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Full Length Research Paper

Seed Germination Characters of New and Aging Seed of Some Maize Hybrids as Influenced by Antioxidant and Growth Hormones

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The influence of antioxidants and growth hormones on seed germination characters of date of seed production 2017and 2016 of some maize (*Zea mays* L.) hybrids was studded. The objectives was aimed to investigate the response of germination characters to antioxidants (Humic acid at 500 ppm, Ascorbic acid at 100 ppm, Folic acid at 15 mM and Salicylic acid at 100 ppm and H_2O_2 at 40 ppm) and growth hormones (GA_3 concentrations at 0 ppm,25 ppm,50 ppm) produced during 2017 and 2016 seasons. A laboratory experiment was conducted at Giza Central Seed Testing Laboratory of Central Administration for Seed Certification during May and June 2018. Hybrids maize seed of T.W.C 310, T.W.C 323 and T.W.C 324. The result clearly indicated that 2017 season recorded highest final germination percentage %, germination rate (days), and Energy of germination%. On the other hand, of highest final germination percentage, Germination rate (Days), Germination Index G.I. % and Energy of Germination E.G. % were obtained from T.W.C. 310 cultivar. It could be concluded that, T.W.C. 310 cultivar surpassed final germination percentage, Germination rate (Days), Germination Index G.I, % and Energy of Germination E.G. % from T.W.C 324 and T.W.C 323. The results showed that there were significant differences among all studied Antioxidants. humic acid at 500 ppm, Ascorbic acid at 100 ppm, Folic acid at 15 mM and salicylic acid at 100 ppm and H_2O_2 at 40 ppm significantly the interaction between Date of production, Hybrids, Growth hormone and antioxidants concentrations as affected final germination percentage germination rate (days), germination index, and Energy of germination were non-significantly. In general, it could be concluded that soaking hybrid TWC 310 seed in salicylic acid at 100 ppm and gibberellic acid at 50 ppm for 24 hours for maximizing germination characters of new and old maize seed.

Keywords: Maize hybrids, antioxidants, growth hormones, Germination parameters

INTRODUCTION

Aging (old) seeds delayed germination and slow post-germination due to seed deterioration during storage. Using antioxidants may be enhance seed viability of the aging seed. During hybrids seed storage, processes of seed deterioration processes may speedily be happening and these processes will followed by starting respiration and so reduction in seed substance, functional and nutritional properties of the grain (Woltz and Tekrony 2001). Seed aging reduces germination characteristics due to reduce in mobilized seed reserve weight (Nik and Tilebeni 2011). Total carbohydrate decreased and increase in lipid per oxidation and seed viability influenced during storage (Sukesh and Chandrashekar 2011). Percentages of germination, germination index and the mean germination time, under conditions, providing aging were significant with accelerated aging of maize seed (Kapilan 2015).

Ageing known as the process of seed quality injury along with time related to decline in vigor seed (Verm et al., 2003). During seed storage, reactive oxygen species such as superoxide radicals (O2–), hydrogen peroxide (H_2O_2) and hydroxyl radicals (OH•), accumulate in ageing seed tissues and have a vital role in seed vigor reduction (Pukacka and Ratajczak 2005). Pre-sowing treatment with 50-ppm salicylic acid and 100-ppm ascorbic acid improved performance seed germination at higher salinity levels (Afzal et al., 2005). Reduction of germination characters and vigor index due to seed storage. Essential mechanisms for germination quality like mobilization of seed storage reserves (Rajjou et al., 2007). The vigor and viability, increasing the germination speed and percentage and a dry mass of corn improved due to seed priming (Dezfuli et al., 2008).

Plant growth hormones such gibberellins acid plays a great role in seed germination facilitated. Priming seed with chitosan may improve germination speed of maize seed under stress. The low ester joining to diverse levels of chitosan recorded by Huang cultivar (Guan et al., 2009). Seed pretreatment using H_2O_2tempted acclimation of the plants to salinity. H_2O_2 reduced the harmful belongings of salt stress on maize growth. The alterations in antioxidative enzyme activities may explain the augmented tolerance to salt stress of plants originated from H_2O_2 pre-treated seeds (Gondim et al., 2010). Maximize germination parameters of both old or new harvested grains maize hybrid TWC 352, soaking grains in antioxidant like ascorbic acid or citric acid or salicylic acid or natural materials like yeast extract at the rate of 100 ppm for 18 hours, it could be recommended (Kandil et al., 2015). The mean germination time significantly enhanced with ageing. The Hybrids TW.C-310, TW.C-323 and TW.C-324 increased mean germination time compared with other hybrids. Severe harm to the cell membrane and antioxidant enzyme activity in the studied hybrids under ageing. Reduces of seed viability reflected the seed deterioration during storage (Mansouri-Far et al., 2015). Priming of corn seeds in water, regardless the application of plant growth regulators, decreases storage resistance capacity seed (Pallaoro et al., 2016).

