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Effect of different seed coatings and packaging on seed quality of maize (*Zea mays* L.) seeds during ambient storage condition

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Abstract
Seeds of three different varieties of maize (HQPM-1, HQPM-7 and BIO-9681) were obtained from IARI, New Delhi. After thorough cleaning and grading the maize seeds were well dried before storage and treated with synthetic polymer @ 9 ml per kg of seed, biocide (Neem oil @ 10ml / kg) and fungicide (Carbendazim) 12% @ 2.5 g/kg. Seeds were stored for 3, 6, 9, 12, 15 and 18 months respectively under ambient condition. The results revealed that, the seed treatment with polymer @ 9 ml + Neem oil @ 10 ml/ kg of seed observed significant maximum germination percentage, shoot length, root length, seedling length and higher vigor index. Seeds stored in cloth bag recorded significantly maximum seed quality parameters compared to plastic bag.

Keywords: *Zea mays*, seed coating, seed storability, polymer coating

Introduction
Maize belongs to poaceae family and is one of the major food and industrial crops of the world. Indian economy continued to receive great support through the commercial crop known as "The king of crops" worldwide [1, 2]. Along with wheat and rice maize provides at least 30% of the food calories in ninety four developed countries. Globally India is in fourth position in terms of area of cultivation and seventh in production of maize [3]. Since agriculture is season bound, the storage of seeds has become inevitable fodder a farmer, seed producer and breeder as the case may be it is a quite ubiquitous natural phenomenon that the seed being living entity loses its viability and vigor under storage as many biological unit due to many subtle detrimental changes such as physico-chemical change, faulty metabolism and accumulation of cytotoxic aldehydes [4-6], however, seed deterioration could be slowed down to some extent by treating them with certain fungicides, pesticides, chemical and biochemical which are known to alleviate seed deterioration during storage and to extend storage life of seed [7-10].
Seed coating technology has developed rapidly during the past two decades and provides an economical approach to seed enhancement [11]. An advantage of seed coating is that the seed enhancement material (fungicide and insecticide) is placed directly on the seed without obscuring the seed shape [12]. Seed coating with natural or synthetic polymers have gained rapid acceptance by the seed industry as a much safer coating material [13]. The storability of poly coated seeds has also to be investigated in order to determine the viability of seeds for long term. Polycoated seeds can be stored for long term, if adequate storage conditions are provided. The polymer coating with the negligible thickness of 84π over the seed coat provides protection from the imposed accelerated ageing, which include fungal invasion. It reduces chemical wastage, helps to make room for including all required ingredient, Protect the nutrient, oxygen suppliers and protect seed from fungal invasion and insect attack. By encasing the seed with thin film of biodegradable polymer, the adherence of seed treatment to the seed is improved, dust free handling, making treated seed both useful and environment friendly [14]. Deterioration is a universal phenomenon in any living beings which involves a series of change and finally ends with death of seeds. The process is the result of a complex interaction of time, environmental factors, intrinsic constituents and mechanisms in the field itself. McDonald [15] have highlighted the consequences of deteriorative changes in seed which include membrane degradation, accumulation of toxic metabolites, decreased enzymatic activity, lipid auto-oxidation, failure of repair mechanisms, genetic degradation, reduced yield, finally loss of germination or death [16].
The present work deals with the evaluation of seed quality parameters in response to different seed coatings and also towards the effect of packaging materials during storage.

A comprehensive analysis of all the factors has been performed, to provide a cost effective and natural solution to seed storage technology, particularly for maize seeds.

Materials and Method

The hybrid seeds of maize (HQPM-1, HQPM-7 and BIO-9681) were obtained from IARI, New Delhi, treated with synthetic polymer at 9ml/kg, biocide (neem oil at 10ml/kg) and fungicide (Carbendazim 12% at 2.5g/kg). Seeds were packed in normal polythene bag (700 gauge) and cloth bag, stored under ambient condition in the seed testing laboratory, SHUATS, Prayagraj for 18 months. The seeds were tested for following seed quality parameters.

Germination Percentage: It was determined as per ISTA rules for seed testing [17]. The seeds were placed in rolled paper towel. Hundred seeds of four replication were tested at a constant temperature of 25 ℃.

Plumule length: Ten normal seedlings were selected from the germination test at random in each replication on final count. The plumule length was measured from collar region to the point of attachment of cotyledons.

Radicle length: Ten normal seedlings were selected from the germination test at random in each replication on final count. The radicle length was measured from collar region to the tip of the primary root.

Seedling length: Sum of the root and shoot length constitute the seedling length and mean was calculated and expressed in centimeters.

Seed Vigor: It was calculated by adopting the formula as suggested by Abdul-Baki and Anderson [18] and expressed in whole number.

