to untreated seeds at the end of six month of storage period.

Suresh (2008) in maize the dosage of Little's red polykote not much effect on germination compared to control but obtained more seedling vigour index compared to the lower or higher dosages, higher root length (28.3cm), shoot length (12.7cm), dry matter production (1.83g) and vigour index (4015) recorded in polymer seed coated @ 6 ml per kg of seeds.

2.2.2 Influence of fungicide on seed quality during storage

Anahosur and Bidari (1973) reported that vitavax (3 g/kg) and thiram (2 g/kg) proved to be the excellent chemicals out of seventeen chemicals listed in preventing seed loss due to rotting of soybean seed in storage. The germination was 85-87 per cent and in thiram treated seed even after six months of storage.

Omvir Singh *et al.* (1973) studied the influence of fungicide treatment on soybean seed and suggested that seeds treated with thiram + terrachlor super – X significantly improved seedling emergence even after six months of storage over control.

Casela *et al.* (1979) reported soybean seed treatment with thiram and captan increased the seed germination from 50 to 63 per cent, respectively.

Sindhan and Bose (1981) reported that, in french bean, among the thirteen seed dressing fungicides tested, benlate followed by bavistin, vitavax, thiram and agrosan were more effective in increasing the seed germination and reducing disease incidence. Fungicide treated seeds recorded maximum germination more than 78 per cent compared to (53%) in control.

Mahendrapal and Grewal (1985) reported that pigeon pea seeds treated with bavistin recorded higher germination (73%) compared to (56%) in control.

Padmini and Radhya (1985) found that bavistin was effective against most of the seed borne fungi in groundnut and improved the storability of seeds.

Pawar *et al*. (1985) observed that paddy seeds treated with carbendazim recorded higher germination (93%), root length (10.89 cm) and shoot length (9.82 cm), compared to untreated control (60.50%, 10.45cm and 8.62 cm, respectively).

Singh and Agarwal (1986) reported that, dry seed treatment with captan, thiram, bavistin + thiram against *Cercospora kikuchii* improved the seed germination of soybean seeds.

Voroveni *et al.* (1986) reported that soybean seed treated with thiram (@ 2 g/kg) showed higher germination and field emergence than untreated seeds.

Sundaresh *et al*. (1987) reported significant improvement in germination under *in vitro* (18.20%) and *in vivo* (22.25%) conditions when soybean seeds were treated with thiram @ 4 g per kg or dithane M-45 @ 3 g per kg of seeds compared to (7.53%) control.

Ranga rao *et al*. (1996) observed that groundnut seeds treated with thiram recorded significantly higher germination (85.0%) over control (23.4%) after 24 months of storage.

Solanke *et al.* (1997) noticed that the sunflower cv. LDMRSH-1 seed treated with thiram + carbendazim recorded higher germination (91.00%) and less seed mycoflora (5.90%) as compared to control (79.00 and 9.00%, respectively).

Savitri *et al*. (1998) observed that groundnut seeds treated with thiram @ 3 g per kg of seeds and stored in cloth bag recorded higher germination (30.66%) and vigour index (452) over control after 18 months of storage.

Vasundhara and Bommegowda (1999) in groundnut, found that the seeds treated with captan @ 3 g per kg of seeds recorded higher germination (85.23%), vigour index (3051), field emergence (80.56%) and the lowest electrical conductivity (292 µ mhos/cm) compared to control (73.07%, 2182, 78.36% and 394 µ mhos/cm, respectively).

Muthuraj *et al*. (2002) noticed that soybean seeds treated with thiram (2 g/ kg of seeds) improved germination (80.75%) and field emergence (70.52%) compared to control (79.10 and 58.63%, respectively).

Abou-Zeid *et al.* (2003) reported that seed treatment with all biological control agents *i.e., Trichoderma harzianum, Gliocladium virens, Bacillus subtilis* and *Paecilomyces* sp.) or Vitavax 200 fungicide significantly decreased damping-off disease and increased percentage of surviving plants in fababean, lentil and chickpea.

2.2.3 Influence of insecticide on seed quality in storage

Bareth and Gupta (1989) concluded that deltamethrin (2 ppm) proved to be the most effective protectant against *R. dominica* in wheat seeds. It was followed by fenvalerate (20 ppm), fenitrothion (20 ppm) and chloropyriphos (20 ppm). Compared to the recommended insecticide malathion (20 ppm) none of the insecticides hampered the germination of seeds under storage condition.

Saroj and Yadav (1989) reported that full protection of greengram seed was observed with 1 ppm deltamethrin dust against *Callosobruchus chinensis* and even with 40 ppm of malathion @ 10 per cent against pulse beetles. Seed germination was not affected by these chemical treatments.

Ravindranath *et al.* (1990) reported that the cowpea seeds treated with malathion (5%) dust and thiram maintained higher germination compared to control up to six months of storage, whereas a sudden decrease in germination and seedling dry weight was seen in the untreated seeds after three months of storage due to infestation of pulse beetle.

Lakshminarasimhaiah (1993) in pigeonpea observed no bruchid infestation in the seeds treated with malathion dust (5 g/kg seed) upto six months of storage without impairing seed germination and vigour.

Paul *et al.* (1996) noticed that mungbean seeds treated with malathion @ 2.00 g per kg +captan @ 5.00 g per kg of seed proved better with respect to germination percentage (81.52), seedling length (26.32 cm) and vigour index (21.45) after nine months of storage.

Wase and Sudam Rao (1998) reported that deltamethrin @4 ppm and cypermethrin @15 ppm were the best protectants which absolutely prevented the insect infestation and weight loss in seed up to six months of storage period followed by cypermethrin 10 ppm and deltamethrin @ 2 ppm and they were at par with each other. None of the insecticide adversely affected the germination of seeds.

Laxminarayan *et al*. (1999) reported that insecticidal treatment maintained better storability of greengram seed than control treatment. Fenvalerate 0.4 D and endosulfan 4D @ 2, 3 and 4 g per kg of seed, were superior in controlling storage pests compared to malathion 5D, quinolphos 1.5 D and control.

Bajpai *et al.* (2000) reported that urdbean seed treated deltamethrin @ 5 ml PER kg of seeds recorded higher germination (78.70%) and seedling length (14.50 cm) compared to control (69.70% and 14.00 cm, respectively) at the end of eight month of storage period.

Malarkodi and Srimathi (2001) observed that the seeds of maize cv. CO-1 can be preserved safely for a period of nine months when treated with deltamethrin 2.8EC (0.04 ml/kg) and stored under ambient condition.

Biradar (2001) reported that greengram seeds treated with malathion @ 10 g per kg of seed recorded higher germination (80.76%), germination rate index (17.09), root length (9.75 cm), shoot length (7.00 cm) and vigour index (1332) as against control at end of 10 months of storage.

Srimathi *et al.* (2001) reported that the pearl millet seeds treated with thiram + Malathion and stored for 18 months recorded higher germination (48.00%) compared to control (22.00%). Similarly, Raghavani *et al.* (2002) revealed that in pearl millet seeds treated with deltamethrin + thiram and stored for 15 months recorded higher germination (55.86%) and low insect activity (8.95%) compared to control (36.22% and 36.12%, respectively).

Patil *et al*. (2004) reported that the pearl millet seeds treated with deltamethrin @ 40 mg per kg were found to be the best treatment recorded 82 per cent germination after nine months of storage followed by carbendazim @ 2.50 g/ kg of seed (76.30%) germination, whereas, control recorded 59.50 % germination.

2.2.4 Influence of fungicide and polymer coating on seed quality during storage

Taylor and Hartman (1990) reported that, film coating provides an ideal method for application of chemicals and/ or biological seed treatment.

Sorghum seeds coated with hydrophilic polymer @ 10 g per kg of seed found to increase seed germination and emergence rate at the lowest available soil moisture level (Joshi *et al.,* 1998).The effect was better when applied as a mixture with the fungicide rather than as a polymer coat over the fungicide.

Williams *et al.* (1999) stated that Easiflo polymer and fungicide mixture coating on fuzzy cotton seed significantly improved the germination and emergence. At 4 days of imbibition, Sugar Bowl film-coated seeds had 5 per cent germination, while untreated seeds had 20 per cent germination. However, after 7 days, film-coated seeds had 94 per cent germination where as untreated recorded at 80 per cent germination (Wilson *et al*., 1999).

Zorato and Henningh (2001) treated soybean seeds with various fungicide (carboxin+ thiram @ 2.00 g/kg of seed) resulted significantly higher field emergence (83.02%) over control (74.00%).

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 the insect onion fly from 20 to 60 per cent to one to eight per cent and also recorded higher germination and the seedlings were vigorous.

Larissa *et al*. (2004) found that bean seed coated with the polymer and fungicide recorded higher germination (89.00%) compared to control (75.00%) after two months of storage.

Wilson and Geneve (2004) reported that in corn seed coated with polymer and fungicide recorded higher germination (98.50%), less number of abnormal seedlings (1.50%) and lower electrical conductivity values (41.60 µ mhos/g) of seed leachate as compared to control (89.00%, 8.50 and 51.40 µ mhos/g, respectively).

Arsego *et al*. (2006) in rice, Polymer CF Clear provided adequate coating of seeds and coating of seeds with carboxim + thiram improved seed quality. GA3 @ 0.50 g/50 kg of seeds was recommended for seed coating.

Geetharani *et al*. (2006) reported that slurry coating of chilli seed with polymer (3.00 g per kg of seed) along with carbendazim (2.00 g per kg of seed) and halogen mixture (3.00 g per kg seed) enhanced the germination and vigour index values by 24.00 per cent, whereas, the pathogen infection was lessened by 1.00 per cent compared to uncoated seeds. This treatment also enhanced the field emergence by 29.00 per cent in the nursery sowing.

Malavika Dadlani and Veena Vashisht (2006) studied the storability of soybean seed by storing the seeds at 10.6% moisture content in cloth bag, 500 gauge polythene bag and superbag (Grain Proc. Inc.TM) for 12 months under ambient condition.

Polymer coating with polykote @ 4 ml per kg of seed with 0.25% Thiram or Vitavax 200, stored in Superbag recorded the highest vigour and 85 and 88 per cent germination as against 70 per cent in control. Germination of untreated seed in Super bag (78%), as well as polykote treated seeds in cloth bag (76%) was also significantly higher than control.

Polimero *et al.* (2007) reported that coating of soybean cv. BRS 153 seeds with micronutrients, fungicide and polymer provide better uniformity (adherence, distribution and colouration) to the seeds; and does not affect its quality and performance up to 2 ml micronutrient per kg of seed. Micronutrient dosage of 4 ml/kg seed is phytotoxic to the seeds.

Manjunatha *et al*. (2008) reported that, the chilli seeds coated with polymer @ 7.0 g per kg and thiram @ 2.0 g per kg of seed recorded significantly higher germination (69.44%) and field emergence (66.14%) as compared to control which recorded the lowest germination (71.08%) and field emergence (38.15%) at the end of 12 months of storage.

2.2.5 Effect of polymer coating, fungicide and insecticide on seed quality during storage

Ellis and Paschal (1979) observed that pigeon pea seed treated with captan and thiram significantly recorded lower percentage of recovery of total fungi and had higher germination.

Rivas *et al.* (1998) reported that the low vigour seed and the emergence rate index (ERI) were increased from 2.70 for the untreated control to 6.06 and 6.28 for captan and captan + Certop (a polymer) treated seeds, respectively in maize seed. For the high vigour seed lot, the ERI was increased from 5.82 in untreated control to 7.02 and 7.54 for captan and captan + Certop, respectively.

Seed viability up to 90 per cent can be maintained upto 10 months in cloth bag as well as polythene bag when the seeds were coated with polymer @ 3g, carbendazim @ 2 g and imidachloropid @1 ml per kg of seed (Sherin and Susan John, 2003).

Vanangamudi *et al.* (2003) noticed that in maize pink polykote @ 3.00 g per kg of seed+ (Fungicide + insecticide) was found to be the best in registering higher germination (98.00 %) compared to control (93.00 %).

The clusterbean seeds film coated with green polykote @3gm /kg of seed with inclusion of bavistin (2g/kg of seed) maintained maximum germination and vigour under predicted storability through accelerated ageing test (Renugadevi, 2004).

Saritha Devi (2004) reported that, higher germination and vigour index was obtained in sorghum seeds when slurry coated with 3 g red polymer plus 2 g carbendazim plus 1 ml imidachloprid per kg of seed. The same treatment has shown superiority under field conditions and increased the seed yield of 24.5 per cent over control.

Imran Baig *et al*. (2005).studied that soybean seeds treated with fungicides and polymer showed significant superiority in seed quality during storage. Among the treatments, seed coating with vitavax or bavistin @ 2 g per kg seed and polymer @ 5 g per kg seed recorded significantly higher germination, vigour index, and rate of germination, dry weight of seedling, lower electrical conductivity and seed infection throughout the storage period.

Pham Long Giang *et al*. (2007) reported that hybrid rice seeds coated with little's polykote yellow, captan + thiaram + gouch + super red @ 1 ml per kg of seeds and stored in polythene bag (700 gauge) recorded higher germination (85.67%) as against the lowest recorded in cloth bag untreated (62.00%) at the end of the storage period. The polymer littles polykote yellow + captain + thiram + gouch treated seeds that were stored in polythene bag recorded highest field emergence (80.00%) compared to other treatments and control.

Vijay kumar (2007) observed that the cotton seeds treated with chemicals recorded significantly higher germination up to nine months of storage as compared to control. Among the different treatment combinations, the seeds coated with thiram @ 1.50 g per kg of seed and imidachloprid @ 7.50 g per kg of seed recorded significantly higher germination (77 %) followed by seed coating with polymer @ 5.00 g per kg of seeds and thiram @ 1.50 g per kg of seeds as compared to control (52.00 %).

Basavaraj *et al.* (2008) noticed that, the onion seed coating with polymer @ 12 ml +thiram @ 2g per kg of seeds recorded higher germination, vigour index, dry weight of seedlings and lower seed infection and lower electrical conductivity as compared to control.

The seeds stored in aluminum pouch recorded higher seed quality parameters as compared to polythene bag throughout the storage period.

Suresh Vegulla, (2008) reported that maize seeds film coated with little red polykote @ 6g + carbendaziam @ 2 g + Imidachloprid @ 1ml + micronutrient mixture (Agromin) @ 4 ml per kg of seeds can be stored upto 6 months over 90 per cent germination and higher vigour index (3060) under ambient conditions of storage with least pathogen and insect infestation.

Rettinasababady *et al.* (2012) conducted a study on hybrid rice seed storage, with polykote, thiram and vitavax stored, in 700 gauge polythene bags and in cloth bags, among all the treatments, seed coated with vitavax recorded maximum germination followed by the seed coated with fungicide flowable thiram whereas reduced germination was found in the seeds coated with polymer alone.

2.3 Influence of polymercoat and seed treatment chemicals on field performance of chickpea

2.3.1 Effect of polymer coating on field performance

Zholbolsynova *et al.* (1992) reported that the seed coating with polymers has increased the yield from 0.93 tonnes to 1.62 tonnes per ha in wheat.

Ruban *et al.* (1983) reported that cotton seeds coated with Penthiuram and polymers initially inhibited the activity of catalase, peroxidase and rate of seedling growth, but stimulated them at later stages.

Bhatnagar and Porwal (1990) reported that the highest seed yield of 1.39 t/ha was obtained with 200 g/ha seed coating of Super Absorbent polymer in chickpea.

Water use efficiency, nodulation and mean seed yield of chickpea found to increase when seeds coated with the jalashakthi @ 15g per kg of seed (Joseph and Varma 1994).

Joseph *et al.* (1995) observed that chickpea seeds treated with polymer @ 1.50 g per kg of seed recorded higher seed yield (23.28 q/ ha) than control (20.03 q/ ha).

Chikkanna *et al.* (2000) concluded that, in groundnut seeds coated with polymer @20.00 g per kg of seeds recorded the highest dry matter, number of pods, test weight and pod yield. Lower concentrations (10-20 g/kg of seed) were on par with each other and on the contrary at higher concentration @ 30.00 g per kg affected the pod yield drastically.

Archer *et al.* (2003) developed a biophysical simulation model which can be used to estimate the impact of polymer coated seed on corn and soybean yields and on field day availability for five planting periods, three crop varieties and two tillage systems on two different soils under varying weather conditions. Temperature-activated polymer-coated seed has the potential to increase net returns by increasing yields due to early planting and use of longer season varieties, as well as reducing yield loss due to delayed planting.

Clayton *et al.* (2004) reported that application of the polymer coat on early-seeded canola increased plant density by 80% compared to uncoated seed. Seed yield and dockage were not affected by seeding date when a polymer seed coating was used. Without the polymer seed coat, canola yield was reduced by 42% and dockage increased up to 6% when seeding occurred in early vs. late fall.

James Jensen and Kevin Van Dee (2005) reported that the intellicoat is derived from natural, biodegradable fatty acids that act as temperature-sensitive switches. Delayed emergence in the non coated seed in the first planting date and the polymer coated seed in the second planting date resulted in better stand and better yields than when the crop emerged more quickly.

Chandravathi *et al* (2008) reported that, among different treatments, hydropriming + polymer coating + *Azospirillum* @ 125 g per kg seed had recorded significantly highest field emergence (88.98%), plant stand (72.50 plants/plot), 1000-seed weight (13.71 g) and seed yield per ha (14.34 q). The treatment hydropriming took less number of days for days to 50 per cent flowering (44.75 days) as compared to control.

Shakuntala *et al.* (2009) revealed that, effect of seed polymer coating with chemicals on growth, yield and storability in sunflower hybrid RSFH-130. Significantly higher seed weight per plant and seed yield per ha were obtained in seeds treated with polymer @ 5g per kg of seeds + vitavax @ 2 g per kg of seeds + imidachloprid @ 5 g per kg of seeds as compared to control.

Seed quality parameters during storage showed better in polymer coating @ 5 g + vitavax @ 2 g + Imidachloprid @ 5 g per kg of seeds as compared to control.

2.3.2 Effect of polymer coat and seed treatment chemicals on field performance

El-Samadisy *et al.* (1988) reported that the Soybean seed treatment with vitavax and captan was found the most effective in increasing nodulation and seed yield.

Anuja Gupta *et al*. (2000) found that field efficacy of seed dressing chemicals on seedling emergence, seed yield and seed weight in soybean, among four different fungicides captan, thiram, mancozeb and carbendazim. All the treatments showed significant improvement in field emergence and seed yield.

Sendur and Natarajan (2001) reported that three commercially available polymers like Terracottem, polyvinyl alcohol and polyacrylamide give improved plant height, branches per plant, root length, root dry weight, fruits per plant and dry matter production in tomato.

Mohd amil *et al*. (2004) Found that the effects of carbendazim, captan, thiram, and mancozeb, on Nodulation, and seed yield in chickpea (*Cicer arietinum*) were assessed in a controlled environment. Seeds treated with fungicides at 2 g. a.i. per kg of seeds captan, thiram and mancozeb, significantly increased seed yield in the following order: Control = carbendazim > thiram > captan > mancozeb.

Sorghum seeds when slurry coated with 3 g red polymer + 2 g carbendazim + 1 ml Imidachloprid per kg of seed was shown better superiority under field conditions and increased yield of 24.5 per cent over control (Saritha devi, 2004).

Praveena (2005) studied the effect of polymer coating in fuzzy and delinted cotton seed and observed that both fuzzy and delinted seed coated with polymer + carbendaziam + Imidachloropid + *Peudomonas* + Azosphos increased the germination by 12 to 13 per cent respectively.

Sujatha *et al.* (2012) revealed that, rice seeds fortified with 1%KCl+ polymer @ 3ml/kg +carbendazim @ 2g/kg Imidachloprid @2ml/kg + Pseudomonase@ 10g/kg+Azophos @ 120g/kg. Was better in fieldemergence, Plant height (cm), number of productive tillers, seed yield /plant (g), pest and disease incidence was less as compared to all other treatments andcontrol.

Vinodkumar *et al.* (2012) reported that redgram seeds were treated with combination of deltamethrin 2.8 EC at 0.3 ml/kg seeds + vitavax power at 3 g/kg seed+ polymer seed coating at 5 ml/kg seeds was found to be significantly superior in growth and yield parameters *viz*., plant height (206.78 cm), number of primary branches (18.12), number of secondary branches (25.16), number of pods/plant (231.33), pod yield per plant (78.85 g), seed yield per plant (40.35 g), seed yield/hectare (16.79 q/ha) as compared to untreated control.

MATERIAL AND METHODS

The present study consisted of two experiments with three objectives *viz*., Influence of storage period on seed quality of chickpea varieties. II. Effect of polymercoat and seed treatment chemicals on chickpea seed quality during storage. III. Influence of polymercoat and seed treatment chemicals on field performance of chickpea. The materials used and methods adopted during the conduct of the experiments are described as below.

3.1 General description

3.1.1 Geographical location of experimental site

Dharwad comes under the Agro climatic zone 8 (Northern Transitional tract) in region 2 of Karnataka State and zone is located between 15^0 26^1 North latitude and 76^0 27^l East longitudes and at the altitude of 678 m above the mean sea level. The field experiment was conducted in 'E' Block of the Main Agricultural Research Station Farm, and the storage experiment was conducted under the ambient conditions in the post graduate laboratory of the Department of Seed Science and Technology, University of Agricultural Sciences, Dharwad. The storage experiment was conducted for a period of twelve months (from April, 2012 to March, 2013).

3.1.2 Climatic conditions

The monthly Meteorological data with regard to rainfall(mm), temperature (^{o}C) and relative humidity(%) at Main Agricultural Research Station, Dharwad for the storage period and field experiment are presented in Table 1. Dharwad receives rainfall from both south west and north east monsoon. Dharwad is considered to be mild tropical rainy region. The highest rainfall received during the period of experimentation was in July, 2012 (112.21mm) and the lowest was in the month of February 2013 (2.2mm). The mean maximum temperature April 2012 (35.73^{0}C) and minimum temperature was in the month of December 2012 (14.52^{0}C). The mean relative humidity ranged from 45.32 (January, 2013) to 84.69 (July, 2012) per cent.

3.1.3 Soil conditions for the field experiment

The soil of the experimental site was medium black clayey loam, deep, porous in nature and well drained.

3.1.4 Source of seeds

The Breeder seeds of chickpea varieties *viz*., BGD 103 (Desi) and BG 1105 (Kabuli) produced in Rabi season 2011-12 were obtained from the Seed unit and MULLaRP scheme, of University of Agricultural Sciences, Dharwad. Immediately after the harvest. The seeds were dried under sunlight for two to three days to bring the seed moisture level to 7.6%.

3.1.5 Description of variety

BGD103: it is a Desi variety with indeterminate and bushy plant type. It grows up to the height of 40 to 45 cm and it has broader leaf lets and bold seed size. It reaches 50 percent flowering in 44-47 days and maturity in 90-95 days, yields ranges from 11-13 q/ha under rain fed condition.

BG 1105: is a *Kabuli* variety that grows up to height of 45-50 cm with light green foliage. Seeds are medium in size, reaches 50 percent flowering in 45- 48 days and maturity of 100-105 days. It is resistant to lodging and shattering its average yield under normal conditions is 10-12q/ha.

3.2 Experiment I: Effect of polymercoating and seed treatment chemicals on chickpea seed quality during storage

3.2.1 Treatment details

The experiment is consisted of totally 16 treatment combinations involving two factors *viz*., first factor consists of two Chickpea varieties BGD103 and BG1105) and second factor consists of 8 seed treatments and replicated four times. The details of the experiment are given below.

Factor – I: Varieties (V)

V_1: BGD 103

$V_{2:}$ BG 1105

Table 1. Mateorological data showing maximum, minimum temperature (^{0}c), Relative humidity(%) and number of rainy days from April, 2012 to March, 2013 recorded at MARS, University of Agricultural Sciences, Dharwad

Month	Rainfall (mm)		Rainy days		Temperature (°C)				Relative humidity (%)	
					Maximum		Minimum			
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
April	56.60	-	7.00	-	35.73	-	21.17	-	55.97	-
May	3.80	-	0.00	-	35.66	-	21.47	-	60.59	-
June	43.40	-	4.00	-	30.18	-	21.19	-	74.90	-
July	112.21	-	10.00	-	27.34	-	20.82	-	84.69	-
August	88.20	-	11.00	-	25.47	-	19.14	-	79.71	-
September	89.60	-	9.00	-	28.19	-	19.71	-	73.78	-
October	89.20	-	4.00	-	28.74	-	17.63	-	62.11	-
November	35.70	-	1.00	-	28.36	-	15.99	-	61.02	-
December	19.60	-	1.00	-	29.32	-	14.52	-	55.23	-
January	-	0.00	-	0.00		31.24	-	14.55	-	45.32
February	-	2.2	-	0.00		32.63	-	16.85	-	49.41
March	-	4.2	-	1.00		35.30	-	19.20	-	48.00

Factor – II: Seed treatments (T)

T_1: Control (Untreated)

T_2: Deltamethrin 2.8EC @ 0.4ml /kg seeds.

T_3: Vitavax power @ 2g/kg seed.

T_4: Polymercoat@10ml/kg of seeds.

T_5: Deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2g/kg seed.

T_6: Deltamethrin 2.8EC @ 0.4ml /kg seeds + polymercoat @10ml/kg of seeds.

T_7: Vitavax power @ 2g/kg seed+ polymercoat @10 ml/kg of seed.

T_8: Deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2g/kg seed+ polymercoat @ 10ml/kg of seeds.

Treatment combinations: 8x2=16.

V_1T_1	V_2T_1
V_1T_2	V_2T_2
V_1T_3	V_2T_3
V_1T_4	V_2T_4
V_1T_5	V_2T_5
V_1T_6	V_2T_6
V_1T_7	V_2T_7
V_1T_8	V_2T_8

Design of the experiment: The laboratory experiment was conducted under completely randomized block design in factorial concept with four replications.

3.2.2 Procurement of experimental materials

The liquid disco agro SP red polymer was used for seed coating, the polycoat was manufactured by Integrated coating and seed technology Pvt Ltd, Ahmadabad and fresh insecticide (deltamethrin), fungicide (vitavax power) chemicals were collected from the local agro chemical dealers, Dharwad.

3.2.3 Imposition of treatments

Imposition of treatments is as follows.

3.2.3.1 Deltamethrin

One kg chickpea seeds were taken in a polythene bag and added 2.8 EC @ 0.4 ml deltamethrin in to the polythene bag. The polythene bag was closed tightly trapping the air in it to form a balloon, then polythene bag was vigorously shaken till the seeds were uniformly coated with deltamethrin later the treated seeds were spread on a polythene sheet and dried under the shade.