Gibberellic acid (GA3) regulates plant growth responses to the external environment (Chakrabarti and Mukherji 2003). Seed soaking in GA3 at a rate of 10 ppm showed the highest germination percentage and the tallest radical and plumule in contrast to other treatments (Chauhan et al., 2009). Salicylic acid as a hormone like substance, play a greater role in regulating physiological processes like ion uptake and transport, reserve of ethylene biosynthesis, transpiration, photosynthesis, nitrate metabolism, stress tolerance and plant growth (Khan et al., 2010). Seed immersion of sweet corn in a gibberellic acid solution generated improved seed viability and vigor (Rivera et al., 2011). Seed dormancy is widely recognized that ascorbic acid and gibberellic acid are the primary hormones that antagonistically regulate seed dormancy and germination (Hoang et al., 2014). The highest percentage of germination for Indole Aacetic Acid and gibberellic acid at a rate of 2 mg/L (Lalitha et al., 2016). The critical roles of phytohormones in regulating seed dormancy and germination, in which AP2-domain-containing transcription factors play key roles (Shu et al., 2016). Corn kernels Orange and Rubin varieties might recommend for further use in food industry producing products with high content of biologically active compounds (Zhirkovaa et al., 2016). Therefore, the goals of this study were aimed to investigate the response of germination characters to antioxidants, and growth hormones of new and aging of some maize hybrid seed.

MATERIALS AND METHODS

Treatments and Experimental Design:

A laboratory experiment conducted in the Giza Central Seed Testing Laboratory of Central Administration for Seed Certification (CASC), Ministry of Agriculture Egypt during May and June 2018. The aims of this investigation aimed to study the response of germination character to antioxidants, and growth hormones of seeds production 2016 and 2017 of some maize hybrids seed. Two factorial experiments assigned to Randomized Complete Block Design in four replications. The three types of maize seeds of production (2016 and 2017) include a separate experiment. The three maize hybrids named T. S. W. 310, 323, 324 include the first factor. The five types of antioxidants, Salicylic acid at 100 ppm, Ascorbic acid at 100 ppm, Folic acid at 100 ppm, H_2O_2 at 40 ppm and humic acid at 500 ppm has the second factor determined at concentrations. The three concentrations of study growth hormone as GA_3 at 0, 25 and 50-ppm concentrations include the third factor studied. Selected hybrids obtained from maize section Field Crop Institute, ARC. Each hybrid was prim in the antioxidants at above concentrations of 24 hours. Each hybrid seed moistened using growth hormones as above concentrations under the chamber condition at 25±1ºc. Thereafter, seeds

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Table (1): Means of final germination percentage %, germination rate (G.R. days) (%), germination Index (G.I. %) and energy of germination (E.G. %) of maize (*Zea mays* L.) cultivars under growth hormone and antioxidants concentrations:

Treatments	FGP %	G.R %	G.I %	E.G %
Date of production (D):				
2017	90.35	3.23	117.17	72.30
2016	78.47	2.80	108.14	71.28
F-test	*	*	*	*

moistened with distilled water under control treatments. The prim seeds in antioxidants and non-primed seed of study hybrids sown in Filter paper used Twenty-five seeds per each treatment for each cultivar allowed to germinate on Filter paper. The experiment consists of 432 Filter paper arranged in a factorial experiment in Randomized Complete Block Design (RCBD) in four replicates in the Filter paper placed in a growth chamber for 8 days at 25-±1 ºc for germination according to (ISTA Rules 2016), rules.

Studied Characters:

The 2016 and 2017of maize hybrids seed subjected for determination of germination characters in the laboratory experiment. Germination characters, namely the final germination percentage, germination rate, germination index and energy of germination estimated.

1-Final Germination Percentage (FGP): The final of total germinated percentage determined by counting of germinated seed after 8 days from sowing date and expressed as a percentage according to the following equation described by (Ellis and Roberts 1981; Ruan et al., 2002).

$$\text{FGP} = \frac{\text{Number of germinated seeds}}{\text{Total Number of seed tested}} \times 100$$

2-Germination Rate (GR): The rate of germination calculated according to the following equation described by (Ellis and Roberts 1981).

$$\text{GR} = \frac{\text{Number of germinated seeds}}{\text{Number of germination days}}$$

3-The Germination Index (GI): The index of germination calculated according to the following equation (Karim et al., 1992).

$$\text{GI} = \frac{\text{\% Germination in each treatment}}{\text{\% Germination in the control}} \times 100$$

4-Energy of germination (EG): The energy of germination estimated at the fourth day as the percentage of germinated seeds four days after sowing on the number of seeds tested according to (Ruan et al., 2002).

$$\text{EG} = \frac{\text{Number of germinated seeds after four days}}{\text{Number of seed tested}} \times 100$$

Experimental analysis:

The data collected was analysis, statistically by the analysis of variance technique using the MSTAT–C statistical package programmed as described by a procedure of (Gomez and Gomez 1991). The Lest Significant Differences test (LSD) for 5 % level of probability used for comparisons between treatment means, according to (Snedecor and Cochran 1980). The data analyzed statistically following RCBD design by MSTAT-C computer package developed by (Russell 1986).

RESULTS AND DISCUSSION

New and old seeds aging:

Results presented in Table 1 showed that highest averages of final germination percentage, germination rate, germination index, and energy of germination were produced from seeds production (2017) Reduction of germination characters and due to seed storage. Essential mechanisms for germination quality like mobilization of seed storage reserves (Rajjou et al., 2007). Seed aging reduced germination characteristics due to a decline in weight of mobilized seed reserve i.e. seed reserve depletion percentage (Nik and Tilebeni 2011). Total carbohydrate decreased and increase in lipid per oxidation and seed viability influenced during storage (Sukesh and Chandrashekar 2011). It could be noticed that, seeds production in 2017 surpassed seeds production in 2016 of Maize in final germination percentage, germination rate, and germination index, energy of germination, by 13.14, 13.31, 7.70, and 1.41%, respectively.

