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Effect of seed priming on quality parameters of wheat (*Triticum aestivum* L.) seeds harvested under irrigated & rainfed conditions

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Abstract

The present study was conducted on wheat variety "K-9351 (Mandakini)"and was procured from Seed Processing Plant, C.S Azad University of Agriculture & Technology, Kanpur. The experiment was conducted in Rabi 2014-15 and 2015-16. The seeds were used for pre-sowing seed treatments, *i.e.*$T_{1=}$ Control (Unprimed), $T_{2=}$ Priming with tap water, $T_{3=}$ Priming with KNO_3 (2.5%), $T_{4=}$ Priming with GA_3 (50ppm), $T_{5=}$ Priming with $Cacl_2$ (1%), $T_{6=}$ Priming with NaCl (1%) & $T_{7=}$ Priming with KH_2 PO_4 (1%). Pre-sowing seed treatment or priming was done by soaking of required quantity of seeds of wheat variety Mandakini K-9351 in tap water and various chemicals' concentration for 12 hrs in ratio of 1:1 (Kg of seeds/volume of solution) by using wet gunny bags. Then the treated or primed seeds were dried in shade to maintain the seed moisture content approximately 12 or 13%. Seed dressing was done on primed and untreated (control) by Thiram (2.5%). Seeds priming were KNO_3 @ 2.5% on wheat variety Mandakini (K-9351) significantly improved the seed quality with percent increase of 15.30 & 20.96 in 1000 seed weight (g), 4.47 & 5.08 in germination (%), 16.03 & 20.91 in seedling length (cm), 27.22 & 40.12 in seedling dry weight (g), 21.29 & 28.86 in SVI-I, 24.86 & 46.81 in SVI-II, 5.75 & 5.51 in E.C. value and 12.72 & 8.92 in protein content over unprimed or control under irrigated and rain fed conditions, respectively.

Keywords: Wheat, Seed Priming, Seedling characters

Introduction

Wheat (*Triticum aestivum* L.) is an important cereal in many developed and developing countries of the world. It is grown all over India from the sea level up to an elevation of 3500 m in the Himalaya. In Uttar Pradesh, productivity of wheat is low, which needs improvement, the main causes of low productivity of wheat in U.P. is its delayed sowing in sizeable area after harvesting the toria, early potato, late paddy, sugarcane, ratoon and early pigeon pea etc. Stand establishment is of primary importance for optimizing field production of any crop plant. At suboptimal conditions of environment conditions, poor seed germination and subsequently poor field establishment is a common phenomenon. It has been reported that one of the major obstacles to high yield and production of crop plants is the lack of synchronized crop establishment due to poor weather and soil conditions (Mwale *et al*., 2003). On the other hand seeds are occasionally sown in seedbeds having unfavorable moisture because of the lack of rainfall at sowing time which results in poor and unsynchronized seedling emergence (Angadi and Entz, 2002). Seed size plays a major role in germination and establishment of vigorous seedlings that is essential to achieving high yield. In drought-prone environments, particularly, cereal germination tends to be irregular and can be extended over long periods (Bougne *et al*., 2000) [7]. Seed germination is negatively affected by drought (Damirkaya *et al*., 2006) [8]. It has been declared that priming had resulted in more germination speed especially in drought stress and low temperatures in sorghum, sunflower and melon (Sivritepe *et al*., 2003) [26]. Priming allows some of the metabolic processes necessary for germination to occur without germination take place. In priming, seeds are soaked in different solutions with high osmotic potential. This prevents the seeds from absorbing enough water for radicle protrusion, thus suspending the seeds in the lag phase (Taylor *et al*., 1998) [27]. Seed priming has been commonly used to reduce the time between seed sowing and seedling emergence and to synchronize emergence (Parera and Cantliffe, 1994) [25]. Various seed priming techniques have been developed which include hydro-priming, halo-priming, osmo-priming and hormonal priming. Ashraf *et al*., (2001) [16] found that GA_3 treatment enhanced the vegetative growth of two wheat cultivars. It enhanced the deposition of Na+ and Cl- in both root and shoots of wheat plant.