3.2.3.2 Vitavax power

One kg chickpea seeds were taken in a polythene bag and added two gram of vitavax power as slurry in to the polythene bag. The polythene bag was closed tightly trapping the air in it to form a balloon, then polythene bag was vigorously shaken till the seeds were uniformly coated with vitavax power later the treated seeds were spread on a polythene sheet and dried under the shade.

3.2.3.3 Polymer seed coating

One kg chickpea seeds were taken in a polythene bag and added 10 ml of liquid disco agro SP red polymer in to the polythene bag. The polythene bag was closed tightly trapping the air in it to form a balloon, then polythene bag was vigorously shaken till the seeds were uniformly coated, later the treated seeds were spread on a polythene sheet and dried under the shade (Plate 1 and 2).

The dried seeds were stored in the cloth bag under ambient condition.

Plate 1. Seed treatment with insecticide, fungicide and polymercoat on var. BGD-103 (Desi)

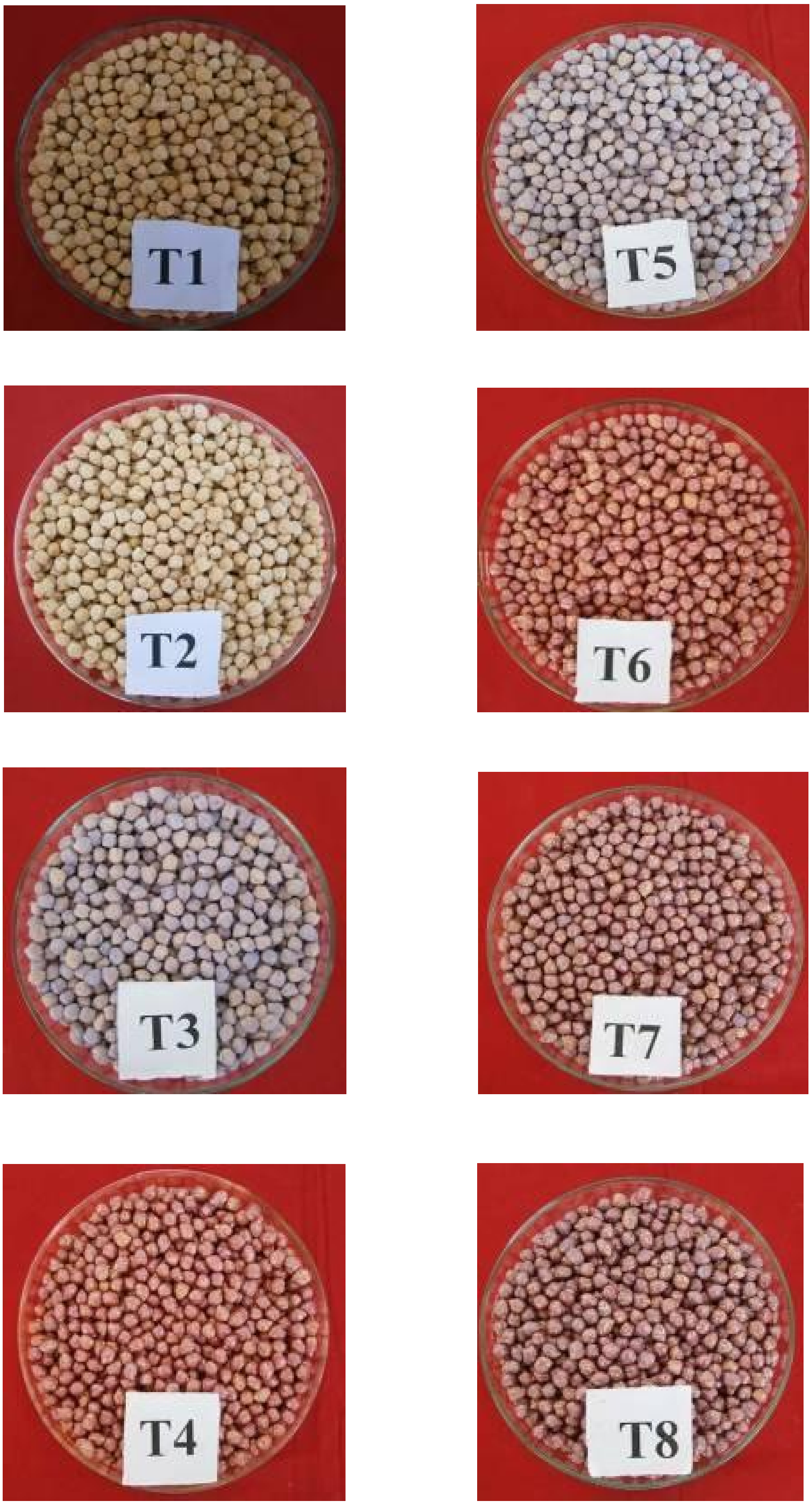


Plate 2. Seed treatment with insecticide, fungicide and polymercoat on var. BG-1105 (Kabuli)

3.2.4 Method of storage

The seeds after treating with polymer coat and chemicals were dried back to their original moisture content and stored in cloth bag in the PG laboratory of Department of Seed Science and Technology, University of Agricultural Sciences, Dharwad.

3.3. Collection of experimental data

The observations on seed quality parameters were recorded during storage at monthly interval as per the method and procedures described below.

3.3.1 Seed moisture content (%)

The moisture content of seeds was determined by adopting the low constant temperature oven method (103 $\pm$ 1^0C for 17 $\pm$ 1 hr) as per the ISTA Rules (Anon., 2011b) and was expressed in percentage on weight basis by using the following formula.

$$\text{Moisture content (\%)} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where,

W_1 – Weight of the empty metal box (g)

W_2 – Weight of empty metal box with seed sample before drying (g)

W_3 – Weight of empty metal box with seed sample after drying (g)

3.3.2 Germination (%)

The standard germination test was conducted as per the ISTA Rules (Anon., 2011b) by adopting the rolled paper towel between the paper method at 25$\pm$$1^{0C}$ and 95$\pm$ 1 per cent relative humidity in the seed germinator in four replications of randomly drawn 100 seeds each. On fifth and eighth day of germination test (first and final count), number of normal seedlings were counted and expressed as germination percentage.

3.3.3 Shoot length (cm)

From the germination test, ten normal seedlings were selected randomly from each treatment and the shoot length was measured from the base of primary leaf to collar region and mean shoot length was expressed in centimetre.

3.3.4 Root length (cm)

The same ten normal seedlings used for shoot length measurement were used for root measurement. The root length of each seedling was measured from collar region to the tip of primary root and the average root length was expressed in centimetre.

3.3.5 Seedling vigour index

The seedling vigour index was calculated as per the formula given by Abdul Baki and Anderson (1973) and expressed in number.

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

3.3.6 Seedling dry weight (mg)

The ten normal seedlings used for shoot and root length measurement were used for seedling dry weight were put in a butter paper pocket and kept in an oven maintained at 70^0 $\pm$ 1^{0C} for 24 h. After drying, the seedlings were kept for cooling in a desiccators for 30 minutes and later on the seedling dry weight was recorded and expressed in milligrams (Anon., 2011b).

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

5 g seed material in four replications from each treatment was drawn randomly and weighed up to two decimal points. The seeds were treated with acetone for half a minute and washed thoroughly for several times with distilled water and then soaked in 25 ml distilled water in a beaker. The beakers were kept in incubator at constant temperature of 25 $\pm$ 1^0C for 24 h along with blank. The electrical conductivity of seeds leachate was measured in the digital electrical conductivity meter, the actual EC due to the electrolyte (leachate) was measured and expressed in dSm^{-1}.

3.3.8 Hundred seed weight (g)

100 seed weight was recorded by adopting ISTA procedure (Anon., 2011b) and was expressed in grams.

3.3.9 Insect damage (%)

One hundred seeds from each treatment and in four replications were taken to determine the insect (*Callosobruchus chinensis*) infestation level in chickpea seeds. The seeds either with egg spot or single or multiple holes were considered as infested seeds. Infested seeds were counted manually and expressed in percentage (Anon., 2011b).

3.4. Observations recorded on monthly basis

3.4.1 Seed quality parameters

The parameters as listed in item no 3.3.1 to 3.3.9 were recorded on monthly basis and after six month storage treated seeds were sown in *Rabi* season 2012 -2013 to conduct the field experiment to see the field performance.

3.5. Experiment II: Influence of polymercoat and seed treatment chemicals on field performance of chickpea.

3.5.1 Experiment details

Factor – I: Varieties (V)

V_1: BGD 103

V_2: BG 1105

Factor – II: Seed treatments (T)

T_1: Control (Untreated)

T_2: Deltamethrin 2.8EC @ 0.4ml /kg seeds.

T_3: Vitavax power @ 2g/kg seed.

T_4: Polymercoat @10ml/kg of seeds.

T_5: Deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2g/kg seed.

T_6: Deltamethrin 2.8EC @ 0.4ml /kg seeds + polymercoat @10ml/kg of seeds.

T_7: Vitavax power @ 2g/kg seed+ polymercoat @10 ml/kg of seed.

T_8: Deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2g/kg seed+ polymercoat @ 10ml/kg of seeds.

3.5.2 Design and plan of layout

The field experiment was laid out by simple RBD with factorial concept in three replications. The plan of experiment is depicted in Fig. 1 and Plate 3.

Plot size : Gross plot: 3mx3 m

Net plot : 2.8 m x 2.4m

Spacing : 30cm between the rows and 10cm between the plants.

3.5.3 Cultural operations

The experimental plot was brought to fine tilth by deep ploughing and repeated harrowings. The required numbers of plots were laid out with small bunds. The seed rows were marked and drawn at a distance of 30 cm apart in each plot.

3.5.4 Application of fertilizers

The recommended dose of fertilizers (20:50:00 kg NPK/ha) were applied as basal dose for each plot in the form of Urea and Diammonium phosphate and incorporated well into the soil.

3.5.5 Method of Sowing

The treated chickpea seeds were sown by manual dibbling at the congenial field condition in *Rabi* season on 29-9-2012 during the year 2012-13. The seeds were hand dibbled at two to three cm deep in the earlier marked rows at 10cm intra row spacing.

3.5.6 After care

The necessary after care operations such as thinning, hand weeding, inter row cultivation and plant protection measures were carried out as and when required to maintain good and healthy seed crop. The crop was sprayed with Avant @ 0.5 ml per litre of water and dichlorovos @ 1 ml per litre for control of pod borer and other sucking pests, in addition to 4 gm carboryl per litre of water at podding stage. Protect the crop from the fusarium wilt, soil was drenched with the vitavax power @ 2 gm per litre of water and carbendazim @ 2gm per litre of water at pod stage.

3.5.7 Harvesting, threshing and cleaning

The crop was harvested when plants started for drying, the colour of leaflets turned pale yellow and pods turn to brown colour. The crop was harvested from the net plot area excluding five tagged plants used for recording the observations. The harvested plants were dried in the shade for seven days. The seeds were separated manually by gently beating the dried plants with the wooden stick. The seeds were cleaned and dried in the shade until the seed moisture content reduced up to 7.5 per cent.

3.5.8 Collection of experimental data

3.5.8.1 Sampling procedure

The biometric observations on growth parameters were recorded at harvesting stage. Five plants were selected randomly from each net plot area and all the selected plants were tagged in each plot for taking observations on plant height, number of branches, days to 50 per cent flowering, days to maturity, number of pods per plant, number of seeds per plant, number of seeds per pod, seed weight per plant (g), seed weight per plot (kg), seed yield per hectare (q).

3.5.8.2 Observations on growth parameters

3.5.8.2.1 Plant height (cm)

The height of the five randomly selected and tagged plants were measured at harvest stage from the ground level to the tip of the plant and average was worked out and expressed in centimeter for each treatment.

3.5.8.2.2 Number of branches per plant

The numbers of branches were counted on the tagged plants and their average was recorded as number of primary branches per plant at harvest from each treatment.

3.5.8.2.3 Days to 50 per cent flowering

The number of days to taken for 50 per cent flowering from the date of sowing in each plot was recorded and expressed in number.

3.5.8.2.4 Days to maturity

The number of days taken for complete maturation of crop in each plot was recorded in days from the date of sowing to complete maturation based upon physiological maturity indices and expressed in number.

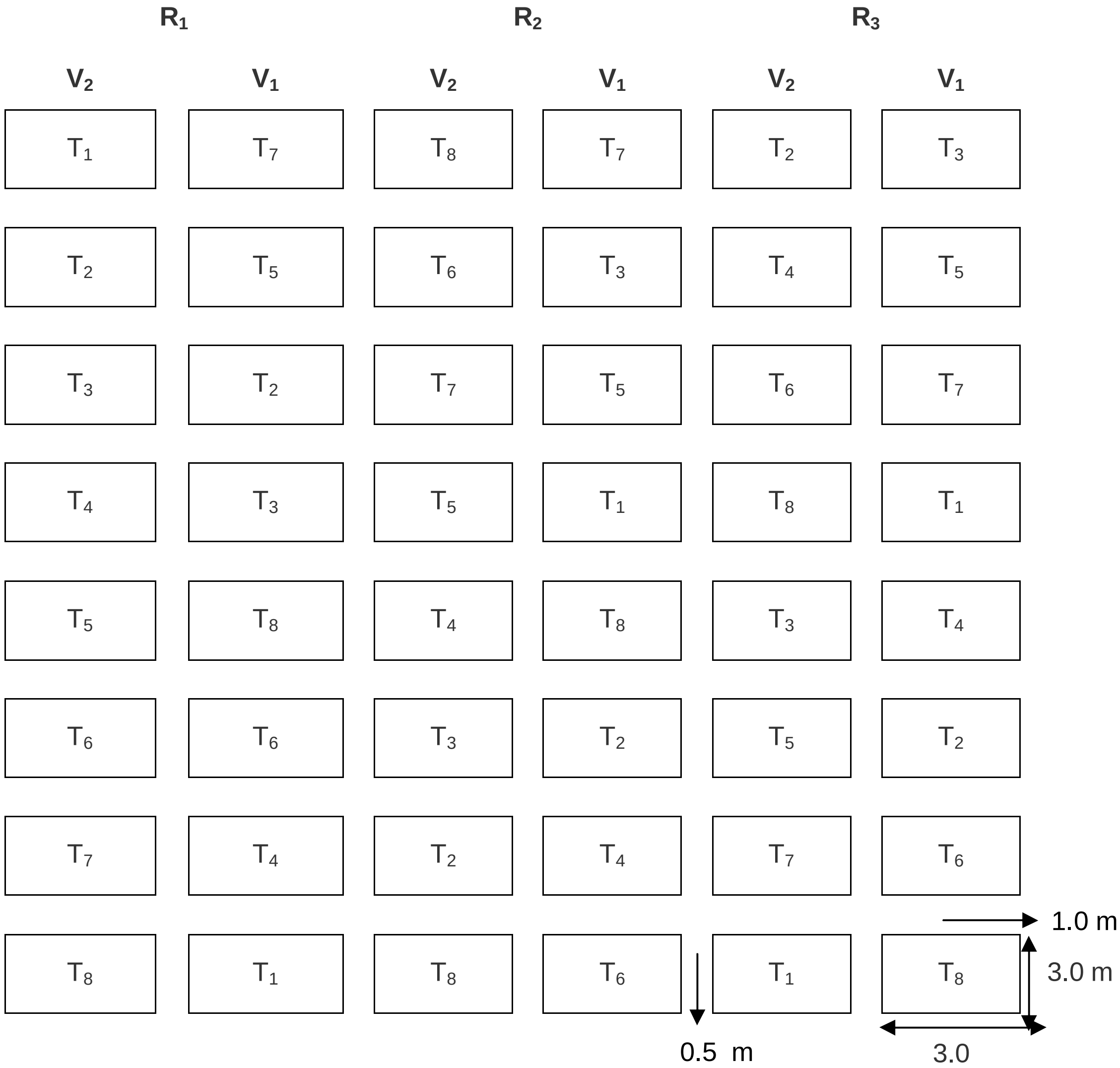
3.5.8.3 Observations on seed yield and yield components

3.5.8.3.1 Number of pods per plant

The number of filled pods present in five tagged plants was counted individually and the average was worked out and expressed as number of pods per plant at harvest.

3.5.8.3.2 Number of seeds per plant

The number of seeds present in five tagged plants was counted individually and the average was worked out and expressed as number of seeds per plant at harvest.



LEGEND

T_1- Control
T_2- Deltamethrin 2. 8EC @ 0.4 ml/kg of seeds.
T_3- Vitavax power@2g/kg of seeds
T_4- Polymer coat @10 ml/kg of seeds.
T_5- Deltamethrin 2.8 EC @ 0.4ml per kg of seeds + vitavax power @2 g/kg of seeds.
T_6- Deltamethrin 2.8EC @ 0.4ml /kg of seeds + polymer coat @10 ml/kg of seeds.
T_7- Vitavax power @ 2 g/kg of seeds+ polymercoat @ 10 ml/kg of seeds
T_8- Deltamethrin @2.8EC per kg of seeds + vitavax power@2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Fig. 1 : Plan of layout of field experiment

Plate 3. General view of experimental plot

3.5.8.3.3 Number of seeds per pod

After separating the filled seeds from five randomly selected pods from each treatment, the filled seeds were counted and average was expressed as number of seeds per pod.

3.5.8.3.3 Seed weight per plant (g)

At harvest, all pods were separated manually from five tagged plants individually and dried, shelled and cleaned. The seed weight from each plant was recorded and average of five plants was expressed as seed yield per plant in grams.

3.5.8.3.4 Seed weight per plot (kg)

All the plants from net plot area of each treatment were uprooted, dried seeds were separated and weight was recorded separately in kilogram per plot.

3.5.8.3.5 Seed yield per hectare (q)

All the plants from net plot area of each treatment were harvested, dried seeds were separated and weight was recorded separately in quintal per hectare.

3.5.8.4 Seed quality parameters

3.5.8.4.1 Hundred seed weight (g)

One hundred seeds in 8 replications were manually counted from the bulk a seed of five plants in each treatment and 100 seed weight were recorded by adopting ISTA procedure (Anon., 2011b) and was expressed in grams.

3.5.8.4.2 Germination percentage (%)

The germination percentage was determined by following the procedure as explained under section 3.3.2.

3.5.8.4.3 Shoot length (cm)

The Shoot length (cm) was determined by following the procedure as explained under section 3.3.3.

3.5.8.4.3 Root length (cm)

The Root length (cm) was determined by following the procedure as explained under section 3.3.4.

3.5.8.4.4 Seedling dry weight (mg)

The Seedling dry weight (mg) was determined by following the procedure as explained under section 3.3.6.

3.5.8.4.5 Seedling vigour index

The Seedling vigour index determined by following the procedure as explained under section 3.3.5.

3.6. Statistical analysis

The data collected from the experiment was analysed statistically and subjected to the analysis of variance by adopting the appropriate methods as outlined by Sundarrajan *et al.* (1972) and critical differences were calculated at one per cent level. The percentage data was transformed into Arcsine square root percentage before analysis (Snedecor and Cochran, 1967).

EXPERIMENTAL RESULTS

An experiment on “effect of polymercoat and seed treatment chemicals on chickpea seed quality during storage” was conducted in the Post Graduate Laboratory of Seed Science and Technology, College of Agriculture, University of Agricultural Sciences, Dharwad from April 2012 to March 2013. The results obtained on different seed quality parameters like seed germination (%), shoot length (cm), root length (cm), vigour index, test weight (g), moisture content (%), electrical conductivity (dSm^{-1}) and insect infestation (%) are presented in this chapter.

4.1 Experiment – I: Effect of polymercoat and seed treatment chemicals on chickpea seed quality during storage

4.1.1 Germination percentage

The results of germination percentage as influenced by varieties, seed treatment and their interaction effects at different months of storage period are presented in Table 2a, 2b and 2c (Fig. 2 and 3).

Irrespective of varieties and seed treatments the mean germination percentage declined gradually with the advancement of storage period. The mean germination percentages recorded at beginning and at the end of storage period were 98.86 and 81.70 per cent, respectively.

The germination percentage was differed significantly due to varieties during storage period of 12 months. Significantly, the higher germination percentage was recorded in BGD-103 (V_1) (99.41 and 82.91 %) as compare to the BG1105 (V_2) (98.31 and 80.50 %) at the initial and twelth month of storage period, respectively.

The significant difference was recorded on germination percentage due to seed treatment from the second month of storage period up to twelth months of storage. The per cent germination decreased with the advancement of storage period in all the seed treatments. Whereas, higher germination was recorded at second month in T_8 (deltamethrin 2.8EC @ 0.4 ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) of 98.88 per cent followed by T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) of 98.63 per cent. While lower germination (97.00%) was recorded in T_1 and T_2 also. Similar trend was noticed up to the end of storage period. At the end of twelve months of storage period, highest germination percentage was recorded in T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) (87.13%) followed by T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) (86.00%), while significantly lowest germination was recorded in T_1 (untreated) (76.13%).

There was no significant difference in germination percentage due to varieties and seed treatment interaction with advancement of storage periods. Numerically, higher germination (87.50 %) was noticed in the V_1T_8 followed by V_1T_7 (86.75%) and V_2T_8 (86.75 %) and it was on par with the V_1T_5 (86.00) where as minimum germination percentage was noticed in the V_2T_1 (74.75 %) at the end of storage period.

4.1.2 Shoot length (cm)

The data on shoot length as influenced by varieties, seed treatments and the interaction between the varieties and seed treatment at different months of storage are presented in the Table 3a, 3b and 3c.

Regardless of varieties and seed treatments, the shoot length was declined progressively as the storage period advanced. The mean shoot length was decreased from 12.52 cm in the initial month to 7.11cm at the end of storage period.

The shoot length differed significantly due to varieties during storage period of twelve months. Significantly higher shoot length (13.02 and 7.47 cm) was recorded in BGD-103 (V_1) as compared to the BG1105 (V_2) (12.02 and 6.74 cm) was recorded at initial and twelth month of storage period respectively.

The significant differences among the seed treatments with polymercoat, fungicide and insecticide on shoot length were noticed from the third month onwards up to twelth month of storage. The shoot length was decreased with the advancement of storage period in all the seed treatments.

Table 2a. Effect of polymercoat and seed treatment chemicals on seed germination percentage of chickpea

Treatments	**Initial month**			**1^{st} month**			**2^{nd} month**			**3^{rd} month**			**4^{th} month**		
	V_1	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**
T_1	99.75 (88.53)	98.50 (84.01)	**99.13 (86.27)**	99.75 (88.53)	98.00 (81.97)	**98.88 (85.25)**	97.50 (80.99)	96.50 (79.53)	**97.00 (80.22)**	95.50 (77.82)	95.00 (77.16)	**95.25 (77.64)**	93.50 (75.20)	92.25 (73.81)	**92.88 (74.49)**
T_2	99.50 (87.10)	98.25 (82.57)	**98.88 (84.83)**	99.25 (86.50)	97.75 (82.56)	**98.50 (84.01)**	97.25 (80.52)	96.75 (79.66)	**97.00 (80.22)**	95.75 (78.28)	95.25 (77.64)	**95.50 (77.82)**	94.00 (75.79)	92.75 (74.35)	**93.38 (75.05)**
T_3	99.50 (87.10)	98.25 (82.57)	**98.88 (85.25)**	99.25 (86.50)	98.25 (82.57)	**98.75 (84.53)**	98.50 (84.01)	97.50 (80.99)	**98.00 (81.97)**	97.50 (80.99)	96.50 (79.53)	**97.00 (80.22)**	96.25 (78.80)	94.25 (76.10)	**95.25 (77.64)**
T_4	99.25 (86.50)	98.25 (82.57)	**98.75 (84.53)**	99.00 (85.55)	97.75 (82.56)	**98.38 (83.81)**	97.75 (82.56)	97.00 (80.22)	**97.38 (80.95)**	97.00 (80.22)	95.75 (78.28)	**96.38 (79.21)**	95.25 (77.64)	93.25 (74.91)	**94.25 (76.10)**
T_5	99.50 (87.10)	98.25 (82.57)	**98.88 (84.83)**	99.50 (87.10)	98.00 (81.97)	**98.75 (84.53)**	98.75 (84.53)	98.00 (81.97)	**98.38 (83.81)**	97.25 (80.52)	97.00 (80.22)	**97.13 (80.40)**	96.50 (79.53)	95.25 (77.64)	**95.88 (78.25)**
T_6	99.25 (86.50)	98.50 (84.01)	**98.88 (85.25)**	99.25 (86.50)	98.00 (81.97)	**98.63 (84.72)**	98.25 (82.57)	97.25 (80.52)	**97.75 (82.56)**	97.25 (80.52)	96.25 (78.80)	**96.75 (79.66)**	95.75 (78.28)	93.75 (75.49)	**94.75 (76.72)**
T_7	99.75 (88.53)	98.25 (82.57)	**99.00 (85.55)**	99.50 (87.10)	98.25 (82.57)	**98.88 (84.83)**	99.25 (86.50)	98.00 (81.97)	**98.63 (84.24)**	97.75 (82.56)	97.50 (80.99)	**97.63 (81.25)**	97.25 (80.52)	96.00 (78.43)	**96.63 (79.38)**
T_8	99.75 (88.53)	98.50 (84.01)	**99.13 (86.20)**	99.75 (88.53)	98.25 (82.57)	**99.00 (85.55)**	99.50 (87.10)	98.25 (82.57)	**98.88 (85.36)**	99.25 (86.50)	97.25 (80.52)	**98.25 (82.57)**	98.00 (81.97)	96.25 (78.80)	**97.13 (80.21)**
V=Mean	**99.41 (86.98)**	**98.31 (83.12)**	**98.86 (85.05)**	**99.41 (86.87)**	**98.03 (82.47)**	**98.72 (84.67)**	**98.34 (83.36)**	**97.41 (81.23)**	**97.88 (82.29)**	**97.16 (80.77)**	**96.31 (79.16)**	**96.73 (79.96)**	**95.81 (78.16)**	**94.22 (76.06)**	**95.02 (77.07)**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.57	2.16		0.60	2.29		0.53	2.02		0.41	1.54		0.39	1.49	
T	1.14	NS		1.21	NS		1.06	4.03		0.81	3.09		0.79	2.99	
VXT	1.61	NS		1.71	NS		1.50	NS		1.15	NS		1.11	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**

NS - Non significant

* Figures in the parenthesis are arcsine transformed values

T_1- Control

T_2- Deltamethrin 2. 8EC @ 0.4 ml/kg of seeds.

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin @ 2.8 EC 0.4ml per kg of seeds + vitavax power @2 g/kg of seeds.

