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Influence of priming and packaging materials on quality attributes of African marigold (*Tagetes erecta* L.) seeds

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ABSTRACT

African marigold (*Tagetes erecta* L.) is a resilient flowering plant, valued for its vibrant blooms and pest-repellent properties. Seed priming involves pre-sowing treatments to enhance and synchronize germination. In African marigold, seed priming improves germination rates, seedling vigor and uniformity, ensuring more successful growth under varying conditions. Consequently, the present study focused on influence of priming and packaging materials on quality attributes of African marigold seeds. The experiment consisted of six priming treatments, *i.e.,* T_1-KNO_3 @ 0.1%, T_2-KNO_3 @ 0.5%, T_3-GA_3 @ 100 ppm, T_4-GA_3 @ 500 ppm, T_5- hydro priming for 2 h and T_6- hydro priming for 6 h, along with untreated control (T_7). Seeds were packaged into four distinct packaging materials, *viz.,* C_1-cloth bag (130 GSM), C_2-yellow paper bag (80 GSM), C_3- polythene bag (180 gauge) and C_4-aluminium bag (200 gauge). The experiment was laid out in factorial completely randomized design. Result exhibited that after 8 months of storage period, seeds treated with 0.5% KNO_3 and stored in aluminium bag (T_2C_4) recorded the highest relative growth index), while those treated with 500 ppm GA_3 and stored in aluminium bag (T_4C_4) recorded the highest seedling root length (cm), shoot length (cm), seedling fresh weight (mg) and dry weight (mg). Therefore, packaging of African marigold seeds in aluminium bag can effectively maintain seed quality and viability. Additionally, treating seeds with 0.5% KNO_3 improves germination, while GA_3 at 500 ppm enhances seedling physical attributes. By use of these techniques farmers can achieve healthy plants for quality flower production.

Key words: Gibberellins, aluminium bag, *Tegetes erecta* L., flower quality.

INTRODUCTION

Flowers, as natural botanical structures, exhibit aesthetic appeal and versatility, making them suitable for various occasions. Marigold is a member of the Asteraceae family, cultivated in India and one of the most important annual commercial flowers (Sudhagar, 14). It is indigenous to Mexico and was introduced to India in the 16th century. Marigold is also grown as a trap crop to control pest activity. The poultry industry extensively uses marigold petals as a natural source of xanthophylls pigment.

Good seed is the basic input for production (Patel *et al.*, 12). Now a days crop growers have frequently struggled with issues related to seeds, such as delayed germination, poor germination, unfavourable weather, dormancy, and low germination percentages, all of which contribute to decreased production (Bose *et al.*, 2). Optimum seed germination is a prime condition for good crop stand establishment, as seed is a fundamental factor in crop production. Over the past twenty years, a number of seed enhancement techniques have been used to improve the quality of the seed. These methods include priming, steeping, pre-germination, hardening, and pelleting. Among all the seed improvement methods, farmers most frequently employ seed priming. The purpose of seed priming is to synchronize emergence, which promotes uniform establishment and increased .yield, as well as to reduce the time of emergence. Priming initiates the early stages of germination but does not permit radicle protrusion and then the seeds are dried until needed (Farooq *et al.*, 4).

Marigold seeds exhibit a rapid decline in vigour and viability under ambient storage conditions from April to October in the Northern Plains. The Seed degrades with improper storage, thus it is essential to understand what kind of material is best for packaging (Figueroa *et al.*, 5).This can be achieved by alternative methods such as storing seeds with low moisture content in different containers such as cloth bags, polythene bags, aluminium foil bags and paper bags, along with seed priming with certain chemicals that will enhance the viability and vigour of seeds. It is well known that storage of seeds in moisture proof containers prevents fluctuations in moisture content, provides protection against contamination and

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mechanical damage and prevents the degradation of fungicides or pesticides. Before packaging, soaking seeds in certain chemicals will help maintain seed viability and extend their storage life.Keeping the same in view, the study was conducted to know the effect of priming and packaging on seed quality of marigold during storage.

