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Effect of halo-priming on germination and vigor index of cabbage (*Brassica oleracea* var. *capitata*).

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Abstract: Vigor is an important biological property of seeds, which determines the potential for uniform emergence and development of normal seedlings even under adverse field conditions. Uniformity in crop stand establishment is mandatory in all vegetable crops and can be achieved by improving seed quality. There are different seed vigor enhancement techniques, priming is one of those. This study was envisaged to profile the effect of halo-priming on germination and vigor related traits of the two cabbage cultivars, Golden Acre and Green Ball. Results depicted that priming with different concentrations of salts i.e. KNO_3, KH_2PO_4, KCl, NaCl, $MgCl_2$ and $MgSO_4$ significantly improved germination percentage, vigor index, fresh and dry weights and decreased mean germination time, except $CuSO_4$, which negatively affected germination and vigor of cabbage seeds. It was observed that halopriming increased final germination of cultivar Green Ball but did not have significant impact on cultivar Golden Acre, which had high germination (100%) in untreated seeds. KNO_3, KH_2PO_4 and KCl had better impact on all parameters than other salts used, which may be attributed to the presence of potassium in these salts. The two cultivars responded differently to NaCl and KNO_3 as priming agents except KNO_3 used @ 1%, while, this difference in response of both cultivars was less pronounced for $MgSO_4$ and $MgCl_2$ and negligible for $CuSO_4$. Results depict that germination and vigor of less vigorous cabbage seed can be enhanced by priming in KNO_3 (1%) and KH_2PO_4 (2%).

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1. Introduction

High germination rate is a prerequisite for the fast and uniform seed germination that combined with the optimal agro technical events, guarantees good growth. Non-uniform germination and seedling emergence have direct influence on productivity even of transplanted vegetable crops. It results in variable sized seedlings which ultimately affects the crop maturity. Extended emergence periods predispose the planting bed to increased soil compaction, particularly under adverse environmental conditions. Rapid and uniform crop emergence is an essential prerequisite to increase yield, quality and ultimately profits (Kaur et al., 2005). Seeds of numerous vegetable and ornamental crop species have been primed successfully. Improved seed priming techniques are used to reduce emergence time, accomplish uniform emergence, better allometric (changes in growth of plant parts over time) attributes and a healthy crop stand in many horticultural and field crops (Ashraf and Foolad, 2005; Khan et al., 2012). Seed enhancement through seed priming has led to great improvements in growers' ability to achieve his goal in both the field and greenhouse. Priming also improves the performance of deteriorated and low vigor seeds due to metabolic repair of the membranes (Thornton and Powell, 1992).

A healthy crop is desirable in direct seeded vegetables to ensure good quality of the produce and is affected by a number of environmental and cultural factors (Ziaf et al., 2014). Variable seed quality leads to prolonged emergence time and non-uniformed nursery stand of cabbage. Such variable sized seedlings, when transplanted, produce variable sized heads which cannot be harvested and marketed at one time. Moreover, single mechanized harvesting of such crop need vigorous grading; otherwise fetch low price. Therefore, Thornton and Powell (1992) reported improvement in quality of hydro primed seeds of *Brassica oleracea*. A number of seed treatments had been used to enhance the performance of seeds in several crops. Present study was designed to identify the most effective concentrations of salts that can be used in halopriming to induce uniform germination and vigor of cabbage seeds. But, it is well established now that leakage of electrolytes is very high from poor quality

aged seeds, when placed in pure (distilled) water. But addition of salts or other osmolytes, reduces the rush of water into the seed and thus repair the damaged membranes without carrying excessive leakage of solutes.

2. Material and Methods

Two cabbage cultivars namely Golden Acre (GA) and Green Ball (GB) differing in their germination percentage and vigor under normal growing conditions were used as experimental material. Various salts were used for priming including KCl, KNO_3, NaCl, KH_2PO_4, $MgCl_2$, $MgSO_4$ and $CuSO_4$ at concentrations of 1%, 2% and 3% of each salt. After priming, seeds were dried. One hundred seeds from each treatment were cultured in Petri dishes on double sheet of Whattman No. 1 filter paper, moistened with 4 ml distilled water and placed in an incubator (Isuzu Seisakusho, Co., LTD, Japan) at 25±2ºC.

Germination was recorded on daily basis and seed with 2 mm radicle protrusion was considered as germinated. Data for final germination (%), radicle and plumule lengths, fresh and dry weights of seedlings was recorded after seven days. Mean germination time (MGT) was calculated according to the equation of Ellis and Roberts (1981):

$$MGT = \frac{\sum Dn}{\sum n}$$

Where 'n' is the number of seeds, which were germinated on day D, where D is number of days counted from the beginning of germination. Vigor index (VI) of the cabbage seeds in response to various seed priming treatments was calculated by the following formula:

Vigor Index = Final Germination (%) × Total Seedling Length (cm)

Experiment was conducted in a completely randomized design under factorial arrangements and four replicates. The recorded data was analyzed statistically using general linear model of STATISTICA 5.5 and treatments means were separated using DMR test ($\alpha = 0.05$).