S.V.I. = Germination (%) × Mean seedling length (cm)

Results and Discussion

The results of the germination percentage, seedling length, seedling fresh weight, seedling dry weight, as well as vigor index of seeds of three varieties i.e. HQPM-1, HQPM-7 and BIO-9681 of maize during 0, 3, 6, 9,12,15 and 18 months of storage as influenced by various seed treatments such as biocide (Neem), Polymer (Polyselect™ 539C Blue Sparkle) and fungicide (Carbendazim) and different packaging material such as plastic bag and cloth bag are presented in Figures 1-5.

It is quite interesting to observe that all the treatments and packaging material shows significant influence on germination percentage of all the varieties at the end of 18 months storage period. Seeds treated with biocides in comparison with other treatments exhibited superiority in maintaining the seed quality throughout the storage period. The seeds treated with neem oil at 10 ml per kg of seed, have shown significantly higher seed quality parameters than the seeds treated with polymer at 9 ml per kg of seed and Carbendazim at 2.5 g per kg. The neem oil at 10 ml per kg of seed recorded significantly higher values for germination, shoot length, root length, seedling length, fresh weight, dry weight and vigor index indicating the superiority, over control and other treatments in maintaining the seed quality in storage in both cloth and plastic bags (Figures 1-5). Among the two packing material i.e. Plastic bag (700 gauge) and Cloth bag (as per seed certification standards), the rate of reduction in all the quality parameters from the beginning of the storage period till the end of 18th month of storage was observed lesser in seeds packed in cloth bag. After storage of 18 months variety HQPM-1 showed higher germination percentage, root length, shoot length, seedling length, fresh weight, dry weight and vigor index of seedling was recorded in seeds treated with biocide (Neem) which stored in cloth bag (51.50%, 9.95 cm, 5.71 cm, 15.66 cm, and 806.49% respectively) and lower in variety BIO-9681 stored in plastic bag of control (29%, 3.18 cm, 1.38 cm, 4.56 cm and 132.24 respectively), at the end of storage (Figures 1-5). Research findings reveal that seed quality parameters declined progressively with the increase in storage period. Seed ageing and deterioration of seed are irreversible, inexorable and inevitable process, but the rate of seed deterioration could be slowed either by storing the seeds under controlled condition or by imposing seed treatment with polymer coating along with seed treatment chemicals [19, 20]. As the controlled conditions involve huge cost, the seed treatment remains the best alternative approach to maintain the seed quality. Similar findings have been reported in literature [21, 22].

Conclusion

By the present investigation we can conclude that there is a great importance of proper storage techniques and their impact on seed quality parameters of maize seeds. The technique of seed treatments have a major role in protecting the seed during storage and can also play an important role in achieving uniform seedling emergence under certain conditions. By the present investigation we can say that during storage all the quality parameters deteriorate as with the time but by the treatments we can slow the speed of deterioration.

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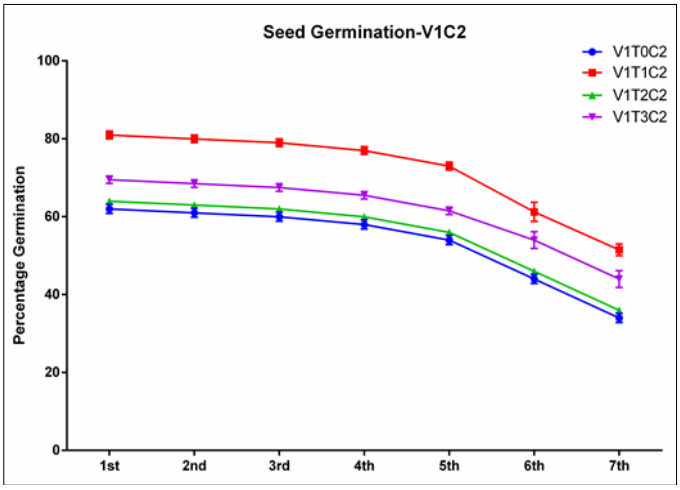

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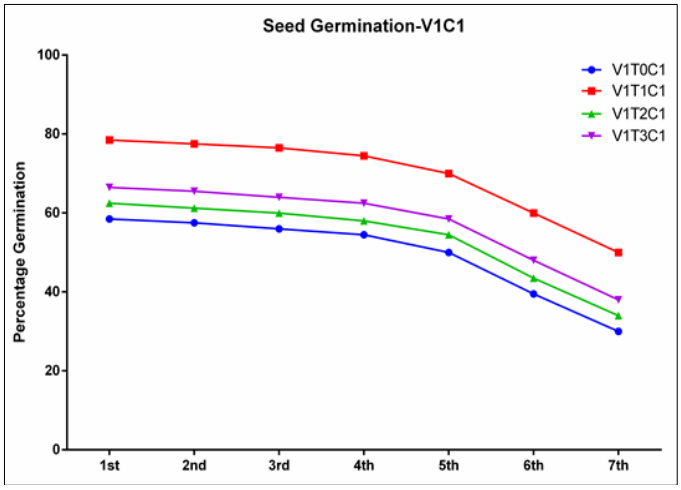

