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# Response of wheat seed to priming combinations

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ABSTRACT

An experiment using the randomized complete block design in three replications was conducted in 2013 under laboratory conditions to study the effects of different treatments of hydro-priming and osmo-priming on seed germination of the Darya cultivar of wheat. The treatments studied included subjecting the seeds for 12 or 24 hours to polyethylene glycol 6000 at three concentrations (5, 10, and 15 percent), potassium nitrate at three concentrations (1, 2 and 3 percent), potassium chloride at three concentrations (1, 2 and 4 percent), and a control treatment of distilled water. Results obtained showed that the rates of germination, total percentages of germination, percentages of normal seedlings, lengths of the radicles and sprouts, length ratios of root to shoot, lengths of the seedlings, dry weight of radicles and weight ratios of root to shoot were statistically significant at one percent level, but the dry weight of the sprouts and seedling weren't statistically significant. The maximum germination rate (22.11) was achieved in the treatment of 8 hrs using distilled water, and the minimum germination rate (7.61) in the 16 hrs treatments with four percent KCL. The highest total germination rate (100) was observed in the treatments of distilled water with 16 hrs, whereas the lowest (40.67) observed in the 16 hrs treatment using 4 percent KCL. The results also indicated that the highest percentages of normal seedlings (95.33 and 100) belonged to the 8 and 16 hrs treatment with distilled water respectively, and to the 8 hrs treatment of using five percent PEG (92.67) and 1 percent KNO3 at 16 hrs (96.67), and the lowest (40.00) was that of the 16 hrs

treatment with four percent KCL. Results observed also suggested that the factors measured, including the rate and the percentage of seed germination and also the lengths of the radicles and sprouts and seedlings, exhibited an ascending trend when higher concentrations of osmo-priming compounds were used. These compounds showed their greatest effects when used at low concentrations.



## 1. Introduction

Germination is the first stage in the vegetative growth of plants, one of the main and sensitive stages in plant life cycle, and also a key process in the emergence of seedlings (De Villiers et al., 1994). One of the main requirements of achieving the highest potential yield of crops is rapid and uniform germination in the field. This stage of growth is greatly influenced by environmental factors, especially temperature and soil moisture (Basra et al., 2004). One of the advanced methods of accelerating crop plant seed germination is the use of the technology of seed dehydration. Through the use of this method, it is possible to increase the ability of seeds to germinate and to grow under conditions of stress (Drew et al., 1997; Srinivasan et al., 1999).

Priming is one of the common techniques of dehydration. In priming, seeds are subjected to low potential osmotic solutions of substances such as Polyethylene glycol, KNO3, NaCl, Glycerol, and Mannitol (Drew et al., 1997; Ellis, 1989; Hardegree and Emmerich, 1994).

Polyethylene glycol is a macromolecular compound (with the molecular weight of 6000 – 8000) that cannot enter seeds and that does not cause the side effects produced by salts (Michel and Kaufmann, 1973). Different plant species require different periods of priming depending on the priming compound used and on the temperature at which priming is carried out. If the duration of priming is increased, the radicles will emerge and irreparable damage will be inflicted on the seeds (Khan et al., 1990; Parera and Cantliff, 1994). Priming treatments reduce the period between planting and emergence, protect seeds from biotic and abiotic factors during the critical period of stand establishment, and also cause uniformity of emergence, which will result in a uniform stand establishment and an improvement in yield (Basra et al., 2004). Among the objectives of the hydration technology are increases in the percentage and rate of germination, more rapid and uniform emergence of seedlings, early maturity and an increase in uniform stand establishment of seedlings, tolerance of great variations in temperature during germination, repair of damaged cells, weakening of obstacles to embryonic development, resistance against pests and diseases, reduction in quiescence, elimination of dormancy, improvement in crop quality and in harvest, resistance against adverse environmental conditions at planting, and increases in plant development vigor (Callen et al.,1990; Bradford et al. , 1997)

Given that wheat the most important crop plants planted in many areas for its seeds and fodder, grows slowly has limited ability to compete with weeds, and is very vulnerable in the early stages of germination, this research was conducted to study the responses of the seeds of wheat cultivar Darya to different concentrations of osmotic solutions of polyethylene glycol, saline solutions of KNO3 and KCl, and distilled water.

## 2. Materials and methods

This experiment was carried out in the format of the randomized complete block design with 10 priming treatments at two priming time periods in three replications (a total of 60 treatments) on seeds of the Darya cultivar of wheat.