It also caused a significant increase in photosynthetic at the vegetative stage of the crops.

Improving in priming is affected by many factors such as plant species, priming media, its concentration, priming duration, temperature and storage conditions etc. With the proper treatment of seeds they are able to germinate and emerge better as the inorganic salts improve germination and growth parameters of the treated seed; KCl increases the protein and starch content in grains and KNO_3 increases yield, fruit size and improves quality in field and vegetables crops. The present investigation is therefore, planned to assess the effect of seed priming treatments on seed quality under irrigated and rainfed conditions and to identify the suitable seed priming treatment for getting higher seed quality.

Materials & Methods

The experiment was conducted on wheat variety "K-9351 (Mandakini)". The good quality seeds of wheat variety were procured from Seed Processing Plant C.S Azad University of Agriculture & Technology, Kanpur. The experiment was conducted in Rabi 2014-15 and 2015-16. Following chemicals and their concentration were used for pre-sowing seed treatments.$T_{1=}$ Control (Unprimed), $T_{2=}$ Priming with tap water, $T_{3=}$ Priming with KNO_3 (2.5%), $T_{4=}$ Priming with GA_3 (50ppm), $T_{5=}$ Priming with $Cacl_2$(1%), $T_{6=}$ Priming with NaCl(1%) & $T_{7=}$ Priming with KH_2 PO_4 (1%). Pre-sowing seed treatment or priming was done by soaking of required quantity of seeds of wheat variety Mandakini K-9351 in tap water and various chemicals' concentration for 12 hrs in ratio of 1:1 (Kg of seeds/volume of solution) by using wet gunny bag. Then the treated or primed seeds were dried in shade to maintain the seed moisture content approximately 12 or 13%. Seed dressing was done on primed and untreated (control) by Thiram (2.5%). Primed seeds along with control (untreated) were sown in two separate experiments for irrigated and rainfed conditions and crop was raised with application of 5 irrigations and no irrigations, respectively, in 4 replications by using RBD design for both at New Dairy Farm, Kalyanpur, Kanpur, respectively. The crop was raised by using all required agronomical practices. Mature crop was harvested in the last week of April 2015 & 2016. Processed seeds were examined for the quality parameters in three replications at Seed Testing Laboratory of C.S. Azad University of Agriculture & Technology, Kanpur. CRD design was used for statistical analysis. The following Laboratory observations were recorded. 1000 seed weight (g), Germination test (%), Seedling dry weight (g), Seedling length (cm), Seed Vigour Index-I (Germination × Seedling length), Seed vigour index-II (Germination × Seedling dry weight), Electrical conductivity (dSm^{-1}) and Protein content (%).

Calculation

Present N in the sample is calculated using formula.

Nitrogen %=1.4 N.V/w(g)

Where,

N=Normality of HCl

W=Weight of sample

V=The titrate value of sample – titrate value of blank

Protein %= Nitrogen % × 6.25

Statistical analysis of data

The analysis of data was done following the Complete Randomized Design. The steps employed are given below. The various statistical techniques were used for calculation of the data as suggested by Cochran and Cox (1957).

Table 1: Skeleton of analysis of variance (ANOVA)

Sources of variance	D.F	SS	M.S.S	'F' Cal	'F' Table value	
					5%	1%
Treatments Error	6 14	SST SSE	VT=SST/6 VE=SSE/14	VT/VE	2.85	4.46
Total	20					

1. Standard error of difference between treatment mean:

$$T = \sqrt{\frac{2Ve}{3}}$$

2. Critical difference in every case:

C.D =[(SE) diff]× t (0.05) t_6d.f.

The value for germination percentage was converted in to respective angular values as suggested by Fisher and Yates (1963).