Maize hybrids Performance:

Averages of final germination percentage, germination rate, the germination index, energy of germination and significantly affected by maize hybrids as shown in Table (2). The results indicated that TW.C0-310 hybrid recorded the highest values of final germination percentage (87.33 %), germination rate (3.12%), germination index (114.62%) and energy of germination (76.07%), was obtained from TW.C-310 hybrid[13]. It could be noticed that TW.C-310 hybrid surpassed TW.C-323 hybrid and TW.C-324 hybrid in

Table (2): Means of final germination percentage %, germination rate (G.R. days) (%), germination Index (G.I. %) and energy of germination (E.G. %) of maize (Zea mays L.) cultivars under growth regulators and antioxidants concentrations:

Treatments	FGP %	G.R %	G.I %	E.G %
Hybrids (H):				
T.W.C 310	87.33	3.12	114.62	76.07
T.W.C 323	82.15	2.93	111.65	65.44
T.W.C 324	83.74	2.99	111.70	70.85
LSD 5%	0.65	0.02	1.19	1.09
D× H	*	*	*	*

Table (3): Means of final germination percentage %, germination rate (G.R. days) (%), germination Index (G.I. %) and energy of germination (E.G. %) of maize (*Zea mays* L.) cultivars under antioxidants concentrations:

Treatments	FGP %	G.R %	G.I %	E.G %
Antioxidant (O):				
Control	75.33	2.69	100.00	65.11
Humic 500 ppm	84.81	3.03	113.24	72.30
Ascorbic 100 ppm	86.96	3.11	116.11	70.74
Folic 15 mM	84.74	3.03	113.04	70.89
Salicylic 100 ppm	88.44	3.16	118.30	72.89
H_2O_2 40 ppm	86.15	3.08	115.26	72.81
LSD 5%	0.93	0.03	1.69	1.54
D× O	*	*	*	*
H× O	*	*	*	*
D × H × O	NS	NS	NS	NS
G× O	*	*	*	*
D × G × O	NS	NS	NS	NS
H × G × O	NS	NS	NS	NS
D × H × G × O	NS	NS	NS	NS

averages of final germination percentage, germination rate, germination index and energy of germination by 4.11, 4.16, 2.59 and 6.86%, respectively and by 5.93, 6.08, 2.54and13.97%, respectively.

Antioxidants Effects:

Averages of final germination percentage, germination rate, the germination index, energy of germination and significantly affected by maize hybrids as shown in Table (3) Pre-sowing treatment with salicylic acid at 100 ppm, improved performance seed final germination percentage (88.44%), germination rate (3.16%), the germination index (118.30%) and energy of germination (73.89%). Similar conclusions were reported by (Afzal et al., 2005). Reduction of germination characters due to seed storage. Essential mechanisms for germination quality like mobilization of seed storage reserves (Rajjou et al., 2007). It could be concluded that, Salicylic acid at 100 ppm surpassed in final germination percentage from Ascorbic acid at 100 ppm, H_2O_2 at 40 ppm, humic acid at 500 ppm and Folic acid at 15 mM by 1.67, 2.59, 4.10, 4.18 and 14.82% respectively. It could be concluded that, Salicylic acid at 100 ppm surpassed in Germination rate (Days) % from Ascorbic acid at 100 ppm, H_2O_2 at 40 ppm, humic acid at 500 ppm and Folic acid at 15 mM by 1.58, 2.53, 4.11, 4.11 and 14.87% respectively. It could be concluded that, Salicylic acid at 100 ppm surpassed in Germination Index G.I. % from Ascorbic acid at 100 ppm, H2O2 at 40 ppm, Humic acid at 500 ppm and Folic acid at 15 mM by 1.72, 2.56, 4.27 and 4.44% respectively compeered with control treatment it was 15.46%. It could be concluded that, Salicylic acid at 100 ppm surpassed in Energy of Germination E.G. % from H_2O_2 at 40 ppm, Humic acid at 500 ppm, Folic acid at 15 mM and Ascorbic acid at 100 ppm by 0.10, 0.80, 2.74 and 2.94%, respectively compared with the control treatment it was 10.67%.

Growth hormones Effects:

Averages of final germination percentage, germination rate, the germination index and energy of germination significantly affected by different Growth Regulators as $GA_3$are presented in Table 4, the results indicated that

Table (4): Means of final germination percentage %, germination rate (G.R. days) (%), germination Index (G.I. %) and energy of germination (E.G. %) of maize (*Zea mays* L.) cultivars under growth regulators concentrations.

Treatments	FGP %	G.R %	G.I %	E.G %
GA3 Concentration (G):				
0 ppm	80.37	2.87	107.39	67.74
25 ppm	84.22	3.01	112.09	70.74
50 ppm	88.63	3.17	118.49	73.89
LSD 5%	0.65	0.02	1.19	1.09
D× G	*	*	*	NS
H × G	*	*	*	*
D× H× G	NS	NS	NS	NS

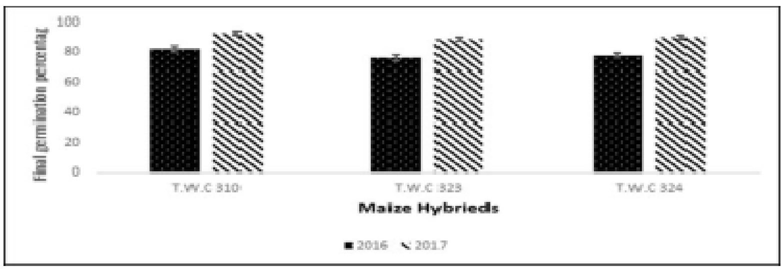

Figure 1: Means of final germination percentage % for the interaction between date of production and maize hybrids.