3. Results

Priming with different concentrations of various salts significantly influenced all germination and vigor indices in two cabbage cultivars. Final germination (%) and germination index was not increased by any priming treatments over control in both cabbage cultivars rather decreased final germination percentage (FGP) value except KNO_3 (1%) which enhanced FGP values of cv. Green Ball over the control (Fig. 1 and 2).

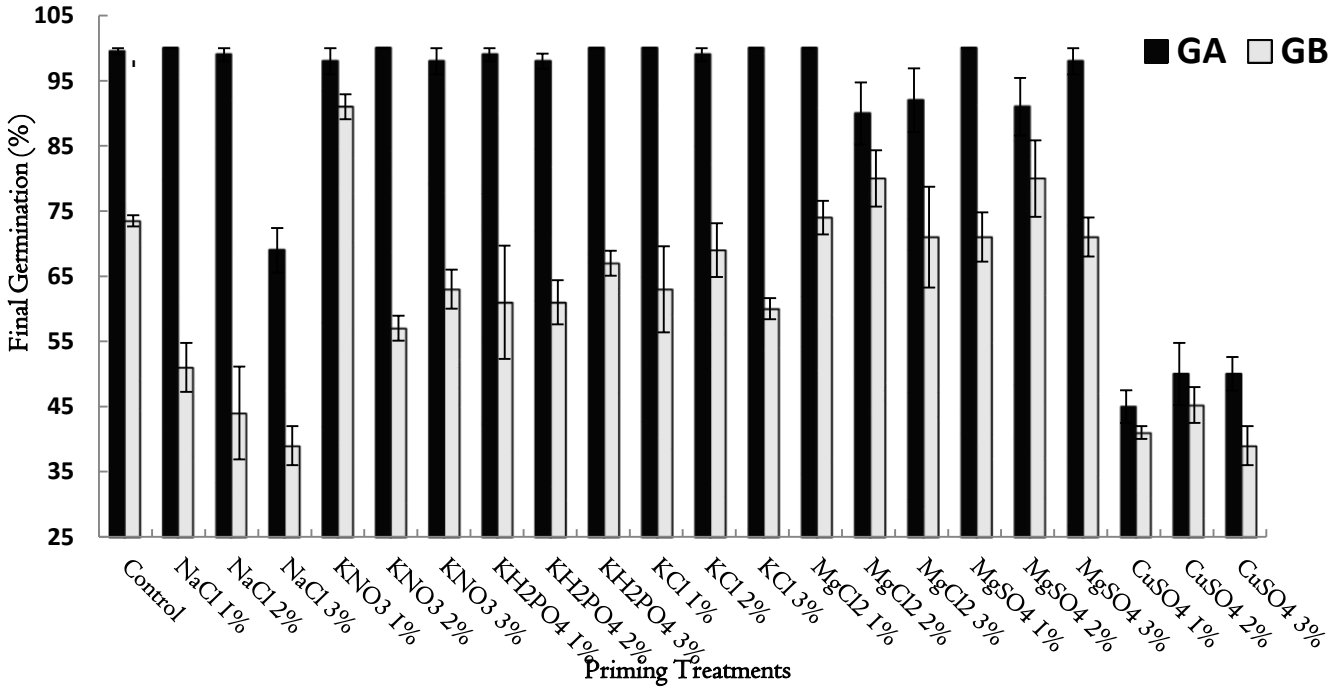

Fig. 1: Effect of halopriming treatments on final germination percentage of two cabbage cultivars Golden Acre (GA) and Green Ball (GB).