Results and Discussion

The result recorded for both years were pooled during the experimental findings have been discussed and mentioned in this chapter in terms of causes and their effects relationship. Since, priming treatments play an important role for improving seed germination seedling growth, seedling dry weight, seed vigour index-I, and seed vigour index-II, electrical conductivity value protein content and yield along with other activities in most of the crop as stated by Ghobadi *et al.* (2012) [12], Iqbal *et al.* (2013) [3], Hamidi *et al.* 2013 [14], and Tian *et al.* (2014) [28].

Seed priming has been found a double beneficial technology to enhance rapid and uniform emergence and to achieve high vigour as well as better yield in field crops. Many studies have been carried out on the effect of seed priming on germination and growth rate of crop. Seeds spend a great deal of time just absorbing water from the soil. If this time is minimized, seed germination and seedling emergence can be significantly speeded up. The easiest way to do this is to soak the seeds in water before sowing (Harris, 1999) [15], a phenomenon called hydro- priming. In recent years, seed osmopriming has been tested in over 1000 trials in India, Pakistan, Nepal, Bangladesh and Zimbabwe on a range of crops including maize (*Zea mays*), sorghum (*Sorghum bicolor*), rice (*Oryza sativa*), wheat (*Triticum spp.*) and Chickpea (*Cicer arietinum*) (Harris *et al*. 2001) [16]. Seed priming is a controlled hydration process followed by re-drying that allows seeds to imbibe water and begin internal biological processes necessary for germination, but which does not allow the seed to actually germinate. A robust seedling establishment enhances competitiveness against weeds, improves tolerance to environmental stresses and maximizes biological and grain yields (Hosseein *et al.* 2011) [17]. Potassium hydro phosphates (KH_2PO_4), have been introduced as the osmoticum which have shown good potential to enhance germination, emergence, growth, and grain yield of wheat (Misra and Dwibedi, 1980) [21]. Several research worker primed the seeds by gibberellic acid (GA_3) which is the most important growth regulator used for seed germination, mobilization of food in seed storage cell, cell elongation, permeability of cell membrane, apical bud dormancy, flowering and fruiting growth. Besides these GA_3 induce synthesis of hydrolytic enzyme, primed corn and wheat seed respectively by Barsa *et al.* (1989) [5] and Ajirloo *et al.* (2013) [2] Potassium nitrate (KNO_3) is the most common known chemical for promoting seed germination. It may interact with temperature and influencing the seed physiology finally, germination and vigour are improved.

Poor crop establishment is a major problem in wheat production due to low soil moisture under rain fed condition (Murungu 2011) [24] and due to this seed emergence and germination are negatively affected in beds (Bougne *et al.* 2000, Sivritepe *et al.* 2003, Damirkaya *et al.* 2006) [7, 26, 8]. Primings may help seed production under rain fed condition by ensuring fast; improve germination vigourously (Harris *et al.* 2001) [16]. It is this way, pre-sowing seed priming treatments by several group of chemicals can influence seed quality in terms of 1000 seed weight, germination, vigour, and protein content.

Table 2: Mean table for the effect of seed priming on quality parameters under Irrigated Condition

Treatments	1000 Seed weight (g)	Germination (%)	Seedling length (cm)	Seedling Dry weight (g)	Seed Vigour Index I	Seed Vigour Index II	E.C. value	Protein Content (%)
Control (T_0)	35.09	92.00	14.78	0.202	1360.84	18.62	1.39	11.71
Tap water (T_1)	37.31	94.00	15.71	0.225	1478.92	20.75	1.33	12.32
KNO_3 (2.5%) (T_2)	40.46	96.12	17.15	0.257	1650.69	23.25	1.31	13.2
GA_3 (50 ppm) (T_3)	35.59	93.62	15.64	0.212	1466.17	19.97	1.35	12.16
C_aCl_2 (1%) (T_4)	35.50	93.37	15.48	0.205	1446.94	19.23	1.36	11.93
NaCl (1%) (T_5)	35.81	92.62	15.16	0.204	1404.68	18.99	1.38	11.82
KH_2PO_4 (1%) (T_6)	38.66	95.12	16.63	0.229	1582.78	21.32	1.32	12.68
S.E.D	0.83	0.78	0.52	0.012	47.58	1.32	0.01	0.16
C.D.	2.07	1.94	1.30	0.031	117.54	3.27	0.02	0.40