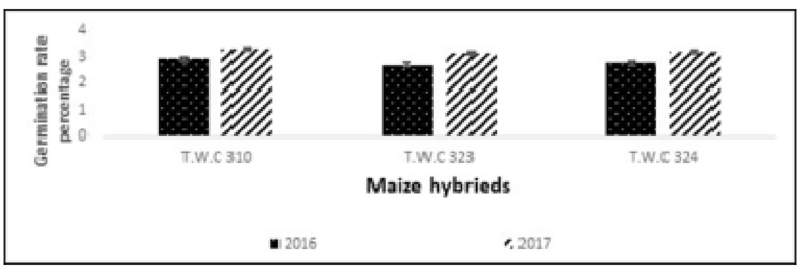

Figure 2: Means of germination rate percentage % for the interaction between date of production and maize hybrids.

Seed pretreatment using 50-ppm concentration of GA_3 significantly increased final germination percentage (88.63%) germination rate (3.17%), the germination index (118.49%) and energy of germination (73.89%) Plant growth regulators have a key role in regulating plant growth and development; especially the process of seed germination (Sharma and Nikita 2016).

Interaction Effects:

Interaction between Date of production and hybrids:

Averages of final germination percentage, germination rate, the germination index and energy of germination significantly influenced by the interaction between date of production and hybrids, as shown in Figs.1, 2, 3 and 4. The results graphically illustrated in Figs. 1,2,3,4 clearly showed that the effect of the interaction between date of production and hybrids on final germination percentage, germination rate, the germination index and energy of germination. The highest percentages germination (92.67%), germination rate (3.31%) germination index percentage (118.98) and energy of germination (80.07) were obtained from T.W.C 310 Hybrid.

Interaction between date of seed production and antioxidants effect:

Averages of final germination percentage, germination rate, the germination index and energy of germination as shown

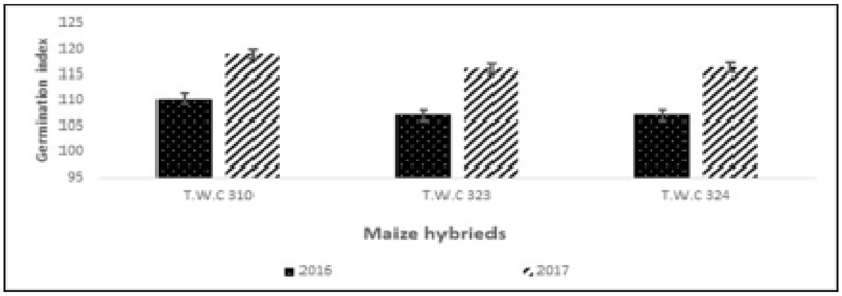

Figure 3: Means of germination index. % for the interaction between date of production and maize hybrids**.**

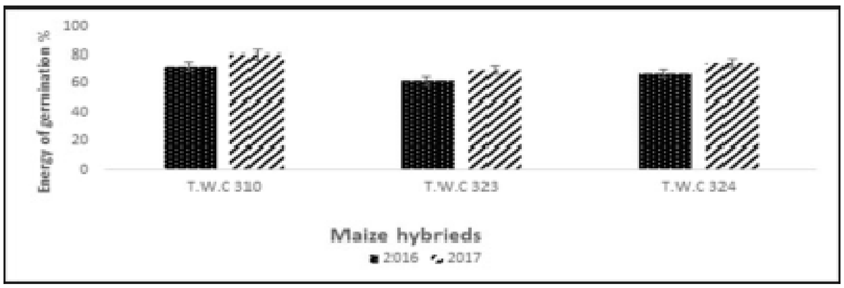

Figure 4: Means of energy of germination % for interaction between date of production and maize hybrids.

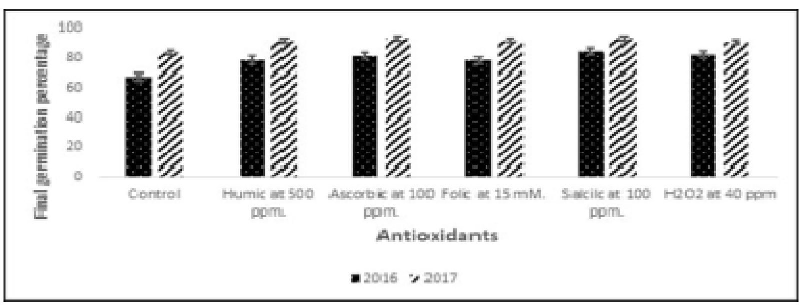

Figure 5: Means of final germination percentage % for the interaction between date of seeds production and antioxidant concentrations.

