Plant Archives Vol. 21, Supplement 1, 2021 pp. 1751-1756 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
doi link : https://doi.org/10.51470/PLANTARCHIVES.2021.v21.S1.278

INFLUENCE OF DIFFERENT SEED PRIMING TECHNIQUES ON THE GROWTH AND VIGOR OF TWO (*TRITICUM AESTIVUM* L.) BREAD WHEAT GENOTYPES

Sirwa A. Qadir
Department of Forestry, College of Agricultural Engineering Sciences, Salahaddin University Erbil- Iraq
Email: Sirwa.qadir@su.edu.krd

ABSTRACT

Seed priming regarded as an easy method to enhance seedling establishment, seedling emergence, growth and yield attributes of crops. This study was conducted to determine the effects of some priming treatments on seed germination, some agro-morphological properties and final grain yield. Two commonly grown bread wheat genotypes, namely Aras and Panda were primed with; Nickle nanoparticle 20nm with 30ppm (P1), Osmopriming (P2) using 5 % Manitol, Hormonal priming (P3) salicylic acid (50 ppm) is used, Botanical priming (P5); *Aloe vera* leaf gel is used and compared to Control (P6). Highest germination percent (G %), mean germination time (MGT) and best seedling vigor index (SVI) were recorded due to priming Aras and Panda with salicylic acid and hydro priming methods as compared to control. Panda genotype exhibited tallest plumule length; 7.5 cm due to *Aloe vera* gel priming (P5G1) similar to control treatment. While, tallest radicle was 6.833 cm due to SA priming method. Tallest length of plumule and radicle length for Aras genotype recorded was; 37.25 and 17.25 cm due to SA priming. maximum plant height 84.33 cm recorded by Aras genotype due to hydro priming, followed by 82.25 cm resulted in priming it with salysilic acid compared to control treatment. While, in case of Panda genotype best priming methods was Salicylic acid, *Aloe vera* and distilled water; 66.33, 62.67 and 62.33 cm respectively. salicylic acid and distilled water priming regarded as best methods to increase number of tillers plant-1. Panda and Aras recorded highest number of grains plant-1 and final yield; 3due SA and hydropriming. Among the different priming methods used in the study; hydropriming and SA were the most effective treatments to attain higher germination percentage and grain yield.
Keywords: Priming, Hydro-priming, *Aloe vera*, salysilic acid, Nickle nanoparticles, Manitol

Introduction

Wheat (*Triticum aestivum* L.) is regarded as a global staple food crop, it is considered nearly as a twenty percent of human food requirement and it cultivated on nearly 2.15 million hectares globally. International Food Policy Research Institute estimated that the world's wheat demand was 552 million tons in 2013. It will be 40 percent higher in 2020. However, the achievable resources will not produce the estimated amount of wheat demand (CGIAR, 2014).

Seed priming is any pre-sowing treatment change the physiological situation of the seed to an efficient germination process (Evenari, 1984). Germination usually reveals three stages; hydration stage related to the imbibition of the seed coat associated in which water moves to the apoplastic spaces, re-stabilizing of the metabolic vigor and repairing processes is the second stage; and the third stage guaranty the cell elongation and leading to radicle bulge. Start and end phases require an increase in the water content while the hydration remains constant during the re-stabilization stage. Generally, it is believed that germination remains a reversible process before the end of the second phase. Thus, the seeds can be dried again as they remain vigor during storage and able to re-set germination under suitable conditions (Lutts *et al.*, 2016). The major purpose of this practice is to accelerate the germination and seedling vigor, growth and yield attributes of crop under normal and stress conditions (Khan *et al.*, 2017).

Different techniques can be used for seed priming; Hydro-priming is the simplest, low-cost and environmentally friendly method, in which seeds soaked in pure water and re-drying to original moisture content prior to sowing. Vaz Mondo *et al.*, 2017; Shah *et al.*, 2017; Khafagy *et al.*, 2017, reported that hydro-priming basically ensured quick and homogeneous germination associated with little irregular seedling%. Osmo-priming includes pre-soaking seeds in low water potential solution like PEG (Poly Ethylene Glycol and Mannitol (Ashraf and Foolad, 2005). Priming of chickpea seeds with mannitol and water improved seedling growth under salt stressed conditions as investigated by Kaur *et al.*, 2003 and Asaduzzaman, 2014. However, poor farmers cannot use high costed plant hormones, antioxidants or nutrients for seed priming. So, there is a need to explore natural and environment friendly plant growth promoters; the potential of *Aloe vera* leaf gel is a source of plant nutrients- calcium, iron, magnesium, potassium, phosphorous and zinc (Dagne *et al.,* 2000); enzymes- amylase, catalase, lipase, oxidase and superoxide dismutase (Vazquez *et al.,* 1996); amino acids- Alanine, glycine, leucine and proline (Reynolds and Dweck, 1999); Vitamins- B complex, C, β-carotene and α-tocopherol and other organic compounds- triglicerides, triterpenoid, gibberillin, potassium sorbate (Vinson *et al.,* 2005). Salicylic acid priming in fennel seeds also showed better germination under low water potential (Farahbakhsh, 2012). As well as Mohamed *et al*. (2019) reported that seed priming with salicylic acid (100 ppm) enhanced seedling vigor by increased photosynthesis and biochemical processes. Imran *et al*. (2014) claimed that Priming with 2% *A. vera* gel was most effective in boosting up germination rate and succeeding seedling growth under chilling conditions. Nanoparticles may help to improve nutrient use efficiency because of their small size between 1 and 100 nm, more surface area and their slow rate of release, and having different physicochemical properties as compared to the bulk materials which facilitate to the plants to take up most of the nutrients without any waste (Nel *et al*., 2006). Rawat *et al.* (2018) revealed that seed treatment with nanoparticles at 50 ppm concentration increases root length, shoot length, seedling length, shoot dry weight, seedling dry weight, seedling vigour index.