Table 3: Mean table for the effect of seed priming on quality parameters under rainfed Condition

Treatments	1000 Seed weight (g)	Germination (%)	Seedling length (cm)	Seedling Dry weight (g)	Seed Vigour Index I	Seed Vigour Index II	E.C. value	Protein Content (%)
Control (T_0)	31.05	88.50	7.89	0.157	701.69	13.97	1.45	12.81
Tap water (T_1)	34.92	89.62	8.72	0.184	815.43	16.63	1.39	13.86
KNO_3 (2.5%) (T_2)	37.56	93.00	9.54	0.220	904.26	20.51	1.37	13.94
GA_3 (50 ppm) (T_3)	34.35	89.37	8.46	0.179	787.48	16.09	1.41	13.68
C_aCl_2 (1%) (T_4)	32.52	89.12	8.01	0.174	746.99	15.63	1.42	13.08
NaCl (1%) (T_5)	32.22	88.87	8.01	0.169	749.40	15.14	1.43	13.02
KH_2PO_4 (1%) (T_6)	36.94	91.37	9.30	0.198	865.04	18.15	1.38	13.88
S.E.D	1.64	1.04	0.51	0.013	50.02	1.18	0.008	0.21
C.D.	4.07	2.58	1.27	0.033	123.55	2.92	0.020	0.53

Effect of seed priming treatments on seed quality parameters.

Under irrigated condition

Significant effect of various pre-sowing seed priming treatments (control), (tap water), (KNO_3 @ 2.5%), (GA_3 @ 50ppm), ($CaCl_2$ @ 1%), (NaCl @ 1%) and (KH_2PO_4 @ 1%)were found on seed quality in terms of 1000 seed weight, germination, seedling length, seedling dry weight, seed vigour index-I, seed vigour index-II, electrical conductivity and protein content of wheat when crop was raised under irrigated condition (Table 2). Similar findings are given by Harris *et al.* (2001) [16], Giri *et al.* (2003) [13], Farooq *et al.* (2006) [10], Tian *et al*. (2014) [28] and Toklu *et al*. (2015) [16].

Seed priming treatment of KNO_3 gave significantly highest percent improvement over control for 1000 seed weight, germination, seedling length, seedling dry weight, seed vigour index-I, seed vigour index-II, electrical conductivity and protein content and showed 15.30, 4.47, 16.03, 27.22, 21.29, 24.86, 5.75 and 12.72 % improvement with values of 40.46g, 96.12 %, 17.05cm, 0.257g, 1650.69cm, 23.25g, 1.31dSm^{-1} and 13.20% respectively (Ghobadi *et al.* 2012, Ajirloo *et al*. 2013.) [12, 2]. Next pre-sowing seed priming treatment was KH_2PO_4, which showed significantly similar performance & at par to KNO_3 for improving the 1000 seed weight, germination, seedling length, seedling dry weight, seed vigour index-I, seed vigour index-II, electrical conductivity and protein content and showed 10.17, 3.39, 12.51, 13.36, 16.30, 14.50, 5.03 and 8.28 % improvement with values of 38.66g, 95.12 %, 16.63cm, 0.229g, 1582.78cm, 21.32g, 1.32dSm^{-1} and 12.68% respectively over unprimed seeds. Seed priming with tap water also showed significant improvement over unprimed seeds for germination, seedling length, seedling dry weight, seed vigour index-I and seed vigour index-II, EC value& protein content whereas percent increase over control were 6.32, 2.17, 6.29, 11.38, 8.67, 11.43, 4.31 and 5.20 but was at par in case of seed vigour index-II & E.C. value. These findings were strongly supported by Moradi Dezfuli *et al.* (2008) [22] in maize and Farooq *et al.* (2008) [11], Arief *et al.* (2011) [4], Lemrasky *et al.* (2012) [18], Hamidi *et al.* (2013) [14], Ali *et al.* (2013) [3], Toklu *et al.* (2015) [29] in wheat.