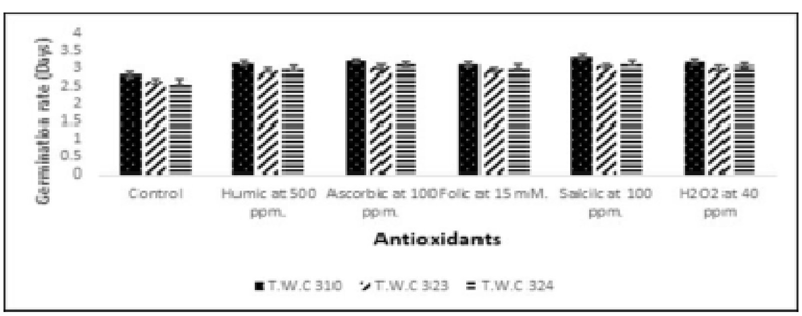

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Figure 6: Means of germination rate percentage % for the interaction between date of seeds production and antioxidant concentrations

in Fig. 5, 6, 7 and 8. The results clearly that, significantly influenced by the interaction between seed type and antioxidants, The in Figs. 5, 6, 7 and 8 clearly showed that the effect of the interaction between seed type and antioxidants on final germination percentage, germination rate, the germination index and energy of germination. The highest final percentages germination (92.74%) and germination rate (3.30%) were obtained from pre-sowing treatment with salicylic acid at 100 ppm in season 2017.The highest energy of germination (78.07) produced from the

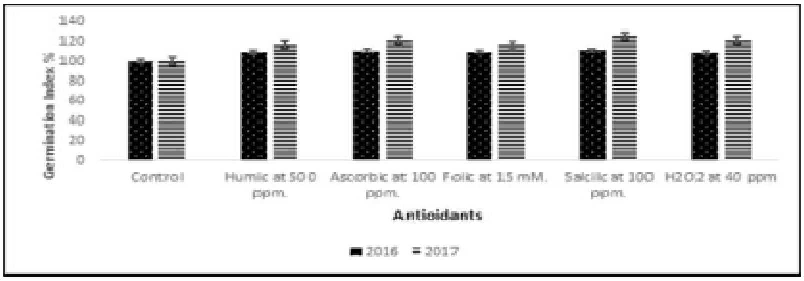

Figure 7: Means of germination index percentage % for the interaction between date of seeds production and antioxidant concentrations**.**

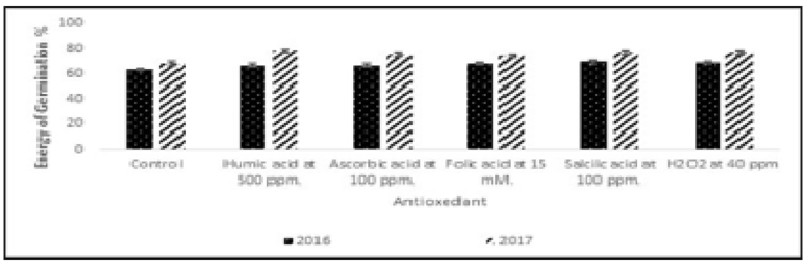

Figure 8: Means of energy of germination percentage % for the interaction between date of seeds production and antioxidant concentrations**.**

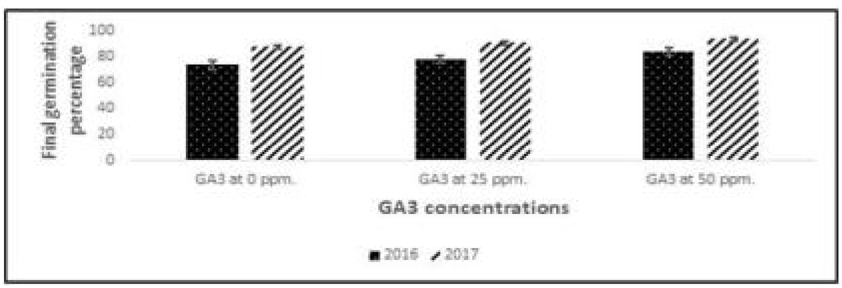

Figure 9: Means of final germination percentage % for the interaction between date of production and gibberellic acid concentrations.

interaction pre-sowing treatment with 500-ppm humic acid in season 2017. The highest germination index percentage (125.59) produced from the interaction pre-sowing treatment with 100-ppm salicylic acid in season 2017. During seed storage, reactive oxygen species such as superoxide radicals (O2–), hydrogen peroxide (H_2O_2) and hydroxyl radicals (OH•), accumulate in ageing seed tissues and have a vital role in seed vigor reduction (Pukacka and Ratajczak 2005).

Interaction between date of seeds production and growth hormone effect:

Averages of final germination percentage, germination rate and the germination index significantly influenced by the interaction between date of seeds production and hybrids, however, energy of germination insignificantly affected as shown in Tables (4). The results graphically illustrated in Figs. 9, 10 and 11 clearly showed that the effect of the interaction between seed type and growth hormone on final germination percentage, germination rate and the germination index. The highest final percentages germination (93.41%) and germination rate (3.34%) were obtained from seed pretreatment using 50-ppm concentration of GA3 in season 2017. The highest germination index percentage (125.17) produced from the interaction of seed pretreatment using 50-ppm concentration of GA3 in season 2017. Seed immersion of sweet corn in gibberellic acid solution generated improved seed viability and vigor (Rivera et al., 2011).

Interaction between hybrids and antioxidants effect:

Averages of final germination percentage, germination rate, the germination index and energy of germination significantly influenced by the interaction between seed type

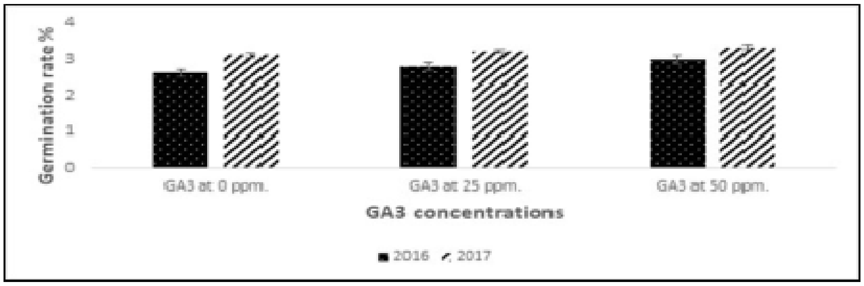

Figure 10: Means of germination rate % for the interaction between date of production and gibberellic acid concentrations.