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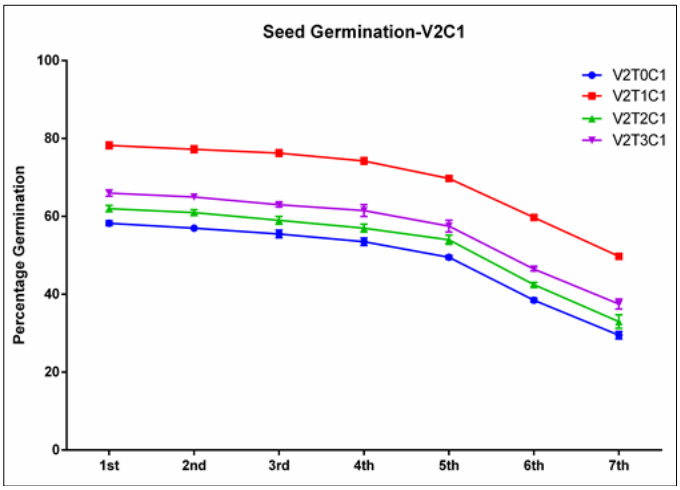

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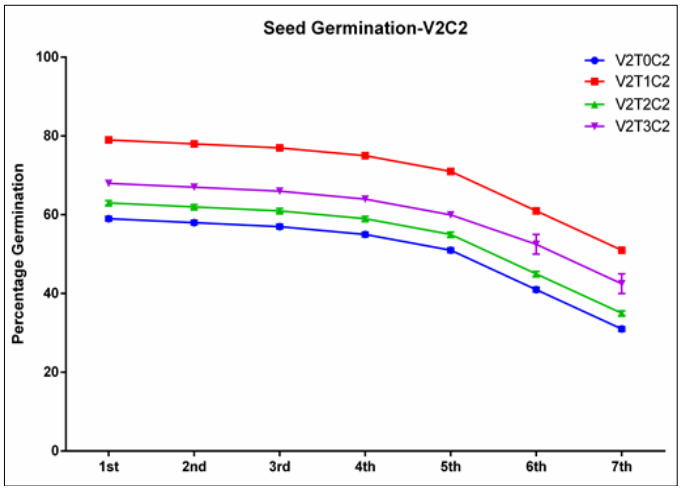

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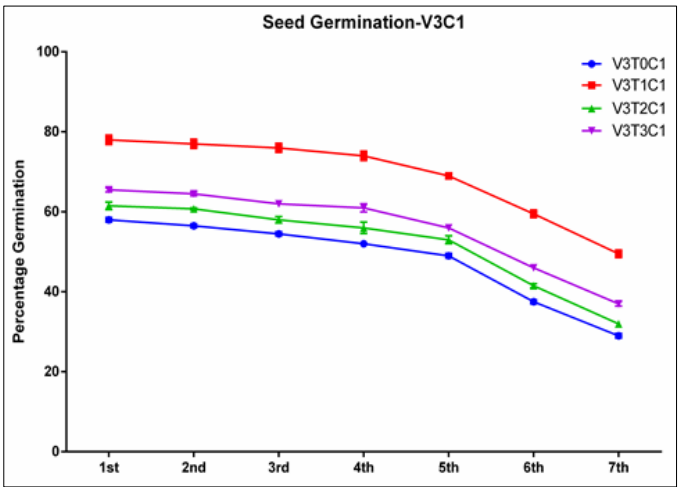

