Effect of Seed Priming with ZnSO\textsubscript{4} and KH\textsubscript{2}PO\textsubscript{4} on Seed Viability of Local Maize (Zea mays L) Seeds Stored for Five Years in Iraq

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Abstract:

An experiment was achieved to explore the effect of priming techniques on viability characteristics of storage local maize seeds for five years, an experiment was conducted at the Seeds obtained directly from the field of Babil governorate during the season of (2009-2010) and stored until 2014. Seeds were treated for 6 hours at 25°C with priming media (2% and 4% of KH\textsubscript{2}PO\textsubscript{4}, 0.5% & 1.5% of ZnSO\textsubscript{4}, hydro-priming and untreated seeds as control). Maximum seed germination percentage, germination speed index (GSI), seedling vigour index (SVI), root length, shoot length, seedling length, seedling fresh and dry weights were observed when the seeds treated with (2% KH\textsubscript{2}PO\textsubscript{4} & 0.5 ZnSO\textsubscript{4}) compared with control.

Keywords: Seed priming; Seed viability; Maize seeds

Introduction:

Maize plant is "one of the important cereal crops in the world agricultural economy both as food for human and feed for animals. Maize as a crop has many benefits but is mainly grown for human and Livestock consumption. The cobs and seeds are used as raw materials in various industries. Seeds of maize are processed and converted into many purposes; pops, flakes and grits for human eating [1]".

Aging is defined as "reduction in germination percentage of seeds and those seeds that do germinate produce flagging seedling" [2]. Deterioration of seeds can be defined as "deteriorative changes occurring with time that increase the seed’s vulnerability to external challenges and decrease the ability of the seeds to survive" and grow. "Three common observations can be made about seeds, First: seed deterioration is an unwanted attribute of agriculture. Annual damages of yield from seed products due to deterioration can be as much as 25 % of the harvested crop [3]. Second, the physiology of seed deterioration is an independent event from seed development and/or seed germination. Third, seed deterioration is cumulative process [4]".

Priming of seed is usually "defined as pre-sowing treatments in water or in an osmotic solution that allows the seed to imbibe water to proceed to the first step of germination, but prevents radicle protrusion through the seed coat". The most widely used priming treatments are hydro-priming and osmo-priming. In hydro-priming seeds, seeds are soaked in water overnight, surface drying and sowing the seeds at the same day. While in osmo-priming seeds, seeds are soaked in osmotic solution to different periods followed by drying the seed before sowing [5]. "Seed vigour can be viewed as a measure of accumulated damage in seed as viability declines". Vigour test becomes more important if seeds were stored under unfavourable conditions or unknown storage conditions [6].
The aim of this work was to reduce and repair the damage of aging by ZnSO₄ and KH₂PO₄ in local maize seeds stored for five years.

Material and Methods:

Plant Materials

Experiments were performed with local Iraqi cultivar of maize (Zea mays L.). Seeds were obtained directly from the field of Babil governorate in the season of (2009-2010). Seeds were sterilized using 5% sodium hypochlorite for 5 minutes and rinsed with sterilized distilled water. The seeds were dried at 25°C for 24 hr in the laboratory [7]. Seeds were stored in dark plastic containers at deep freeze until 2014.

Seed priming treatment:
In order to priming, maize seeds were subjected to hydro-priming (distilled water only), Osmo-priming with 0.5% ZnSO₄, Osmo-priming with 1.5% ZnSO₄, Osmo-priming with 2% of KH₂PO₄ and with 4% of KH₂PO₄ for 6 hr at 25°C. Seed weight to solution volume ratio was 1:5 (w/v) [8]. After seed priming, seeds were removed from priming solutions, given three times surface washings and re-dried with forced air near to its original weight. Untreated seeds were used as control treatment.

Germination test:

In order to determine germination percentage "Four replicates, each of 25 seeds, were germinated in 9 cm diameter plastic Petri dishes on filter paper. Distilled water about 2.5 ml to moisten the filter paper was provided initially. Moisture level was checked daily and topped-up as necessary. Radicle emergence percentage and seed germination speed was recorded at 25°C after every 24 h time interval. Time for initial signs of radical emergence and maximum emergence was recorded for seven days [9]".

Germination speed index (GSI):

Germination speed index (G.S.I) was measured according to [10] by the following formula:

\[ \text{G.S.I} = \frac{\text{No.of germinated seed}}{\text{Days of first count}} + \ldots + \frac{\text{No.of germinated seed}}{\text{Days of final count}} \]

Seedling vigour index (S.V.I):

Seedling vigour index (S.V.I) was calculated following modified formula of [11]:

\[ \text{S.V.I} = \frac{\text{[seedling length per (cm) \times germination percentage (%)]/100}}{\text{}} \]

Relative Growth Rate (R.G.R):

Seedlings of local maize cultivar were transplanted into plastic trays filled with clean and sterilized sawdust. Water was topped after seven days of planting, seedlings were harvested from trays. Shoot and root were separated, dry and fresh weights were determined, and shoot: root lengths were calculated days [9].
Statistical test:
All treatments were determined by using four replicates. Data were analysed with analysis of variance, a completely randomized (C.R.D) and L.S.D (least significant difference) was calculated at P ≤ 0.05

Results:

Germination test:

Seed priming had a significant positive effect on germination. The results in Fig (1) shown hydro-priming, osmo-priming with 0.5% ZnSO4 and osmo-priming with 2% of KH2PO4 caused significant increase in seeds germination percentage compared with control. The highest germination percentage was observed in 2% of KH2PO4 was 76% and lowest germination percentage was observed in control was 30%.