Significantly similar performance was exhibited by tap water for 1000 seed weight, germination% seedling length (cm), seedling dry weight (g), seed vigour index-I, seed vigour index-II and protein content and ranked 3rd with values 37.31g, 94.00%, 15.71cm, 0.225g, 1478.92, 20.75 & 12.32% respectively followed by NaCl, $CaCl_2$, GA_3 that scored nearly similar values and were at par to control that exhibited 35.09, 92.00, 14.78, 0.202, 1360.84, 18.62, 1.39 & 11.71% for 1000 seed weight (g), germination (%), seedling length (cm), seedling dry weight (g), seed vigour index-I, seed vigour index-II, electrical conductivity dSm^{-1} and protein content (%) respectively. It was very much clear for the findings of experiment that untreated or unprimed (control) seeds exhibited significantly inferior performance than KNO_3 and KH_2PO_4. These results are in accordance with the finding of Basra *et al.* (2005) [6], Bassi (2005), Moradi Dezfuli *et al*.,

(2008) [22], Khan *et al*., (2009), Arief *et al* (2011) [4], Ghobadi *et al.* (2012) [12], Ghassemi-Golezani *et al*. (2013), Hamidi *et al*. (2013) [14], Tian *et al*. (2014) [28]. It was very much clear from the findings of experiment that untreated or unprimed (control) seeds exhibited significantly inferior performance regarding 1000 seed weight, germination, seedling length, seedling dry weight, seed vigour index-I, seed vigour index-II, electrical conductivity and protein content. Priming treatments KNO_3 and KH_2PO_4 showed best performance among all the treatments and were at par with each other

Under rain fed condition

Seed priming treatments of various chemicals viz. control, tap water, KNO_3 (2.5%), GA_3(50ppm),$CaCl_2$ (1%), NaCl (1%) and KH_2PO_4 (1%) showed significant influence on all the seed quality parameters those were observed i.e. 1000 seed weight, germination, seedling length, seedling dry weight, seed vigour index-I, seed vigour index-II, electrical conductivity and protein content. Poor crop establishment is a major problem in wheat production under rain fed condition Murungu (2011) [24]. Various scientists reported that priming treatments significantly increased the strength of the seeds to face the moisture or stress condition of the field under drought or low rain condition. (Demir and Van de Venter 1999, Bougne *et al.* 2000, Harries 2001, Sivritepe *et al.* 2003, Damirkaya *et al*. 2006) [9, 7, 16, 26, 8]. Seed priming treatments of KNO_3 significantly improved the all seed quality parameters with percent increase of 20.96 in 1000 seed weight, 5.08 germination, seedling length 20.91, seedling dry weight 40.12, 28.86 in seed vigour index-I, 46.81 seed vigour index-II, 8.82 in protein content and percent decrease of 5.51 in EC over control (table.3). This treatment showed the highest improvement in seed quality parameters including the performance of cell membrane. Next to best KNO_3 was KH_2PO_4 priming treatment which exhibited statistically similar performance to KNO_3 for 1000 seed weight, germination, seedling length, seedling dry weight, seed vigour index-I, seed vigour index-II, protein content and electrical conductivity with percent increase of 18.96, 3.24, 17.87, 26.11, 23.27, 29.92, 8.35 and percent decrease of 4.82dSm^{-1}over unprimed seeds. Seed priming treatments of tap water stood at par to KNO_3 and KH_2PO_4 for protein content with value of 13.86% (Morunugu, 2011, Ali *et al*, 2013) [3]. But stood significantly inferior to $KNO_3$and KH_2PO_4 and ranked on third place for improving the germination with value of 89.62% with percent increase of 1.26 over control. Seed priming treatments of tap water showed at par performance to $GA_3$for 1000 seed weight, seedling length, seed vigour index – I & protein content. Seed priming treatments of $GA_{3,}$ NaCl, $CaCl_2$ for germination, $CaCl_{2,}$ NaCl for SVI-I, NaCl, $CaCl_{2,}$ GA_3 for SVI-II, NaCl for EC and $CaCl_{2,}$ and NaCl for protein did not show any significant improvement over control or unprimed seeds.