Identifying the efficient priming solutions is necessary for wheat farmers to meet his objective of early seedling development and increase yield income. Therefore, this study was undertaken to appraise the potential of seed priming to improve the performance of poor-quality wheat grains that guaranty the germination, seedling growth and final yield production.

Materials and Methods

Plant material and priming methods

The experiment was conducted to study the influence of different seed priming techniques on the growth and vigor of two (*Triticum aestivum* L.) bread wheat genotypes; Aras; G1 and Panda; G2. Previously their poor germination behavior was proved under Laboratory condition by (Qadir, 2018). Seeds were surface sterilized with 3% solution of sodium hypochlorite. The experiment comprises six treatments; Nickle nanoparticle 20nm with 30ppm (P1). The nanoparticles were weighed and dispersed in distilled water at concentrations 30 ppm. The nanoparticles were dispersed easily without precipitation by ultra-sonicator and agglomerates were broken up with sufficient shaking (Miri *et al*., 2017). Osmopriming (P2) using 5 % Manitol. Hormonal priming (P3) salicylic acid (SA @ 50 ppm) is used. Botanical priming (P5); *Aloe vera* leaf gel is used. All priming methods compared to Control (P6). All priming media were prepared in distilled water and seeds soaked at 25°C for 24 hours.

Effect of seed priming techniques on germination conductance

Ten seeds were set equally on sterilized filter paper in 90 mm diameter Petri dishes, wetted with a 15 ml sterilized distilled water. Petri dishes were sealed tightly to conserve moisture and obviate contamination. All treatments placed in a germination chamber at 25 °C. Germination process was observed daily and continued until fixed state. Radicle length of more than 2 mm was regarded as germinated case. After 12 days seeds reached the fixed state, thus germination indices and growth characters of seedlings were measured. Germination indices includes; Germination (%) = Total no. of seeds sown /Number of seeds germinated x100 (ISTA 2009). Seed Vigor Index (SVI) = germination (%) * seedling length (Dezfuli *et al*., 2008). Mean germination time (MGT) was calculated by the formula of Ellis and Roberts (1981); MGT= Σ (ni/di). With ni: number of germinated seeds and di: day of counting. While growth characters were included; shoot length and dry weight, root length and dry weight and total dry weight have been measured. The dry weight (DW) obtained after drying the seedlings for 48 h at 72ºC (Bağci *et al*., 2003).

Effect of seed priming techniques on agronomic and yield characters

Same two bread wheat genotypes; Aras and Panda were used as their low productivity investigated under glass house condition by (Qadir *et al*., 2016). Seeds were primed with the six priming methods. Four primed seeds had been sowed in plastic pots, each containing 6 kg of soil. Thinning was done after the 15th day of seedling emergence. The recommended primary dose of fertilizer 120 kg ha-1 DAP (N=18% and P=46%) brought prior to seed sowing and the second dose was Urea (N= 46%) after 60 days from sowing. The experiment was conducted as factorial in completely randomized design with five replicates, included 12 treatments combination of two genotypes and six priming methods. Agronomic characters were measured after (80-90) days from sowing (late stem elongation before heading stage). Includes; plant height (cm), number of tillers per plant. Yield and yield components were evaluated after harvesting. Spike length (cm), number of spikes plant^{-1}, number of grains plant^{-1}, 1000 grains weight (g) and final yield (g plant^{-1}).