T_6- Deltamethrin @2.8EC 0.4ml /kg of seeds + polymer coat @10 ml/kg of seeds.

T_7- Vitavax power @ 2 g/kg of seeds+ polymercoat @ 10 ml/kg of seeds

T_8- Deltamethrin @2.8EC per kg of seeds + vitavax power@2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Table 2b. Effect of polymercoat and seed treatment chemicals on seed germination percentage of chickpea

Treatments	5th month			6th month			7th month			8th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	91.76 (73.29)	90.76 (72.27)	**91.26 (72.77)**	90.01 (71.55)	88.51 (70.16)	**89.26 70.84**	87.51 69.28	85.51 67.60	**86.51 68.42**	85.26 67.39	83.76 66.21	**84.51 (66.80)**
T_2	92.01 (73.55)	91.26 (72.77)	**91.63 (73.16)**	90.76 (72.27)	89.76 (71.31)	**90.26 (71.79)**	88.26 (69.93)	86.76 (68.63)	**87.51 (69.28)**	86.51 (68.42)	84.51 (66.80)	**85.51 (67.60)**
T_3	95.26 (77.39)	92.76 (74.36)	**94.01 (75.80)**	93.51 (75.21)	91.76 (73.29)	**92.63 (74.22)**	91.76 (73.29)	89.76 (71.31)	**90.76 (72.27)**	90.01 (71.55)	88.26 (69.93)	**89.13 (70.73)**
T_4	92.51 (74.09)	91.76 (73.29)	**92.13 (73.68)**	91.26 (72.77)	90.26 (71.79)	**90.76 (72.27)**	88.76 (70.38)	87.26 (69.06)	**88.01 (69.71)**	87.26 (69.06)	85.51 (67.60)	**86.38 (68.32)**
T_5	96.01 (78.45)	93.51 (75.21)	**94.76 (76.74)**	94.01 (75.80)	92.51 (74.09)	**93.26 (74.92)**	92.76 (74.36)	91.51 (73.03)	**92.13 (73.68)**	91.51 (73.03)	90.51 (73.03)	**91.01 (72.52)**
T_6	93.01 (74.64)	92.26 (73.82)	**92.63 (74.22)**	91.76 (73.29)	91.01 (72.52)	**91.38 (72.90)**	90.51 (72.03)	89.26 (70.84)	**89.88 (71.43)**	89.26 (70.84)	87.51 (70.84)	**88.38 (70.05)**
T_7	96.51 (79.20)	94.76 (76.74)	**95.64 (77.91)**	95.26 (77.39)	93.26 (74.92)	**94.26 (76.11)**	94.01 (75.80)	92.01 (73.55)	**93.01 (74.64)**	92.76 (74.36)	91.26 (72.77)	**92.01 (73.55)**
T_8	97.51 (80.89)	95.51 (77.74)	**96.51 (79.20)**	96.76 (79.60)	94.76 (76.74)	**95.76 (78.09)**	95.26 (77.39)	93.26 (74.92)	**94.26 (76.11)**	94.26 (76.11)	92.51 (74.09)	**93.38 (75.07)**
V=Mean	**94.32 (76.18)**	**92.82 (74.43)**	**93.57 (75.28)**	**92.92 (74.53)**	**91.48 (73.00)**	**92.20 (73.75)**	**91.10 (72.62)**	**89.42 (70.99)**	**90.26 (71.79)**	**89.60 (71.16)**	**87.98 (69.68)**	**88.79 (70.41)**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.36	1.37		0.36	1.35		0.35	1.33		0.34	1.31	
T	0.72	2.75		0.71	2.71		0.70	2.65		0.69	2.61	
VXT	1.03	NS		1.01	NS		0.99	NS		0.97	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**

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

T_1- Control

T_2- Deltamethrin 2. 8EC @ 0.4 ml/kg of seeds.

T_3- Vitavax power@2g/kg of seeds

T_4- Polymercoat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8 EC @ 0.4 ml /kg of seeds + vitavax power @2 g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymercoat @ 10 ml/kg of seeds.

T_7- Vitavax power @ 2 g/kg of seeds+ polymercoat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Table 2c. Effect of polymercoat and seed treatment chemicals on seed germination percentage of chickpea

Treatments	9th month			10th month			11th month			12th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	83.50 (66.01)	81.26 (64.32)	**82.38 (65.15)**	81.01 (64.14)	78.01 (62.01)	**79.51 (63.06)**	78.76 (62.53)	76.26 (60.82)	**77.51 (61.66)**	77.50 (61.66)	74.75 (59.81)	**76.13 (60.73)**
T_2	84.25 (66.59)	82.26 (65.06)	**83.25 (65.82)**	82.26 (65.06)	80.76 (63.96)	**81.51 (64.51)**	81.51 (64.51)	78.26 (62.18)	**79.88 (63.33)**	79.25 (62.88)	76.50 (60.98)	**77.88 (61.92)**
T_3	88.25 (69.93)	85.76 (67.80)	**87.00 (68.84)**	87.01 (68.85)	84.26 (66.60)	**85.63 (67.70)**	85.51 (67.60)	82.26 (65.06)	**83.88 (66.30)**	84.25 (66.59)	80.51 (63.78)	**82.38 (65.15)**
T_4	85.76 (67.80)	83.26 (65.82)	**84.51 (66.80)**	83.26 (65.82)	81.76 (64.69)	**82.51 (65.25)**	81.51 (64.51)	79.51 (63.06)	**80.51 (63.78)**	80.25 (63.59)	77.75 (61.83)	**79.00 (62.70)**
T_5	90.26 (71.79)	88.26 (69.93)	**89.26 (70.84)**	88.51 (70.16)	86.26 (68.21)	**87.38 (69.17)**	87.26 (69.06)	85.21 (67.35)	**86.23 (68.19)**	86.00 (68.00)	83.75 (66.20)	**84.88 (67.09)**
T_6	87.76 (69.49)	84.76 (66.99)	**86.26 (68.21)**	85.26 (67.39)	83.26 (65.82)	**84.26 (66.60)**	83.51 (66.01)	81.51 (64.51)	**82.51 (65.25)**	81.75 (64.68)	78.75 (62.52)	**80.25 (63.59)**
T_7	91.26 (72.77)	89.51 (71.07)	**90.38 (71.91)**	89.51 (71.07)	87.75 (69.48)	**88.63 (70.27)**	88.26 (69.93)	86.51 (68.42)	**87.38 (69.17)**	86.75 (68.63)	85.25 (67.39)	**86.00 (68.00)**
T_8	93.51 (75.21)	91.76 (73.29)	**92.63 (74.22)**	91.76 (73.29)	90.50 (72.02)	**91.13 (72.64)**	89.76 (69.93)	88.26 (69.93)	**89.01 (70.61)**	87.50 (69.27)	86.75 (68.63)	**87.13 (68.94)**
V=Mean	**88.07 (69.76)**	**85.85 (67.88)**	**86.96 (68.80)**	**86.07 (68.06)**	**84.07 (66.45)**	**85.07 (67.24)**	**84.51 (66.80)**	**82.22 (65.04)**	**83.37 (65.90)**	**82.91 (65.55)**	**80.50 (63.77)**	**81.70 (64.65)**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.36	1.36		0.39	1.48		0.32	1.23		0.36	1.35	
T	0.72	2.72		0.78	2.96		0.65	2.45		0.71	2.70	
VXT	1.01	NS		1.10	NS		0.91	NS		1.01	NS	

Legend: V_1-BGD 103 (*Desi*) V_2 – BG 1105 (*Kabuli*)

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

T_1- Control

T_2- Deltamethrin 2. 8EC @ 0.4 ml/kg of seeds.

T_3- Vitavax power @ 2 g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8 EC @ 0.4ml /kg of seeds + vitavax power @2 g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymercoat @10 ml/kg of seeds.

T_7- Vitavax power @ 2 g/kg of seeds+ polymercoat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml/ kg of seeds + vitavax power @2g/kg of seeds + polymer coat @10 ml/kg of seeds.

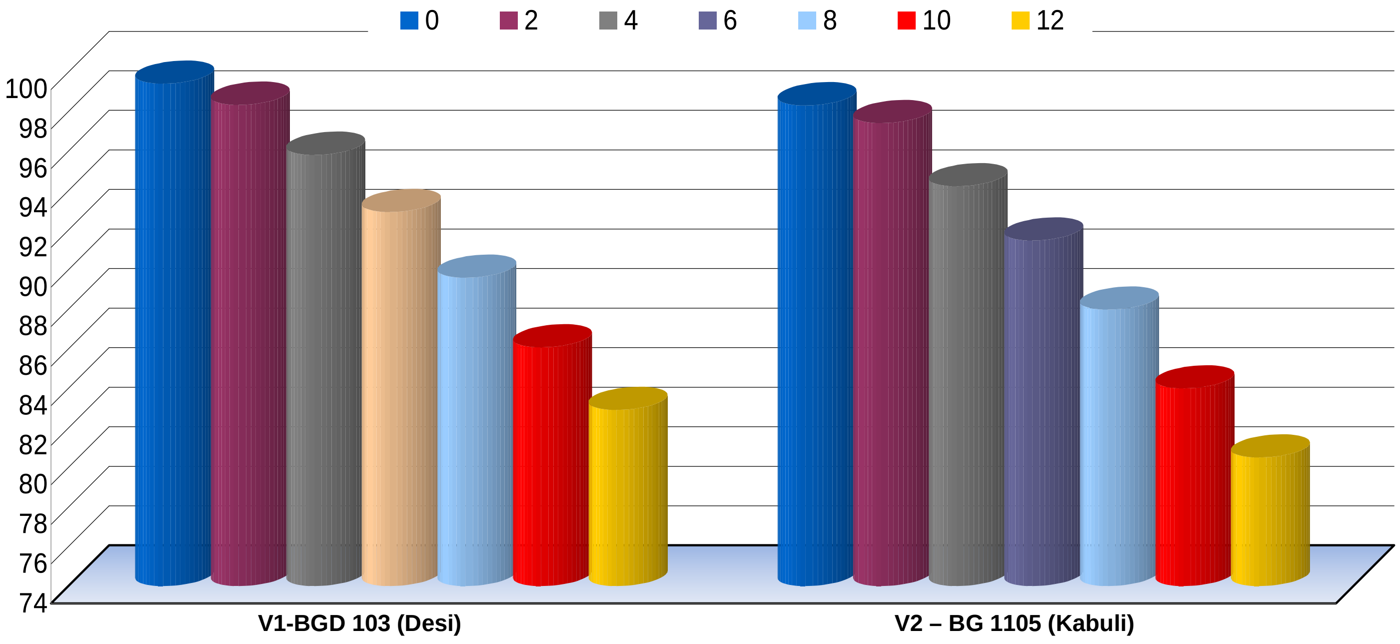


Fig. 2 : Influence of storage period on germination percentage of chickpea varieties

Fig. 2: Influence of storage period on germination percentage of chickpea varieties

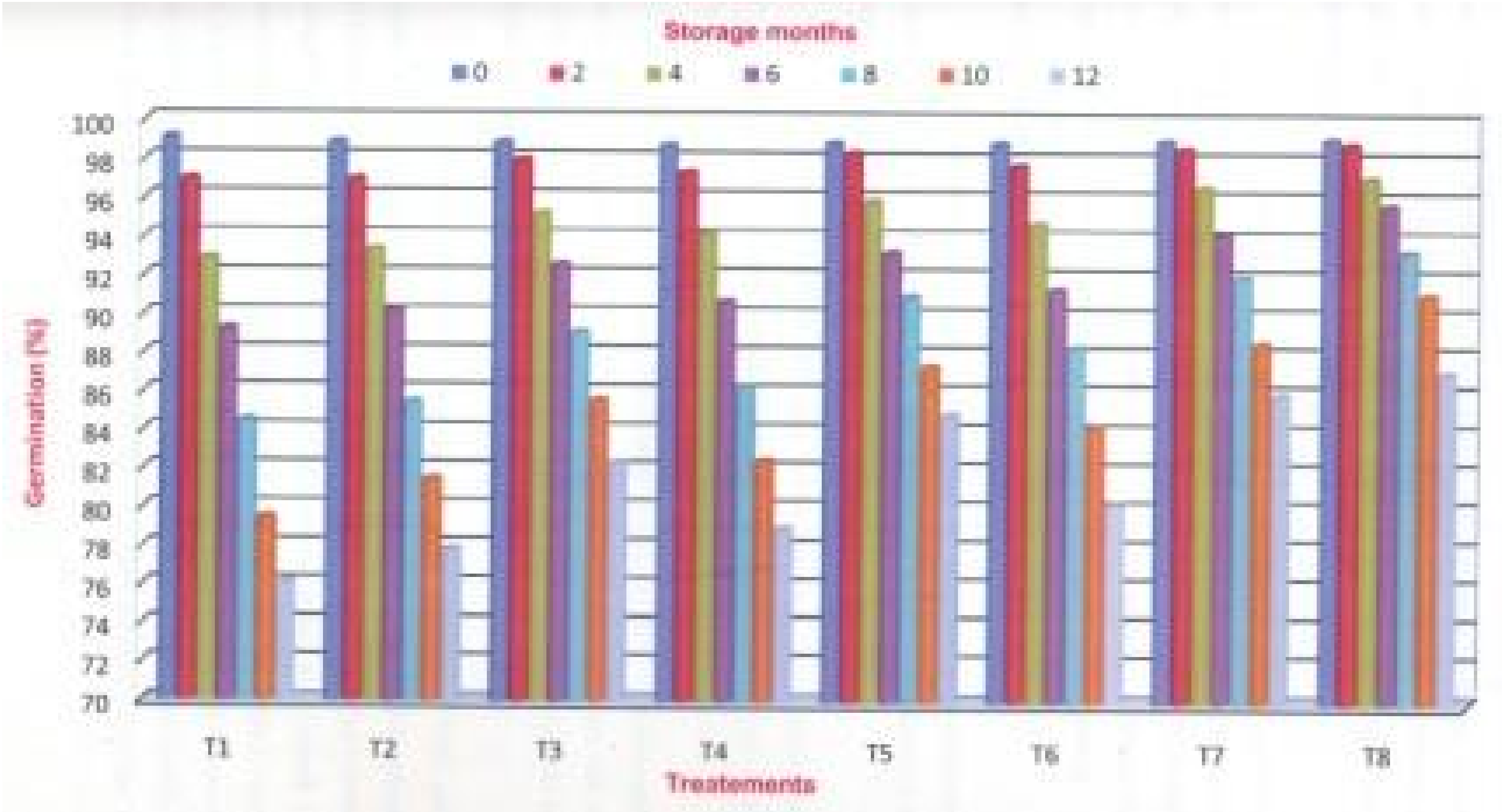


Fig. 3: Effect of polymercoat and seed treatment chemicals on chickpea seed germination percentage during storage

Table 3a. Effect of polymercoat and seed treatment chemicals on shoot length (cm) of chickpea

Treatments	Storage months														
	Initial month			1st month			2nd month			3rd month			4th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_1	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	12.91	11.96	**12.44**	12.84	11.92	**12.38**	12.61	11.50	**12.06**	11.68	10.69	**11.19**	11.38	10.37	**10.88**
T_2	12.93	11.96	**12.45**	12.84	11.95	**12.40**	12.68	11.51	**12.10**	11.89	10.78	**11.34**	11.53	10.45	**10.99**
T_3	13.06	12.03	**12.55**	12.87	11.96	**12.42**	12.79	11.79	**12.29**	12.37	11.21	**11.79**	12.19	11.03	**11.61**
T_4	12.96	11.97	**12.47**	12.86	12.01	**12.44**	12.71	11.58	**12.15**	12.06	10.89	**11.48**	11.72	10.62	**11.17**
T_5	13.05	12.06	**12.56**	12.92	11.96	**12.44**	12.88	11.85	**12.37**	12.49	11.42	**11.96**	12.34	11.21	**11.78**
T_6	13.03	11.99	**12.51**	12.88	11.97	**12.43**	12.77	11.67	**12.22**	12.21	11.01	**11.61**	11.92	10.79	**11.36**
T_7	13.09	12.07	**12.58**	12.95	12.04	**12.50**	12.89	11.91	**12.40**	12.61	11.68	**12.15**	12.48	11.38	**11.93**
T8	13.10	12.09	**12.60**	13.08	12.06	**12.57**	13.01	11.96	**12.49**	12.78	11.72	**12.25**	12.57	11.52	**12.05**
V=Mean	**13.02**	**12.02**	**12.52**	**12.91**	**11.99**	**12.45**	**12.79**	**11.72**	**12.26**	**12.26**	**11.18**	**11.72**	**12.02**	**10.92**	**11.47**
	SEm±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.05	0.18		0.07	0.25		0.10	0.36		0.05	0.17		0.06	0.21	
T	0.10	NS		0.13	NS		0.19	NS		0.09	0.34		0.11	0.43	
VXT	0.14	NS		0.19	NS		0.27	NS		0.13	NS		0.16	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC@ 0.4ml/kg of seeds.

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC@ 0.4ml/kg of seeds + polymer coat @10 ml/kg of seeds.

T_7- Vitavax power@2g/kg of seeds + polymercoat @10 ml/kg of seeds

T_8- deltamethrin2.8EC @ 0.4ml per kg of seeds + Vitavax power @2g/kg of seeds + Polymer coat @10 ml/kg of seeds.

Table 3b. Effect of polymercoat and seed treatment chemicals on shoot length (cm) of chickpea

Treatments	5th month			6th month			7th month			8th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	10.81	9.62	**10.22**	10.06	9.22	**9.64**	9.42	8.61	**9.02**	8.76	8.21	**8.49**
T_2	11.09	9.81	**10.45**	10.49	9.43	**9.96**	9.68	8.89	**9.29**	9.11	8.47	**8.79**
T_3	11.69	10.31	**11.00**	11.18	10.10	**10.64**	10.52	9.61	**10.07**	10.11	9.28	**9.70**
T_4	11.32	10.02	**10.67**	10.76	9.62	**10.19**	9.83	9.21	**9.52**	9.48	8.78	**9.13**
T_5	11.89	10.67	**11.28**	11.38	10.42	**10.90**	10.79	9.88	**10.34**	10.32	9.45	**9.89**
T_6	11.41	10.19	**10.80**	10.96	9.87	**10.42**	10.13	9.44	**9.79**	9.79	9.07	**9.43**
T_7	12.08	10.87	**11.48**	11.57	10.67	**11.12**	11.06	10.09	**10.58**	10.59	9.74	**10.17**
T8	12.13	11.11	**11.62**	11.72	10.89	**11.31**	11.21	10.42	**10.82**	10.82	10.08	**10.45**
V=Mean	**11.55**	**10.33**	**10.94**	**11.02**	**10.03**	**10.52**	**10.33**	**9.52**	**9.93**	**9.87**	**9.14**	**9.50**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.04	0.16		0.04	0.15		0.05	0.20		0.04	0.14	
T	0.08	0.32		0.08	0.29		0.11	0.41		0.07	0.28	
VXT	0.12	NS		0.11	NS		0.15	NS		0.10	NS	

Legend: **V_1-BGD 103 (*Desi)*** **V_2 – BG 1105 (*Kabuli*)**

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds.

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml / kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC@ 0.4mlkg of seeds + polymercoat @10 ml/kg of seeds.

T_7- Vitavax power@2g/kg of seeds+ polymer coat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Table 3c. Effect of polymercoat and seed treatment chemicals on shoot length (cm) of chickpea

Treatments	9th month			10th month			11th month			12th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	7.86	7.52	**7.69**	6.91	6.41	**6.66**	6.23	5.11	**5.67**	5.99	4.26	**5.12**
T_2	8.31	7.91	**8.11**	7.53	7.12	**7.33**	6.96	6.14	**6.55**	6.21	5.82	**6.02**
T_3	9.53	8.91	**9.22**	9.11	8.42	**8.77**	8.37	7.89	**8.13**	7.89	7.26	**7.58**
T_4	8.53	8.21	**8.37**	7.77	7.36	**7.57**	7.43	6.61	**7.02**	6.96	6.12	**6.54**
T_5	9.76	9.07	**9.42**	9.49	8.73	**9.11**	8.62	8.16	**8.39**	8.21	7.59	**7.90**
T_6	8.88	8.67	**8.78**	8.19	8.12	**8.16**	7.91	7.41	**7.66**	7.42	6.79	**7.11**
T_7	10.07	9.34	**9.71**	9.73	9.04	**9.39**	8.89	8.41	**8.65**	8.42	7.98	**8.20**
T8	10.35	9.71	**10.03**	9.92	9.38	**9.65**	9.13	8.91	**9.02**	8.67	8.11	**8.39**
V=Mean	**9.16**	**8.67**	**8.92**	**8.58**	**8.07**	**8.33**	**7.94**	**7.33**	**7.64**	**7.47**	**6.74**	**7.11**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.03	0.12		0.03	0.12		0.03	0.11		0.03	0.11	
T	0.06	0.23		0.07	0.25		0.06	0.23		0.06	0.21	
VXT	0.09	NS		0.09	NS		0.14	NS		0.18	NS	

Legend: V_1-BGD 103 (*Desi*) V_2 – BG 1105 (*Kabuli*)

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds.

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml / kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC@ 0.4mlkg of seeds + polymercoat @10 ml/kg of seeds.

T_7- Vitavax power@2g/kg of seeds+ polymer coat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Significantly highest shoot length (12.25 cm) was noticed at 3^{rd} month in T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) as 12.25 cm and it was on par with the T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds), while the lowest shoot length (11.19 cm) was recorded in T_1 (untreated). Similar trend was noticed up to end of storage period. At the end of twelve months of storage period, significantly highest shoot length (8.39 cm) was recorded in T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) followed by T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) as 8.20 cm, while significantly lowest shoot length was recorded in T_1 (untreated) as 5.12 cm.

Interaction effect between the varieties and seed treatments recorded non significant differences in all the months of storage. However, numerically highest shoot length was found in V_1T_8 (8.67 cm) which was on par with the V_1T_7 (8.42 cm) and V_1T_5 (8.21cm). Whereas, the lowest shoot length in the V_2T_1 (4.26 cm) combinations at the end of twelth month storage.

4.1.3 Root length (cm)

The results on root length as influenced by varieties, seed treatments and their interaction at different months of storage period are presented in the Table 4a, 4b and 4c.

Irrespective of varieties and seed treatments the root length declined gradually with the advancement of storage period. The mean root length was decreased from 20.64 cm in the initial month to 14.69 cm at the end 12^{th} month of storage period.

The root length differed significantly due to varieties throughout storage period. Significantly, maximum root length (21.18 and 15.23cm) was recorded in BGD-103 (V_1) followed by BG1105 (V_2) (20.10 and 14.14cm) initial and twelth month of storage period respectively.

Due to seed treatments, the significant difference in root length was recorded from third month to twelth month of storage period. Significantly highest root length (19.45 cm) was noticed at 3^{rd} month in T_8 (deltamethrin 2.8EC@ 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymer coat @ 10ml/kg of seeds) and it was on par with the T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) as 19.32 cm and lowest shoot length (18.46cm) was recorded in T_1 (untreated). Similar trend was noticed up to twelve months of storage period. At the end of twelve months of storage period, significantly highest root length (15.63 cm) was recorded in T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) and it was on par with T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10 ml/kg of seeds) as 15.53 cm. While, significantly lowest root length was recorded in T_1 (untreated) as 13.44 cm.

The interaction between the varieties and seed treatments with polymer coat insecticide and fungicide showed non-significant differences throughout storage period. However, numerically higher value was recorded in V_1T_8 (16.16 cm), which was on par with V_1T_7 (16.04 cm) and minimum in V_2T_1 (12.85 cm) at the end of twelve month of storage period.

4.1.4 Vigour index

The data on vigour index as influenced by varieties, seed treatment and their interaction effects at different months of storage period are presented in Table 5a, 5b and 5c (Fig. 4 and 5).

Irrespective of varieties and treatments the vigour index was declined gradually as the storage period advanced. The mean vigour index was decreased from 3280 in the first month to 1788 at the end of storage period.

The significant difference was noticed on vigour index during storage period of 12 months due to the varieties. Significantly, the higher vigour index at initial and twelth month of storage period (3403 and 1888, respectively) was recorded in BGD103 (V_1) and it was followed by BG1105 (V_2) (3157 and 1689, respectively). As storage period advanced decline in vigour index was noticed.

Vigour index differed significantly due to seed treatment from the second month and similar trend continues up to twelfth month of storage. The vigour index decreased with the advancement of storage period in all the seed treatments whereas, significantly higher vigour index (3247) was recorded at second month in T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) followed by T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) as 3220 .While significantly lower vigour index (3115) was recorded in T_1 (untreated). Similar trend was noticed up to the end of storage period.

Table 4a. Effect of polymercoat and seed treatment chemicals on root length (cm) of chickpea

Treatments	Initial month			1st month			2nd month			3rd month			4th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	21.17	20.10	**20.64**	21.15	20.10	**20.63**	20.86	19.00	**19.93**	18.86	18.06	**18.46**	17.49	17.51	**17.50**
T_2	21.15	20.05	**20.60**	21.13	20.00	**20.57**	20.96	19.07	**20.02**	19.03	18.12	**18.58**	17.96	17.76	**17.86**
T_3	21.14	20.12	**20.63**	21.13	20.11	**20.62**	20.98	19.42	**20.20**	19.38	18.79	**19.09**	18.79	18.23	**18.51**
T_4	21.15	20.09	**20.62**	21.14	20.07	**20.61**	21.07	19.12	**20.10**	19.11	18.21	**18.66**	18.09	18.03	**18.06**
T_5	21.16	20.10	**20.63**	21.09	20.09	**20.59**	21.01	19.63	**20.32**	19.43	19.08	**19.26**	19.08	18.49	**18.79**
T_6	21.17	20.09	**20.63**	21.15	20.09	**20.62**	21.09	19.31	**20.20**	19.13	18.46	**18.80**	18.41	18.12	**18.27**
T_7	21.19	20.09	**20.64**	21.16	20.00	**20.58**	21.00	19.72	**20.36**	19.51	19.13	**19.32**	19.28	18.75	**19.02**
T8	21.26	20.12	**20.69**	21.23	20.05	**20.64**	21.06	19.89	**20.48**	19.68	19.21	**19.45**	19.42	18.76	**19.09**
V=Mean	**21.18**	**20.10**	**20.64**	**21.15**	**20.07**	**20.61**	**21.01**	**19.40**	**20.20**	**19.27**	**18.63**	**18.95**	**18.57**	**18.21**	**18.39**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.08	0.30		0.08	0.30		0.08	0.30		0.09	0.32		0.07	0.27	
T	0.16	NS		0.16	NS		0.16	NS		0.17	0.65		0.14	0.54	
VXT	0.23	NS		0.23	NS		0.22	NS		0.24	NS		0.20	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds.