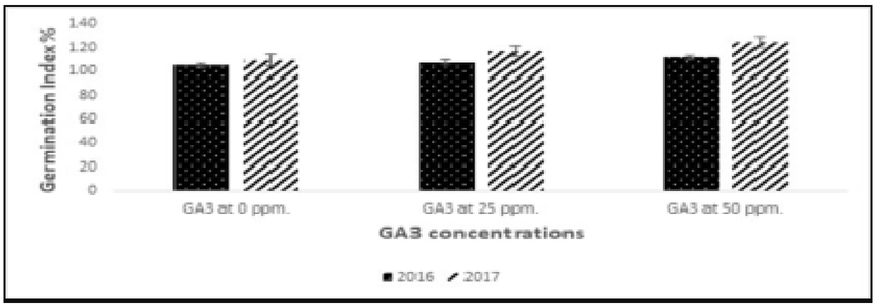

Figure 11: Means of germination index percentage % for the interaction between date of production and gibberellic acid concentrations.

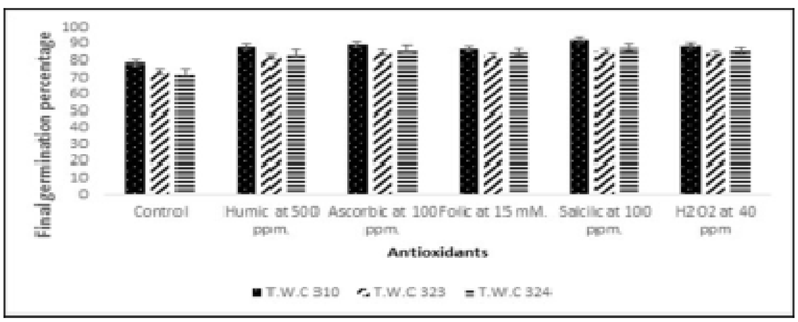

Figure 12: Means of final germination percentage % for the interaction between maize hybrids and antioxidant concentrations

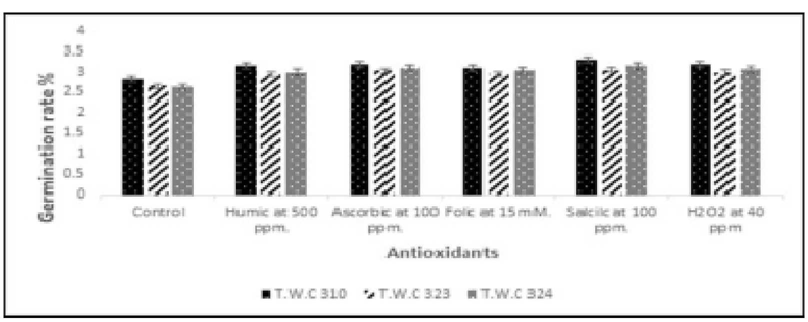

Figure 13: Means of germination rate % for the interaction between maize hybrids and antioxidant concentrations:

and antioxidants, The results graphically illustrated in Figs. 12, 13, 14 and 15 clearly showed that the effect of the interaction between hybrids and antioxidants on final germination percentage, germination rate, the germination index and energy of germination. The highest final percentages germination (92.22%) and germination rate (3.30%) were obtained from pre-sowing treatment with 100-ppm salicylic acid and T.W.C 310 Hybrid. The highest

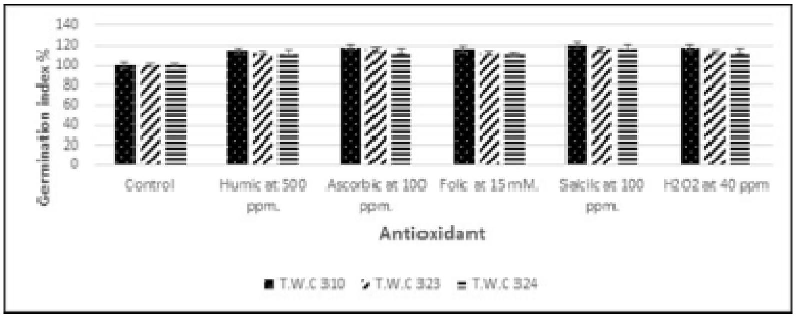

Figure 14: Means of germination index % for the interaction between maize hybrids and antioxidant concentrations

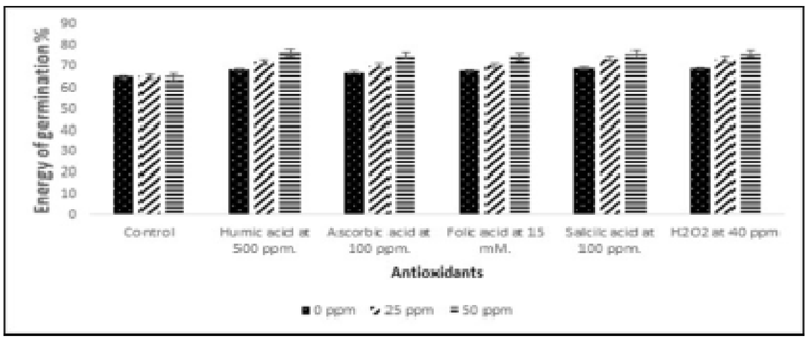

Figure 15: Means of energy of germination % for the interaction between gibberellic acid and antioxidant concentrations**.**