Conclusion

It was concluded from the present study that the seed priming were KNO_3 @ 2.5% on wheat variety Mandakini (K-9351) significantly improved the seed quality with percent increase of 15.30 & 20.96 in 1000 seed weight (g), 4.47 & 5.08 in germination (%), 16.03 & 20.91 in seedling length (cm), 27.22 & 40.12 in seedling dry weight (g), 21.29 & 28.86 in SVI-I, 24.86 & 46.81 in SVI-II, 5.75 & 5.51 in E.C. value & 12.72 & 8.92 in protein content over unprimed or control under irrigated and rain fed conditions, respectively. Among all the treatments, KNO_3 was found to be the best which was at par with KH_2PO_4 for both the conditions.

References

1. Abdul Baki AA, Anderson JD. Vigour determination in soybean by multiple criteria. Crop Science, 1973; 13:630-633.
2. Ajirloo AR, Shaban M, Moghanloo GD, Ahmadi A. Effect of priming on seed germination characteristics of wheat (*Triticum aestivum* L.). Journal of Agriculture and Crop Sciences (IJACS), 2013; 5(15):1670-1674.
3. Ali Hakoomat, Iqbal Nadeem, Shahzad N, Sarwar Naeem, Ahmad Shakeel, Mehmood Athar. Seed priming improves irrigation water use efficiency, yield, and yield components of Late sown wheat under limited water conditions. Turkish Journal of Agriculture and Forestry, 2013; 37(5):534-544.
4. Arief Ramlah, Koes Fauziah, Komalasari Oom. Effect of priming on seed vigour of wheat (*Triticum aestivum* L.). Agrivita. 2011; 34(1):50-54.
5. Basra AS, Dhillon R, Malik CP. Influence of seed pre-treatment with plant growth regulators on metabolic alterations of germinating maize embryos under stressing temperature regions. Annals of Botany. (London). 1989; 64:37-41.
6. Basra SMA, Farooq M, Tabassum R. Physiological and biochemical aspects of seed vigour enhancement treatments in fine rice (*Oryza sativa* L.). Seed Science and Technology, 2005; 33:623-628.
7. Bougne S, Job C, Job D. Sugar beet seed priming: solublization of the basic subunit of 11– S globulin in individual seeds, Seed Science Research, 2000; 10:153-161.
8. Damirkaya M, Okgu G, Atak GY, Kolsarici O. Seed treatments to overcome salt and drought stress during germination in sunflower (*Helianthus annuus* L.). European Journal of Agronomy. 2006; 24:291-295.
9. Demir I, Van De Venter HA. The effect of priming treatments on the performance of watermelon (*Citrulluslanatus Thunb*.) Matsum. Et Nakai) seeds under temperature and osmotic stress. *Seed Science and Technology*, 1999; 27:871-875.
10. Farooq M, Basra SMA, Tabassum R, Afzal I. Enhancing the performance of direct seeded fine rice by seed priming. Plant Production Sciences. 2006; 9:446-456.
11. Farooq M, Basra SMA, Rehaman H, Saleem BA. Seed priming enhance the performance of late sown wheat (*Triticum aestivum* L.) by improving chilling tolerance. Journal of Agronomy and Crop Science. 2008; 194(1):55-60.
12. Ghobadi M, Shafiei-Abnavi M, JalaliHonarmand S, Ghobadi ME, Mohammadi GR. Does KNO3 and hydro priming improve wheat (*Triticum aestivum* L.) seeds germination and seedlings growth. Annals of Biological Research. 2012; 3(7):3156-3160.
13. Giri GS, Schillnger WF. Effect of seed priming in winter wheat for germination, emergence and yield. Crop Science. 2003; 46(6):2135-2141.
14. Hamidi R, Pirasteh Anosheh H, Izadi M. Effect of seed halopriming compared with hydropriming on wheat germination and growth. Journal of Agronomy and Plant Production. 2013; 4(7):1611-1615.
15. Harris D, Joshi A, Khan PA, Gothkar P, Sodhi PS. On farm seed priming in semi-arid agriculture. Development and evaluation in maize, rice and chickpea in India, using participatory methods. Experimental Agriculture, 1999;