Statistical analyses

The two experiments were conducted as factorial experiment in a completely randomized design, of two genotypes; G1 and G2 and six priming methods; P1, P2, P3, P4, P5 and P6. Generating 12 treatment combinations; P1G1, P1G2, P2G1, P2G2, P3G1, P3G2, P4G1, P4G2, P5G1, P5G2, P6G1, P6G2 with five replicates. Analysis of variance (ANOVA) of the data computed using the Statistical package for the Social Sciences (SPSS) model 25. The Duncan’s test used to check the variations among the mean values of studied parameters. 5% level of possibility for glass house measurements and 1% degree for the laboratory measurements.

Results and Discussion

Effect of seed priming techniques on germination conductance

Seed priming can lead to fast, uniform of germination, seedling growth, establishment and higher yield in many crops such as maize (Ghiyasi *et al*., 2008) and wheat (Hamza, 2012). All the priming treatments significantly affect the germination indices (Figure 1). The comparison of treatment means elaborates that the highest germination percentages (G %) for Panda was 76.67, and highest mean germination time (MGT); 3.5 and 3.83. as well as best seedling vigor index (SVI) were; 1483.33 and 1746.67 due to priming the seeds with salicylic acid and hydro priming methods as compared to control. Similarly, best response of Aras genotype seed for G%; 76.67 and 70.00 %, SVI; 1993.33 and 1583.33 and MGT; 3.83 and 3.5 were recorded due to same priming methods as Panda; P3G1, P3G2, P4G1 and P4G2. hydro-priming affects the water potential and driving force for water uptake during imbibition. The activity of α-amylase was examined in wheat and rice kernels are key enzymes that play a vital role in hydrolyzing the seed's starch reserve, thereby supplying sugars to the developing embryo.

(Andoh and Kobata, 2002). Toklu *et al.* (2015) recorded similar results and declared that distilled water treatments increased seed germination percentage, seedling emergence percentage, and seedling growth rate. The growth parameters increased due to priming methods. Panda genotype exhibited tallest plumule length; 7.5 cm due to *Aloe vera* gel priming (P5G1) similar to control treatment. It is might be due to presence of natural antioxidants, mineral nutrients, osmo-protectants and plant growth hormones. Similar finding has earlier been reported by (Imran *et al.*, 2013 and Imran, 2014). While, tallest radicle was 6.833 cm due to SA priming method. Tallest length of plumule and radicle length for Aras genotype recorded was; 37.25 and 17.25 cm due to SA priming (Figure 2). The highest weight of seedling biomass of Panda genotype was 0.24 g recorded due to salycilic acid priming. But Aras genotype shows highest accumulated dry matter; 0.28 g due to hydro priming method (Figure 3). These results corroborate with those of Yücel and Heybet (2016) and Mohamed *et al.* (2019) for Salicylic acid. SA increases the level of cell division of seedlings and roots, which increased seedling growth and higher germination indices as compared to control plants (Dolatabadian *et al.*, 2009). Pre-germination process: repair and synthesis of nucleic acids (DNA and mRNA), protein, repair of membranes (Jowkar *et al.*, 2012). In addition, it can be concluded that different responses of the two genotypes may be related to their genetic variability.