T_3- Vitavax power@2g/kg of seeds

T_4- Polymercoat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml / kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC@ 0.4mlkg of seeds + polymercoat @10 ml/kg of seeds.

T_7- Vitavax power@2g/kg of seeds+ polymercoat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Table 4b. Effect of polymercoat and seed treatment chemicals on root length (cm) of chickpea

Treatments	5th month			6th month			7th month			8th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	17.31	16.76	**17.04**	16.98	15.89	**16.44**	16.60	15.21	**15.91**	15.85	14.79	**15.32**
T_2	17.42	17.00	**17.21**	17.13	16.08	**16.61**	16.84	15.76	**16.30**	16.08	15.06	**15.57**
T_3	18.23	17.42	**17.83**	18.09	16.97	**17.53**	17.36	16.34	**16.85**	16.87	16.01	**16.44**
T_4	17.79	17.11	**17.45**	17.54	16.39	**16.97**	17.03	16.02	**16.53**	16.21	15.31	**15.76**
T_5	18.46	17.87	**18.17**	18.23	17.03	**17.63**	17.86	16.51	**17.19**	17.21	16.19	**16.70**
T_6	18.09	17.31	**17.70**	17.94	16.72	**17.33**	17.21	16.13	**16.67**	16.49	15.76	**16.13**
T_7	18.79	18.03	**18.41**	18.46	17.11	**17.79**	18.01	16.83	**17.42**	17.86	16.42	**17.14**
T8	19.01	18.07	**18.54**	18.79	17.23	**18.01**	18.19	17.06	**17.63**	18.05	16.84	**17.45**
V=Mean	**18.14**	**17.45**	**17.79**	**17.90**	**16.68**	**17.29**	**17.39**	**16.23**	**16.81**	**16.83**	**15.80**	**16.31**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.06	0.22		0.07	0.25		0.06	0.23		0.06	0.24	
T	0.12	0.45		0.13	0.51		0.12	0.46		0.13	0.48	
VXT	0.17	NS		0.19	NS		0.17	NS		0.18	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds.

T_3- Vitavax power@2g/kg of seeds

T_4- Polymercoat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml / kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC@ 0.4mlkg of seeds + polymercoat @10 ml/kg of seeds.

T_7- Vitavax power@2g/kg of seeds+ polymercoat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Table 4c. Effect of polymercoat and seed treatment chemicals on root length (cm) of chickpea

Treatments	9th month			10th month			11th month			12th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	15.13	14.12	**14.63**	14.89	13.89	**14.39**	14.61	13.21	**13.91**	14.03	12.85	**13.44**
T_2	15.49	14.42	**14.96**	15.13	14.12	**14.63**	14.97	13.79	**14.38**	14.34	13.21	**13.78**
T_3	16.54	15.43	**15.99**	16.13	15.03	**15.58**	15.87	14.82	**15.35**	15.43	14.34	**14.89**
T_4	15.87	14.98	**15.43**	15.41	14.49	**14.95**	15.13	14.09	**14.61**	14.89	13.76	**14.33**
T_5	16.98	15.78	**16.38**	16.48	15.21	**15.85**	16.01	15.09	**15.55**	15.89	14.82	**15.36**
T_6	16.09	15.21	**15.65**	15.86	14.82	**15.34**	15.27	14.35	**14.81**	15.07	14.02	**14.55**
T_7	17.14	15.98	**16.56**	16.87	15.49	**16.18**	16.26	15.13	**15.70**	16.04	15.01	**15.53**
T_8	17.85	16.12	**16.99**	17.12	15.96	**16.54**	16.79	15.49	**16.14**	16.16	15.09	**15.63**
V=Mean	**16.39**	**15.26**	**15.82**	**15.99**	**14.88**	**15.43**	**15.62**	**14.50**	**15.06**	**15.23**	**14.14**	**14.69**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.08	0.31		0.06	0.23		0.05	0.20		0.06	0.22	
T	0.16	0.62		0.12	0.45		0.10	0.39		0.11	0.43	
VXT	0.23	NS		0.17	NS		0.15	NS		0.16	NS	

Legend: V_1-BGD 103 (*Desi*) V_2 – BG 1105 (*Kabuli*)

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds.

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml / kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC@ 0.4mlkg of seeds + polymercoat @10 ml/kg of seeds.

T_7- Vitavax power@2g/kg of seeds+ polymer coat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Table 5a.Effect of polymer coat and seed treatment chemicals on seedling vigour index of chickpea

Treatments	Initial month			1st month			2nd month			3rd month			4th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	3400	3158	**3279**	3391	3147	**3269**	3264	2967	**3115**	2910	2732	**2821**	2700	2572	**2636**
T_2	3391	3145	**3268**	3372	3132	**3252**	3272	2967	**3120**	2946	2753	**2850**	2773	2617	**2695**
T_3	3403	3159	**3281**	3358	3159	**3259**	3319	3043	**3181**	3080	2888	**2984**	2982	2758	**2870**
T_4	3386	3142	**3264**	3358	3153	**3255**	3303	2994	**3148**	3008	2888	**2948**	2840	2672	**2756**
T_5	3404	3160	**3282**	3376	3150	**3263**	3339	3062	**3200**	3105	2959	**3032**	3033	2829	**2931**
T_6	3395	3160	**3277**	3361	3151	**3256**	3319	3013	**3166**	3033	2837	**2935**	2905	2711	**2808**
T_7	3420	3160	**3290**	3395	3157	**3276**	3339	3100	**3220**	3140	2997	**3069**	3089	2893	**2991**
T_8	3428	3173	**3300**	3415	3172	**3293**	3365	3130	**3247**	3190	3016	**3103**	3136	2915	**3025**
V=Mean	**3403**	**3157**	**3280**	**3378**	**3152**	**3265**	**3315**	**3035**	**3175**	**3051**	**2884**	**2968**	**2932**	**2746**	**2839**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	13	48		13	48		12	47		10	38		11	42	
T	25	NS		25	NS		25	93		20	76		22	84	
VXT	36	NS		36	NS		35	NS		28	NS		31	NS	

Legend: V_1-BGD 103 (*Desi*) V_2 – BG 1105 (*Kabuli*)

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @0.4ml/kg of seeds.

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml / kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC@ 0.4mlkg of seeds + polymercoat @10 ml/kg of seeds.

T_7- Vitavax power@2g/kg of seeds+ polymer coat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Table 5b. Effect of polymercoat and seed treatment chemicals on seedling vigour index of chickpea

Treatments	5^{th} month			6^{th} month			7^{th} month			8^{th} month		
	V_1	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**
T_1	2581	2395	**2488**	2434	2223	**2329**	2277	2037	**2157**	2099	1927	**2013**
T_2	2624	2447	**2535**	2507	2290	**2399**	2341	2139	**2240**	2180	1989	**2084**
T_3	2851	2573	**2712**	2738	2484	**2611**	2559	2330	**2444**	2429	2233	**2331**
T_4	2694	2490	**2592**	2583	2348	**2466**	2385	2202	**2293**	2242	2060	**2151**
T_5	2914	2669	**2792**	2784	2540	**2662**	2658	2415	**2537**	2520	2321	**2420**
T_6	2744	2538	**2641**	2652	2420	**2536**	2475	2283	**2379**	2346	2173	**2260**
T_7	2980	2739	**2860**	2861	2591	**2726**	2733	2477	**2605**	2640	2388	**2514**
T_8	3037	2788	**2912**	2953	2665	**2809**	2801	2563	**2682**	2722	2491	**2606**
V=Mean	**2803**	**2580**	**2691**	**2689**	**2445**	**2567**	**2529**	**2306**	**2417**	**2397**	**2198**	**2297**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	10	40		10	38		9	35		9	34	
T	21	79		20	76		18	70		18	68	
VXT	30	NS		28	NS		26	NS		25	NS	

Legend: V_1-BGD 103 (*Desi*) V_2 – BG 1105 (*Kabuli*)

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @0.4ml/kg of seeds.

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml / kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC@ 0.4mlkg of seeds + polymercoat @10 ml/kg of seeds.

T_7- Vitavax power@2g/kg of seeds+ polymer coat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Table 5c. Effect of polymercoat and seed treatment chemicals on seedling vigour index of chickpea

Treatments	9th month			10th month			11th month			12th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	1920	1759	**1839**	1766	1584	**1675**	1642	1397	**1519**	1550	1279	**1415**
T_2	2006	1837	**1921**	1864	1716	**1790**	1788	1560	**1674**	1629	1456	**1543**
T_3	2301	2088	**2194**	2197	1976	**2086**	2073	1868	**1971**	1965	1739	**1852**
T_4	2093	1931	**2012**	1930	1787	**1859**	1839	1646	**1743**	1754	1546	**1650**
T_5	2414	2194	**2304**	2299	2065	**2182**	2150	1982	**2066**	2073	1877	**1975**
T_6	2192	2024	**2108**	2051	1910	**1981**	1936	1774	**1855**	1839	1639	**1739**
T_7	2484	2267	**2375**	2381	2153	**2267**	2220	2037	**2129**	2122	1960	**2041**
T_8	2638	2371	**2504**	2482	2294	**2388**	2327	2154	**2241**	2173	2013	**2093**
V=Mean	**2256**	**2059**	**2157**	**2121**	**1936**	**2028**	**1997**	**1802**	**1900**	**1888**	**1689**	**1788**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	8	32		8	30		7	28		7	27	
T	17	64		16	60		15	56		14	53	
VXT	24	NS		22	NS		21	NS		20	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @0.4ml/kg of seeds.

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml / kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC@ 0.4mlkg of seeds + polymercoat @10 ml/kg of seeds.

T_7- Vitavax power@2g/kg of seeds+ polymer coat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @2g/kg of seeds + polymer coat @10 ml/kg of seeds.

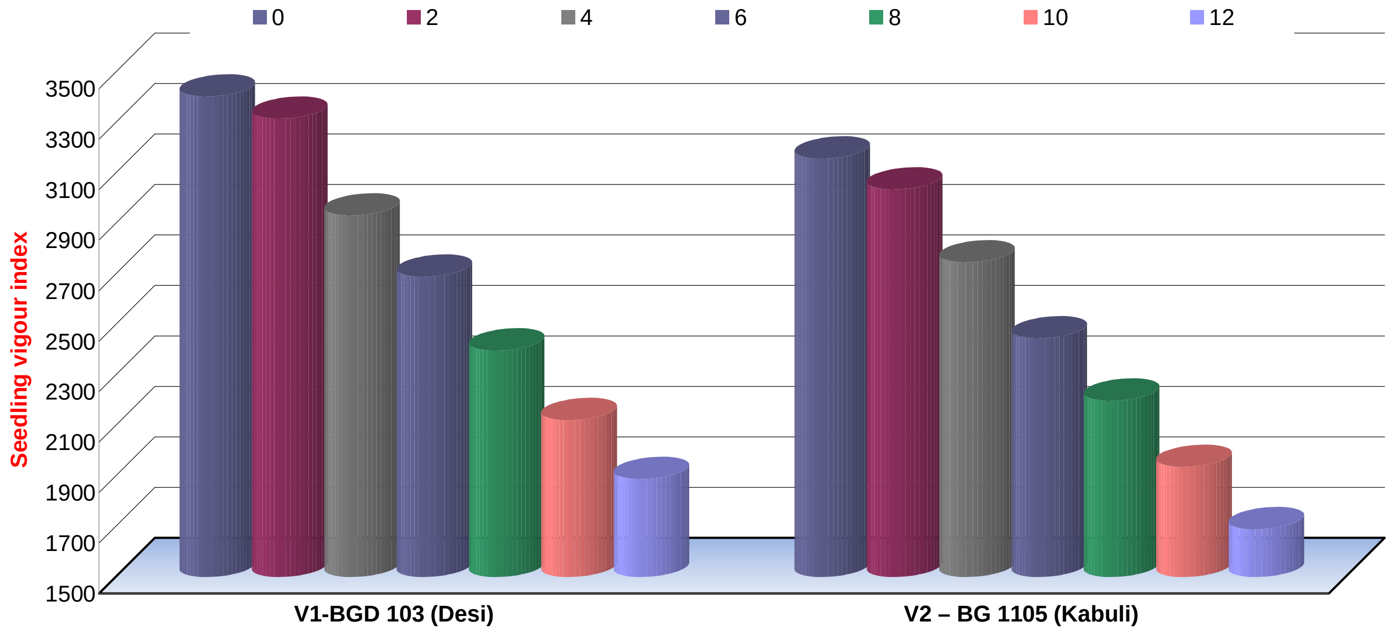


Fig. 4: Influence of storage period on seedling vigour index of chickpea varieties

Fig. 4: Influence of storage period on seedling vigour index of chickpea varieties

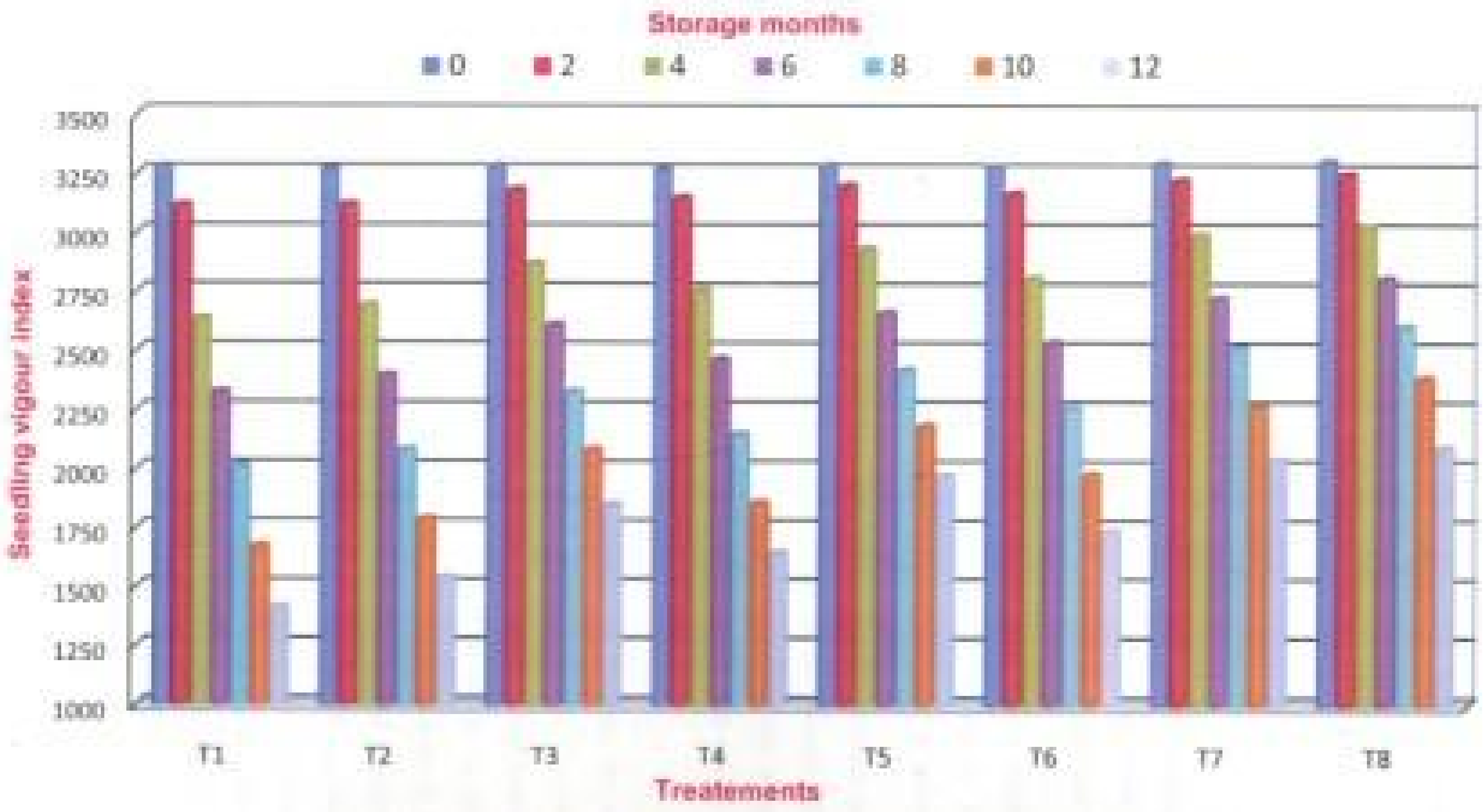


Fig. 5: Effect of polymercoat and seed treatment chemicals on chickpea seedling vigour index during storage

At the end of twelve months of storage period, significantly higher vigour index (2093) was recorded in T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) and it was on par with T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) as 2041, while significantly lower vigour index was recorded in T_1 (untreated) as 1415.

The interaction effect of varieties and seed treatments showed non-significant difference on vigour index in all the months of storage period. With the advancement of storage period vigour index was decreased and the highest vigour index of 2173 was noticed in V_1T_8 followed by V_1T_7 (2122) and V_1T_5 (2073) while it was lesser in the V_2T_1 (1279) combination.

4.1.5 Seedling dry weight (mg/10 seedlings)

The results on seedling dry weight (mg/10 seedlings) as influenced by varieties, seed treatments and the interaction between the varieties and seed treatment at different months of storage period are presented in the Table 6a, 6b and 6c (Fig. 6 and 7).

Regardless of varieties and seed treatments the seedling dry weight declined progressively as the storage period advanced. The mean seedling dry weight was decreased from 267.33 mg in the zero month to 150.31 mg at the end of storage period.

A significant difference in seedling dry weight due to varieties was noticed during storage period. Significantly, maximum seedling dry weight (279.74 and 166.27mg) was recorded in BGD103 (V_1) and minimum seedling dry weight (254.91 and 134.35mg) was recorded in BG1105 (V_2) at initial and twelth month of storage period, respectively.

The significant difference due to seed treatments on seedling dry weight was recorded during the storage period from second month onwards. The seedling dry weight was declined gradually as storage period advanced. Significantly highest seedling dry weight (263.32 mg) was noticed at second month in T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) and it was on par with the T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) as 260.77mg and lesser seedling dry weight (37.47mg) was recorded in T_1 (untreated). Similar trend was noticed up to twelve months of storage period. Significantly highest seedling dry weight (177.12 mg) was recorded in T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) followed by T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) as 170.56mg, while significantly lowest seedling dry weight was recorded in T_1 (untreated) as 121. 46 mg at the end of twelve months of storage period.

The interaction effects due to varieties and seed treatments were not differed significantly throughout the storage period. The higher dry weight of seedling was recorded in all the seed treatments in BGD 103 (V_1) as compared to BG1105 (V_2). However, numerically V_1T_8 recorded maximum seedling dry weight (192.44 mg/ 10 seedling) followed by V_1T_7 (185.23 mg/10seedling) and V_1T_5 (178.27 mg / 10 seedling) While, V_2T_1 recorded minimum seedling dry weight (104.53 mg/10 seedling) at the end of twelth month of storage period.

4.1.6 Hundred seed weight (g)

The results on hundred seed weight as influenced by varieties, seed treatments, and their interaction are presented in Table 7a, 7b and 7c.

Irrespective of varieties and seed treatments, the hundred seed weight was declined progressively as the storage period advanced. The mean hundred seed weight was decreased from 32.45 g to 28.43g in the initial and at the end of twelth month, respectively.

The significant difference was noticed on hundred seed weight due to the varieties during storage period of twelve months. Significantly, the maximum hundred seed weight at initial and twelth month of storage period (35.53 and 30.66 g, respectively) was recorded in BGD-103 (V_1) and it was followed by BG1105 (V_2) (29.38 and 26.21 g, respectively).

Due to seed treatments, the significant difference in hundred seed weight was recorded from fourth month to twelth month of storage period. Significantly maximum hundred seed weight (31.90 g) was noticed at 4^{th} month in T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) and it was on par with the T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) as 31.75 g and minimum hundred seed weight (30.74 g) was recorded in T_1 (untreated).

Table 6a. Effect of polymercoat and seed treatment chemicals on seedling dry weight (mg/10 seedling) of chickpea

Treatments	Initial month			1st month			2nd month			3rd month			4th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	278.94	254.62	**266.78**	271.89	249.92	**260.90**	248.38	226.56	**237.47**	234.56	207.56	**221.06**	224.58	189.67	**207.13**
T_2	279.01	254.72	**266.86**	272.31	250.68	**261.49**	251.28	229.00	**240.14**	242.28	212.26	**227.27**	231.30	196.56	**213.93**
T_3	279.94	254.82	**267.38**	279.93	253.79	**266.86**	267.24	237.22	**252.23**	259.41	227.57	**243.49**	246.28	214.81	**230.54**
T_4	279.82	254.79	**267.30**	279.78	253.57	**266.67**	259.39	231.77	**245.58**	248.74	217.91	**233.32**	229.38	199.88	**214.63**
T_5	279.99	254.92	**267.45**	279.98	254.82	**267.40**	271.29	242.91	**257.10**	264.29	233.87	**249.08**	253.80	221.18	**237.49**
T_6	279.92	254.74	**267.33**	279.89	253.71	**266.80**	263.14	233.56	**248.35**	254.31	221.27	**237.79**	237.71	206.80	**222.26**
T_7	280.15	255.31	**267.73**	280.13	255.24	**267.68**	273.15	248.39	**260.77**	267.39	239.87	**253.63**	258.45	228.91	**243.68**
T_8	280.18	255.42	**267.80**	280.15	255.39	**267.77**	276.16	250.48	**263.32**	272.14	244.59	**258.36**	264.15	237.91	**251.03**
Mean	**279.74**	**254.91**	**267.33**	**278.01**	**253.39**	**265.70**	**263.75**	**237.49**	**250.62**	**255.39**	**225.61**	**240.50**	**243.21**	**211.97**	**227.59**

	S Em±	CD(P=0.01)	S Em±	CD(P=0.01)	S Em±	CD(P=0.01)	S Em±	CD(P=0.01)	S Em±	CD(P=0.01)
V	1.04	3.93	1.03	3.91	0.97	3.69	0.93	3.54	0.89	3.36
T	2.07	NS	2.06	NS	1.94	7.38	1.87	7.09	1.77	6.72
VxT	2.93	NS	2.91	NS	2.75	NS	2.64	NS	2.50	NS

Legend: V_1-BGD 103 (*Desi*) V_2 – BG 1105 (*Kabuli*)

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @0.4ml/kg of seeds.

T_3-Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymer coat @10 ml/kg of seeds.

T_7-Vitavax power@2g/kg of seeds + polymer coat @10 ml/kg of seeds

T_8-Deltamethrin 2.8 EC @ 0.4ml per kg of seeds + Vitavax power @2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Table 6b. Effect of polymercoat and seed treatment chemicals on seedling dry weight (mg/10 seedling) of chickpea

Treatments	5th month			6th month			7th month			8th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	208.64	174.26	**191.45**	193.54	163.44	**178.49**	182.13	151.47	**166.80**	172.30	143.54	**157.92**
T_2	215.60	182.47	**199.04**	204.77	171.26	**188.01**	191.26	159.71	**175.48**	183.88	151.44	**167.66**
T_3	237.40	203.44	**220.42**	229.38	194.84	**212.11**	221.81	185.81	**203.81**	213.51	178.55	**196.03**
T_4	221.21	188.91	**205.06**	211.80	179.23	**195.52**	203.50	167.16	**185.33**	192.80	157.87	**175.33**
T_5	243.59	209.88	**226.73**	234.23	201.75	**217.99**	226.58	194.57	**210.58**	217.27	186.57	**201.92**
T_6	229.91	194.91	**212.41**	220.79	183.67	**202.23**	213.48	174.77	**194.13**	204.91	163.88	**184.39**
T_7	251.65	219.00	**235.32**	242.47	210.77	**226.62**	233.74	203.91	**218.83**	221.69	193.80	**207.75**
T_8	258.19	227.91	**243.05**	249.38	221.60	**235.49**	241.26	215.91	**228.58**	232.21	204.80	**218.51**
Mean	**233.27**	**200.10**	**216.69**	**223.30**	**190.82**	**207.06**	**214.22**	**181.66**	**197.94**	**204.82**	**172.55**	**188.69**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**SEm±**	**CD(P=0.01)**		**SEm±**	**CD(P=0.01)**	
V	0.84	3.20		0.81	3.06		0.77	2.93		0.74	2.80	
T	1.69	6.40		1.61	6.13		1.55	5.86		1.47	5.59	
VxT	2.39	NS		2.28	NS		2.19	NS		2.09	NS	

Legend: V_1-BGD 103 (*Desi*) V_2 – BG 1105 (*Kabuli*)

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds.

T_3-Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @2g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymer coat @10 ml/kg of seeds.

T_7-Vitavax power@2g/kg of seeds + polymercoat @10 ml/kg of seeds

T_8-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + Vitavax power @2g/kg of seeds + Polymer coat @10 ml/kg of seeds.

Table 6c. Effect of polymercoat and seed treatment chemicals on seedling dry weight (mg /10 seedling) of chickpea

Treatments	9^{th} month			10^{th} month			11^{th} month			12^{th} month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	165.37	131.43	**148.40**	154.27	122.22	**138.24**	145.87	113.23	**129.55**	138.39	104.53	**121.46**
T_2	174.60	137.55	**156.08**	163.87	131.46	**147.67**	156.77	124.58	**140.67**	145.87	115.86	**130.86**
T_3	201.14	169.14	**185.14**	191.88	154.88	**173.38**	181.28	146.80	**164.04**	172.40	135.90	**154.15**
T_4	184.80	145.47	**165.13**	176.88	139.73	**158.31**	164.91	131.43	**148.17**	154.70	124.86	**139.78**
T_5	208.38	177.25	**192.82**	198.60	166.90	**182.75**	186.56	153.84	**170.20**	178.27	144.23	**161.25**
T_6	193.87	152.78	**173.32**	182.16	144.77	**163.46**	173.80	137.39	**155.60**	162.91	131.73	**147.32**
T_7	214.57	184.30	**199.44**	204.24	173.88	**189.06**	193.76	164.84	**179.30**	185.23	155.90	**170.56**
T_8	224.15	193.91	**209.03**	213.28	181.91	**197.60**	201.33	173.76	**187.54**	192.44	161.80	**177.12**
Mean	**195.86**	**161.48**	**178.67**	**185.65**	**151.97**	**168.81**	**175.53**	**143.23**	**159.38**	**166.27**	**134.35**	**150.31**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.70	2.65		0.66	2.51		0.62	2.37		0.59	2.24	
T	1.40	5.31		1.32	5.02		1.25	4.74		1.18	4.47	
VxT	1.98	NS		1.87	NS		1.77	NS		1.67	NS	

Legend: V_1-BGD 103 (*Desi*) V_2 – BG 1105 (*Kabuli*)

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds.