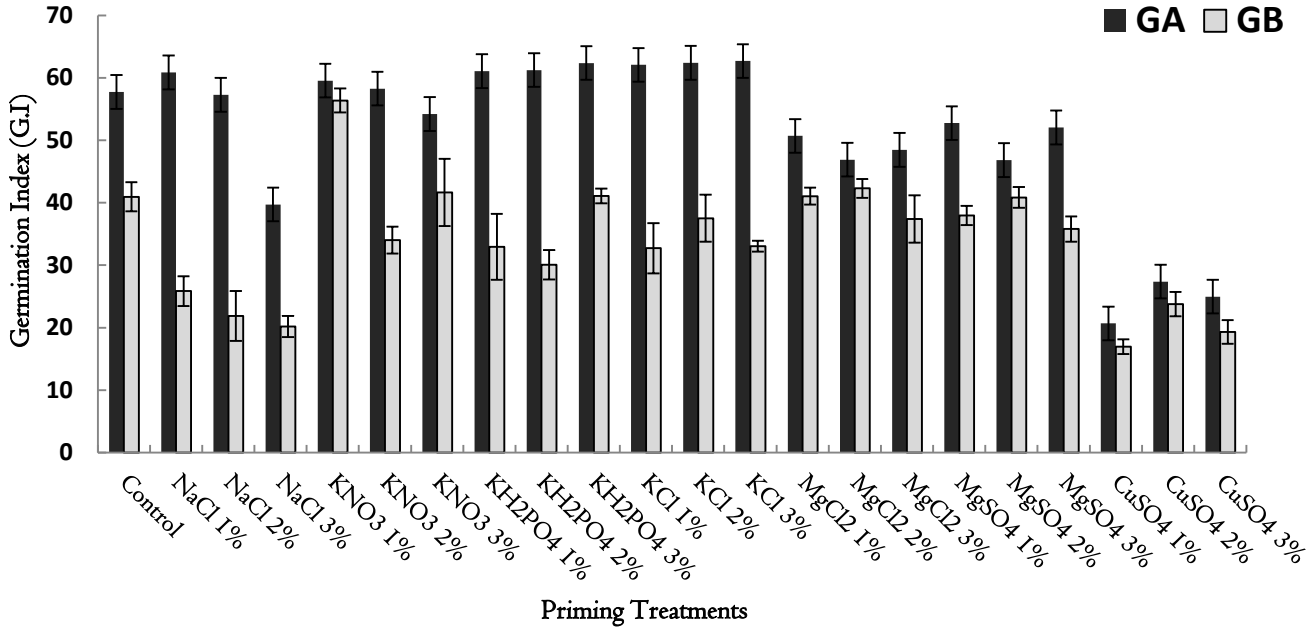

Fig. 2: Effect of halopriming treatments on germination index of two cabbage cultivars Golden Acre (GA) & Green Ball (GB).

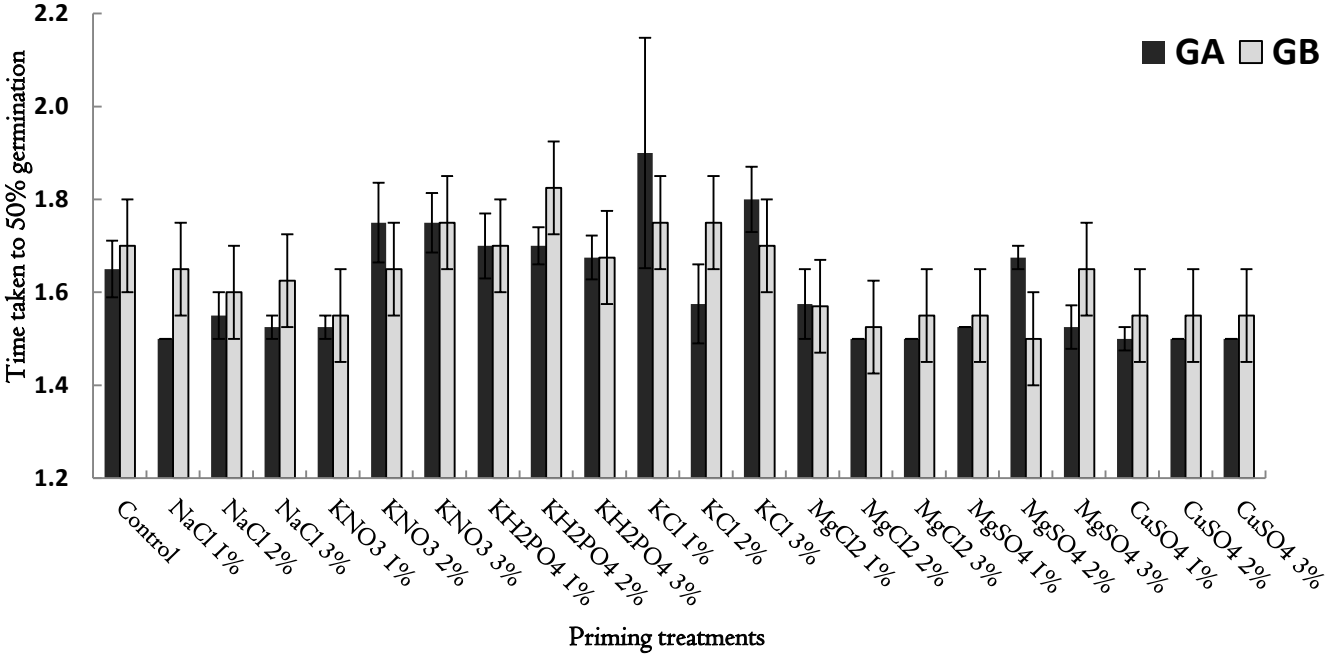

Fig. 3: Effect of halopriming treatments on time taken to 50 percent germination of two cabbage cultivars Golden Acre (GA) and Green Ball (GB).