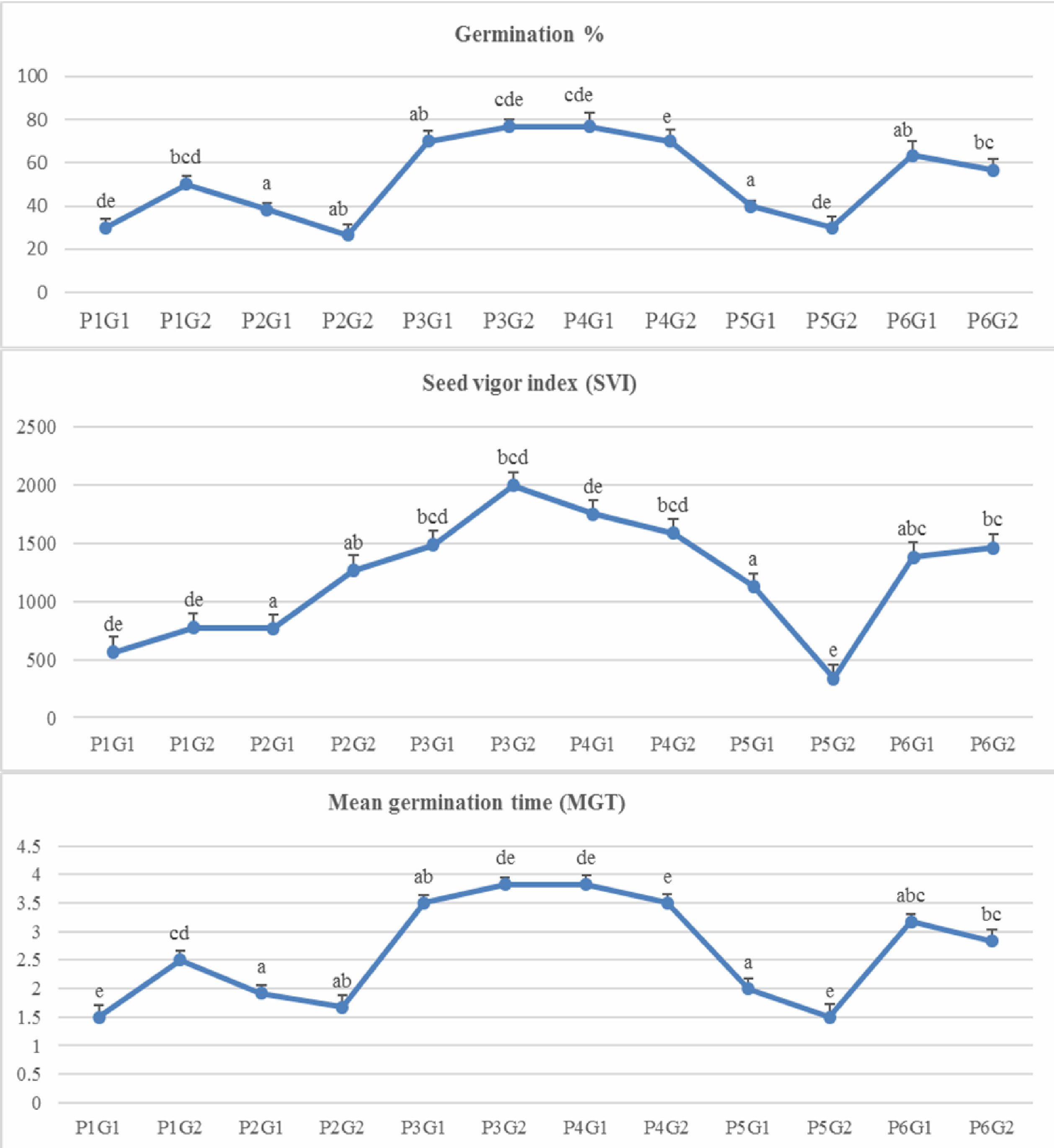

Fig. 1 : Effect of different priming methods on germination indices of two *Triticum aestivum* genotypes

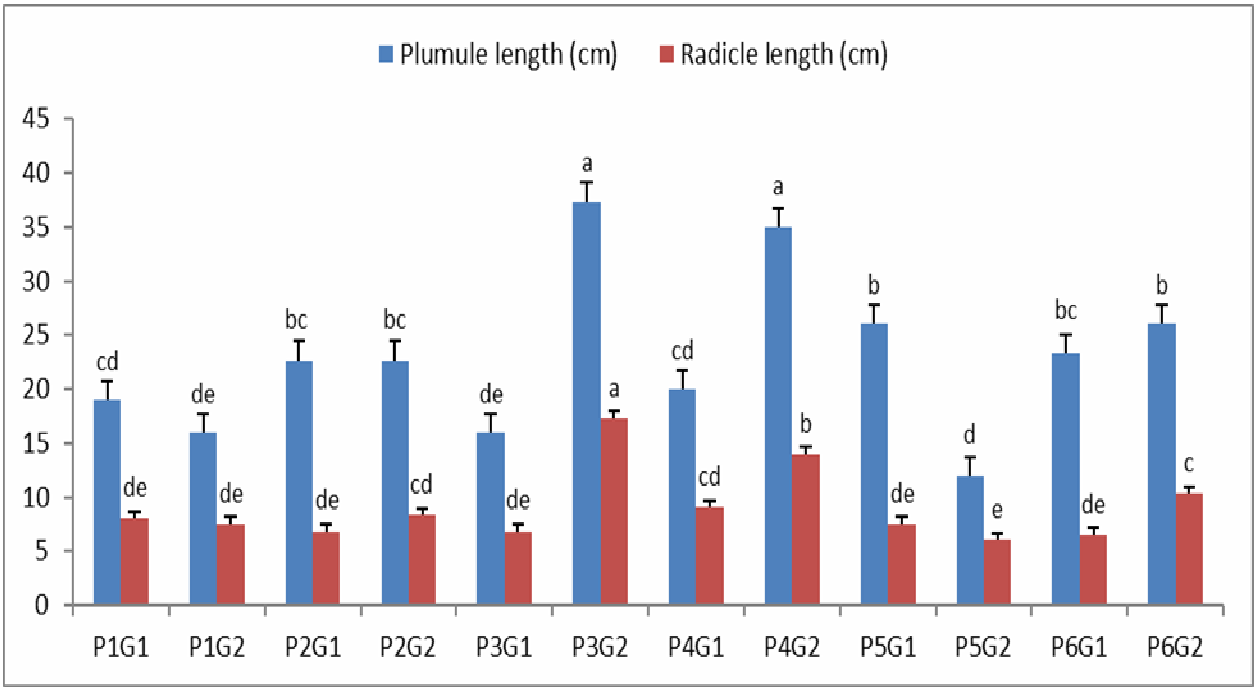

Fig. 2: Effect of different priming methods on radicle and plumule length (cm) of two *Triticum aestivum* genotypes