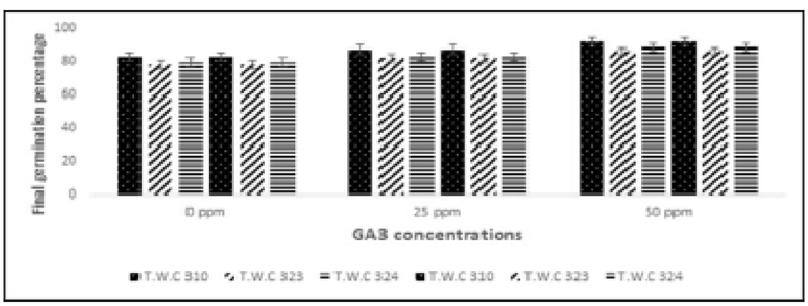

Figure 16: Means of final germination percentage % for the interaction between maize hybrids and gibberellic acid concentrations.

germination index percentage (120.56) produced from the interaction pre-sowing treatment with 100-ppm salicylic acid and T.W.C 310 Hybrid. The highest energy of germination (79.56) produced from the interaction pre-sowing treatment with pre-sowing treatment with H2O2 at 40 ppm and T.W.C 310 Hybrid. The Hybrids SC-260, SC-370 and SC-647 increased mean germination time compared with other hybrids. Severe harm to the cell membrane and antioxidant enzyme activity in the studied hybrids under ageing. Reduces of seed viability reflected the seed deterioration during storage (Pallaoro et al., 2016).

Interaction between hybrids and growth hormone effect:

Averages of final germination percentage, germination rate, the germination index and energy of germination significantly influenced by the interaction between hybrids and growth hormone. The results graphically illustrated in Figs. 16, 17, 18 and 19 clearly showed that the effect of the interaction between hybrids and growth hormone on final germination percentage, germination rate, the germination index and energy of germination. The highest final

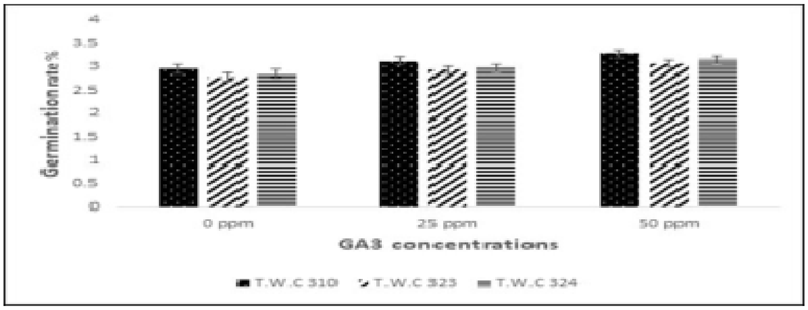

Figure 17: Means of germination rate (days) % for the interaction between maize hybrids and gibberellic acid concentrations.

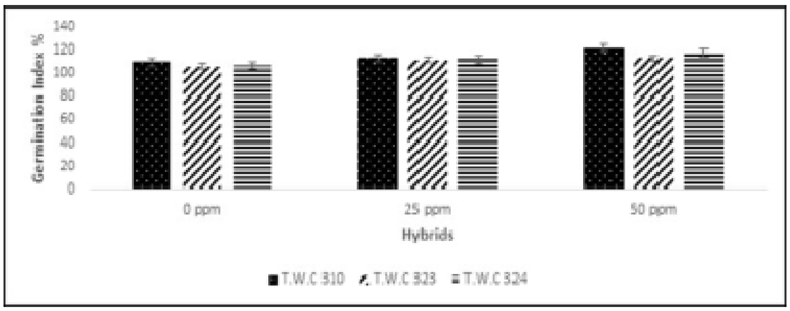

Figure 18: Means of germination index GI % for the interaction between maize hybrids and gibberellic acid concentrations.

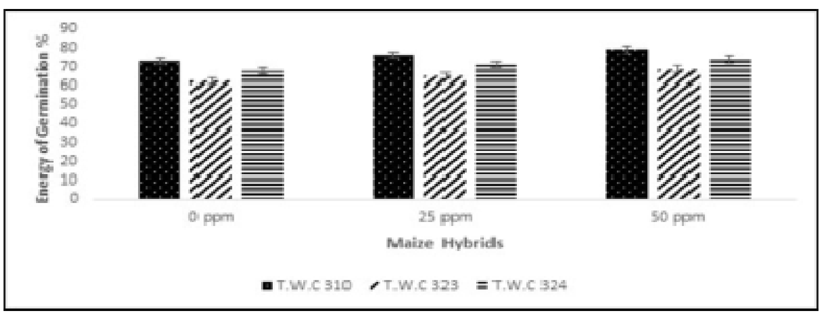

Figure 19. Means of energy of germination E.G. % for the interaction between maize hybrids and gibberellic acid concentrations.

percentages germination (91.78%), germination rate (3.28%) and energy of germination (79.22) were obtained from T.W.C 310 hybrid and seed pretreatment using 50-ppm concentration of GA3. The highest germination index percentage (121.06) produced from the interaction of T.W.C 310 hybrid and seed pretreatment using 50-ppm concentration of GA3. Corn kernels Orange and Rubin varieties might recommend for further use in food industry producing products with high content of biologically active compounds (Zhirkovaa et al., 2016).