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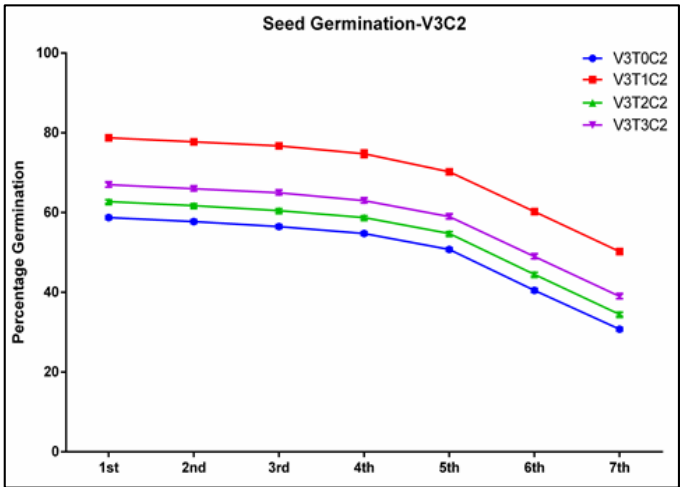
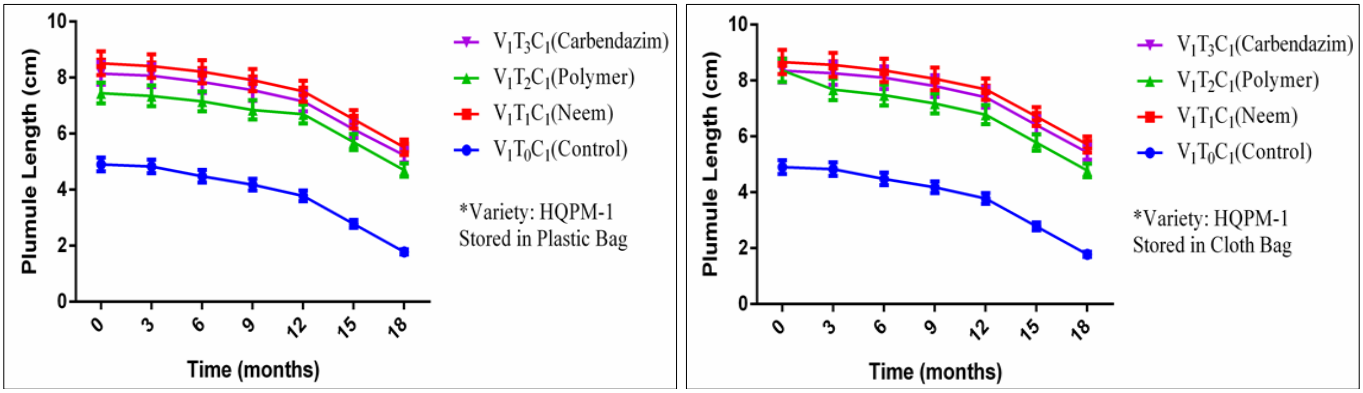


(f)

Fig 1: Effect of seed treatment and packaging material on germination % during storage, in maize (a)HQPM-1 (c) HQPM-7 (e) Bio-9681 with plastic bag (b)HQPM-1 (d) HQPM-7 (f) Bio-9681 with cloth bag



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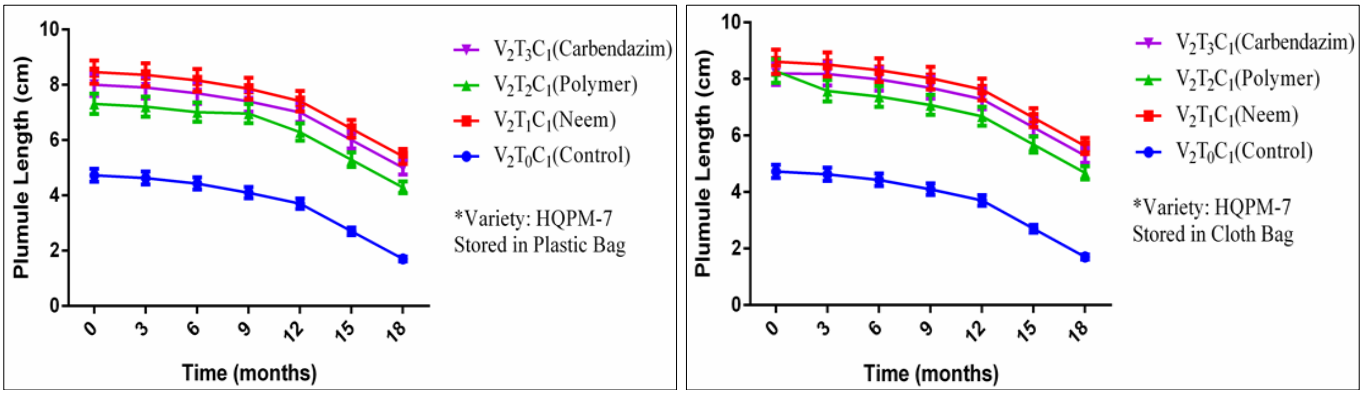