35:15-29
16. Harris D, Pathan AK, Gothkar P, Joshi A, Chivasa W, Nyamudeza P. On-farm seed priming using participatory methods to revive and refine a key technology. Agricultural Systems, 2001; 69:151-164.
17. Hosseein Farahani A, Karsa M. Effect of hydro-priming on seedling vigour in Basil (*Ocimum basilicum* L.) under salinity conditions. Advances in Environmental Biology, 2011; 5(5):828-833.
18. Lemrasky MG, Hosseini SZ. Effect of seed priming on the germination behaviour of wheat. UK. International Journal of Agriculture and Crop Sciences (IJACS). 2012; 4(9):564-567.
19. Mahammad F, Basra MA. Rice cultivation by seed priming DAWN Business, 2005.
20. Matthews S, Wagner MH, Ratzenboeck A, Khajeh Hosseini M, Casarini E, El-Khadem R *et al*. Early counts of radicle emergence during germination as a repeatable and re-producible vigour test for maize. Seed Testing International, 2011; 141:39-45.
21. Misra NM, Dwibedi DP. Effects of pre-sowing seed treatments on growth and dry matter accumulation of high yielding wheat under rain fed conditions. Indian Journal of Agronomy. 1980; 25:230-234
22. Moradi Dezfuli P, Sharif-zadeh F, Janmohammadi M. Influence of priming techniques on seed germination behavior of maize inbred lines (*Zea mays* L.). ARPN Journal of Agricultural and Biological Science. 2008; 3(3):22-25.
23. Muhammad Iqbal, Muhammad Ashraf, Fan L, Qu, L. Gibberellic acid mediated induction of salt tolerance in wheat plants: growth, ionic partitioning, photosynthesis, yield and hormonal homeostasis. Environmental and Experimental Botany. 2013; 86:76-85.
24. Murungu FS. Effects of seed priming and water potential on seed germination and emergence of wheat (*Triticum aestivum* L.) varieties in laboratory assays and in the field. African Journal of Biotechnology. 2011; 10(21):4365-4371.
25. Parera CA, Cantliffe DJ. Pre-sowing seed priming. Horticulture. Rev. 1994; 16:109-141.
26. Sivritepe N, Sivritepe HO, Eris A. The effects of NaCl priming on salt tolerance in melon seedling grown under saline conditions. Scientia Horticulturae, 2003; 97:229-237.
27. Taylor AG, Allen PS, Bennett MA, Bradford KJ, Burrisand JS, Misra MK. Seed enhancements. Seed Science Research. 1998; 8:245-256.
28. Tian Yu, Bo Guan, Daowei Zhou, Junbao Yu, Guangdi Li, Yujie Lou. Responses of Seed Germination, Seedling Growth, and Seed Yield Traits to Seed Pretreatment in Maize (*Zea mays* L.). Scientific World Journal. 2014, 834630.
29. Toklu F, Baloch SF, Karaköy T, Özkan H. Effects of different priming applications on seed germination and some agro-morphological characteristics of bread wheat (*Triticum aestivum* L.). Turkish Journal of Agriculture and Forestry. 2015; 39(6):1005-101.