T_3-Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml/ kg of seeds + vitavax power @ 2g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymer coat @10 ml/kg of seeds.

T_7-Vitavax power@2g/kg of seeds + polymer coat @10 ml/kg of seeds

T_8-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @2g/kg of seeds + polymer coat @10 ml/kg of seeds.

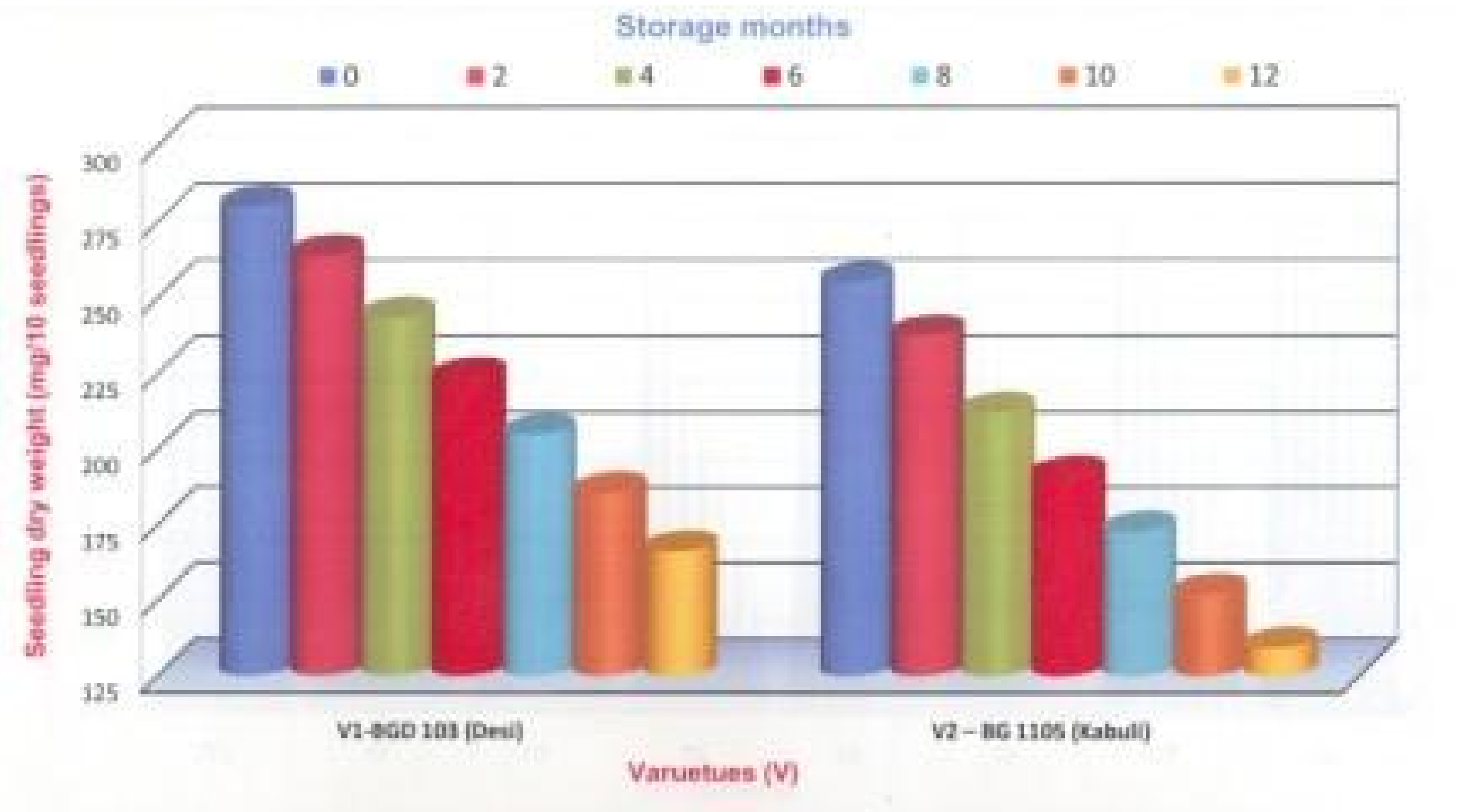


Fig. 6: Influence of storage period on seedling dry weight (mg/10 seedlings) of chickpea varieties

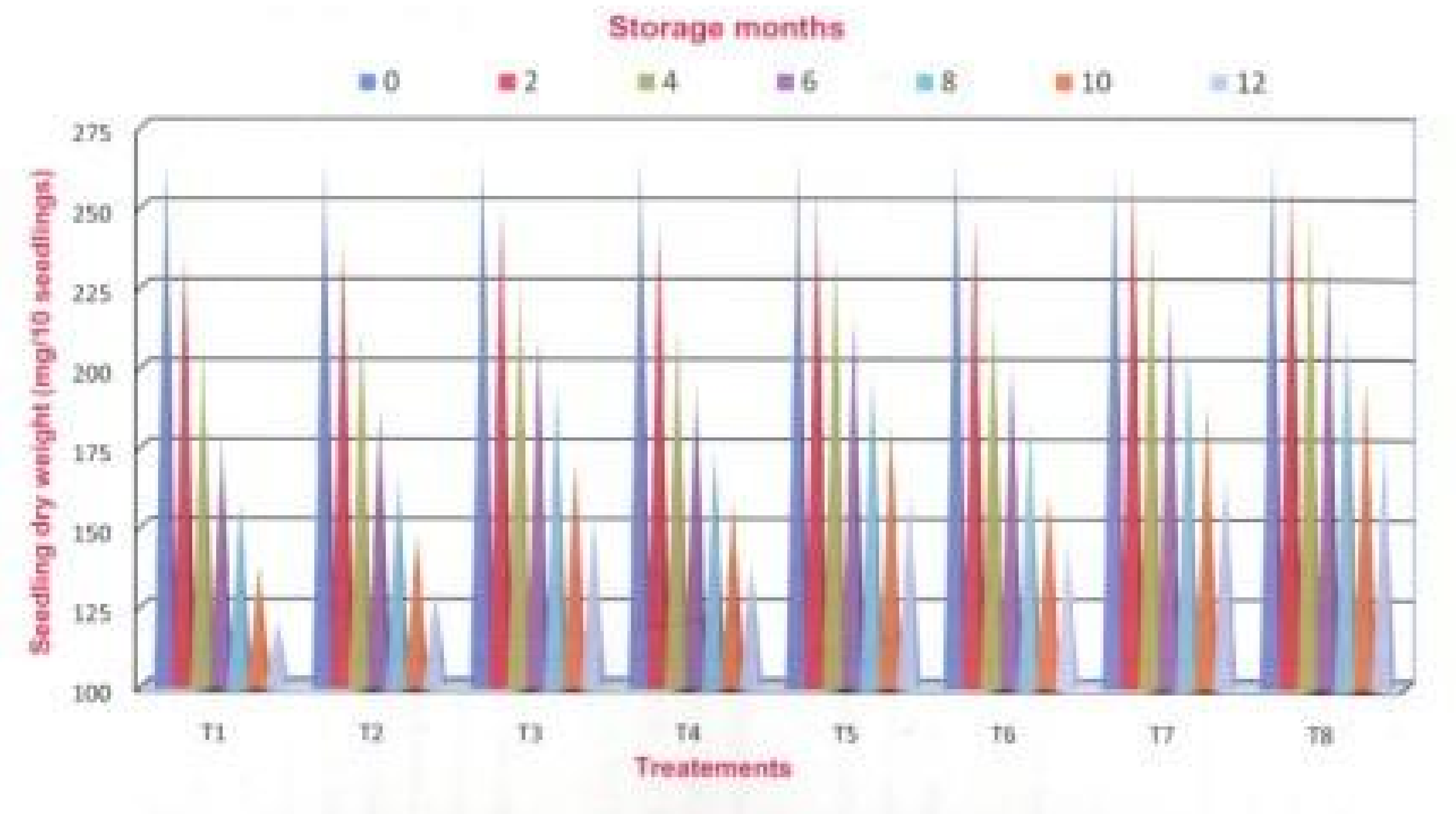


Fig. 7: Effect of polymercoat and seed treatment chemicals on chickpea seedling dry weight (mg/10 seedlings) during storage

Table 7a. Effect of polymer coat and seed treatment chemicals on hundred seed weight (g) of chickpea

Treatments	Initial month			1st month			2nd month			3rd month			4th month		
	V_1	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**
T_1	35.43	29.28	**32.36**	35.41	29.16	**32.29**	34.93	28.61	**31.77**	34.10	28.10	**31.10**	33.69	27.79	**30.74**
T_2	35.46	29.33	**32.40**	35.42	29.20	**32.31**	34.97	28.79	**31.88**	34.19	28.20	**31.20**	33.83	27.96	**30.90**
T_3	35.53	29.38	**32.46**	35.49	29.29	**32.39**	35.07	29.06	**32.07**	34.52	28.63	**31.58**	34.16	28.43	**31.30**
T_4	35.52	29.35	**32.44**	35.44	29.21	**32.33**	35.03	28.88	**31.95**	34.21	28.32	**31.27**	33.91	28.11	**31.01**
T_5	35.54	29.40	**32.47**	35.52	29.33	**32.43**	35.12	29.12	**32.12**	34.79	28.82	**31.81**	34.48	28.71	**31.60**
T_6	35.52	29.37	**32.45**	35.46	29.22	**32.34**	35.04	28.93	**31.99**	34.39	28.43	**31.41**	34.02	28.26	**31.14**
T_7	35.58	29.41	**32.50**	35.58	29.36	**32.47**	35.21	29.13	**32.17**	34.96	29.03	**32.00**	34.59	28.91	**31.75**
T_8	35.61	29.46	**32.54**	35.60	29.43	**32.52**	35.33	29.29	**32.31**	35.07	29.13	**32.10**	34.76	29.04	**31.90**
V=Mean	**35.53**	**29.38**	**32.45**	**35.49**	**29.28**	**32.39**	**35.09**	**28.98**	**32.03**	**34.53**	**28.59**	**31.56**	**34.18**	**28.40**	**31.29**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.13	0.48		0.13	0.48		0.18	0.68		0.12	0.47		0.11	0.41	
T	0.25	NS		0.25	NS		0.36	NS		0.25	NS		0.21	0.81	
VXT	0.36	NS		0.36	NS		0.51	NS		0.35	NS		0.30	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds.

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC@ 0.4ml/kg of seeds + polymercoat @10 ml/kg of seeds.

T_7- Vitavax power@2g/kg of seeds+ polymercoat @10 ml/kg of seeds.

T_8- Deltamethrin @2.8EC 0.4ml per kg of seeds + vitavax power @2g/kg of seeds + Polymer coat @10 ml/kg of seeds.

Table 7b. Effect of polymercoat and seed treatment chemicals on hundred seed weight (g) of chickpea

Treatments	5th month			6th month			7th month			8th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V2	Mean	V_1	V_2	Mean
T_1	32.88	27.49	**30.19**	32.19	27.03	**29.61**	31.76	26.71	**29.24**	31.29	26.29	**28.79**
T_2	33.13	27.74	**30.44**	32.42	27.26	**29.84**	32.08	26.98	**29.53**	31.61	26.73	**29.17**
T_3	33.76	28.21	**30.99**	33.24	27.96	**30.60**	32.79	27.71	**30.25**	32.31	27.33	**29.82**
T_4	33.28	28.02	**30.65**	32.74	27.48	**30.11**	32.36	27.19	**29.78**	31.83	27.03	**29.43**
T_5	33.91	28.43	**31.17**	33.49	28.17	**30.83**	33.06	27.93	**30.50**	32.81	27.67	**30.24**
T_6	33.49	28.12	**30.81**	33.06	27.79	**30.43**	32.62	27.39	**30.01**	32.10	27.18	**29.64**
T_7	34.12	28.72	**31.42**	33.62	28.41	**31.02**	33.23	28.19	**30.71**	33.02	28.03	**30.53**
T_8	34.23	28.86	**31.55**	33.89	28.62	**31.26**	33.43	28.32	**30.88**	33.16	28.13	**30.65**
V=Mean	**33.60**	**28.20**	**30.90**	**33.08**	**27.84**	**30.46**	**32.67**	**27.56**	**30.11**	**32.27**	**27.30**	**29.79**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.12	0.46		0.15	0.55		0.12	0.44		0.12	0.44	
T	0.24	0.91		0.29	1.11		0.23	0.89		0.23	0.88	
VXT	0.34	NS		0.41	NS		0.33	NS		0.33	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**
NS - Non significant
T_1- Control
T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds.
T_3- Vitavax power@2g/kg of seeds
T_4- Polymer coat @10 ml/kg of seeds.
T_5-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power@2g/kg of seeds.
T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymercoat @10 ml/kg of seeds.
T_7- Vitavax power @ 2 g/kg of seeds+ polymercoat @ 10 ml/kg of seeds
T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power@2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Table 7c. Effect of polymercoat and seed treatment chemicals on hundred seed weight (g) of chickpea

Treatments	9th month			10th month			11th month			12th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	30.91	26.08	**28.50**	30.48	25.76	**28.12**	30.17	25.43	**27.80**	29.81	25.12	**27.47**
T_2	31.16	26.36	**28.76**	30.87	26.04	**28.46**	30.59	25.89	**28.24**	30.13	25.51	**27.82**
T_3	32.09	27.12	**29.61**	31.61	26.84	**29.23**	31.09	26.43	**28.76**	30.83	26.21	**28.52**
T_4	31.49	26.61	**29.05**	31.09	26.32	**28.71**	30.78	26.03	**28.41**	30.37	25.86	**28.12**
T_5	32.46	27.36	**29.91**	31.83	27.11	**29.47**	31.31	26.91	**29.11**	31.16	26.72	**28.94**
T_6	31.87	26.88	**29.38**	31.31	26.62	**28.97**	30.91	26.20	**28.56**	30.61	26.03	**28.32**
T_7	32.69	27.79	**30.24**	32.07	27.46	**29.77**	31.59	27.13	**29.36**	31.11	27.02	**29.07**
T_8	32.84	27.88	**30.36**	32.29	27.63	**29.96**	31.86	27.33	**29.60**	31.23	27.19	**29.21**
V=Mean	**31.94**	**27.01**	**29.48**	**31.45**	**26.73**	**29.09**	**31.04**	**26.42**	**28.73**	**30.66**	**26.21**	**28.43**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.10	0.38		0.11	0.43		0.11	0.42		0.13	0.48	
T	0.20	0.75		0.23	0.86		0.22	0.85		0.25	0.96	
VXT	0.28	NS		0.32	NS		0.32	NS		0.36	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds.

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymer @10 ml/kg of seeds.

T_7- Vitavax power @ 2g/kg of seeds+ polymercoat @10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Similar trend was noticed up to twelve months of storage period. At the end of twelve months of storage period, significantly maximum hundred seed weight (29.21g) was recorded in T_8 (deltamethrin 2.8EC@ 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) and it was on par with T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) (29.07g), while significantly minimum hundred seed weight (27.47g) was recorded in T_1 (untreated).

The interaction effects due to varieties and seed treatments showed a non significant difference on seed weight in all the months of storage period. However, numerically maximum hundred seed weight was noticed in the V_1T_8 (31.23) followed by V_1T_5 (31.11g) and it was on par with the V_1T_7 (31.16 g) and the lowest was in V_2T_1 (25.12 g) and followed by V_1T_1 (29.81 g).

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

The data on electrical conductivity of seed leachate as influenced by varieties seed treatments and interactions are presented in the Table 8a, 8b and 8c.

Regardless of varieties and seed treatments, the electrical conductivity of seed leachate was increased gradually as the storage period advanced. On an average the electrical conductivity was increased from (0.307 dSm^{-1}) in the zero month to (0.990 dSm^{-1}) at the end of storage period.

The electrical conductivity (dSm^{-1}) of seed leachate differed significantly due to varieties throughout storage period. Significantly, lowest (0.294 and 0.973 dSm^{-1}) electrical conductivity of seed leachate was recorded in BGD103 (V_1) compare to BG1105 (V_2) (0.320 and 1.007 dSm^{-1}) at initial and twelth month of storage period, respectively.

Electrical conductivity of seed leachate differed significantly due to seed treatment from the second month of storage period up to twelth month. The electrical conductivity increased with the advancement of storage period in all the seed treatments whereas, significantly lower electrical conductivity of seed leachate (0.325 dSm^{-1}) was recorded at second month in T_8 (deltamethrin 2.8EC 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymer seed coating @ 10ml/kg of seeds) followed by T_7 (vitavax power @ 2 g/kg seed + polymer seed coating @ 10ml/kg of seeds) as 0.334 dSm^{-1}. While significantly higher electrical conductivity of seed leachate (0.384dSm^{-1}) was recorded in T_1 (untreated). Similar trend was noticed up to the end of storage period. Significantly lower electrical conductivity (0.831 dSm^{-1}) was recorded in T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) and it was followed by T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) as 0.886 dSm^{-1}, while significantly higher electrical conductivity of seed leachate (1.130 dSm^{-1})was recorded in T_1 (untreated) at the end of storage period.

The interaction effect of varieties and seed treatments found to register no significant difference in EC value in all the months of storage period. However, numerically highest EC value of seed leachate (1.146 dSm^{-1}) was noticed in the V_2T_1 combination followed by V_1T_1 (1.113dSm^{-1}) and V_2T_2 (1.108 dSm^{-1}). Whereas, lowest (0.812 $dSm^{-1)}$ EC was recorded in the V_1T_8 at the end of the storage period.

4.1.8 Moisture content (%)

The results on moisture content as influenced by varieties, seed treatments and their interaction at different months of storage period are presented in the Table 9a, 9b and 9c.

Irrespective of varieties and seed treatments, the moisture content was increased gradually as the storage period advanced from April, 2012 to August, 2012 and from the the month of September, 2012 to December, 2012 a gradual decrease in the moisture content was noticed. From January, 2013 to February, 2013 a slight increase in the moisture content was noticed. However, the average moisture content of seeds was increased from 7.75 % to 8.73% in April, 2012 and March, 2013 respectively.

Significant difference in moisture content of seeds due to varieties was noticed throughout the storage period. Significantly, higher moisture content of 7.78 and 8.81 per cent was recorded in BG1105 (V_2) than the BGD103 (V_1) (7.72 and 8.65%) at initial month to twelth month of storage period, respectively.

The non significant difference due to seed treatments and interaction between the varieties and seed treatments on seed moisture content was recorded throughout the storage period.

Table 8a.Effect of polymercoat and seed treatment chemicals on electric conductivity of seed leachate (dSm^{-1}) in chickpea

Treatments	Initial month			1st month			2nd month			3rd month			4th month		
	V_1	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**
T_1	0.294	0.323	**0.309**	0.298	0.327	**0.313**	0.364	0.403	**0.384**	0.456	0.498	**0.477**	0.538	0.576	**0.557**
T_2	0.295	0.322	**0.309**	0.299	0.326	**0.313**	0.363	0.396	**0.380**	0.448	0.470	**0.459**	0.523	0.569	**0.546**
T_3	0.296	0.319	**0.308**	0.293	0.321	**0.307**	0.335	0.363	**0.349**	0.416	0.439	**0.428**	0.463	0.509	**0.486**
T_4	0.293	0.321	**0.307**	0.296	0.324	**0.310**	0.351	0.386	**0.369**	0.436	0.463	**0.450**	0.498	0.554	**0.526**
T_5	0.295	0.318	**0.307**	0.298	0.322	**0.310**	0.329	0.352	**0.340**	0.409	0.431	**0.420**	0.455	0.493	**0.474**
T_6	0.294	0.319	**0.307**	0.295	0.320	**0.308**	0.341	0.371	**0.356**	0.428	0.451	**0.440**	0.489	0.532	**0.511**
T_7	0.295	0.317	**0.306**	0.296	0.321	**0.309**	0.326	0.341	**0.334**	0.391	0.419	**0.405**	0.438	0.478	**0.458**
T_8	0.293	0.317	**0.305**	0.297	0.320	**0.309**	0.315	0.335	**0.325**	0.375	0.391	**0.383**	0.425	0.449	**0.437**
V=Mean	**0.294**	**0.320**	**0.307**	**0.297**	**0.323**	**0.310**	**0.341**	**0.368**	**0.354**	**0.420**	**0.445**	**0.433**	**0.479**	**0.520**	**0.499**
	SEm±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.001	0.005		0.001	0.005		0.001	0.005		0.002	0.006		0.002	0.009	
T	0.002	NS		0.002	NS		0.003	0.010		0.003	0.013		0.005	0.019	
VXT	0.003	NS		0.003	NS		0.004	NS		0.005	NS		0.007	NS	

Legend: V_1-BGD 103 (*Desi*) V_2 – BG 1105 (*Kabuli*)

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds.

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @2g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymercoat @10 ml/kg of seeds.

T_7- Vitavax power@2g/kg of seeds + polymercoat @10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @2g/kg of seeds + Polymer coat @10 ml/kg of seeds.

Table 8b.Effect of polymercoat and seed treatment chemicals on electric conductivity of seed leachate (dSm^{-1}) in chickpea

Treatments	5^{th} month			6^{th} month			7^{th} month			8^{th} month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V1	V_2	Mean
T_1	0.571	0.610	**0.591**	0.652	0.688	**0.670**	0.708	0.756	**0.732**	0.789	0.846	**0.818**
T_2	0.559	0.583	**0.571**	0.621	0.659	**0.640**	0.683	0.738	**0.711**	0.753	0.809	**0.781**
T_3	0.489	0.536	**0.513**	0.551	0.583	**0.567**	0.591	0.642	**0.617**	0.683	0.729	**0.706**
T_4	0.531	0.571	**0.551**	0.609	0.643	**0.626**	0.653	0.713	**0.683**	0.734	0.783	**0.759**
T_5	0.471	0.509	**0.490**	0.532	0.556	**0.544**	0.579	0.619	**0.599**	0.653	0.691	**0.672**
T_6	0.508	0.548	**0.528**	0.582	0.624	**0.603**	0.636	0.687	**0.662**	0.709	0.741	**0.725**
T_7	0.462	0.483	**0.473**	0.509	0.531	**0.520**	0.567	0.608	**0.588**	0.631	0.662	**0.647**
T_8	0.456	0.471	**0.464**	0.491	0.498	**0.495**	0.542	0.568	**0.555**	0.609	0.638	**0.624**
V=Mean	**0.506**	**0.539**	**0.522**	**0.568**	**0.598**	**0.583**	**0.620**	**0.666**	**0.643**	**0.695**	**0.737**	**0.716**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.002	0.008		0.002	0.009		0.002	0.008		0.003	0.011	
T	0.004	0.015		0.005	0.017		0.004	0.017		0.006	0.021	
VXT	0.006	NS		0.006	NS		0.006	NS		0.008	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**

NS - Non significant

T_1- Control

T_2- Deltamethrin @2.8EC0.4ml/kg of seeds.

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml/ kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8 EC @ 0.4ml/kg of seeds + polymer coat @10 ml/kg of seeds.

T_7- Vitavax power@2g/kg of seeds + polymercoat @10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power@2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Table 8c. Effect of polymer coat and seed treatment chemicals on electric conductivity of seed leachate (dSm^{-1}) in chickpea

Treatments	9th month			10th month			11th month			12th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	0.867	0.926	**0.897**	0.979	1.023	**1.001**	1.038	1.098	**1.068**	1.113	1.146	**1.130**
T_2	0.842	0.891	**0.867**	0.938	0.958	**0.948**	0.997	1.036	**1.017**	1.089	1.108	**1.099**
T_3	0.749	0.781	**0.765**	0.811	0.852	**0.831**	0.893	0.946	**0.920**	0.961	0.992	**0.977**
T_4	0.809	0.851	**0.830**	0.881	0.926	**0.904**	0.957	0.987	**0.972**	1.041	1.079	**1.060**
T_5	0.721	0.758	**0.740**	0.789	0.836	**0.813**	0.852	0.909	**0.881**	0.907	0.953	**0.930**
T_6	0.779	0.810	**0.795**	0.864	0.892	**0.878**	0.926	0.958	**0.942**	0.991	1.026	**1.009**
T_7	0.691	0.729	**0.710**	0.763	0.798	**0.781**	0.829	0.858	**0.844**	0.867	0.904	**0.886**
T_8	0.661	0.697	**0.679**	0.721	0.758	**0.740**	0.776	0.812	**0.794**	0.812	0.849	**0.831**
V=Mean	**0.765**	**0.805**	**0.785**	**0.843**	**0.880**	**0.862**	**0.909**	**0.951**	**0.930**	**0.973**	**1.007**	**0.990**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.003	0.012		0.005	0.018		0.004	0.014		0.004	0.015	
T	0.006	0.023		0.010	0.036		0.007	0.027		0.008	0.029	
VXT	0.009	NS		0.014	NS		0.010	NS		0.011	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds

T_5-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymer coat @10 ml/kg of seeds.

T_7- Vitavax power @ 2 g/kg of seeds+ polymercoat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @ 2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Table 9a. Effect of polymercoat and seed treatment chemicals on seed moisture content (%) of chickpea

Treatments	Initial month			1st month			2nd month			3rd month			4th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	7.72	7.75	**7.74**	7.87	7.94	**7.91**	7.91	8.03	**7.97**	8.25	8.38	**8.32**	9.14	9.32	**9.23**
T_2	7.73	7.78	**7.76**	7.84	7.95	**7.90**	7.92	8.04	**7.98**	8.26	8.40	**8.33**	9.14	9.34	**9.24**
T_3	7.72	7.79	**7.76**	7.86	7.97	**7.92**	7.94	8.06	**8.00**	8.27	8.43	**8.35**	9.15	9.36	**9.26**
T_4	7.71	7.79	**7.75**	7.83	7.98	**7.91**	7.92	8.08	**8.00**	8.27	8.45	**8.36**	9.18	9.38	**9.28**
T_5	7.74	7.76	**7.75**	7.86	7.99	**7.93**	7.93	8.06	**8.00**	8.29	8.42	**8.36**	9.17	9.37	**9.27**
T_6	7.72	7.79	**7.76**	7.84	7.97	**7.91**	7.93	8.07	**8.00**	8.28	8.43	**8.36**	9.15	9.37	**9.26**
T_7	7.73	7.78	**7.76**	7.86	7.99	**7.93**	7.94	8.08	**8.01**	8.29	8.42	**8.36**	9.16	9.37	**9.27**
T_8	7.72	7.79	**7.76**	7.85	7.96	**7.91**	7.93	8.05	**7.99**	8.28	8.41	**8.35**	9.15	9.36	**9.26**
Mean	**7.72**	**7.78**	**7.75**	**7.85**	**7.97**	**7.91**	**7.93**	**8.06**	**7.99**	**8.27**	**8.42**	**8.35**	**9.16**	**9.36**	**9.26**
	S Em±	**CD(P=0.01)**		**SEm±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.03	NS		0.03	0.12		0.03	0.12		0.03	0.12		0.04	0.14	
T	0.06	NS		0.06	NS		0.06	NS		0.06	NS		0.07	NS	
VXT	0.08	NS		0.09	NS		0.09	NS		0.09	NS		0.10	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds

T_5-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymer coat @10 ml/kg of seeds.