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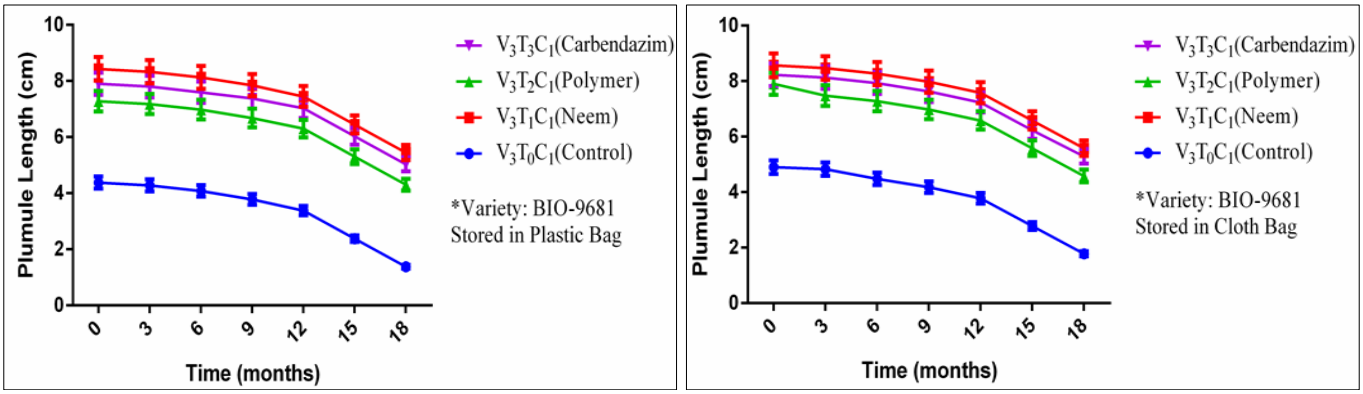

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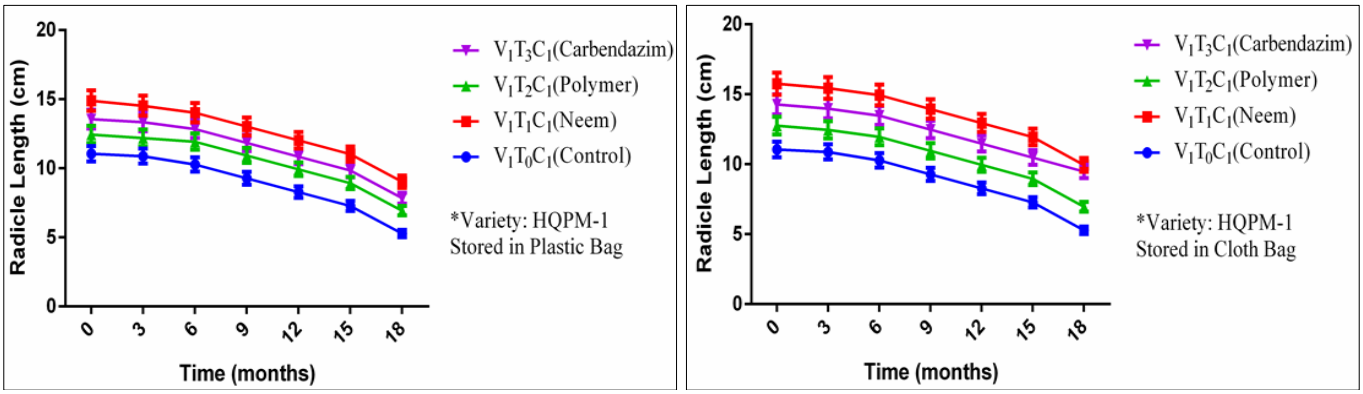
Fig 2: Effect of seed treatment and packaging material on Plumule Length during storage, in maize (a)HQPM-1 (c) HQPM-7 (e) Bio-9681 with plastic bag (b)HQPM-1 (d) HQPM-7 (f) Bio-9681 with cloth bag



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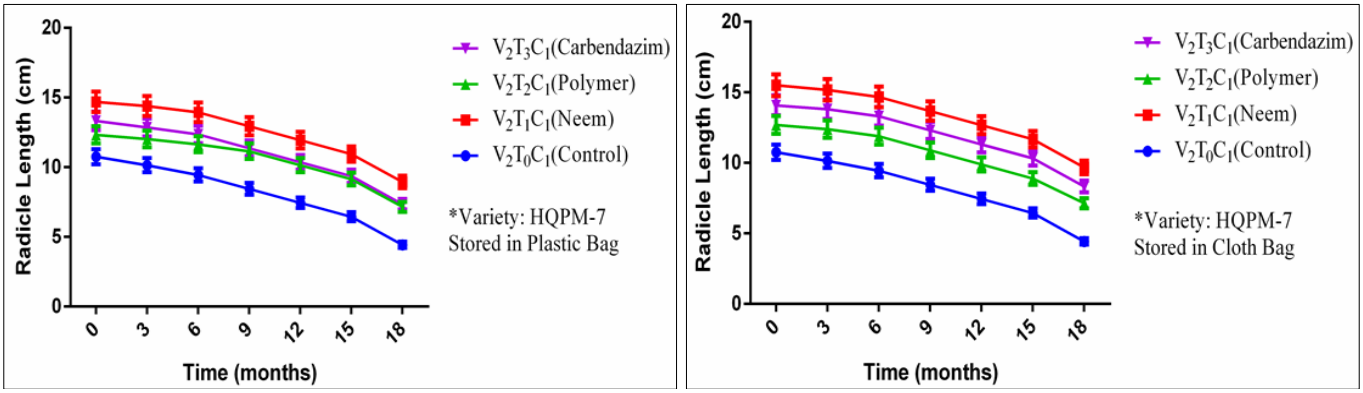