MATERIALS AND METHODS

For the present study, seeds of African marigold variety Pusa Narangi Gainda were obtained from the Model Floriculture Centre, G. B. Pant University of Agriculture and Technology, Pantnagar, U. S. Nagar, Uttarakhand. The experiment was laid out in factorial completely randomized design, including 3 factors, 15 treatments and 3 replications.

Ten grams of seeds were soaked in each treatment solution as presented (Table 1) in a glass beaker at room temperature then placed separately in each beaker. Seeds were removed from priming solutions after specified time and re-dried for 48 at a moisture content of 10% (near the original weight). Ten gram seed was packed in each packaging materials, *viz.* Cloth bag, yellow paper bag, plastic bag and aluminum bag and kept for eight months storage under ambient conditions (Plate 1). The required quantity of seeds was drawn in alternate month from each bag for taking observations on seed quality parameters. Three replications of 100 seeds each were taken randomly from each treatment. Seeds were sown on moist filter paper in a petri dish. The samples were then being kept in the germinator at 25°C. The final count

Table 1. Details of experimental variables.

Factor 1: Priming treatments (T)	T_1 (0.1% KNO_3 for 6 h)
	T_2 (0.5% KNO_3 for 6 h)
	T_3 (100 ppm GA_3 for 6 h)
	T_4 (500 ppm GA_3 for 6 h)
	T_5 (Hydro-priming for 2 h)
	T_6 (Hydro-priming for 6 h)
	T_7 (Control)
Factor 2: Packaging Materials (C)	C_1 (130 GSM cloth bag)
	C_2 (80 GSM Yellow paper bag)
	C_3 (180 gauge plastic bag)
	C_4 (200 gauge aluminium bag)
Factor 3: Storage period (S)	S_1 (2 months)
	S_2 (4 months)
	S_3 (6 months)
	S_4 (8 months)

Plate 1. Priming solutions (a), Seed soaking (b), Seed drying (c), Seed packaging (d).

(Standard germination percentage) was recorded before removal of seedlings on the 8th day, the seedling length (cm) was measured with the help of a measuring scale and the mean root and shoot length (cm) was calculated. Seedling fresh weight and dry weight (mg)were recorded using an electronic balanceon the 8th day of seedling germination. The relative growth index was calculated using Brown and Mayer's method as follows:

$$RGI = \frac{\text{No. of seeds germinated (1st count)}}{\text{No. of seeds germinated (Final count)}} \times 100$$

RESULTS AND DISCUSSION

GA_3 at 500 ppm (T_4) exhibited the longest root length, ranging from (6.00 to 5.59 cm), throughout the storage period. It remains longest in aluminium bags (C_4) up to 5.44 to 4.87 cm. The highest (6.24 to 5.84 cm) seedling root length was observed in interaction $T_4 \times C_4$ after second to eight months respectively (Fig. 1). Similarly, in the second month, the highest (4.73 to 4.41 cm) seedlings shoot length was observed with GA_3 @ 500 ppm (T_4). Regarding packaging, it was maximum in aluminium bag (C_4) ranging from 4.63 to 4.36 cm. Among all interactions, the maximum (5.10 to 4.77 cm) seedling shoot length occurred in the combination of GA_3 @ 500 ppm and aluminium bag ($T_4 \times C_4$) throughout the eight months (Fig. 2.) The increased length after GA_3 priming might be due to the enhanced rate of cell division in the root and shoot tips stimulated by GA_3. The application and the corresponding studies corroborate the work of, (Kaya *et al.,* 7) in chickpea, and Kumar and Singh, (9) in bitter gourd, who similarly noticed increasing root and shoot lengths with GA_3 @ 500 ppm priming. This decline in seedling length, in respect of treatments and packaging materials used, could potentially be attributed to the lack of food mobilization in the aged seeds. Similar results were also reported by Kumar