T_7- Vitavax power @ 2 g/kg of seeds+ polymercoat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @ 2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Table 9b. Effect of polymercoat and chemicals on seed moisture content (%) of chickpea

Treatments	5th month			6th month			7th month			8th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	9.12	9.27	**9.20**	9.08	9.21	**9.15**	8.86	9.04	**8.95**	8.51	8.73	**8.62**
T_2	9.12	9.29	**9.21**	9.09	9.23	**9.16**	8.87	9.05	**8.96**	8.52	8.75	**8.64**
T_3	9.13	9.30	**9.22**	9.10	9.26	**9.18**	8.91	9.10	**9.01**	8.53	8.77	**8.65**
T_4	9.16	9.31	**9.24**	9.12	9.25	**9.19**	8.93	9.08	**9.01**	8.56	8.76	**8.66**
T_5	9.14	9.31	**9.23**	9.11	9.26	**9.19**	8.91	9.09	**9.00**	8.54	8.76	**8.65**
T_6	9.15	9.32	**9.24**	9.12	9.26	**9.19**	8.92	9.09	**9.01**	8.51	8.77	**8.64**
T_7	9.15	9.31	**9.23**	9.11	9.24	**9.18**	8.91	9.07	**8.99**	8.53	8.75	**8.64**
T_8	9.14	9.32	**9.23**	9.10	9.25	**9.18**	8.88	9.08	**8.98**	8.52	8.76	**8.64**
Mean	**9.14**	**9.30**	**9.22**	**9.10**	**9.25**	**9.18**	**8.90**	**9.08**	**8.99**	**8.53**	**8.76**	**8.64**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.04	0.14		0.04	0.13		0.03	0.13		0.03	0.13	
T	0.07	NS		0.07	NS		0.07	NS		0.07	NS	
VXT	0.10	NS		0.10	NS		0.10	NS		0.09	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds

T_5-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymer coat @10 ml/kg of seeds.

T_7- Vitavax power @ 2 g/kg of seeds+ polymercoat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @ 2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Table 9c. Effect of polymercoat and chemicals on seed moisture content (%) of chickpea

Treatments	9th month			10th month			11th month			12th month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	8.18	8.41	**8.30**	8.57	8.74	**8.66**	8.79	8.94	**8.87**	8.61	8.79	**8.70**
T_2	8.20	8.43	**8.32**	8.60	8.76	**8.68**	8.81	8.96	**8.89**	8.63	8.80	**8.72**
T_3	8.23	8.48	**8.36**	8.64	8.78	**8.71**	8.83	8.97	**8.90**	8.67	8.82	**8.75**
T_4	8.21	8.45	**8.33**	8.61	8.78	**8.70**	8.84	8.97	**8.91**	8.65	8.82	**8.74**
T_5	8.23	8.46	**8.35**	8.63	8.79	**8.71**	8.83	8.98	**8.91**	8.66	8.81	**8.74**
T_6	8.21	8.47	**8.34**	8.62	8.79	**8.71**	8.83	8.97	**8.90**	8.66	8.83	**8.75**
T_7	8.22	8.47	**8.35**	8.62	8.78	**8.70**	8.82	8.98	**8.90**	8.64	8.81	**8.73**
T_8	8.21	8.46	**8.34**	8.61	8.79	**8.70**	8.83	8.97	**8.90**	8.65	8.80	**8.73**
Mean	**8.21**	**8.45**	**8.33**	**8.61**	**8.78**	**8.70**	**8.82**	**8.97**	**8.90**	**8.65**	**8.81**	**8.73**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.03	0.12		0.03	0.13		0.03	0.13		0.03	0.13	
T	0.06	NS		0.07	NS		0.07	NS		0.07	NS	
VXT	0.09	NS		0.10	NS		0.10	NS		0.10	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds

T_5-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymer coat @10 ml/kg of seeds.

T_7- Vitavax power @ 2 g/kg of seeds+ polymercoat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @ 2g/kg of seeds + polymer coat @10 ml/kg of seeds.

Table 10a. Effect of polymer coat and chemicals on insect infestation (%) of chickpea varieties

Treatments	7^{th} month			8^{th} month			9^{th} month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	0.38	0.49	**0.43**	0.94	1.30	**1.12**	2.43	3.29	**2.86**
T_2	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00	**0.00**
T_3	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00	**0.00**
T_4	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00	**0.00**
T_5	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00	**0.00**
T_6	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00	**0.00**
T_7	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00	**0.00**
T_8	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00	**0.00**
Total	**0.38**	**0.49**	**0.43**	**0.94**	**1.30**	**1.12**	**2.43**	**3.29**	**2.86**
	NA	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*).**
NA= not statistically analysed

T_1- Control
T_2- Deltamethrin @2.8EC 0.4ml/kg of seeds.
T_3- Vitavax power@2g/kg of seeds
T_4- Polymer coat @10 ml/kg of seeds.
T_5-Deltamethrin @ 2.8EC 0.4ml per kg of seeds + Vitavax power@2g/kg of seeds.
T_6- Deltamethrin @2.8EC 0.4ml/kg of seeds + Polymer @10 ml/kg of seeds.
T_7- Vitavax power@2g/kg of seeds).+ Polymer coating @10 ml/kg of seeds
T_8- Deltamethrin @2.8 EC 0.4ml per kg of seeds + Vitavax power@2g/kg of seeds + Polymer coat @10 ml/kg of seeds.

Table 10b. Effect of polymer coat and chemicals on insect infestation (%) of chickpea varieties

Treatments	10^{th} month			11^{th} month			12^{th} month		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	5.02	7.26	**6.14**	9.08	13.40	**11.24**	13.9	17.87	**15.88**
T_2	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00	**0.00**
T_3	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00	**0.00**
T_4	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00	**0.00**
T_5	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00	**0.00**
T_6	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00	**0.00**
T_7	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00	**0.00**
T_8	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00	**0.00**
Total	**5.02**	**7.026**	**6.14**	**9.08**	**13.40**	**11.24**	**13.9**	**17.87**	**15.88**
	NA	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Legend : BGD 103 (*Desi*) V_2 – BG 1105 (*Kabuli*)

NA= not statistically analyzed

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds.

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds.

T_5-Deltamethrin 2.8EC @ 0.4ml/kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymer coat @10 ml/kg of seeds.

T_7- Vitavax power @ 2 g/kg of seeds+ polymer coat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8 EC @ 0.4ml per kg of seeds + vitavax power @ 2g/kg of seeds + Polymer coat @10 ml/kg of seeds.

4.1.9 Insect infestation (%)

The data on insect infestation (%) due to varieties and seed treatments are depicted in the Table 10a, 10b and 10c.

Due to insufficient data on insect infestation, data was not analysed statistically, however the per cent of insect infestation is presented in the Table 9. From the initial month to 6th month of storage there was no insect infestation noticed in both the varieties. From the 7th month onwards there was insect damage noticed only in the T_1 (control) without seed treatment in the BGD103 (V_1) as 0.38 % and it was relatively less as compared to the BG1105 (V_2) of (0.49 %). At the end of twelve months of storage period the BGD-103 (V_1) (13.9 %) and BG1105 (V_2) (17.87%) total insect infestation was recorded.

4.2 Experiment – II: Influence of polymercoat and seed treatment chemicals on field performance of chickpea

4.2.1 Growth parameters

Observations on growth parameters like plant height (cm), number of branches, days to 50 per cent flowering, days to maturity in chickpea varieties *viz.,* BGD 103 (desi) and BG1105 (kabuli) as influenced by seed treated with polymer coat, insecticide, fungicide are presented in the Table 11 and Table 12.

4.2.1.1 Plant height (cm) at harvest

The results on plant height at harvest as influenced by varieties and seed treatment with the polymercoat, fungicide and insecticide are presented in the Table 11 and depicted in Fig. 8.

Significant difference was noticed on plant height due to varieties, significantly higher plant height (41.39cm) was recorded in BGD 103 (V_1) as compared to BGD1105 (V_2) (45.21cm) at harvesting stage.

There was no significant difference was noticed due to seed treatment on plant height of chickpea varieties at harvest stage. However, numerically highest plant height (44.71cm) was recorded in T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2 g/kg of seed + polymercoat @ 10 ml/kg of seed) followed by T_7 (vitavax @ 2g/kg of seeds+ polymercoat @10 ml/kg of seeds) of 44.67 cm. While, the lowest plant height (41.65 cm) was recorded in T_1 (control).

Interactions between varieties and seed treatments with polymercoat, fungicide and insecticide had no significant difference on plant height. However, numerically maximum plant height (46.26cm) was recorded with V_2T_8 followed by V_2T_7 (44.21cm) and V_2T_5 (46.04 cm) and lower plant height (39.48 cm) was recorded with V_1T_1.

4.2.2 Number of branches per plant

The results on number of branches per plant at harvest stage as influenced by varieties and seed treatments with polymercoat, fungicide and insecticide and their interactions are presented in Table 11 and depicted in Fig. 9a.

Number of branches per plant at harvest stage showed significant differences due to varietal influences. Higher number of branches (19.25) per plant were noticed in BGD103 (V_1) as compared to BG1105 (V_2) as 16.67.

Significant differences were recorded due to seed treatment with polymercoat and chemicals at harvest stage. Among the seed treatments T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2 g/kg of seed + polymercoat @ 10ml/kg of seed) was recorded maximum number of branches (21.30) followed by T_7 (vitavax @2g/kg of seeds+ polymercoat @10 ml/kg of seeds) of 20.29. Whereas, minimum number of branches (14.99) were recorded in T_1 (Control).

Interaction effects due to varieties and seed treatment on number of branches per plant showed non-significant differences. However, numerically higher number of branches (22.33) per plant was recorded with V_1T_8 followed by V_1T_7 (21.55) and V_2T_8 (20.27) and lower (13.18) with V_2T_1.

4.2.3 Days to 50 per cent flowering

The data on days to 50 per cent flowering as influenced by varieties, seed treatments and their interactions are presented in Table 11.

Table 11. Effect of polymer coat and seed treatment chemicals on plant height (cm), number of branches per plant and days to 50 per cent flowering in chickpea

Treatments	Plant height(cm)			Number of branches/plant			Days to 50% flowering		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	39.48	43.82	**41.65**	16.80	13.18	**14.99**	47.33	51.00	**49.17**
T_2	39.91	44.04	**41.97**	17.19	14.74	**15.97**	47.00	50.00	**48.50**
T_3	42.03	45.98	**44.00**	19.40	17.19	**18.29**	46.67	48.67	**47.67**
T_4	40.26	44.32	**42.29**	18.07	15.18	**16.62**	46.67	48.67	**47.67**
T_5	42.31	46.04	**44.17**	20.00	17.73	**18.87**	45.67	48.00	**46.83**
T_6	40.88	44.98	**42.93**	18.67	16.03	**17.35**	46.00	48.17	**47.08**
T_7	43.13	46.21	**44.67**	21.55	19.03	**20.29**	45.67	48.00	**46.83**
T_8	43.17	46.26	**44.71**	22.33	20.27	**21.30**	45.33	47.67	**46.50**
Mean	**41.39**	**45.21**	**43.30**	**19.25**	**16.67**	**17.96**	**46.29**	**48.77**	**47.5**
	S Em±	**CD(P=0.05)**		**S Em±**	**CD(P=0.05)**		**S Em±**	**CD(P=0.05)**	
V	0.82	2.36		0.50	1.44		0.30	1.17	
T	1.63	NS		0.99	2.87		0.60	NS	
VXT	2.31	NS		1.41	NS		0.85	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds

T_5-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymer coat @10 ml/kg of seeds.

T_7- Vitavax power @ 2 g/kg of seeds+ polymercoat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @ 2g/kg of seeds + polymer coat @10 ml/kg of seeds.

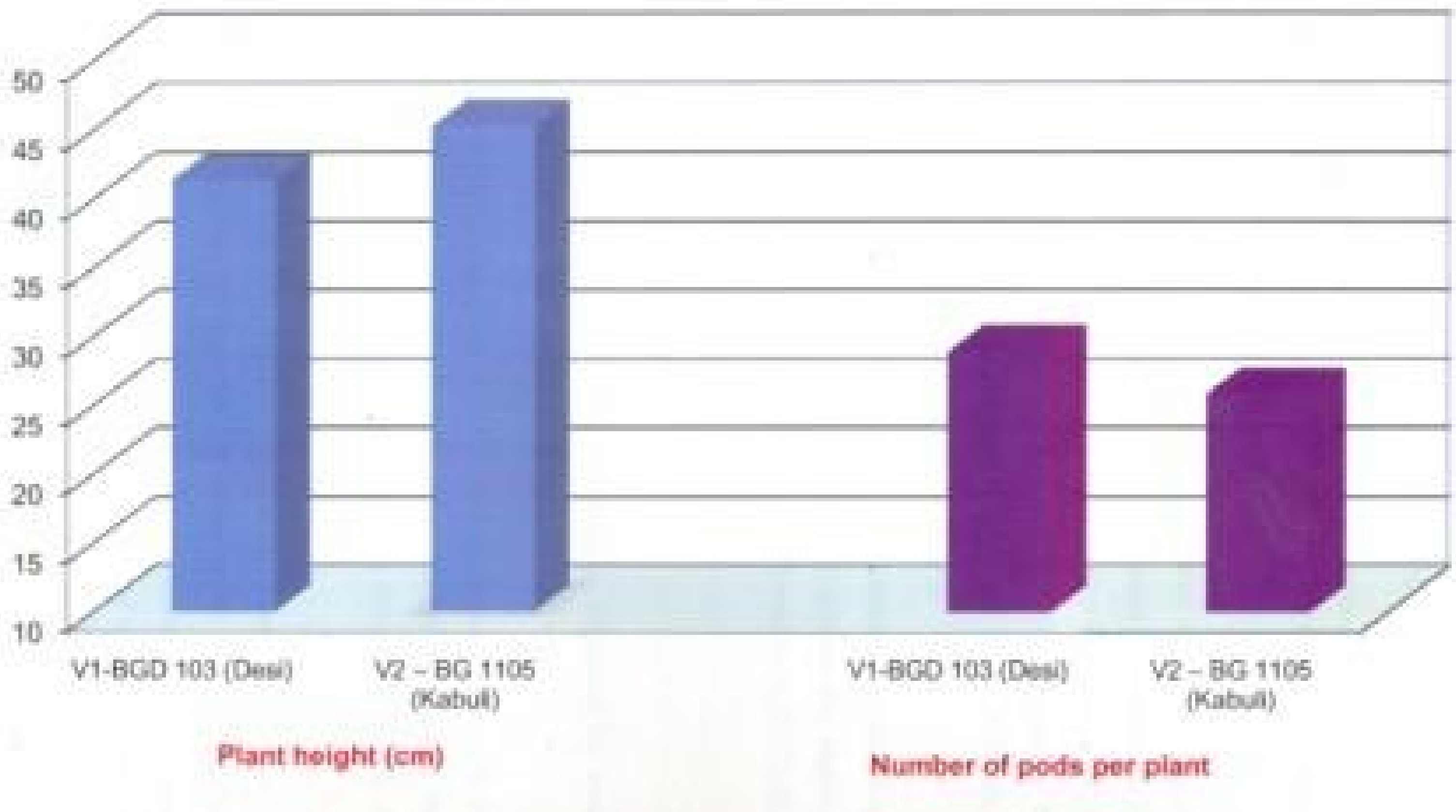


Fig. 8: Effect of polymercoat and seed treatment chemicals on plant height (cm) and number of pods per plant of chickpea

Due to varieties, significant differences were found for days to 50 per cent flowering, BG1105 (V_2) significantly took more number of days to 50 per cent flowering (48.77). While, BGD 103 (V_1) recorded less number of days to 50 per cent flowering (46.29) .

Days to 50 per cent flowering did not differ significantly due to seed treatments. Numerically more number of days (49.17) taken to 50 per cent flowering in T_1 (untreated) control. While less number of days (46.50) recorded in the T_8 (Deltamethrin 2.8EC @ 0.4 ml /kg of seeds + Vitavax power @ 2 g/kg of seed + polymer seed coating @ 10ml/kg of seed) and it was on par with the T_7 (Vitavax @2g/kg of seeds+ polymercoat @10 ml/kg of seeds) as 46.83.

Interaction effects due to varieties and seed treatments with polymercoat, fungicide and insecticide did not differ significantly for days to 50 per cent flowering. However, numerically maximum number of days (51.00) were taken for 50 per cent flowering in V_2T_1 and minimum number of days to 50 per cent flowering (45.33) in V_1T_8 and it was on par with the V_1T_7 (45.67).

4.2.4 Days to maturity

The data on days to maturity as influenced by varieties, seed treatments and their interactions are presented in Table 12.

Due to variety significant difference was found for days to maturity. The Variety BG 1105 (V_2) took more days to maturity (103.16) compare to BGD 103 (V_1) as 92.91.

The seed treatments with polymercoat, fungicide and insecticide not varied significantly for days to maturity. Numerically, lesser number of days (96.00) was observed in T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2 g/kg of seed + polymer seed coating @ 10 ml/kg of seed) followed by T_7 (vitavax @2g/kg of seeds+ polymercoat @10 ml/kg of seeds) as 96.83. While, more number of days (94.33) were observed in T_1 (Control) as 99.16.

There was no significant difference on days to maturity due to interaction of varieties and seed treatments. However, numerically more number of days (104.00) were recorded in V_2T_1 V_2T_2, V_2T_4 and V_2T_5 treatment combinations, whereas less number of days (90.67) were observed in V_1T_8.

4.2.2 Yield parameters

4.2.2.1 Number of pods per plant

The results on number of pods per plant as influenced by varieties, seed treatment and their interactions are presented Table 12 and depicted in Fig. 8 and 9b.

The varieties differed significantly on number of pods per plant, BGD 103 (V_1) recorded significantly maximum number of pods per plant (28.90). While, BG1105 (V_2) recorded minimum number of pods per plant (25.85) at the harvest.

A significant difference was noticed on number of pods per plant due to seed treatments. Significantly maximum number of pods (31.91) were recorded in T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2 g/kg of seed + polymercoat @ 10 ml/kg of seed) followed by T_7 (vitavax @2g/kg of seeds + polymercoat @10 ml/kg of seeds) as 30.82. While, minimum number of pods per plant were recorded in T_1 (control) as 23.15.

Non-significant difference was noticed due to interaction of varieties and seed treatments with polymercoat, fungicide and insecticide on number of pods per plant. However, numerically maximum number of pods (33.05) per plant were recorded in V_1T_8 followed by V_1T_7 (32.72) and it was on par with V_2T_8 (30.76) and V_1T_5 (30.76) and less number of pods per plant (21.80) was with V_2T_1 (control).

4.2.2.2 Number of seeds per plant

The results on number of seeds per plant as influenced by varieties, seed treatments and their interactions are presented in Table 12 and depicted in Fig. 10.

The number of seeds per plant differed significantly due to varieties. BGD103 (V_1) recorded more (35.46) number of seeds per plant as compared to BG 1105 (V_2) as 32.71.

The seed treatment with polymercoat, fungicide and insecticide found to differ significantly for number of seeds per plant. Among the seed treatments T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2 g/kg of seed + polymercoat @ 10 ml/kg of seed) recorded more number of seeds per plant (39.39) followed by T_7 (Vitavax @2g/kg of seeds+ polymercoat @10 ml/kg of seeds) of 37.54. Less number of seeds per plant (28.50) were recorded in the T_1 (control).

Table 12. Effect of polymer coat and seed treatment chemicals on days to maturity, number of pods per plant and number of seeds per plant in chickpea

Treatments	Days to maturity			Number of pods/plant			Number of seeds/ plant		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	93.00	104.00	**98.50**	24.51	21.80	**23.15**	30.10	26.89	**28.50**
T_2	93.00	104.00	**98.50**	25.87	23.63	**24.75**	32.39	28.93	**30.66**
T_3	93.00	103.67	**98.33**	28.93	25.87	**27.40**	35.85	33.82	**34.84**
T_4	94.33	104.00	**98.83**	27.03	24.65	**25.84**	33.90	31.37	**32.64**
T_5	93.67	104.00	**99.17**	30.76	26.27	**28.51**	37.08	35.04	**36.06**
T_6	94.00	102.33	**98.17**	28.32	24.85	**26.59**	34.84	31.27	**33.05**
T_7	91.67	102.00	**96.83**	32.72	28.93	**30.82**	38.62	36.47	**37.54**
T_8	90.67	101.33	**96.00**	33.05	30.76	**31.91**	40.88	37.89	**39.39**
Mean	**92.917**	**103.167**	**98.04**	**28.90**	**25.85**	**27.37**	**35.46**	**32.71**	**34.08**
	S Em±	**CD(P=0.05)**		**S Em±**	**CD(P=0.05)**		**S Em±**	**CD(P=0.05)**	
V	0.36	1.40		0.64	1.84		0.70	2.01	
T	0.72	NS		1.27	3.68		1.39	4.02	
VXT	1.02	NS		1.80	NS		1.97	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds

T_5-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymer coat @10 ml/kg of seeds.

T_7- Vitavax power @ 2 g/kg of seeds+ polymercoat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @ 2g/kg of seeds + polymer coat @10 ml/kg of seeds.

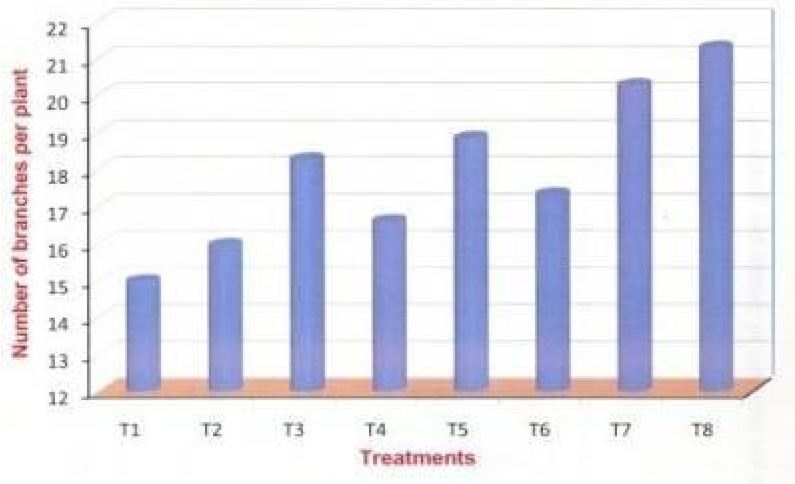


Fig. 9a: Effect of polymercoat and seed treatment chemicals on number of branches per plant of chickpea

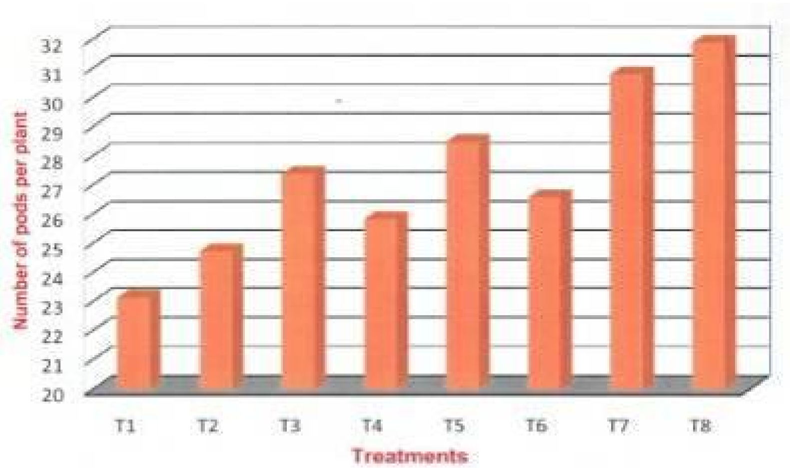


Fig. 9b: Effect of polymercoat and seed treatment chemicals on number of pods per plant of chickpea

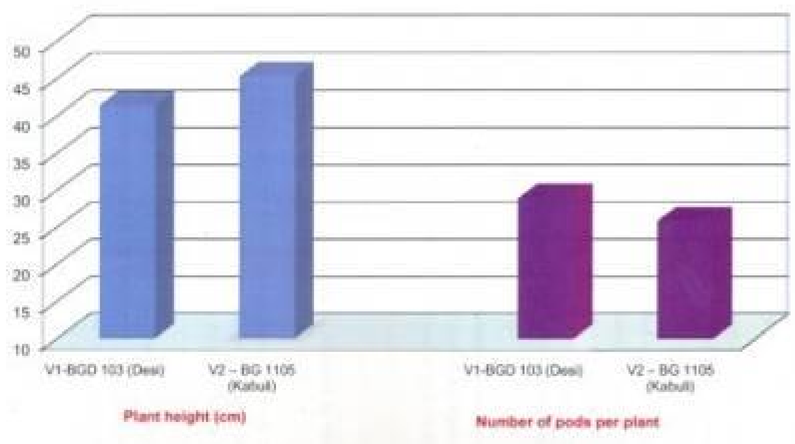


Fig. 10: Effect of polymercoat and seed treatment chemicals on number of seeds per plant and seed yield of chickpea

The interaction effects due to varieties and seed treatment with polymercoat, fungicide and insecticide were found non-significant for number of seeds per plant. The V_1T_8 recorded numerically higher number of seeds per plant (40.88) followed by V_1T_7 (38.62) and it was on par with V_2T_8 (37.89). While the lowest was in the V_2T_1 (26.89) combination.

4.2.2.3 Number of seeds per pod

The data on number of seeds per pod as influenced by varieties, seed treatments and their interactions are presented Table 13.