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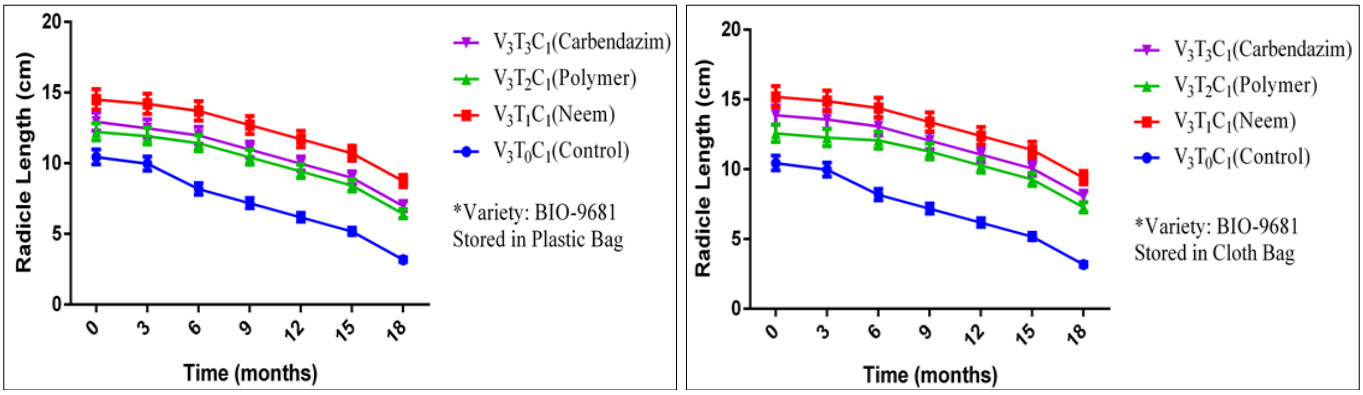

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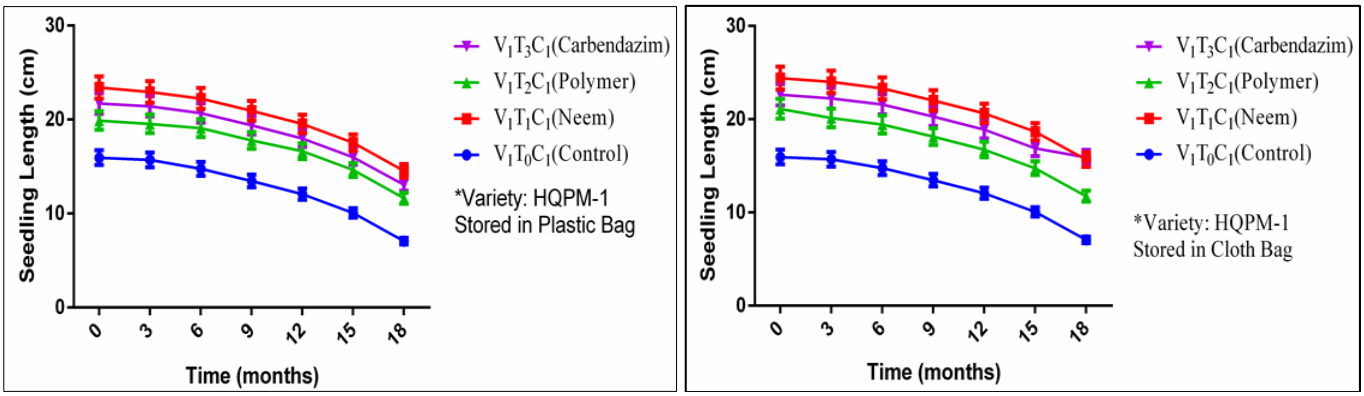
Fig 3: Effect of seed treatment and packaging material on Radicle Length during storage, in maize (a)HQPM-1 (c) HQPM-7 (e) Bio-9681 with plastic bag (b)HQPM-1 (d) HQPM-7 (f) Bio-9681 with cloth bag