![Germination Chart](image)

Fig (1) Effect of seeds priming with ZnSO4 and KH2PO4 at 25 C° on seed germination % L.S.D= 5.43

Germination speed index:
The highest germination speed index was obtained from seeds treated with 2% of KH2PO4 and 0.5% ZnSO4. Results in Fig (2) showed significantly increased (G.S.I) from 13.17 in control to 43.28 in 2% of KH2PO4 and 36.69 in 0.5% ZnSO4 treatments.
Fig (2) Effect of seeds priming with ZnSO₄ and KH₂PO₄ at 25 C° on Germination speed index L.S.D= 3.47

Seedling vigour index:

The maximum seedling vigour index was obtained from seeds soaked in 2% of KH₂PO₄ at 25 C°. Results in Fig (3) showed the high value of (S.V.I) reached to 14.84 in KH₂PO₄ compared with control that gave 3.12.

Fig (3) Effect of seeds priming with ZnSO₄ and KH₂PO₄ at 25 C° on seedling vigour index, L.S.D= 1.60

Relative Growth Rate (RGR)

Seed priming treatments with 2% KH₂PO₄ and 0.5% ZnSO₄ increased relative growth rate at 25 C°. Figs (4 and 5) present that shoot and root length had been significant increased, the
highest shoot and root length were obtained from seeds treated with 2% of KH₂PO₄ and 0.5% ZnSO₄ compared to the control, they were 11.0 and 8.5cm respectively

Fig (4) Effect of seeds priming with ZnSO₄ and KH₂PO₄ at 25 Cº on shoot length L.S.D= 0.98

Fig (5) Effect of seeds priming with ZnSO₄ and KH₂PO₄ at 25 Cº on root length L.S.D= 2.66

Seed priming caused significant increase in seedling growth, Fig (6). Analysing of cultivar in the various treatment of priming revealed that the maximum effect of priming was gained with 2% of KH₂PO₄ (19.5 cm\(\text{plant}\)), and in 0.5% ZnSO₄ that gave (18 cm\(\text{plant}\)) compared to the control which gave (10.33 cm\(\text{plant}\)).
Fig (6) Effect of seeds priming with ZnSO$_4$ and KH$_2$PO$_4$ at 25 C$^\circ$ on seedling length L.S.D= 1.67

Results in Fig (7), indicates that priming treatments of the maize seeds with 2% KH$_2$PO$_4$ and 0.5% ZnSO$_4$ at 25 C$^\circ$ caused significantly increased fresh weight compared to the control.

Fig (7) Effect of seeds priming with ZnSO$_4$ and KH$_2$PO$_4$ at 25 C$^\circ$ on seedling fresh weight L.S.D= 0.0526

In addition, the maximum dry weight was gained in seedling under the priming by 2% KH$_2$PO$_4$ (0.0652g) and 0.5% ZnSO$_4$ (0.0439g) at 25 C$^\circ$ compared to the control (0.0275g).
Discussion:

On the basis of the cellular level, seed ageing is related with various changes including reduced energy metabolism, loss of membrane integrity, impairment of proteins and RNA synthesis, and DNA damaged [12]. During storage of seeds, a number of physiological and physicochemical changes occur, termed ageing [13]. The results of the present study revealed that osmo-priming with 2% KH$_2$PO$_4$ and 0.5% ZnSO$_4$ at 25 C$^\circ$ enhanced viability of storage maize seeds. Pre-treatment with KH$_2$PO$_4$ and ZnSO$_4$ at 25 C$^\circ$ in low concentrations (2% and 0.5%), increased germination percentage, germination speed index and seedling vigour index compared with control Fig (1, 2 and 3).

[14] Reported that "the leaf area index (LAI), leaf area duration (LAD) and net assimilation rate (NAR) was increased in maize by priming of seeds with 1.5% ZnSO$_4$ solution. Also seed priming with Zn improving the performance of maize hybrids [15]". [16] Reported that priming of low vigour sunflower seeds with KH$_2$PO$_4$ (−1.25Mpa) increased germination percentage in all hybrids. Enhancement in germination percentage, germination speed index and seedling vigour index "might be due to that Priming of seed induces germination by repair of proteins damage, RNA and DNA [17]". Alternatively, enhancement in seed viability under storage conditions might be attributed to the enhanced metabolic activities in primed seeds [18], or increment in activities of anti-oxidant enzymes like superoxide dismutase.

Seed priming treatments with 2% KH$_2$PO$_4$ and 0.5% ZnSO$_4$ at 25 C$^\circ$ increased growth parameters (Fig 4, 5, 6, 7 and 8). These results are in agreement with [19] that seed soaked with 0.5 to 1% solution of KCl or potassium sulphate K$_2$SO$_4$ significantly increased plant growth parameters in wheat. Also primed with KH$_2$PO$_4$ enhances seed germination and seedling growth of rapeseed under difference aging levels [20]. Enhancement in growth parameters might be due to that seed priming could improve negative effects of ageing [20].

In conclusion, 2% KH$_2$PO$_4$ and 0.5% ZnSO$_4$ may be effective for enhanced germination and seeds viability for long-term storage maize seeds.

Fig (8) Effect of seeds priming with ZnSO$_4$ and KH$_2$PO$_4$ at 25 C$^\circ$ on seedling dry weight L.S.D= 0.0177
References