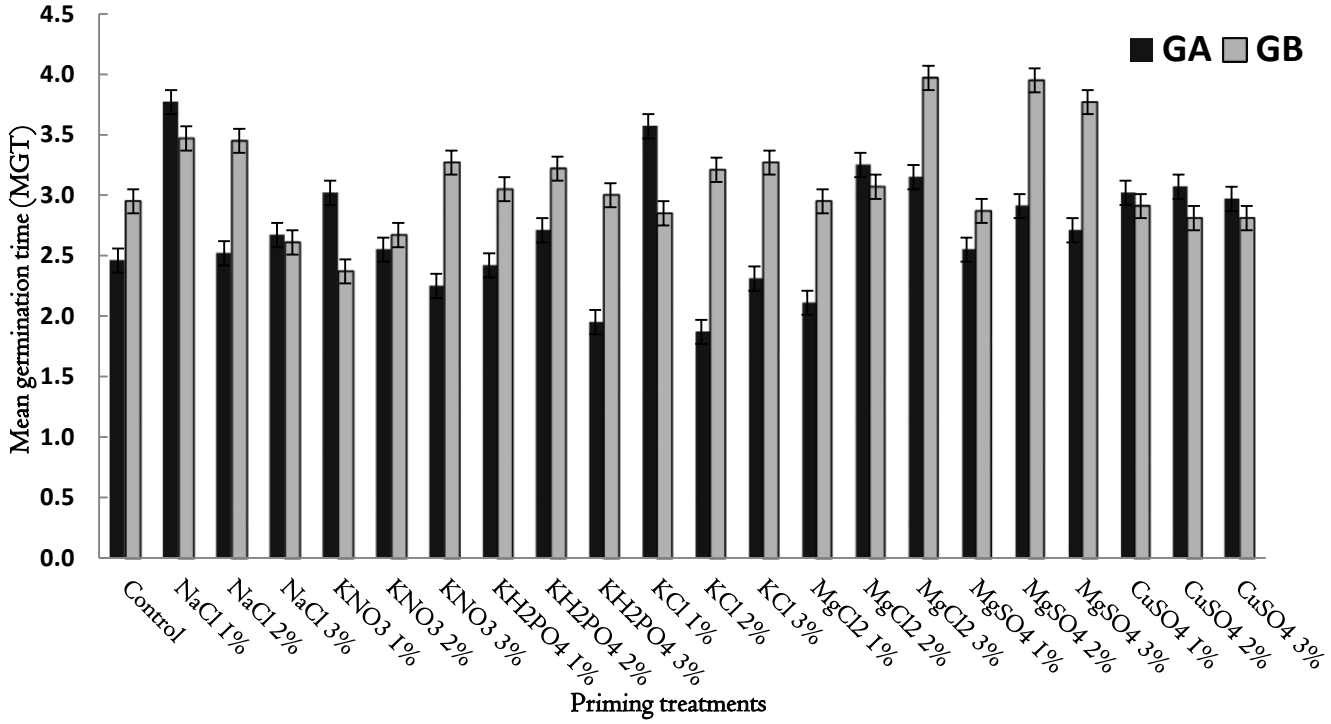

Fig. 4: Effect of halopriming treatments on mean germination time of two cabbage cultivars Golden Acre (GA) & Green Ball (GB).