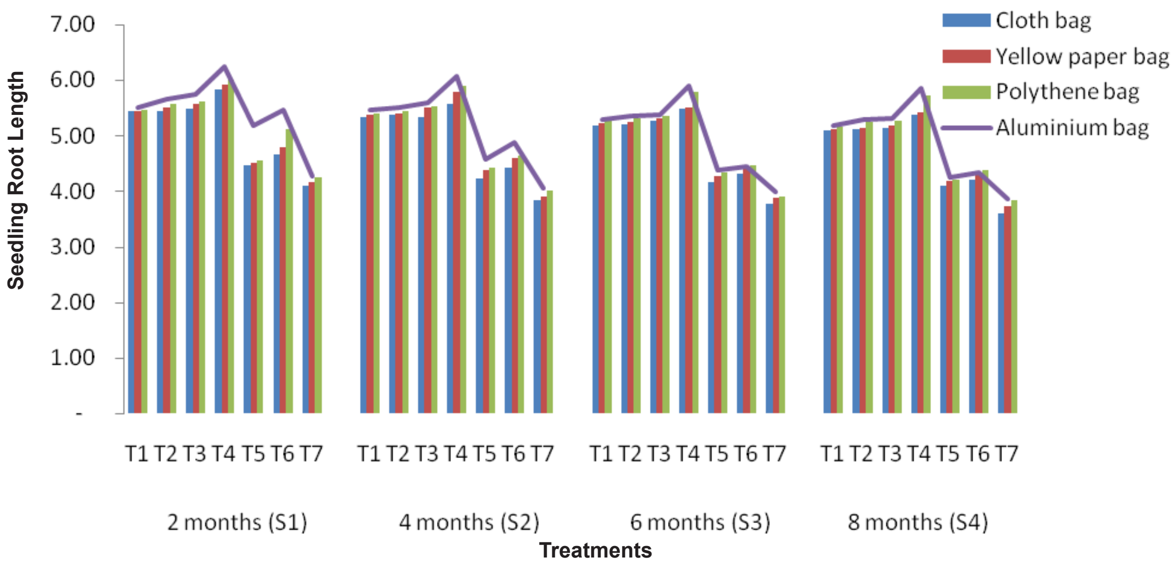

Fig. 1. Effect of priming and packaging on seedling root length (cm) of African marigold upto eight months storage.

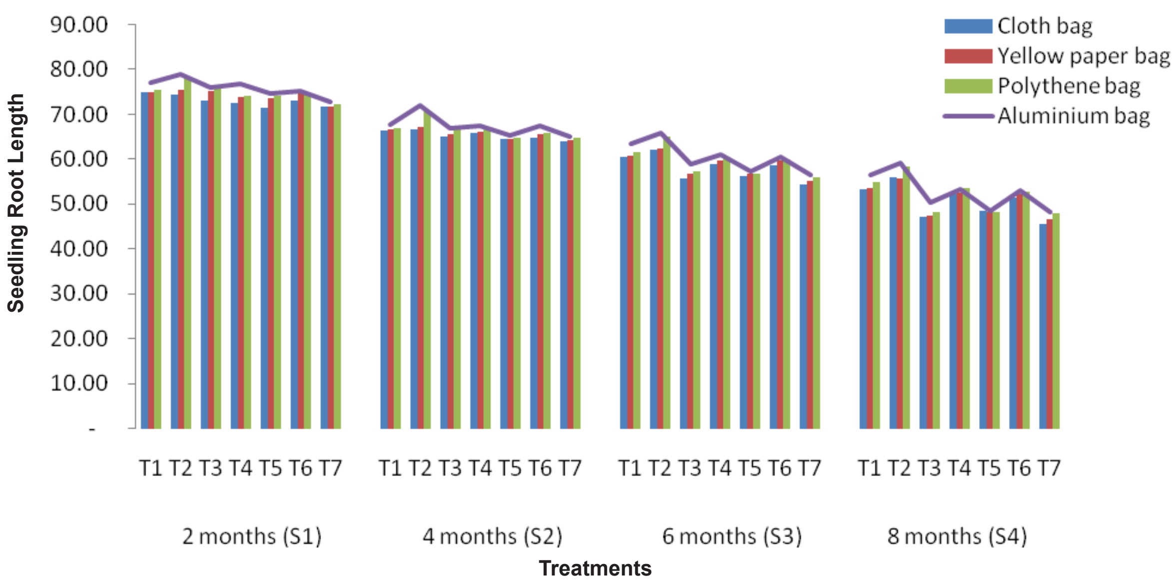

Fig. 2. Effect of priming and packaging on seedling shoot length (cm) of African marigold upto eight months storage.

et al., (10) in marigold and (Khalequzzaman *et al.*, 8) in French bean.