The number of seeds per pod did not differ significantly due to varieties. Because in both varieties, one or two seeds were present per pod. However, numerically BGD 103(V_1) and BG1105 (V_2) recorded 1.22 and 1.26 number of seeds per pod respectively.

Seed treatment with polymercoat, fungicide and insecticide did not differ significantly for number of seeds per pod. The interaction effect due to varieties and seed treatment with polymercoat, fungicide and insecticide were found non significant for number of seeds per pod. However, numerically V_2T_5 recorded more number seed per pod (1.38). Whereas, less number of seeds per pod (1.17) were found in V_1T_7.

4.2.2.4 Seed weight/ plant (g)

The results on seed weight per plant as influenced by varieties, seed treatments and their interactions are presented in Table 13 and depicted in Fig. 11a.

The varieties varied significantly for seed weight per plant wherein BGD103 (V_1) recorded higher (4.33 g) seed weight per plant compared to BG1105 (V_2) as 3.46 g.

Seed weight per plant differed significantly due to seed treatments. Among the seed treatments, T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2 g/kg of seed + polymercoat @ 10 ml/kg of seed) recorded maximum seed weight (4.38g), followed by T_7 (Vitavax @2g/kg of seeds+ polymercoat @10 ml/kg of seeds) as 4.22 g. While, the minimum seed weight per plant (3.44) were recorded in T_1 (control).

Interaction effect due to varieties and seed treatments were found non-significant for seed weight per plant. Among all the treatment combination the V_1T_8 recorded the highest (4.84 g) followed by V_1T_7 (4.62 g), V_1T_5 (4.48 g) and V_1T_3 (4.22 g) seed weight per plant. While, significantly lowest seed weight (2.98 g) per plant was recorded in V_2T_1 combination.

4.2.2.5 Seed weight per plot (kg)

The results on seed weight per plot as influenced by varieties, seed treatments and their interactions are presented in Table 13.

The varieties differed significantly for seed weight per plot. BGD103 (V_1) recorded significantly higher (1.30 kg) seed weight per plant compared to BG1105 (V_2) as 1.04 kg.

The seed weight per plot differed significantly due to seed treatments. Among all the seed treatments, T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2 g/kg of seed + polymer coat @ 10 ml/kg of seed) recorded significantly higher seed weight per plot (1.31kg) and it was followed by T_7 (vitavax @2g/kg of seeds+ polymercoat @10 ml/kg of seeds) as 1.27 kg. While, the lower seed weight per plot (1.03 kg) was recorded in the T_1 (control).

The interaction between varieties and seed treatment did not show significant differences for seed weight per plot. However, numerically higher (1.45 kg) seed weight per plot was found in V_1T_8. This was followed by V_1T_7 (1.39 kg), and V_1T_5 (1.34 kg) and lower seed weight (0.89 kg) was observed in V_2T_1.

4.2.2.4 Seed yield per ha (q)

The data on seed yield per hectare as influenced by varieties, seed treatments and their interactions are presented in Table 13 and depicted in Fig. 10 and 11b.

Due to varieties, the significant difference was recorded on seed yield per hectare. Wherein, BGD 103 (V_1) recorded significantly higher seed yield (14.42 q) per ha compared to BG1105 (V_2) as 11.58 q.

Table 13. Effect of polymer coat and seed treatment chemical on number of seeds per pod, seed weight per plant (g), seed weight per plot (kg) and seed yield (q/ha) in chickpea

Treatments	Number of Seeds / pod			Seed weight/ plant (g)			Seed weight/ plot (Kg)			Seed yield(q/ha)		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	1.26	1.22	**1.24**	3.89	2.98	**3.44**	1.17	0.89	**1.03**	12.97	9.93	**11.45**
T_2	1.25	1.22	**1.23**	4.13	3.20	**3.67**	1.24	0.96	**1.10**	13.77	10.67	**12.22**
T_3	1.23	1.30	**1.27**	4.22	3.47	**3.85**	1.27	1.04	**1.16**	14.07	11.57	**12.82**
T_4	1.25	1.27	**1.26**	4.19	3.34	**3.76**	1.26	1.00	**1.13**	13.97	11.13	**12.55**
T_5	1.20	1.33	**1.29**	4.48	3.58	**4.03**	1.34	1.10	**1.22**	14.93	12.23	**13.58**
T_6	1.23	1.24	**1.24**	4.24	3.41	**3.83**	1.27	1.02	**1.15**	14.13	11.37	**12.75**
T_7	1.17	1.26	**1.22**	4.62	3.82	**4.22**	1.39	1.15	**1.27**	15.40	12.73	**14.06**
T_8	1.23	1.23	**1.23**	4.84	3.91	**4.38**	1.45	1.17	**1.31**	16.13	13.03	**14.58**
Mean	**1.228**	**1.264**	**1.25**	**4.33**	**3.46**	**3.90**	**1.30**	**1.04**	**1.17**	**14.42**	**11.58**	**13.00**
	S Em±	**CD(P=0.05)**		**S Em±**	**CD(P=0.05)**		**S Em±**	**CD(P=0.05)**		**S Em±**	**CD(P=0.05)**	
V	0.01	NS		0.05	0.14		0.01	0.03		0.25	0.72	
T	0.03	NS		0.09	0.27		0.02	0.06		0.50	1.44	
VxT	0.05	NS		0.13	NS		0.03	NS		0.71	NS	

Legend: V_1-BGD 103 (*Desi*) V_2 – BG 1105 (*Kabuli*)

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds

T_5-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymer coat @10 ml/kg of seeds.

T_7- Vitavax power @ 2 g/kg of seeds+ polymercoat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @ 2g/kg of seeds + polymer coat @10 ml/kg of seeds.

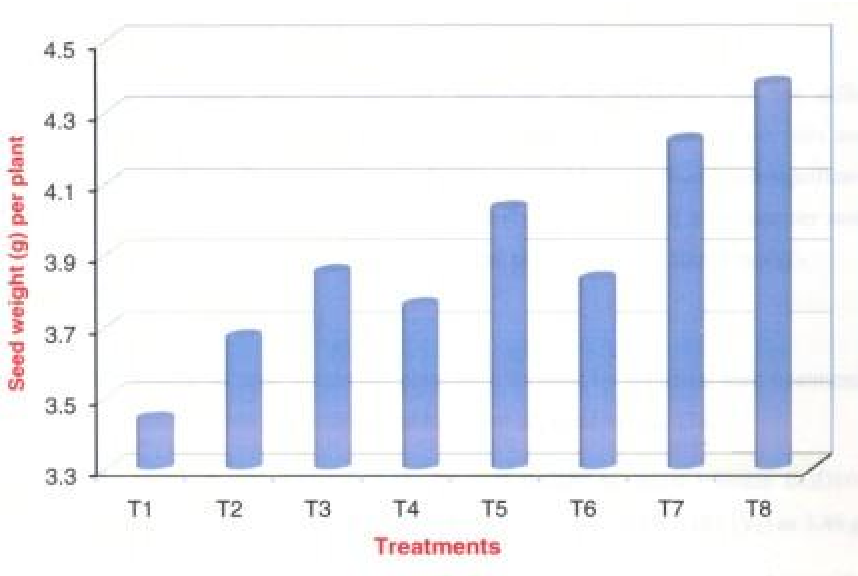


Fig. 11a: Effect of polymercoat and seed treatment chemicals on seed weight (g) per plant of chickpea

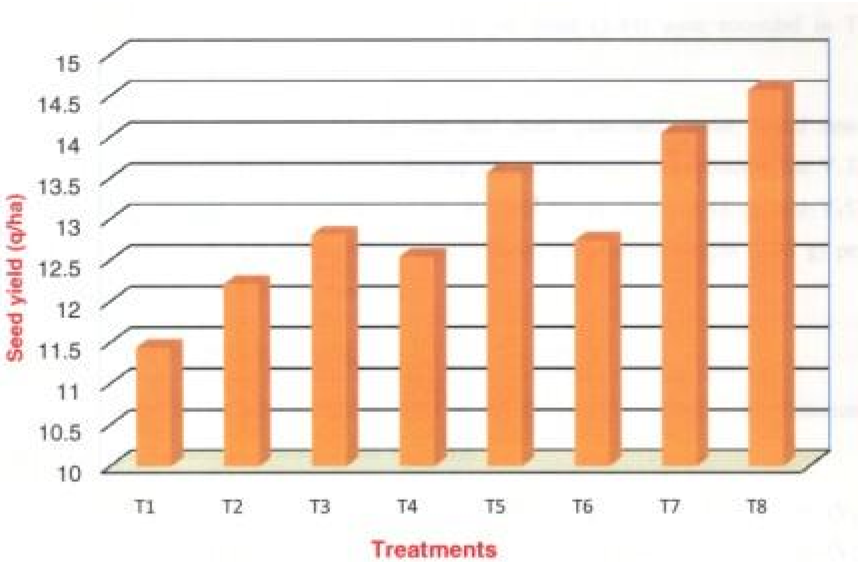


Fig. 11b: Effect of polymercoat and seed treatment chemicals on seed yield (q/ha) of chickpea

Significant difference was seen on the seed yield per hectare due to seed treatment. Among the seed treatments, T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2 g/kg of seed + polymercoat @ 10 ml/kg of seed) recorded significantly higher seed yield per ha (14.58 q) and it was followed by T_7 (vitavax @2g/kg of seeds+ polymercoat @10 ml/kg of seeds) ass 14.06 q and minimum seed yield per hectare was found in the T_1 (control) as 11.45 q.

Interaction between the varieties and seed treatment with polymercoat, fungicide and insecticide did not differ significantly on seed yield per hectare. However, numerically higher seed yield (16.13 q) per hectare was found in V_1T_8 followed by V_1T_7 (15.40 q), V_1T_5 (14.93 q) and lower seed yield was found in the V_2T_1 (9.93 q) combination.

4.2.3 Seed quality parameters

4.2.3.1 Germination (%)

The results recorded on germination percentage as influenced by varieties, seed treatment with polymercoat, fungicide, insecticide and their interactions are presented in Table 14.

The germination percentage was differed significantly due to Varieties. The variety BGD103 (V_1) recorded significantly higher (95.46) germination percentage compared to BG1105 (V_2) (93.96 %). The germination percentage was differed significantly due to seed treatments, T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2g/kg of seed + polymercoat @ 10 ml/kg of seed) (98.41%) recorded significantly higher germination followed by T_7 (vitavax @2g/kg of seeds+ polymercoat @10 ml/kg of seeds) (98.06 %). While, the lower germination (90.05%) was seen in the T_1 (control).

Interaction between the varieties and seed treatment did not show any significant effect on seed germination. However, numerically higher germination (99.06 %) was seen in the V_1T_8 followed by V_1T_7 (98.62 %), V_2T_8 (97.96 %) and V_2T_7 (97.49 %). While lower per cent of germination (89.23 %) was noticed in the V_2T_1 combination.

4.2.3.2 Shoot length (cm)

The results on shoot length as influenced by varieties, seed treatments and their interactions effects are presented in Table 14.

Varieties showed significant difference on shoot length. The variety BGD103 (V_1) recorded significantly higher shoot length (12.48 cm) compare to BG1105 (V_2) as 11.55 cm. Significant difference in shoot length was observed due to seed treatments. Significantly higher shoot length (12.46 cm) was recorded in the T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2 g/kg of seed + polymercoat @ 10ml/kg of seed) and followed by T_7 (vitavax @2g/kg of seeds+ polymercoat @ 10 ml/kg of seeds) as 12.36 cm. While, less shoot length (11.58 cm) was noticed in T_1 (control).

Interaction between the varieties and seed treatment did not showed any significant effect on shoot length. However, numerically highest shoot length (12.98 cm) was noticed in the V_1T_8 followed by V_1T_7 (12.86 cm) and V_1T_5 (12.71cm). While, the lowest shoot length (11.13cm) was noticed in V_2T_1 combination.

4.2.3.3 Root length (cm)

The results on root length as influenced by varieties, seed treatments and their interactions effects are presented in Table 14.

Varieties showed significant difference in root length. Significantly BGD103 (V_1) recorded maximum (20.87 cm) root length compared to BG1105 (V_2) (19.44 cm).

Significant difference in root length was observed due to seed treatment. Significantly, maximum root length (20.66 cm) was recorded in the T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2 g/kg of seed + polymercoat @ 10 ml/kg of seed) followed by T_7 (vitavax @2g/kg of seeds+ polymercoat @10 ml/kg of seeds) of 20.51cm. While, minimum root length (19.63cm) was noticed in the T_1 (untreated).

Interaction between the varieties and seed treatment did not show any significant effect on root length. However, numerically higher root length (21.34 cm) was seen in the V_1T_8 followed by V_1T_7 (21.12cm) and V_1T_5 (21.10cm). While, minimum root length (18.98cm) was in V_2T_1 combination.

Table 14. Effect of polymer coat and seed treatment chemical on germination (%), shoot length (cm) and root length (cm) in chickpea

Treatments	**Germination (%)**			**Shoot length (cm)**			**Root length (cm)**		
	V_1	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**	**V_1**	**V_2**	**Mean**
T_1	90.88 (72.47)*	89.23 (70.87)	**90.05 (71.67)**	12.03	11.13	**11.58**	20.28	18.98	**19.63**
T_2	92.00 (73.64)	90.38 (71.97)	**91.19 (72.81)**	12.11	11.21	**11.66**	20.49	19.13	**19.81**
T_3	96.82 (80.53)	95.14 (77.51)	**95.98 (79.02)**	12.58	11.63	**12.11**	21.02	19.42	**20.22**
T_4	93.31 (75.12)	91.21 (72.81)	**92.26 (73.97)**	12.19	11.32	**11.76**	20.71	19.26	**19.99**
T_5	97.30 (80.78)	96.10 (79.03)	**96.70 (79.90)**	12.71	11.79	**12.25**	21.10	19.58	**20.34**
T_6	95.72 (78.39)	94.15 (76.16)	**94.93 (77.27)**	12.33	11.49	**11.91**	20.86	19.25	**20.06**
T_7	98.62 (83.73)	97.49 (81.10)	**98.06 (82.41)**	12.86	11.86	**12.36**	21.12	19.89	**20.51**
T_8	99.06 (84.53)	97.96 (82.06)	**98.51 (83.29)**	12.98	11.93	**12.46**	21.34	19.98	**20.66**
Mean	**95.46 (77.67)**	**93.96 (75.74)**	**94.71 (76.67)**	**12.48**	**11.55**	**12.01**	**20.87**	**19.44**	**20.15**
	S Em±	**CD (P=0.01)**		**S Em±**	**CD (P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	0.49	1.86		0.05	0.18		0.08	0.30	
T	0.98	3.71		0.09	0.35		0.16	0.59	
VxT	1.38	NS		0.13	NS		0.22	NS	

Legend: **V_1-BGD 103 (*Desi*)** **V_2 – BG 1105 (*Kabuli*)**

NS - Non significant

* Figures in the parenthesis are arcsine transformed values

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds

T_5-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymer coat @10 ml/kg of seeds.

T_7- Vitavax power @ 2 g/kg of seeds+ polymercoat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @ 2g/kg of seeds + polymer coat @10 ml/kg of seeds.

4.2.3.5 Seedling vigour index

The data recorded on vigour index as influenced by varieties, seed treatments and their interactions effects are presented in Table 15.

Seedling vigour index showed significant differences among the varieties Where in, higher seedling vigour index (3185) was observed in BGD103 (V_1). While, lower seedling vigour index (2913) was observed in BGD1105 (V_2).

Significant difference on vigour index was recorded due to seed treatments. Significantly, maximum vigour index (3264) was recorded in the T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2 g/kg of seed + polymercoat @ 10ml/kg of seed) followed by T_7 (vitavax @2g/kg of seeds+ polymercoat @ 10 ml/kg of seeds) (3224). While, minimum vigour index (2812) was noticed in T_1 (untreated).

Interaction between the varieties and seed treatment did not show any significant effect on vigour index. However, numerically higher seedling vigour index (3401) was seen in the V_1T_8 followed by V_1T_7 (3352) and V_1T_5 (3290). While, lower vigour index (2687) was found in V_2T_1 combination.

4.2.3.6 Seedling dry weight (mg)

The data recorded on seedling dry weight (mg) as influenced by varieties, seed treatments and their interactions effects are presented in Table 15.

Seedling dry weight varied significantly between the two varieties higher seedling dry weight (207.18 mg) recorded in BGD103(V_1) as compared to the BG1105 (V_2) (199.34 mg).

Influence of seed treatment on seedling dry weight showed significant differences. Among the treatments, T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 3 g/kg of seed + polymercoat @ 10 ml/kg of seed) recorded significantly higher seedling dry weight (226.30 mg) and it was on par with T_7 (vitavax @ 2g/kg of seeds+ polymercoat @10 ml/kg of seeds) (223.51mg) Whereas, lowest seedling dry weight (182.53 mg) was found in the T_1 (untreated).

Interaction between the varieties and seed treatment on seedling dry weight was non-significant. Numerically higher seedling dry weight (230.17 mg) was seen in the V_1T_8 and it was on par with the V_1T_7 (228.47 mg) followed by V_2T_8 (222.43 mg). While, lower seedling dry weight (175.47mg) was found in V_2T_1 combination.

4.2.3.6 Test weight (g)

The results on test weight (g) as influenced by varieties, seed treatments and their interactions effects are presented in Table 15.

Significant difference was noticed for test weight between two varieties. BGD103 (V_1) recorded maximum test weight (34.12 g) compared to BG1105 (V_2) (29.80 g)

The test weight of chickpea seeds differed significantly due to seed treatments. Among the seed treatments, T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2g/kg of seed + polymercoat @ 10ml/kg of seed) recorded more test weight (32.55g) followed by T_7 (vitavax @2g/kg of seeds+ polymercoat @10 ml/kg of seeds) of 32.47g While, significantly less test weight (31.37 g) was recorded in the T_1 (untreated).

On 100 seed weight, no significant difference was seen due to interactions of varieties and seed treatments on 100 seed weight. However, numerically higher test weight (34.59 g) was observed with V_1T_8 which was on par with the V_1T_7 (35.40 g) followed by V_1T_5 (34.38 g) and lesser test weight (29.13 g) in V_2T_1 combination.

4.2.3.7 Electrical conductivity (dSm^{-1})

The results on electrical conductivity of seed leachate as influenced by varieties, seed treatments and their interaction effects are presented in Table 15.

Significant difference was observed on electrical conductivity (EC) due to varieties. Significantly, higher EC (0.351 dSm^{-1}) was recorded in BG1105 (V_2) as compare to BGD103 (V_1) (0.343 dSm^{-1}). The electrical conductivity of seed leachate found to differ significantly due to the seed treatments. Significantly, higher EC (0.379 dSm^{-1}) of seed leachate was recorded in T_1 (untreated). While, lesser EC (0.324dSm^{-1}) was recorded in T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2 g/kg of seed + polymercoat @ 10ml/kg of seed).

The interaction between the varieties and seed treatments did not differ significantly on EC of seed leachate. However, relatively higher EC of seed leachate (0.379 dSm^{-1}) was observed in V_2T_1 treatment combination followed by V_2T_2 (0.371 dsm^{-1}) and was minimum (0.319 dSm^{-1}) in V_1T_8 combination.

Table 15. Effect of polymer coat and seed treatment chemical on vigour index, dry weight (mg), test weight (g) and electrical conductivity (dSm[1]) in chickpea

Treatments	Vigour Index			Dry weight(G)			Test weight(g)			Electrical conductivity		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	2937	2687	**2812**	189.60	175.47	**182.53**	33.61	29.13	**31.37**	0.369	0.379	**0.374**
T_2	3000	2743	**2871**	192.32	182.23	**187.27**	33.79	29.28	**31.54**	0.365	0.371	**0.368**
T_3	3254	2955	**3104**	205.88	201.63	**203.76**	34.21	29.83	**32.02**	0.338	0.345	**0.342**
T_4	3071	2790	**2930**	195.40	189.48	**192.44**	33.87	29.42	**31.65**	0.354	0.362	**0.358**
T_5	3290	3015	**3153**	216.82	210.15	**213.49**	34.38	30.09	**32.24**	0.331	0.338	**0.335**
T_6	3178	2895	**3036**	198.73	194.81	**196.77**	33.98	29.69	**31.84**	0.343	0.352	**0.348**
T_7	3352	3096	**3224**	228.47	218.54	**223.51**	34.51	30.42	**32.47**	0.325	0.332	**0.329**
T_8	3401	3127	**3264**	230.17	222.43	**226.30**	34.59	30.51	**32.55**	0.319	0.328	**0.324**
Mean	**3185**	**2913**	**3049**	**207.18**	**199.34**	**203.26**	**34.12**	**29.80**	**31.96**	**0.343**	**0.351**	**0.347**
	S Em±	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**		**S Em±**	**CD(P=0.01)**	
V	12	45		0.79	2.99		0.12	0.47		0.001	0.004	
T	24	90		1.58	5.99		0.25	0.94		0.003	0.010	
VxT	33	NS		2.23	NS		0.35	NS		0.004	NS	

Legend: V_1-BGD 103 (*Desi*) V_2 – BG 1105 (*Kabuli*)

NS - Non significant

T_1- Control

T_2- Deltamethrin 2.8EC @ 0.4ml/kg of seeds

T_3- Vitavax power@2g/kg of seeds

T_4- Polymer coat @10 ml/kg of seeds

T_5-Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power@2g/kg of seeds.

T_6- Deltamethrin 2.8EC @ 0.4ml/kg of seeds + polymer coat @10 ml/kg of seeds.

T_7- Vitavax power @ 2 g/kg of seeds+ polymercoat @ 10 ml/kg of seeds

T_8- Deltamethrin 2.8EC @ 0.4ml per kg of seeds + vitavax power @ 2g/kg of seeds + polymer coat @10 ml/kg of seeds.

DISCUSSION

Seed is an important basic and crucial input in agriculture. The two most important aspects in maintaining the continuous supply of high quality seeds to producers are, mainly to produce genetically pure seed and to preserve the quality of seeds from harvest to next sowing. As it is well established fact that only high quality seed respond better to all inputs and management practices. The maintenance of high quality during storage is of the great significance. Internal and external factors like seed moisture content, temperature and oxygen availability will influence the viability of seeds during storage period. Deterioration of seed is a natural process; but the rate of deterioration on viability and vigour of seed may differ due to genetic causes (Roberts, 1972; wittington, 1978; Kneebone, 1976), cultivar differences (Bourland and Ibrahim, 1980; Chouhan *et al.* 1984), storage environment (Roberts, 1961) and period of storage. Therefore an understanding of how best the seeds can be stored under ambient temperature, relative humidity at relatively low cost, with minimum deterioration in seed quality for periods extending over one or more seasons will be of immense important to seed industry and farming community.

In any seed production programme, storage of seeds from harvest to next planting season assumes greater importance. Chickpea is predominately a *rabi* pulse crop and after the harvest of seed crop, the seeds are to be stored for nearly 8-10 months until next *rabi* season without affecting the sowing quality of seed. Therefore, one has to store the seeds in good conditions as the "seed saved is seed produced" an adage still holds good even today's modern agriculture. Seed storage potential depends on various factors *viz*., genetic, environmental factors, pest and disease, kind of crops, varieties, seed physical and biochemical factors *etc*. It is believed that well developed bold seeds with initial high vigour always store for longer period than small and immature seeds. Both *Desi* and *Kabuli* types of chickpea varieties differ greatly during the storage period. Keeping this in the view, the present investigation was undertaken to know the influence of storage period on seed quality of chickpea varieties.

5.1 Influence of storage period on seed quality of chickpea varieties

The storage quality of seed varies from variety to variety; genera to genera as the viability of seeds are influenced by genetic factors the storability of different varieties is also regulated by initial seed quality, physical and chemical composition of seed (Doijoide, 1988). The different cultivars possess different physical structure and chemical composition which determines the longevity of seed in storage.

The present study revealed that, irrespective of seed treatments, the chickpea varieties *viz.,* BGD103 (*desi)* and BG1105 *(Kabuli*) showed significant variations for germination from initial and subsequent months. Among the varieties, *desi* type recorded the higher germination percentage than the *kabuli* type throughout the storage period. Significantly, higher germination percentage (82.91) was recorded in BGD103 as compared to BG1105 (80.50%) at the end of storage period. Retention of higher germination in BGD103 may be due to genotypic factor, thicker seed coat nature in desi type varieties (Upadhayay, 1994) Such varietal variation with respect to germination was reported by Vanangamudi (1988) in Soybean, Kumbar *et al*. (1999) in chickpea, and Arati *et al.* (2000) in chickpea.

As the storage period advances, seed quality parameters such as shoot length, root length, vigour index and seedling dry weight were decreased. This may be due to the natural ageing of seeds, decrease in germination and integrity of seed, increase in seed leachate as the storage period advanced and also increase in fungal infection. These results are in conformity with the reports of Kumar *et al*. (1997) who have observed that germination and seedling vigour decreased in all the varieties of peas with the advancement of storage period. These results are in conformity with the reports of Kumar *et al*. (1997) who have observed that germination and seedling vigour decreased in all the varieties of peas with the advancement of storage period.

Root length, shoot length, vigour index, and seedling dry weight were significantly higher in BGD103 throughout the storage period. Root length differed significantly in all the months of storage period. However, significantly highest root length (15.23 cm) was found in BGD 103 and the lowest (14.14 cm) root length in BG1105 at the end of storage period this may be due to genotypic difference in chickpea varieties.

Significantly highest shoot length (7.47cm), vigour index (1888) and seedling dry weight (166.27 mg) were noticed in BGD103 at the end of storage period. Whereas BG1105 recorded significantly lowest shoot length (6.74cm), vigour index (1689) and seedling dry weight (134.35 mg) at the end of storage period. These differences indicate the genotypic difference with respect to longevity of seed.

Amount of reserve food material mobilized which ultimately contributed to longer seedling length, higher seedling dry weight as well as vigour index. Differential decrease in all these vigour parameters in chickpea varieties during storage may ascribed due to their genetic differences existing and age induced deterioration at various degrees with the increase in the storage period (Delouche, 1973). Similar decrease in seedling vigour parameters with the advancement in the storage period were reported by Mohanrao (1993) in soybean and Merwade (2000) in Chickpea.

The electrical conductivity of seed leachate is inversely related to seed quality; higher the electrical conductivity, lower is the seed quality and vice-versa. In aged and deteriorated seeds, the electrical conductivity will be higher owing to decrease in the membrane integrity caused by detrimental physico-biochemical and ultra structural changes occurring in the seeds during storage (Koostra and Harington, 1969 and Roberts, 1972). The different electrical conductivity values recorded between the varieties indicate that membrane integrity is lost during seed ageing, the nature and extent of membrane damage may not be similar for all the varieties and thus differences in electrical conductivity values are bound to occur (Kurdikeri, 1991).