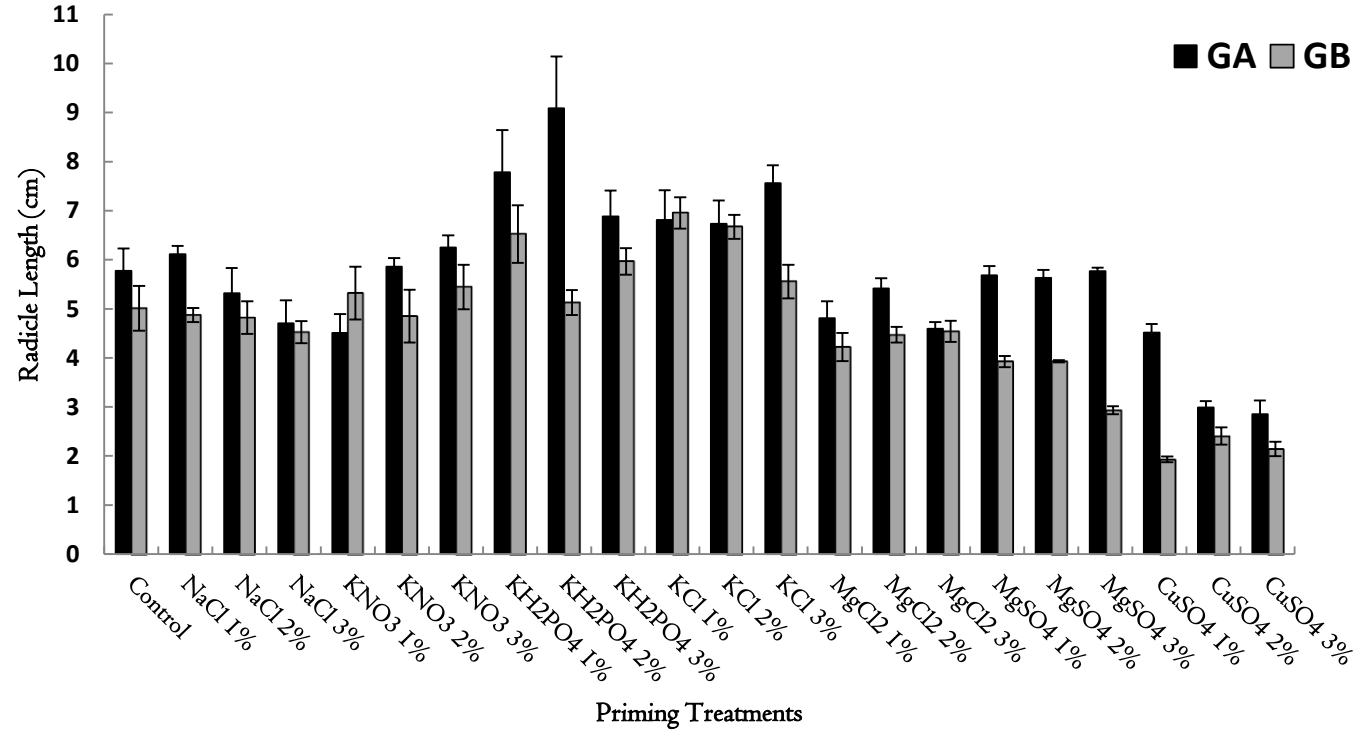

Fig. 5: Effect of halopriming treatments on root length of two cabbage cultivars Golden Acre (GA) & Green Ball (GB).

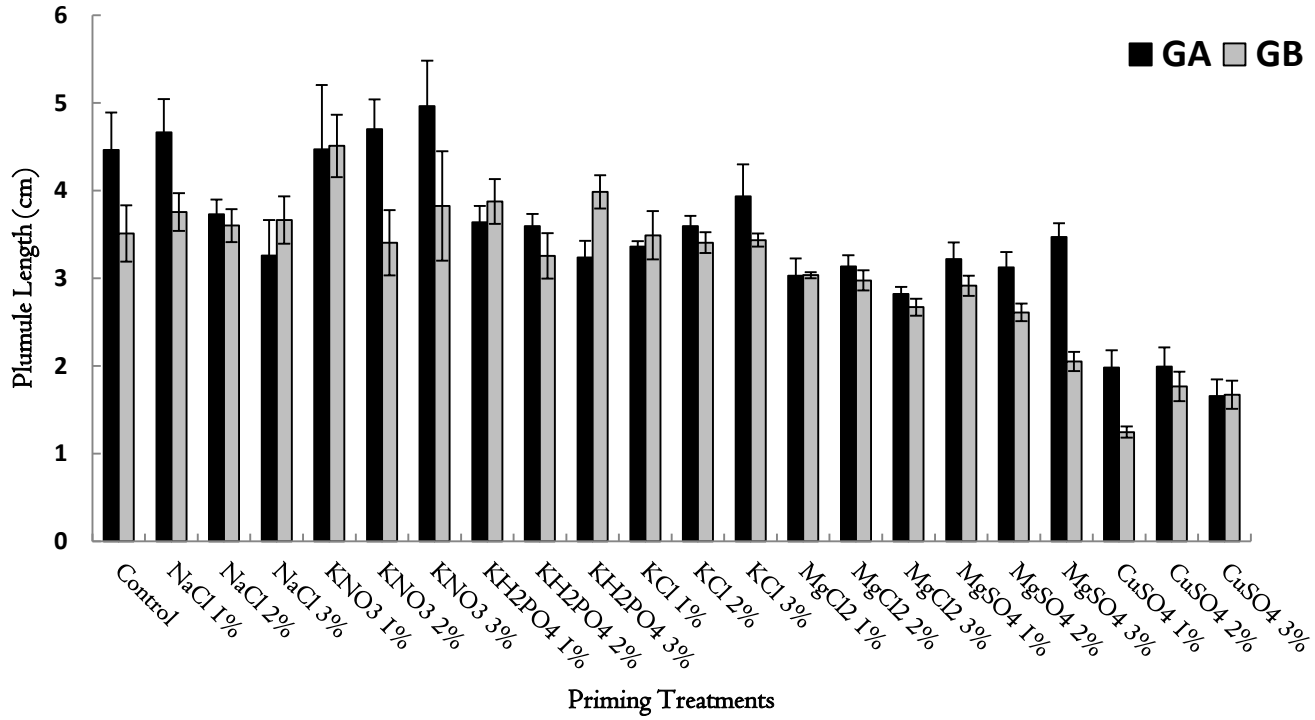

Fig. 6: Effect of halopriming treatments on shoot length of two cabbage cultivars Golden Acre (GA) & Green Ball (GB).