In the second month, highest (36.04 to 35.56 mg) seedling fresh weight was in GA_3 @ 500 ppm treated seeds (T_4). Seeds stored in aluminium bags (C_4) had the highest (35.42 to 34.84 mg) seedling fresh weight. The combination of GA_3 @ 500 ppm treatment and aluminium bags ($T_4 \times C_4$) showed the maximum seedling fresh weight of 36.24 mg in the second month, decreasing to 35.77 mg after eight months Fig. 3. Maximum seedling dry weight of 4.38 to 3.96 mg also found in GA_3 @ 500 ppm treated seeds (T_4). Seeds stored in aluminium bags (C_4) had highest (4.13 to 3.64 mg) seedling dry weight during the entire storage period. The combination of GA_3 @ 500 ppm treatment and aluminium bags ($T_4 \times C_4$) resulted in maximum seedling dry weight ranging from 4.43 to 4.04 mg throughout eight months storage Fig. 4. The significant increase in dry weight of the seedlings treated with GA_3 @ 500 ppm compared to the control can be attributed to the stimulatory effect of GA_3 on cell elongation and division. This stimulation results in enhanced growth, ultimately leading to greater biomass accumulation in the treated seedlings. These results are in line with results of Zahedi (15), who also found the highest

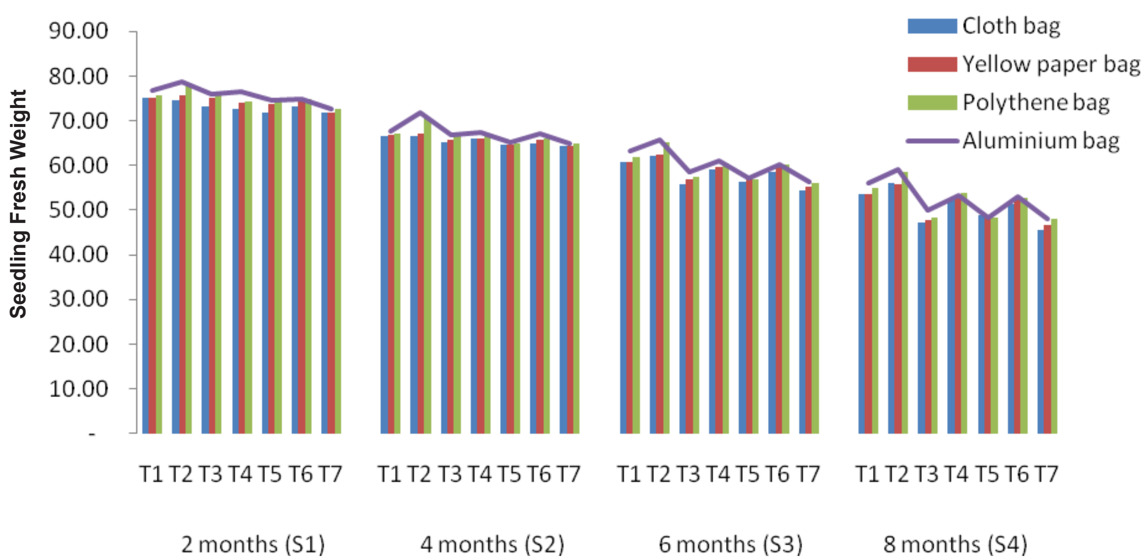

Fig. 3. Effect of priming and packaging on seedling fresh weight (mg) of African marigold upto eight months storage.

Fig. 4. Effect of priming and packaging on seedling dry weight (mg) of African marigold upto eight months storage.