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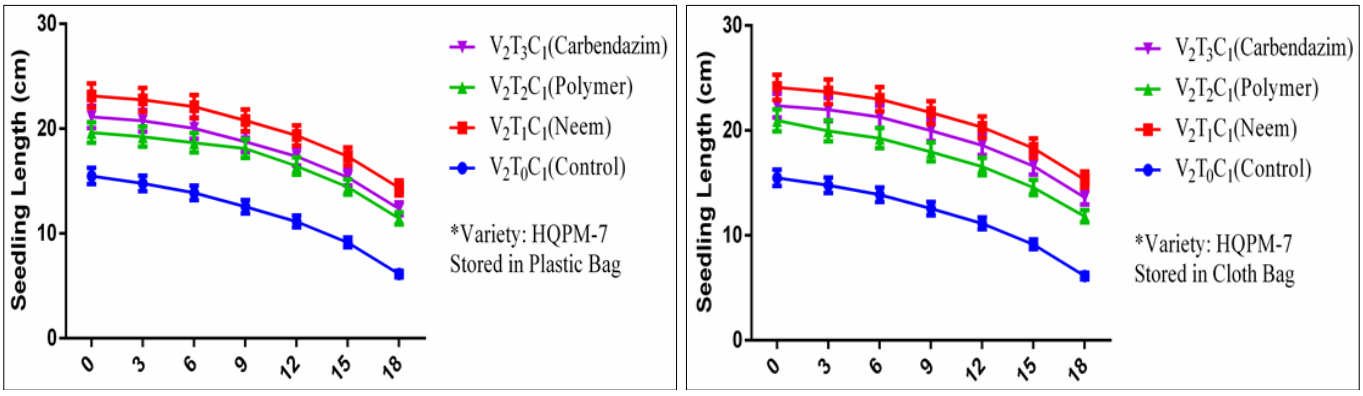

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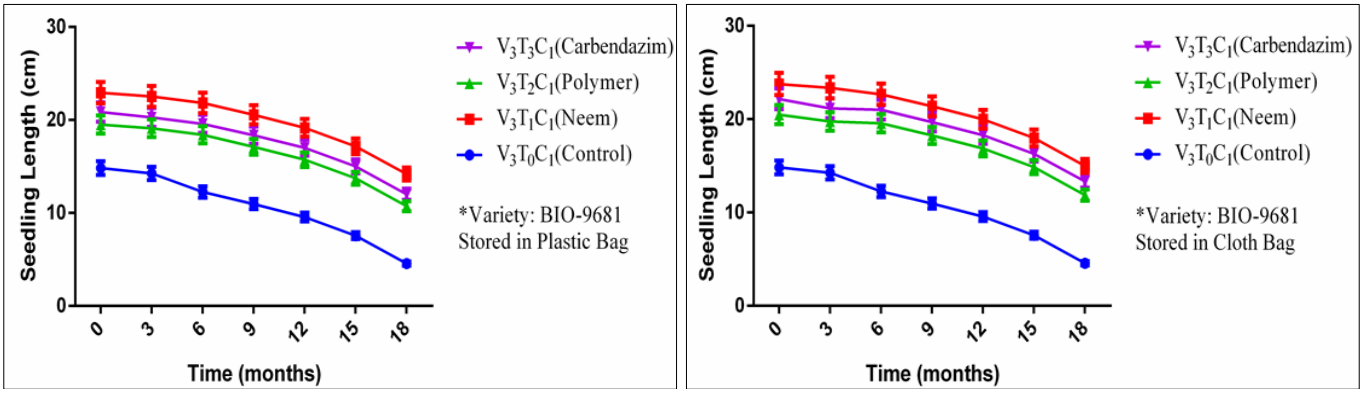

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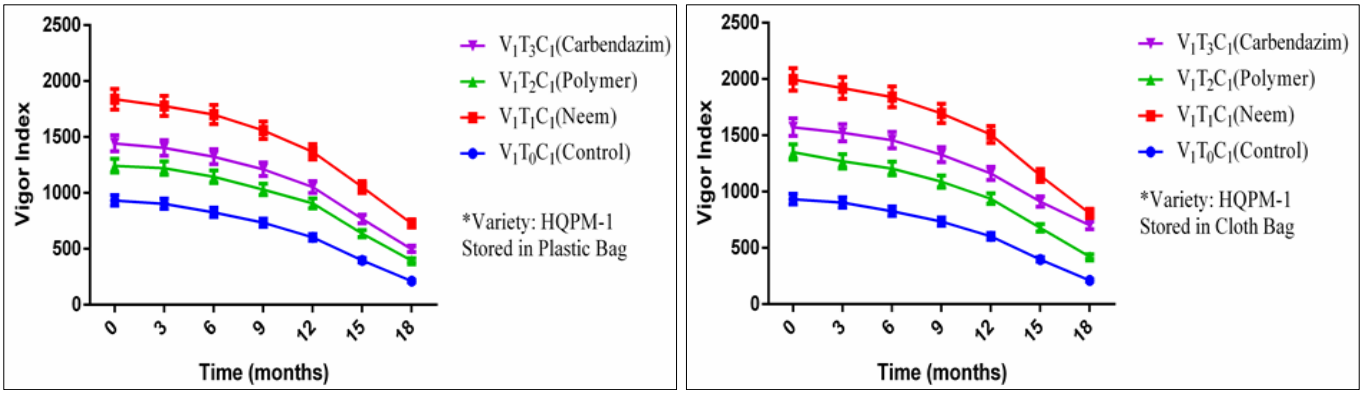
Fig 4: Effect of seed treatment and packaging material on Seedling Length during storage, in maize (a)HQPM-1 (c) HQPM-7 (e) Bio-9681 with plastic bag (b)HQPM-1 (d) HQPM-7 (f) Bio-9681 with cloth bag