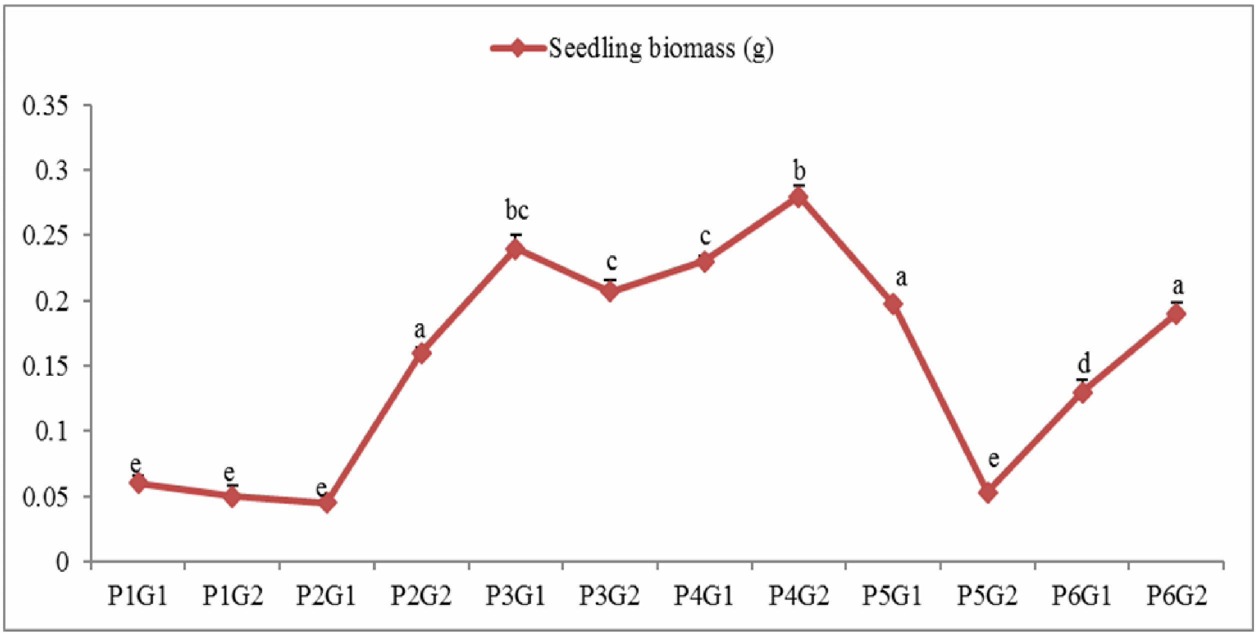

Fig. 3: Effect of different priming methods on seedling biomass (g) of two *Triticum aestivum* genotypes

The plant height cm of wheat genotypes as influenced by various priming methods on are shown in figure 4. Results showed that maximum plant height 84.33 cm recorded by Aras genotype when primed with distilled water (P4G2), followed by 82.25 plant height cm resulted in priming it with salysilic acid compared to control treatment. While, in case of Panda genotype best priming methods was Salicylic acid (P3G1), *Aloe vera* (P5G1) and distilled water (P4G1); 66.33, 62.67 and 62.33 cm respectively. As well as maximum tillers 1.75 and 1.167 plant^{-1} recorded by Aras genotype as primed with salysilic acid and distilled water; G2P3 and G2P4 treatment combinations. Similarly, 1.67 tillers plant^{-1} recorded as highest reproduction tillers due to salysilic acid and distilled water; G1P3 and G1P4 treatment combinations. The increase in plant height and tillers number due priming the seeds in water, salysilic acid and *Aloe vera* gel might belongs to the enhancement of cell elongation, cell division and enlargement (Tolbert, 1974). The findings are in accordance with the results reported by Panhwar *et al.*, 2017 in wheat, Golizadeh *et al.* (2015) in Cannabis seed, Jalilian *et al.* (2014) in barley and Abnavi and Ghbadi (2012) in wheat.