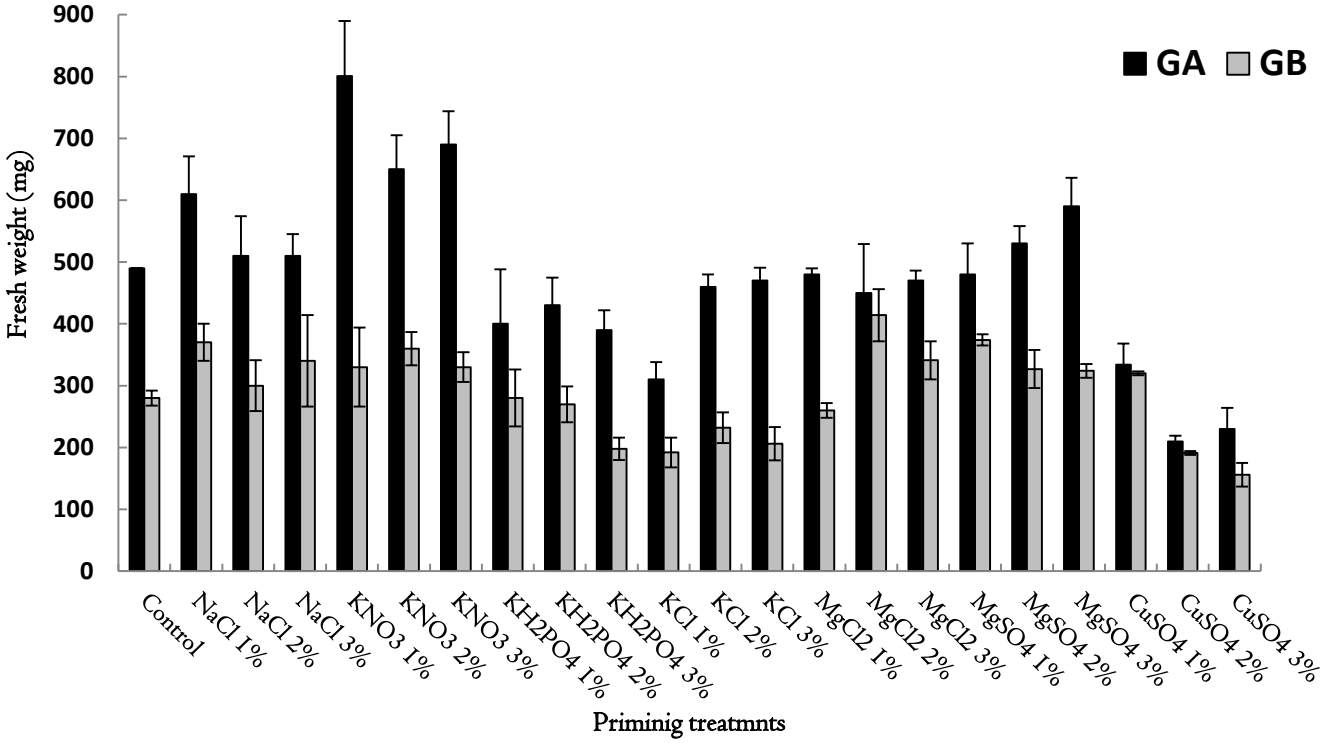

Fig. 7: Effect of halopriming treatments on fresh weight of two cabbage cultivars Golden Acre (GA) & Green Ball (GB).