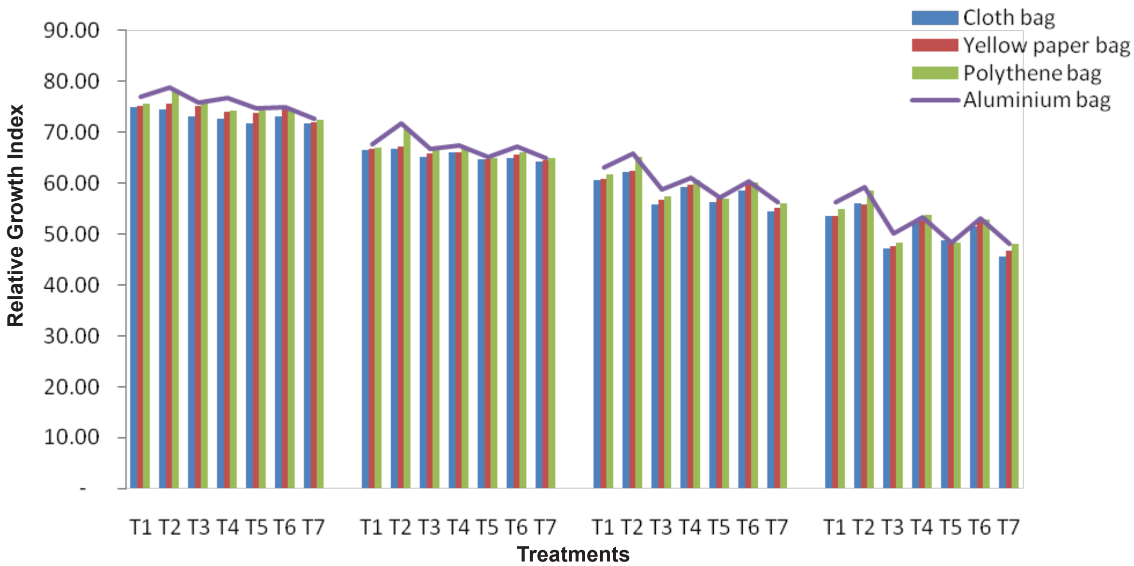

Fig. 5. Effect of priming treatments and packaging on relative growth index of African marigold upto eight months of storage.

fresh weight and dry weight of the radicle and plumule with GA_3 in *Dianthus barbatus* and (Hunje *et al.,* 6), reported that aluminium bag showed significantly higher dry weight and fresh weight in chilli seeds. The reduction in both dry weight and fresh weight of the seeds after two, four, six and eight months is likely due to natural seed aging and the gradual loss of moisture and nutrient reserves overtime (Dhatt and Ramesh, 3).

Seeds treated with 0.5% KNO_3 (T_2) displayed consistently higher 76.87 to 61.24 growth rates, favorable growth conditions were also observed with seeds stored in aluminium bag (C_4) which maintained a maximum (75.82 to 57.71) growth index during the entire storage period. The combined effect of KNO_3 @ 0.5% treatment and aluminium bag storage ($T_2 \times C_4$) showed the highest 78.82 to 63.13 relative growth index throughout the eight months Fig 5. The possible reason for the observed results is that the combination of seed treatment with KNO_3 0.5% and storage in aluminium bag created an optimal environment for seed germination Meseret (11). However the relative growth index is directly affected by the speed of germination; a faster germination rate generally leads to a higher growth rate. The findings from (Selvarani *et al.*, 13) in onion and (Basavegowda and Nanjareddy, 1), in groundnut seeds also suggest that seeds stored in aluminium bag led to increased speed of germination and higher growth rate.

Based on the above findings of present investigation, it can be concluded that priming treatments, packaging materials and storage environment, all determine the storability of African marigold seeds. The aluminium bags (200 gauge) proved to be the best packaging material for seed quality parameters and viability of African marigold seeds for longer storage period at ambient conditions. For optimal results, farmers should use KNO_3 @ 0.5 per cent to enhance germination, while GA_3 @ 500 ppm can be applied to improve seedling growth and physical parameters, ensuring better seed health over time.

AUTHORS' CONTRIBUTION

Conceptualization (VKR); Methodology (BP); Investigation (GC); Data curation and Formal analysis (VKR, BP); Writing original draft (GC).

DECLARATION

The authors declare that they do not have any conflict of obligation.

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