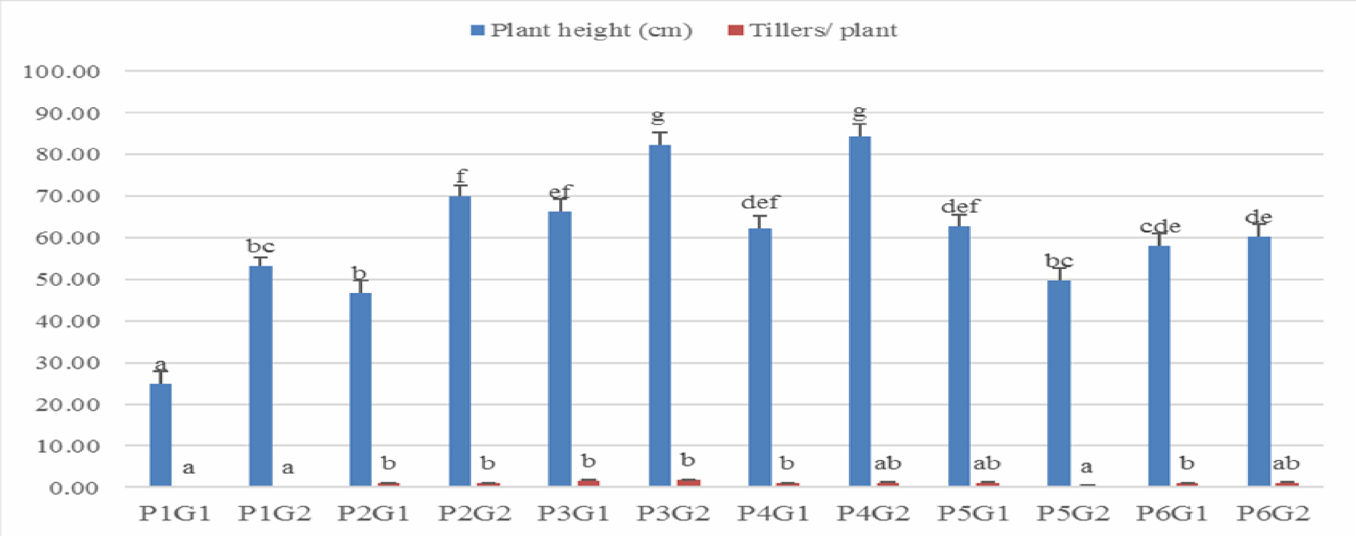

Fig. 4: Effect of different priming methods on agronomic characters of two *Triticum aestivum* genotypes

Yield is the assembly and consequence of physiological and biochemical process. Hydro-priming and salysilic acid had proved significant effect on yield characters; grain number plant^{-1} and final yield g plant^{-1} (Table 1). Panda genotype recorded highest number of grains; 71.33 and 68.00 grain plant^{-1} and final yield; 3.43 and 3.1 0 g plant^{-1} due SA and hydropriming; P3G1 and P4G1. Similarly, Aras showed best assimilation in outcoming the final yield 110.00 and 103.00 grain plant-1 and4.32 and 3.60 g plant^{-1}; due to same methods of priming; P3G2 and P4G2. This may be a result of best performance of the two genotypes at germination stage aw well as production highest number of reproduction tillers at late tillering to stem elongation stage as in (figure 2). Accelerating and homogenizing the germination process is a prerequisite for a good crop establishment and an increase, the efficient use of resources, and eventually to increase yields (Harris, 1996). This may belong to that seed priming causing biochemical changes in the structure of the seeds, such as activation of enzymes related to germination and stand establishment. The results in agreement with Panhwar *et al.* (2017) concluded that 1. 5 hours seed hydro priming has positive effect on growth and yield traits of wheat varieties. Toklu *et al.* (2015) concluded hydropriming treatments as a simple, cheap, and effective methods to improve seed germination and seedling growth in field conditions in Panda and Adana-99.

Table 1: Effect of different priming methods on yield characters of two *Triticum aestivum* genotypes

Treatment combinations (PG)	Gain number plant^{-1}	Grain yield (g plant^{-1})
P1G1	15.00 + 3.27 gh	0.58 + 0.17 fg
P1G2	26.67 + 3.56 ef	0.80 + 0.21 ef
P2G1	21.33 + 3.79 fg	1.90 + 0.43 c
P2G2	27.33 + 4.23 ef	1.64 + 0.87 cd
P3G1	71.33 + 6.74 b	3.43 + 1.12 b
P3G2	110.00 + 9.32 a	4.32 + 1.31 a
P4G1	68.00 + 6.45 b	3.1 0 + 0.92 b
P4G2	103.00 + 8.45 a	3.60 + 0.89 b
P5G1	40.00 + 7.98 cd	1.60 + 0.26 cd
P5G2	4.33 + .95 h	0.13 + 0.04 g
P6G1	48.67 + 4.98 c	1.60 + 0.42 cd
P6G2	33.33 + 3.76 de	1.20 + 0.15 de

Conclusions

Hydropriming and SA treatments are simple, cheap, and effective methods to improve seed germination and seedling growth performance for poor quality seeds as Aras and Panda to ensure better yield under field conditions. Although other priming treatments appear to have approximate effect like; *Aloe vera* gel, further work is needed to ascertain.