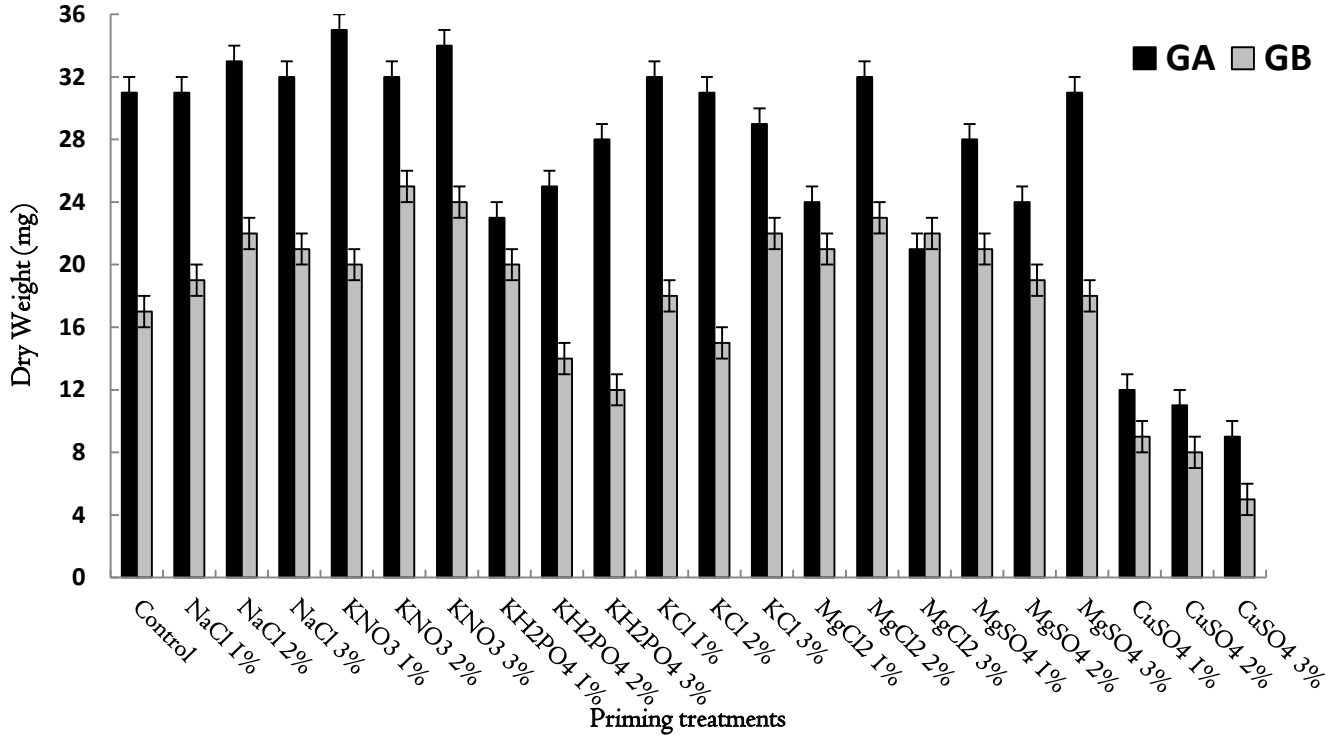

Fig. 8: Effect of halopriming treatments on dry weight of two cabbage cultivars Golden Acre (GA) & Green Ball (GB).