In the present study, the mean electrical conductivity of seed leachate values were found to increase from the initial month to the end of 12th month of storage. Electrical conductivity was higher (0.320 and 1.007 dSm^{-1}) in BG1105 (kabuli) and lower (0.294 and 0.973 dSm^{-1}) with BGD- 103 (desi) at initial and twelve months of storage period, respectively.

With respect to moisture content of seeds, there was large variation depending on the relative humidity and temperature of the ambient conditions (Table 1). Significantly higher moisture content (8.81 %) in BG1105 (kabuli) and lower (8.65%) in BGD103 (desi) at the end of storage period. This difference in moisture content may be related to seed coat factor and chemical composition of seeds. Similar variation in seed moisture content during storage was reported in chickpea by Kumbar *et al*. (1999), Arati *et al*. (2000) and Merwade (2000) in chickpea.

The variation noticed in electrical conductivity of seed leachates and moisture content in both the cultivars may be due to anatomical structure, permeability of membrane difference in seed coat composition. As *Kabuli* seeds gained more moisture with variation in moisture content and leached more electrolytes which might be due to cellular membrane deterioration. Similar variation in moisture content and electrical conductivity value was noticed by Kumar and Singh (1989) in chickpea; Arati *et al*. (2000) in chickpea and Sushma *et al*. (2003) in garden pea.

The hundred seed weight of chickpea varieties differed significantly during storage period. It decreased gradually with advancement of storage period. The mean hundred seed weight was decreased from initial month (35.49 and 29.28 g) to at the end (30.66 and 26.21g) in both the varieties *viz.* BGD103 and BG1105, respectively.

The decrease in hundred seed weight during storage may be attributed to the changes in physico-chemical properties of seeds and pest and disease attack resulting in the decrease of the storage food reserve of the seed. In the present study the hundred seed weight was maximum in desi type (BGD-103) in all months of storage period than BG1105. Similar results were reported by Gnyandev (2009) in chickpea.

The higher per cent infestation was recorded in BG1105 variety may be due to the higher protein content, thin smooth and white coloured testa of kabuli type chickpea. In the beginning of the storage period, per cent infestation was zero and with advancement of storage period, increase in infestation was observed in both the varieties. This difference may be due to variation in inherent genotypic composition to withstand the impact of pest infestation. These results are in agreement with the reports of Arati *et al*. (2000) and Gnyandev (2009) in chickpea.

5.2 Effect of polymercoat and seed treatment chemicals on chickpea seed quality during storage

Chickpea seeds were treated with insecticide, fungicides and polymer coating exhibited superiority in maintaining the seed quality throughout the storage period.

The seeds treated with deltamethrin 2.8EC @0.4ml /kg seeds + vitavax power @2 g/kg seed. + polymercoat @10ml/kg of seeds (T_8) recorded significantly higher seed quality parameters followed by seeds treated with vitavax power @2 g/kg seed+ polymercoat @10ml/kg of seed (T_7) which were on par with each other in most of the seed quality parameters compared to the untreated control (T_1).

The germination per cent of chickpea seeds declined progressively with increase in the period of storage in all the treatment combinations, which may be attributed to the phenomenon of natural ageing and depletion of food reserves and decline in metabolic activity of seed due to respiration. There was a significant difference on germination per cent from the second month onwards of storage period and up to the end of twelve months of storage. The germination was significantly higher (87.13%) in the seeds treated with deltamethrin 2.8EC 0.4ml /kg seeds. + vitavax power @2 g/kg seed. + polymercoat @10ml/kg of seeds (T_8) and 86.00 per cent in T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds). These treatments are above the level of Indian minimum seed certification standard (85 %) for chickpea. Significantly, lowest germination (76.13%) was noticed in the T_1 (untreated) at the end of storage period.

Higher germination percentage can be seen in treated seeds and it is may be due to pathogen and pest suppressive nature of chemicals. In general vitavax power reduces the impact of ageing enzymes, seed deterioration due to fungal invasion and physiological ageing as a result. Deltamethrin is a pyrathroid and it was very effective in controlling the insect pest during storage due to the phytotoxic effect and polymer film may acts as physical barrier, which has been reported to reduce the leaching of inhibitors from the seed coverings and may restrict oxygen diffusion to embryo. So the seed viability was maintained for a comparatively longer period of time. These finding are in agreement with results obtained by Shankutala (2009) in sunflower; Imran Baig (2005) in soybean and Vinodkumar *et al.* (2012) in pigeonpea.

At the end of twelth month of storage period, significantly higher shoot length (8.39 cm) was recorded in T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds. + vitavax power @2 g/kg seed. + polymer Seed coating @10ml/kg of seeds) followed by T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) as 8.20 cm and the lower shoot length (5.12 cm) was observed in T_1 (untreated). Similarly, maximum root length (15.63 cm) was noticed in T_8 (deltamethrin 2.8EC 0.4ml /kg seeds. + vitavax power @2 g/kg seed. + polymercoat @10ml/kg of seeds) and it was on par with T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) (15.53 cm). While, significantly lowest root length was recorded in T_1 (untreated) (13.44 cm).

The shoot length and root length of polymer coated seeds with insecticide and fungicide were more compared to the uncoated seeds. It is due to higher germination and healthy seedlings in seed coated with polymer and fungicide as this protected from fungi invasion and there by good and better germination and subsequent higher root and shoot length was produced. Similar results were reported by Shakuntala (2009) in Sunflower and Imran Baig (2005) in Soybean.

Dry weight of seedling decreased with increase in the storage period. This may be due to ageing, which may be resulted due to deterioration of seed, decrease in the germination percentage and seedling length. Among the treatment combinations the seeds treated with deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds (T_8) recorded significantly highest seedling dry weight (177.12 mg) followed by T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) (170.56 mg). While, the significantly lowest seedling dry weight was recorded in T_1 (untreated) as 121. 46 mg noticed at the end of twelve months of storage period. These results are in conformity with the findings of Paul *et al*. (1996) in Mungbean; Imran Baig (2005) in soybean and Shakuntala (2009) in sunflower

In the present study, significantly highest vigour index was recorded in T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymer coat @ 10ml/kg of seeds) as 2093 and it was on par with T_7 (vitavax power @ 2 g/kg seed + polymer coat @ 10ml/kg of seeds) as 2041. While, significantly lower vigour index (1415) was recorded in T_1 (untreated). This decrease in dry weight and seedling vigour index was due to decrease in germination percentage, seedling length; it leads to the lower seed vigour index and dry weight. Seed coated with the polymer combined with insecticide and fungicide gave better results due to good germination percentage. Higher seedling length, seedling dry weight and vigour index. These results are in conformity with findings of Shakuntala (2009) in sunflower and Vinodkumar (2012) in the pigeon pea.

Hundred seed weight of treated seeds showed significant variation from fourth month up to the end of twelth month. Significantly maximum hundred seed weight (29.21g) was recorded in T_8 (deltamethrin 2.8EC 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) it was on par with T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) (29.07 g), while significantly minimum hundred seed weight (27.47 g) was recorded in T_1 (untreated).

A number of water soluble compounds such as sugars, amino acids and organic acids are released when seeds were soaked in water. The electrical conductivity of seed leachate indicates the membrane integrity and quality of seed and it was negatively correlated with seed quality. In the present investigation significantly lower electrical conductivity (0.831 dSm^{-1}) was recorded in T_8 (deltamethrin 2.8EC 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) and it was followed by T_7 (vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) (0.886 dSm^{-1}), while significantly higher electrical conductivity was recorded in T_1 (untreated) (1.130 dSm^{-1}) at the end of storage period. This variation in electrical conductivity of seed leachate indicating that increased membrane permeability and decreased compactness of seed coat and cellular membrane deterioration. Similar, findings were reported by Vasundhara and Bommegowda (1999) in groundnut and Vinodkumar (2012) in Pigeonpea. The polymer film formed around seed acts a physical barrier, which has been reported to reduce leaching of inhibitors from seed covering and may restrict oxygen diffusion to the embryo (Vanangamudi *et al.* (2003). The stable cell membrane also rendered resistance to peroxidase and free radical reactions and vitavax power acted as antifungal agent and anti oxident agent.

There was no insect infestation in the seeds treated with polymer coat, insecticide and fungicide. Seeds coated with liquid polymer creates smooth surface on seed coat so there is no choice to lay eggs on seed coat apart from that deltamethrin is a pyrathroid which is very effective in controlling the insect pest during storage due to phytotoxic effect. It was evident from the study that the seeds film coated with little red polykote @ 6g + carbendazim @ 2g + imidachloroprid @1ml + micronutrient mixture (Agromin) @ 4 ml per kg of seeds can be stored up to six months over 90 per cent of germination and high vigour index (3060) under ambient conditions of storage with least pathogen and insect infestation (Suresh Vegulla, 2008) in maize and similar results reported by Vijaykumar (2007) in cotton.

Interaction between varieties and seed treatment with polymercoat, insecticide and fungicide found to be non significant in all the seed quality parameters throughout the storage period.

5.3 Influence of polymercoat and seed treatment chemicals on field performance of chickpea

Chickpea is an important leguminous crop of our country, grown mainly under rain fed conditions. In recent year several Kabuli and desi types of chickpea varieties are released for cultivation. The area under chickpea is decreasing in every year due to non availability required quantity of quality seeds for sowing mainly because of lesser area under seed production. The seed yield and quality seed needs to be enhanced by adopting certain agronomic practices and scientific seed production techniques.

Polymer coating acts as a temperature switch and protective coating by regulating the seed coating uptake of water, until the soil has warmed to a predetermined temperature. It enables accurate and even doses of chemicals and reduces the chemical wastage; it also makes room for including all the required ingredients like inoculants, protectants, nutrients, herbicides, oxygen suppliers etc. It also provides resistance against mechanical damage in the seed drill. Thus improves the appearance and quality of polymer coated seeds (Vanangamudi *et al*., 2003). As the seed treatments with fungicide and insecticide help in the protection of seed from the seed rot and seedling diseases. Seed treatments by its protective coating around the seed, acts as a barrier once the seed is been planted to ward off attack of seed borne diseases and soil borne organisms by this way it enhances the better field stand.

In the present investigation, varietal differences with respect to field performance have been noticed in chickpea varieties. Significant variation in the plant height at the harvest was observed in chickpea varieties irrespective of treatments. In general, BG1105 recorded maximum plant height (45.21cm) than BGD103 (41.39cm) at harvest stage. This may be mainly due to efficient accumulation of photosynthates in the vegetative plant parts. Besides the plant height is also a genetic character of varieties (Poma *et al*., 1990). The varietal difference in plant height in chickpea was also observed by Gnyandev (2009).

The number of branches was the highest (19.25) in BGD103 compared to BG1105 (16.67). Such varietal differences were also reported by Merwade (2000) and Gyandev (2009) in chickpea. The days to 50 per cent flowering is under genetic control and influenced by the environment prevailing during crop growth period.

BGD103 (46.29 and 92.91) took significantly less days for 50 per cent flowering and days to maturity compared to BG1105 (48.77 and 103.16) respectively. This difference may be because of genetic and morphological characteristics of chickpea varieties. Similar reports on varietal variation on days to 50 per cent flowering and maturity were made in chickpea with respect to days to 50 per cent flowering by Merwade (2000), Gnyandev (2009) and with respect to days to 50 per cent flowering and days to maturity in chickpea Tripathi *et al*. (2012).

The significant differences were seen between the chickpea varieties with respect to number of pods per plant, number of seeds per plant, seed weight per plant, seed weight per plot and seed yield per hectare, irrespective of seed treatments, Between the varieties, BGD103 recorded significantly more number of pods per plant (28.90), number of seed per plant (35.46), seed weight per plant (4.33 g), seed weight per plot (1.30 kg), and seed yield per hectare (14.42 q) as compared to BG1105 (25.85, 32.71 3.46 g, 1.04 kg and 11.58q respectively).

The differences on seed yield and yield components were observed between varieties in the present study may be attributed to their varietal differences in their growth habit and genetic yielding ability. Similar varietal difference in chickpea with respect to plant growth was reported by Aziz and Rahman (1996) and on seed yield and yield attributes by Merwade (2000) in chickpea and in cowpea by Reddy (2005), Gnyandev (2009) and Tripathi *et al*. (2012).

It is an established fact that seed yield and quality attributes are reported to vary between the varieties of several crop species owing to genetic and environmental factors. In the present investigation, all the seed quality parameters were found to differ between chickpea varieties.

The hundred seed weight (34.12 g), germination (95.46 %), shoot length (12.48 cm), root length (20.87 cm), dry weight (207.18 mg), vigour index (3185) were more and low electrical conductivity (0.343 dSm^{-1}) in BGD103 (V_1) as compared to BG1105 (V_2) (Table 13 and 14). The differences in seed quality attributes were noticed between chickpea varieties it may be ascertained due to the varietal differences in seed development and accumulation of reserved food material. The similar results were reported by Ramteke (1995) and Gnyandev (2009) in chickpea.

The results of the present investigation revealed that, T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds), significantly superior in number of branches, number of pods per plant, number of seeds per plant, Seed weight per plant (g), seed weight per plot (kg), seed yield per ha (q) in both the varieties. These results are in conformity with the observations of Zholbolsynova *et al.* (1992) who have reported that the seed coating with polymers increased the yield from 0.93 tonnes to 1.62 tonnes per ha in wheat. Bhatnagar and Porwal (1990) reported higher seed yield of 1.39 t per ha when seed coating of super absorbent polymer in chickpea. Chikkanna *et al.* (2000) in his experiment in groundnut seeds coated with polymer @ 20.00 g per kg of seeds recorded higher dry matter, number of pods, test weight and pod yield per plant and per ha and Vinodkumar *et al* (2012) in Pigeonpea.

Among the treatments, T_8 (deltamethrin 2.8EC 0.4ml /kg seeds + vitavax power @ 2 g/kg seed + polymercoat @ 10ml/kg of seeds) recorded significantly higher number of branches (21.30), number of pods per plant (31.91), number of seeds per plant (39.39), seed weight per plant(4.38 g), seed weight per plot (1.31 kg), seed yield per ha (14.58 q). While T_1 (control) recorded significantly lower number of branches (14.99), number of pods per plant (23.15), number of seeds per plant (28.50), seed weight per plant (3.44), seed weight per plot (1.03 kg) and seed yield per ha (11.45 q).

The results of seed quality parameters due to seed treatments showed significant difference. T_8 (deltamethrin 2.8EC 0.4ml /kg seeds + vitavax power @ 2g/kg seed + polymercoat @10ml/kg of seeds), recorded the higher vigour index (3264) over all other treatments and the lowest values (2812) was with T_1 (control). These results are in agreement with the findings of Vanangamudi *et al.* (2003) who have noticed higher germination (98.00 %) compared to control (93.00%) in maize coated with pink polykote @ 3 g kg-1 of seed + fungicide + insecticide treatment. Similar trend was noticed with 100 seed weight (32.55 g) germination percentage (98.51) root length (20.66 cm), shoot length (12.46 cm) and seedling dry weight of (226.30 mg) as compared to the T_1 (control). These findings were similar with Shankutala (2009) in sunflower and Vinodkumar *et al.* (2012) in pigeonpea.

Interactions between varieties and seed treatments unable to exhibit significant results on growth parameter, yield parameter and seed quality parameter on field performance of chickpea.

Practical utility

Based on the results of present study following practical applications are proposed for chickpea varieties.

1. BGD103 (Desi type) seeds maintained better seed quality parameters throughout the storage period as compared to BG1105 (Kabuli type) when it was stored in cloth bag under ambient condition.
2. The combined application of polymer, insecticide and fungicide coating maintained higher seed quality parameters as compared to the coating with polymer alone.
3. Seed coating with deltamethrin 2.8EC @ 0.4ml /kg seeds. + vitavax power @ 2g/kg seed+ polymercoat @ 10ml/kg of seed helped to maintained seed quality above minimum seed certification standard (85%) for more than 12 months.
4. Better yield coupled with good quality of seeds were obtained from the treatment combination of deltamethrin 2.8EC @ 0.4ml /kg seeds. + vitavax power @ 2g/kg seed+ polymercoat@ 10ml/kg, when it was sown after six months of storage.

Future line of work

1. The present study can also be extended to other varieties of *desi* and *kabuli* types of Chickpea.
2. The present study was also extended to analyse protein profile of both *desi* and *kabuli* type chickpea seeds were treated with insecticide, fungicide and polymercoat during a storage period.
3. New molecules of insecticide, fungicide may be tested at different concentrations along with polymercoat as seed treatments.
4. There is a need to standardize the polymercoat and concentration of chemicals (insecticide and fungicide) and their dosage.
5. There is a need to standardize the colour of the polymercoat for the chickpea genotypes.

SUMMARY AND CONCLUSIONS

The investigation was carried out with the objective of studying the "Influence of storage period on seed quality of Chickpea varieties" and "Effect of polymercoat, fungicide, and insecticide on storability of Chickpea varieties". The laboratory experiments were conducted in Department of Seed Science and Technology, from April 2012 to March 2013. Further, the field experiment was conducted at the Main Agricultural Research Station, College of Agriculture, University of Agricultural Sciences, Dharwad during *rabi* season 2012-13 to ascertain the "Effect of polymercoat and chemicals on field performance of Chickpea". The results of laboratory and field experiments are summarised in this chapter.

Influence of storage period on seed quality of chickpea varieties

The laboratory experiment was conducted with two varieties *viz*., desi (var. BGD103) and kabuli (var. BG1105). The monthly observations on the seed germination (%), shoot length (cm), root length (cm), seedling vigour index, seedling dry weight (mg), moisture content (%), hundred seed weight (g), electrical conductivity of seed leachate (dSm^{-1}) and pest infestation (%) were recorded from initial (before treatment) or zero month to till the end 12^{th} month of storage period in both the varieties of chickpea.

1. The germination percentage decreased gradually in both the chickpea varieties during twelve months of ambient storage in cloth bag. The satisfactory germination (85 %) as per the Indian minimum seed certification standard was maintained in BGD103 (desi variety) for ten months and BG1105 (kabuli variety) for nine month only.
2. The significantly higher shoot length (7.47 cm), root length (15.23 cm), seedling dry weight (166.27 mg), vigour index (1888), and test weight (30.66 g) and lesser moisture content (8.65 %), electrical conductivity of seed leachate (0.973 dSm^{-1}) and per cent pest infestation (13.9%) was found in BGD103 at the end of storage period.
3. The significantly minimum shoot length (6.74 cm), root length (14.14 cm), seedling dry weight (134.35 mg), vigour index (1689), and test weight (26.21 g) and higher moisture content (8.81 %), electrical conductivity of seed leachate (1.00 dSm^{-1}) and insect infestation (17.87 %) was noticed in BG1105 at the end of storage period.

On the basis of above results of seed quality parameters, it can be concluded that BGD 103 (desi) has maintained good seed quality over period of 10 months storage than the BG1105 (kabuli)

Effect of polymercoat and seed treatment chemicals on chickpea seed quality during storage

The laboratory experiment was conducted with eight seed treatments (T) *viz.,* T_1 (control), T_2 (deltamethrin 2.8EC @ 0.4ml /kg seeds), T_3 (vitavax power @ 2g/kg seed), T_4 (polymer coat @10ml/kg of seeds), T_5 (deltamethrin 2.8EC @ 0.4ml /kg seeds. + vitavax power @ 2g/kg seed), T_6 (deltamethrin 2.8EC @0.4ml /kg seeds + polymercoat @10ml/kg of seeds), T_7 (vitavax power @ 2g/kg seed+ polymer coat @10 ml/kg of seed), T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2g/kg seed+ polymercoat @ 10ml/kg of seeds).

1. Throughout the storage period superior seed quality was observed in T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds. + vitavax power @ 2g/kg seed+ polymercoat @ 10ml/kg of seeds) followed by T_7 (vitavax power @ 2g/kg seed+ polymercoat @10 ml/kg of seed) and T_5 (deltamethrin 2.8EC @ 0.4ml /kg seeds + vitavax power @ 2g/kg seed) when compared to T_1 (untreated).
2. Among all the seed treatments, T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds. + vitavax power @ 2g/kg seed+ polymer coat @ 10ml/kg of seeds). recorded significantly higher seed germination (87.13%), followed by T_7 (vitavax power @ 2g/kg seed+ polymer coat @10 ml/kg of seed) (86.00%), However, the minimum satisfactory germination of 85% as the Indian minimum seed certification standard was maintained even after the twelve months of storage period.
3. Maximum germination (87.13 %), shoot length (8.39 cm), root length (15.63 cm), vigour index (2093), seedling dry weight (177.12 mg) and test weight (29.21 g) was recorded in T_8 (deltamethrin 2.8EC @ 0.4ml /kg seeds. + vitavax power @ 2g/kg seed+ polymer seed coating @ 10ml/kg of seeds) where in T_1(control) recorded minimum 76.13 %, 5.12 cm, 13.44 cm, 1415, 121.46 mg, 27.47 g respectively at the end of storage period.

4. Lower electrical conductivity (0.831dSm^{-1}) was noticed in seeds treated with deltamethrin 2.8EC @ 0.4ml /kg seeds. + vitavax power @ 2g/kg seed+ polymer seed coating @ 10ml/kg of seeds followed by T_7 (vitavax power @ 2 g/kg seed + polymer seed coating @ 10ml/kg of seeds) (0.886 dSm^{-1}) and significantly higher electrical conductivity was recorded in T_1 (untreated) (1.130 dSm^{-1}) at the end of storage period.
5. The moisture content of seed fluctuated throughout the storage period. However, non significant differences among the seed treatments were observed throughout the storage period.
6. Throughout the storage period zero per cent of insect infestation was observed in treated seeds but in the control (T_1) insect infestation was noticed from the seventh month onwards then gradually increased till the end of the storage period of both the varieties *viz*., BGD103 and BG1105.

Influence of polymercoat and seed treatment chemicals on field performance of chickpea

The field experiment was conducted to know the effect of polymer coat, insecticide and fungicide on field performance of chickpea seeds in two varieties *viz,* BGD103 (*Desi*) and BG1105 (*Kabuli*) with eight different treatment combinations.

1. Irrespective of seed treatments the variety BGD103 (desi) recorded significantly higher number of branches (22.33), and less plant height (41.39 cm), number of days to 50 per cent flowering (46.29), and days to maturity (92.91) over the variety BG1105 (kabuli).
2. In BGD103 (desi) similar trend was noticed with number of pods per plant (28.90), number of seeds per plant (35.46), seed weight(4.33 g), seed weight per plot (1.30 kg), and seed yield (14.42 q) as compared to the BGD1105 (kabuli) , 25.85, 32.71, 3.46 g, 1.04 kg and 11.58 q respectively.
3. Significantly maximum seed germination (95.46%), shoot and root length (12.48 and 20.87 cm), vigour index (3185), dry weight (207.18 mg), test weight (34.12 g) was observed in BGD103 (*desi*) than the BGD1105 (*kabuli*) .
4. Due to seed treatments, significantly higher number of branches (21.30), number of pods per plant (31.91), number of seeds per plant (39.39), maximum seed weight (4.38 g), seed weight per plot (1.31kg), seed yield per ha (14.58 q) were recorded in T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2 g/kg of seed + polymer seed coating @ 10 ml/kg of seed) than the T_1 (control).
5. The results of seed quality parameters due to seed treatments showed significant difference, and seed quality parameter found higher germination (98.41 %), shoot length (12.46 cm), root length (20.66 cm), vigour index (3264), seedling dry weight (226.30 mg), test weight (32.55 g) and lesser electrical conductivity of seed leachate (0.32 dSm^{-1}) recorded in T_8 (deltamethrin 2.8EC @ 0.4 ml /kg of seeds + vitavax power @ 2 g/kg of seed + polmercoat @ 10 ml/kg of seed).

It can be concluded from the results of the present investigations that, desi type (var.BGD103) seeds store better during a period of storage with good seed quality than the kabuli type (var.BG1105). Large quantity of seed can be stored for longer period, with superior seed quality with least insect infestation by treating the seeds with Deltamethrin 2.8EC 0.4ml /kg seeds. + Vitavax power @ 2g/kg seed+ polymer seed coating @ 10ml/kg of seeds. Seeds stored with the treatment combination of deltamethrin 2.8EC @ 0.4ml /kg seeds. + vitavax power @ 2g/kg seed+ polymer seed coating @ 10ml/kg of seeds , when sown in the field , the good seed yield coupled with higher seed quality.

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EFFECT POLYMERCOAT AND SEED TREATMENT CHEMICALS ON SEED STORABILITY AND FIELD PERFORMANCE OF CHICKPEA

SUSHMA P. P. **2013** **B. S. VYAKARANAL**
Major Advisor

ABSTRACT

The laboratory and field experiment was carried out with two factorial concept in CRD and RCBD design respectively. First factor consisted of varieties *viz.,* BGD103 (desi) and BG1105 (kabuli), second factor consists of eight treatments. The results of present investigation revealed that seed storability and field performance was superior in BGD 103 (desi type) as compared to BG1105 (Kabuli type). Significantly high seed germination (82.91%), vigour (1888), seedling dry weight (166.27mg), and test weight (30.66 g) and less EC value (0.973 dSm^{-1}) was found at the end of storage period. minimum plant height (41.39cm) with maximum number of branches (19.25) per plant less number of days taken for 50 per cent flowering and maturity (46.29 and 92.9) number of pods per plant (28.90) , number of seeds per plant (35.46), seed weight per plant (4.33 g), seed yield per hectare (14.42 q) was recorded in BGD103 during field experiment.

At the end of storage period, treatment combination of polymer coated seed (10 ml/kg) along with deltamethrin 2.8 EC @ 0.4 ml/kg of seed + vitavax power @ 2 gm/ Kg of seed treatment combination recorded significantly higher seed germination (98.88%), shoot and root length (8.39 cm and 15.63 cm), seedling vigour index (2093), seedling dry weight (263.32 mg) test weight (177.12g), and lower EC value (0.831$dSm-^{1}$) as compared to T_1. In the field experiment significantly higher number of branches (21.30), number of pods per plant (31.91), number of seeds per plant (39.39), seed weight per plant (4.38g), seed yield per hectare (14.58q), with good germination percentage (98.5), shoot length (12.46 cm), root length (20.66 cm), seedling vigour index (3264), seedling dry weight (226.30mg), test weight (32.55g) and lesser EC value (0.324 dSm^{-1}) was recorded in T_8 as compared to T_1 .