References

Abnavi, M.S. and Ghobadi, M. (2012). The effects of source of priming and post-priming storage duration on seed germination and seedling growth characteristics in wheat (*Triticum aestivem* L.). J. of Agril. Sci. (Toronto); 4(9): 256-268.

Andoh, H. and Kobata, T. (2002). Effect of seed hardening on the seedling emergence and alpha-amylase activity in the grains of wheat (*Triticum aestivum*) and rice (*Oryza sativa*) sown in dry soil. *Japanese Journal of Crop Science (Japan)*.

Asaduzzaman, M. (2014). Mannitol Induced Seed Priming Enhances Salt Tolerance Capability In Mungbean *(Vigna Radiata)* Under Salt Stress (Doctoral Dissertation, Department Of Agronomy).

Ashraf, M. and Foolad, M.R. (2005). Pre-sowing seed treatment–a shotgun approach to improve germination, plant growth, and crop yield under saline and non-saline conditions. Advances in Agronomy, 88: 223-271.

BAĞCI, S.A.; Ekiz, H. And Yilmaz, A. (2003). Determination of The Salt Tolerance Of Some Barley Genotypes And The Characteristics Affecting Tolerance. Turkish Journal Of Agriculture And Forestry, 27(5): 253-260.

CGIAR, (2014). WHEAT. Wheat: vital grain of civilization and food security 2013 Annual Report, CGIAR Research Program on Wheat, Mexico, 2014.

Dagne, E.; Bisrat, D.; Viljoen, A.; Van Wyk, B-E. (2000). Chemistry of Aloe species. Current Organic Chemistry, 4: 1055-1078.

Dezfuli, P.M.; Sharif-Zadeh, F. and Janmohammadi, M. (2008). Influence of priming techniques on seed germination behavior of maize inbred lines (*Zea mays* L.). J. Agric. Biol. Sci, 3(3): 22-25.

Dolatabadian, A.; Modarres Sanavy, S.A.M. and Sharifi, M. (2009). Effect of salicylic acid and salt on wheat seed germination. Acta Agriculturae Scandinavica Section B– Soil and Plant Science, 59(5): 456-464.

Ellis, R.A. and Roberts, E.H. (1981). The quantification of ageing and survival in orthodox seeds. Seed Science and Technology, 9: 373–409.

Evenari, M. (1984). Seed physiology: from ovule to maturing seed. The Botanical Review, 50(2): 143-170.

Farahbakhsh, H. (2012). Germination and seedling growth in unprimed and primed seeds of fennel as affected by reduced water potential induced by NaCl. International Research Journal of Applied and Basic Sciences, 3(4): pp.737-744.

Ghiyasi, M.; Myandoab, M.P.; Tajbakhsh, M.; Salehzadeh, H. and Meshkat, M.V. (2008). Influence of different osmopriming treatments on emergency and yield of maize (*Zea mays* L.). Research Journal of Biological Sciences, 3(12): 1452-1455.

Golizadeh, S.K.; Mahmoodi, T.M. and Khaliliaqdam, N. (2015). Effect of priming of (KNO_3, $ZnSO_4$, distilled water) on rate germination and seedling establishment on cannabis seed (*Cannabis sativa* L.). Biological Forum-An Inter J.; 7: 190-194.

Hamza, J.H. (2012). Seed priming of bread wheat to improve germination under drought stress. Iraqi Journal of Agricultural Science, 43(3): 100-107.

Harris, D. (1996). The effects of manure, genotype, seed priming, depth and date of sowing on the emergence and early growth of Sorghum bicolor (L.) Moench in semi-arid Botswana. Soil and Tillage Research, 40(1-2): 73-88.

Imran, S.; Afzal, I.; Amjad, M.; Akram, A.; Khawar, K.M. and Pretorius, S. (2014). Seed priming with aqueous plant extracts improved seed germination and seedling growth under chilling stress in Lentil (*Lens culinaris* Medik). Acta advances in agricultural sciences, 2: 58-69.

Imran, S.; Afzal, I.; Basra, S. and Saqib, M. (2013). Integrated seed priming with growth promoting substances enhances germination and seedling vigour of spring maize at low temperature. International Journal of Agriculture & Biology, 15(6).

ISTA (2009): International Rules for Seed Testing. International Seed Testing Association. Switzerland.

Jalilian, J.; Khalilzadeh, R. and Khanpaye, E. (2014). Improving of Barley Seedling Growth by Seed Priming Under Water Deficit Stress Journal of Stress Physiology & Biochemistry, 10 No. 2 2014, pp. 125-134 ISSN 1997-0838.

Jowkar, M.; Ghanbari, A.; Moradi, F. and Heidari, M. (2012). Alterations in seed vigor and antioxidant enzymes activities in *Silybum marianum* under seed priming with KNO_3. J. Med. Plants Res, 6(7): 1176-1180.