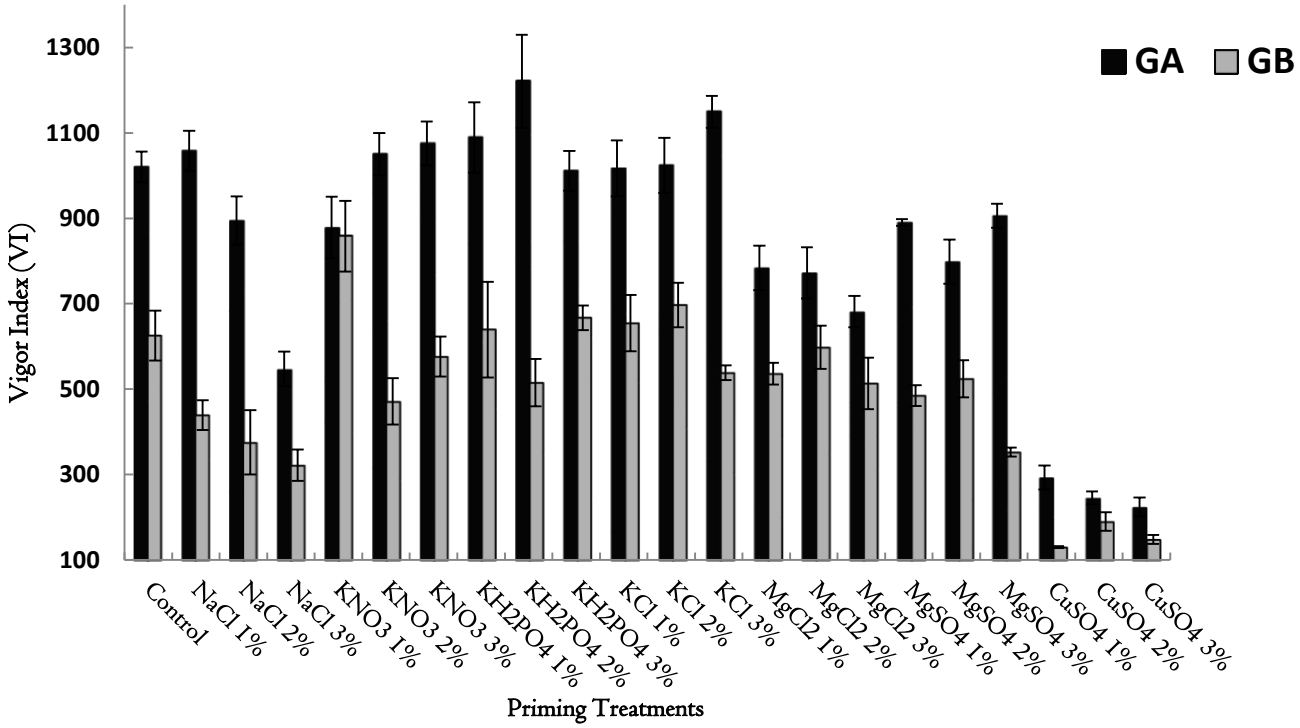

Fig. 9: Effect of halopriming treatments on vigor index of two cabbage cultivars Golden Acre (GA) and Green Ball (GB).

Time taken to 50% germination was significantly decreased in both cultivars when seeds were primed in various salt solutions except KNO_3 (2 and 3%), KH_2PO_4 (1, 2 and 3%) and KCl 1% (Fig. 3). Both cabbage cultivars behaved differently in response to priming treatments for MGT. Mean germination time value of Golden Acre was significantly decreased when seeds were primed in KCl (2%) while, Green Ball seeds primed in KNO_3 (1%) showed the least value of MGT (Fig. 4).

Radicle length of Golden Acre was significantly increased in response to seed priming with KH_2PO_4 (1, 2 and 3%) and KCl (1, 2 and 3%); KH_2PO_4 (2%) yielded the maximum value. Maximum increase in radicle length of Green Ball was recorded for seeds primed in KCl (1%) followed by KCl2 and KH_2PO_4 (Fig. 5). Maximum improvement in plumule length of Golden Acre was recorded in KNO_3 (3%) primed seeds while, that of Green Ball was maximum in KNO_3 (1%) primed seeds. Most of the priming treatments significantly decreased plumule length but more reduction in plumule length was observed when seeds were primed with $CuSO_4$ (Fig. 6).

Fresh and dry weight of Golden Acre seedling was maximum in seeds primed with KNO_3 (1%) while, maximum fresh and dry weight of Green Ball seedlings was noticed in $MgCl_2$ (2%) (Fig. 7 and 8). Vigor index of both cabbage cultivars was not significantly enhanced in response to priming except KNO_3 (1%) and KH_2PO_4 (2%) which substantially improved seedling vigor of Green Ball and Golden Acre, respectively (Fig. 9).

4. Discussion

Uniform stand in both nursery and field is mandatory to achieve uniformity in crop maturity and quality of vegetable crops. Response of a crop to priming is much dependent on composition of priming medium and duration. We, therefore, evaluated a range of salts at different concentration to check their potential to enhance germination and vigor of two cabbage cultivars, previously reported to be differing in their germination and vigor.

It was evident from results that KNO_3 (1%) significantly improved germination and vigor related traits in both cultivars. KH_2PO_4 (1 and 2%), KCl (1%) and $MgCl_2$ (2%) also proved as better priming agents than other salts used in this study. KNO_3 has been used in several crops for example Soybean (Mohammad, 2009), Tomato (Amjad et al., 2007; Nawaz et al., 2011), bitter gourd (Renugadevi et al., 1994) and cotton (Sudarshan et al., 2006). Though KNO_3 significantly improved performance of both cabbage cultivars but radicle growth was more in KH_2PO_4 (2%) primed seeds that can be due to availability of phosphorus that promotes root growth in crop plants. Jagadesh et al. (1994) also observed significant improvement in seedling size of tomato, capsicum and onion seeds when primed in KH_2PO_4. Lee et al. (1997) reported reduction in T_{50} of capsicum when KNO_3 was used to prime seeds and strengthen our results. It is now well established fact that potassium increases membrane integrity in crop plants both under normal and stress conditions. Addition of potassium source in priming medium helps in repairing the damaged membranes of low vigor seeds as was observed in Green Ball. From these results, it can be concluded that KNO_3 (1%) and KH_2PO_4 (2%) can be successfully employed in priming of low and moderate vigor cabbage seeds, respectively, It will ensure uniform crop stand in nursery and uniform maturity to facilitate single harvest of cabbage crop. On the other hand, $CuSO_4$ significantly reduced major indices studied. The present study suggests that halopriming improved rapid and uniform seedling emergence.

5. Conclusion

Germination capacity is an important biological property of seeds to be used for sowing. High germination rate is a prerequisite for the fast and uniform seed germination that combined with the optimal agro technical events, guarantees good growth, the present study suggests that halopriming improved rapid and uniform seedling emergence.

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Competing Interests

The authors declared that they have no conflict of interest about the contents of this article

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