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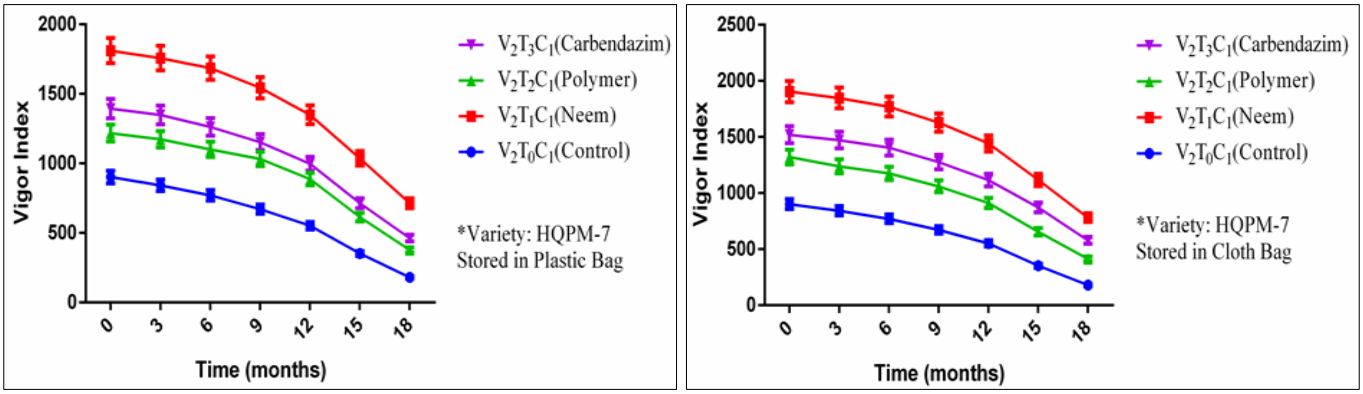

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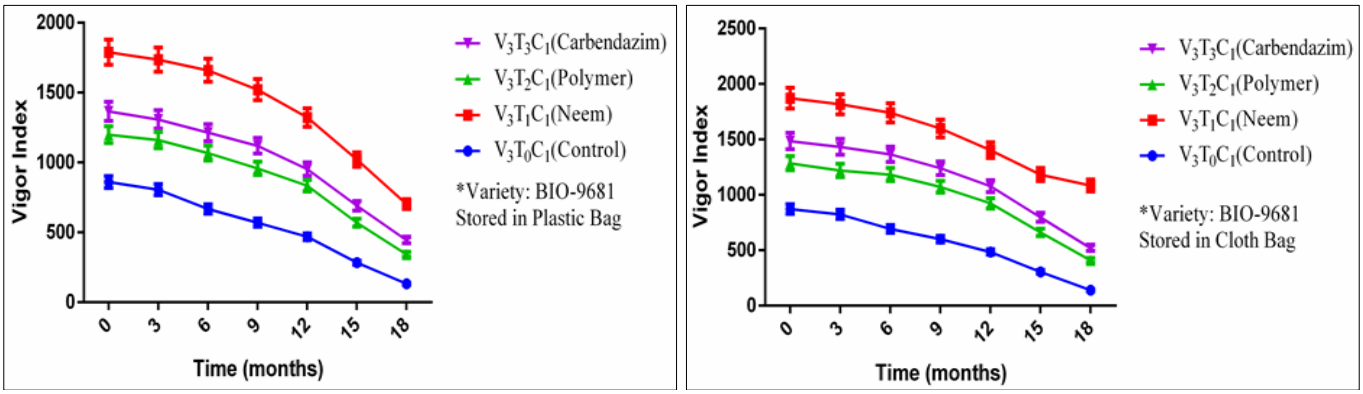

(e) (f)

Fig 5: Effect of seed treatment and packaging material on Seed Vigor Index during storage, in maize (a)HQPM-1 (c) HQPM-7 (e) Bio-9681 with plastic bag (b)HQPM-1 (d) HQPM-7 (f) Bio-9681 with cloth bag

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