Kaur, S.; Gupta, A.K. and Kaur, N. (2002). Effect of osmo-and hydropriming of chickpea seeds on seedling growth and carbohydrate metabolism under water deficit stress. Plant growth regulation, 37(1): 17-22.

Khafagy, M.A.; Mohamed, Z.A.A.; Farouk, S. and Amrajaa, H.K. (2017). Effect of pre-treatment of barely grain on germination and seedling growth under drought stress. Advances in Applied Science, 2: 33-42.

Khan, A.; Shafi, M.; Bakht, J. and Anwar, S. (2017). Effect of salinity and seed priming on growth characters of wheat varieties. Sarhad J. of Agriculture, 33: 435-446.

Lutts, S.; Benincasa, P.; Wojtyla, L.; Kubala, S.S.; Pace, R.; Lechowska, K.; Quinet, M. and Garnczarska, M. (2016). Seed priming: new comprehensive approaches for an old empirical technique. New Challenges in Seed Biology-Basic and Translational Research Driving Seed Technology. Intechopen.

Miri, A.H.; shakib, E.S.; Ebrahimi, O. and Sharifi-Rad, J. (2017). Impacts of Nickel Nanoparticles on Grow Characteristics, Photosynthetic Pigment Content and Antioxidant Activity of *Coriandrum sativum* L. Oriental Journal of Chemistry, 33(3): 1297-1303.

Mohamed, A.B.; El-Banna, M.F.; Farouk, S. and Khafagy, M.A. (2019). The role of grain priming and its duration on wheat germination and seedling growth. Journal of Plant Production, 10(4): 343-349.

Nel, A.; Xia, T.; Mädler, L. and Li, N.; 2006. Toxic potential of materials at the nanolevel. science, 311(5761), pp.622-627.

Panhwar, M.; Keerio, M.I. and Robert, M.R. (2017). Evaluating changes in wheat genotypes caused by hydrogen peroxide during seed treatment and their involvement in salt tolerance. Pakistan Journal of Agriculture, Agricultural Engineering and Veterinary Sciences, 33(1): 23-36.

Qadir, S.A. (2018). Wheat Grains Germination and Seedling Growth Performance under Drought Condition. Basrah Journal of Agricultural Sciences, 31(2): 44-52.

Qadir, S.A.; Khursheed, M.Q. and Huyop, F.Z. (2016). Effect of Drought Stress on Morphology, Growth and Yield of Six Bread Wheat (*Triticum aestivum* L.) Cultivars. *ZANCO* Journal of Pure and Applied Sciences, 28(3): 37-48.

Rawat, P.S.; Kumar, R.; Ram, P. and Pandey, P. (2018). Effect of Nanoparticles on Wheat Seed Germination and Seedling Growth. International Journal of Agricultural and Biosystems Engineering, 12(1): 13-16.

Reynolds, T. and Dweck, A.C. (1999). *Aloe vera* leaf gel: a review update. Journal of Ethnopharmacology, 68: 3-37.

Shah, T.; Khan, A.Z.; urRehman, A.; Akbar, H.; Muhammad, A. and Khalil, S.K. (2017). Influence of pre-sowing seed treatments on germination properties and seedling vigor of wheat. Research in Agricultural & Vet. Sci. 1: 62-70.

Toklu, F.; Baloch, F.S.; Karaköy, T. and Özkan, H. (2015). Effects of different priming applications on seed germination and some agromorphological characteristics of bread wheat (*Triticum aestivum* L.). Turkish Journal of Agriculture and Forestry, 39(6): 1005-1013.

Tolbert, N.E. (1974). Photorespiration. In Algal physiology and biochemistry, pp. 474-504. Ed. by W.D. P. Stewart. University of California Press, Los Angeles.

Vaz Mondo, V.H.; Nascente, A.S.; Neves, P.de-C.F.; Taillebois, J.E. and Oliveira, F.H.S. (2016). Seed hydropriming in upland rice improves germination and seed vigor and has no effects on crop cycle and grain yield. Australian J. of Crop Science, 10: 1534-1542.

Vazquez, B.; Avila, G.; Segura, D.; Escalante, B. (1996). Anti-inflammatory activity of extracts from *Aloe vera* gel. Journal of Ethnopharmacology, 55: 69-75.

Vinson, J.A.; Al Kharrat, H. and Andreoli, L. (2005). Effect of Aloe vera preparations on the human bioavailability of vitamins C and E. Phytomedicine, 12: 760-765.

Yücel, N.C. and Heybet, E.H. (2016). Salicylic acid and calcium treatments improves wheat vigor, lipid and phenolics under high salinity. Acta Chimica Slovenica, 63:738-746.