Interaction between antioxidants and growth hormone effect:

Averages of final germination percentage, germination rate, the germination index and energy of germination significantly influenced by the interaction between antioxidants and growth hormone, The results graphically illustrated in Figs. 20, 21, 22 and 23 clearly showed that the effect of the interaction antioxidants and growth hormone on final germination percentage, germination rate, the germination index and energy of germination. The highest

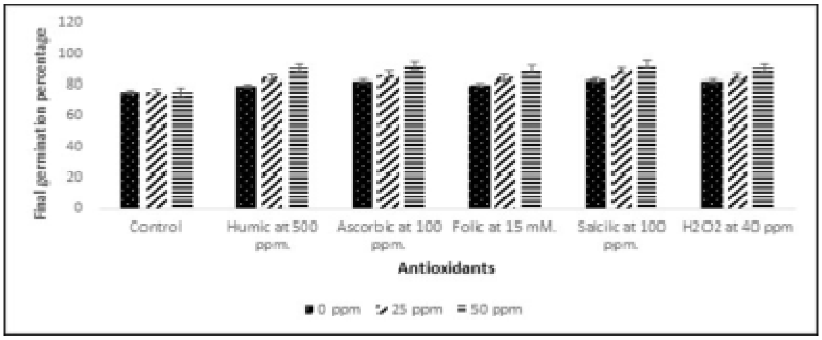

Figure 20: Means of final germination percentage % for the interaction between gibberellic acid and antioxidant concentrations.

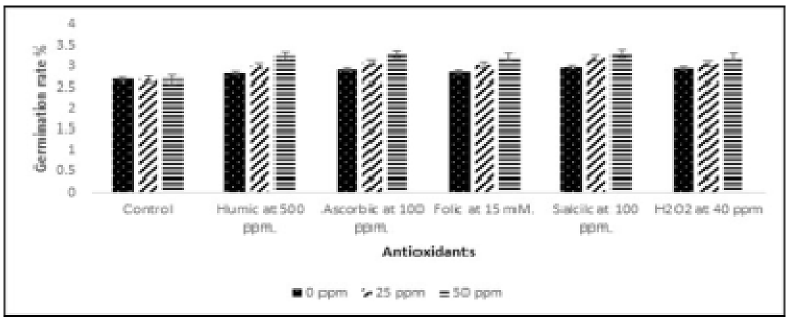

Figure 21: Means of final germination rate % for the interaction between gibberellic acid and antioxidant concentrations:

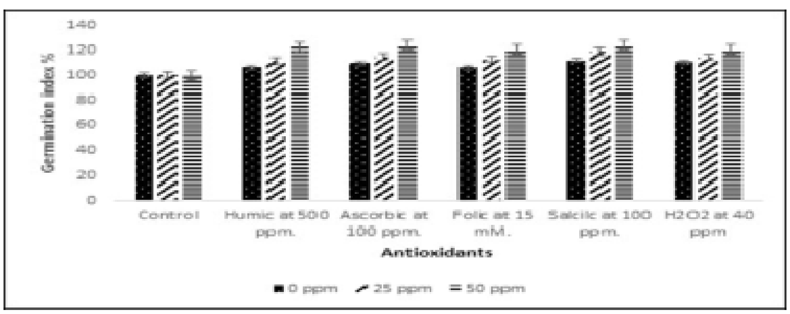

Figure 22: Means of germination index % for the interaction between gibberellic acid and antioxidant concentrations:

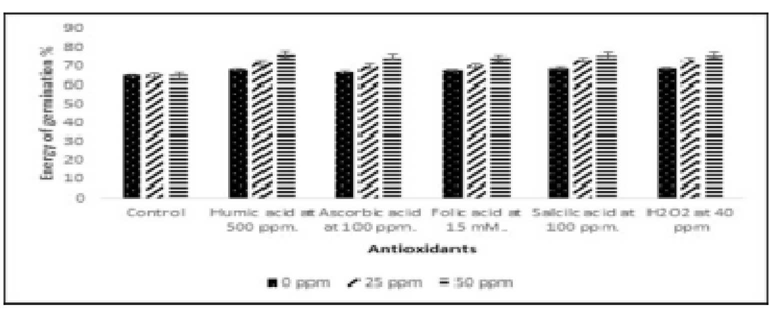

Figure 23: Means of energy of germination % for the interaction between Growth Regulators concentrations and Antioxidant concentrations.

final germination percentages (92.67%) and germination rate (3.31%) were obtained from seed pretreatment using 50-ppm concentration of GA3with 100-ppm salicylic acid. The highest germination index percentage (123.94) produced from the interaction of seed pretreatment using 50-ppm concentration of GA3 with Ascorbic at 100 ppm.

The highest energy of germination (76.44) produced from the interaction pre-sowing treatment with using 50-ppm concentration of GA3 with Ascorbic at 100 ppm with 500-ppm humic acid.

CONCLUSION

For maximizing germination characters of new and aging hybrids maize seed, it could be recommended that soaking maize hybrid TWC 310 seed in salicylic acid at 100 ppm and gibberellic acid at 50 ppm for 24 hours.

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