The solutions used for the durations of 8 or 16 hours were 5, 10, and 15 percent PEG6000, one, two, and three percent $KNO_3$; one, two, and four percent KCl; and distilled water. All chemical treatments were conducted in sterile petri dishes (with two filter papers in each petri dish, between which 50 seeds were put). After the priming time periods, the seeds were removed from the solutions and dried at the ambient temperature and, according to ISTA instructions, were soaked in distilled water for one week at room temperature to germinate and grow. Subsequently, the features related to germination were measured including the length of the radicles, the

length of the sprouts, the length of the seedlings, the rates of germination, the total number of germinated seeds, the total germination percentage, the percentage of normal germination, the dry weight of the radicles, the dry weight of the sprouts, the dry weight of the seedlings, the length ratio of R/S, and the dry weight ratio of R/S.

Analysis of the variance of the data obtained was performed using the SAS statistical software, and Duncan's multiple range tests at the five percent probability level was employed to compare the means.

## 3. Results and Discussion

### 3.1. Germination rate

Results of analysis of the variation showed that the differences in the rates of germination were statistically significant at the one percent probability level (Table 1). Comparison of the means of the data revealed that the maximum germination rate (22.11) was achieved in the 8 hrs treatment using distilled water, and the minimum germination rate (7.61) in the 16 hrs treatments with four percent KCL (Table 2).

The experiment Pourkolhar et al (2009) conducted on corn showed that the highest germination rate belonged to the 12 hrs treatment using one percent KCL, and the lowest to the 36 hrs treatment in which four percent KCL was used.

The observations of Mohseni et al (2010) suggested that the highest germination rates belonged to the treatment of using water and to the control, while the lowest were those of the treatments of using four percent KCL and two percent KNO3. They also found that the rate of germination increased significantly in the treatments of priming with distilled water.

The decrease in the amount of water entering seeds, due to the increase in water stress, causes a decline in hydraulic conduction, and hence the physiological and metabolic processes of germination are affected (i.e., the degrees or rates of these processes decline). If water absorption by seeds is disrupted or takes place slowly, the metabolic processes of germination inside the seeds will happen slowly and, therefore, more time will be required for the sprouts to come out of the seeds and the germination rate will decrease (De and Kar, 1994). Penalosa and Eira (1993) reported that if priming is carried out at the appropriate time, it will keep the rate of germination of tomato seeds from being affected by adverse influences. Chojnowski and Come (1997) reported that priming sunflower seeds for three to five days increased the rate of germination and improved seedling growth. They attributed this increase to the rise in respiration activities, ATP production, stimulation of RNA activities, and to protein production in primed seeds. Khajeh Hosseini et al (2003) stated that potassium chloride caused a greater decrease in the rate of germination of soybean seeds than polyethylene glycol.

Yadavi and Balouchi (2010), in their experiments on the effects of priming treatments on the rate of germination of garden fennel - flower seeds, showed that the maximum and the minimum rate of seed germination belonged to hydro-priming and osmo-priming carried out using minus ten bar polyethylene glycol.

### 3.2. Total percentage of germination

The number of germinated seeds (germinated in such a way that only two to five millimeters of the radicles come out of the seeds) out of a total of 100 seeds in each dish is called the total percentage of germination.

Results of analysis of the variance of the data (Table 1) indicated that the total percentages of germination differed significantly at the one percent probability rate. The highest total germination rate (100 and 95.33) was observed in the 16 and 8 hrs treatments using distilled water, respectively, and 5 percent PEG at 8 hrs (94.67), 10 percent PEG at 16 hrs (96.00), 15 percent PEG at 16 hrs (92.67), 2 percent KCL at 16 hrs (91.33), 1 percent KNO3 at 16 hrs (97.33) and 3 percent KNO3 at 16 hrs (95.33), where as the lowest (40.67) in the 16 hrs treatment using 4 percent KCL (Table 2).

### 3.3. Percentage of normal seedlings

The number of seeds the sprouts and sprouts of which have come out of the seeds and have grown is called the percentage of normal seedlings. Results of analysis of the variance of the data (Table 1) showed that the percentages of normal seedlings differ significantly at the one percent probability level.

The results indicated that the highest percentages of normal seedlings (95.33 and 100) belonged to the 8 and 16 hrs treatment with distilled water, respectively, and to the 8 hrs treatment of using five percent PEG (92.67)

and 1 percent KNO3 at 16 hrs (96.67), and the lowest (40.00) was that of the 16 hrs treatment with four percent KCL (Table 2).

**Table 1**
Mean Squares of the Features in Pre - germination Priming Treatments.

| Sources of change | Degree of freedom | Rate of germination | Total percentage of germination | Percentage of normal Seedlings |
|---|---|---|---|---|
| Treatment | 19 | 37.87** | 763.66 ** | 736.42 * |
| Error | 40 | 14.94 | 316.73 | 313.73 |
| Coefficient of Variation (%) | - | 22.54 | 21.47 | 21.77 |

The symbols * and ** indicate significant differences at the one and five percent probability levels, respectively.

**Table 2**
Comparisons of the Means of Features in Pre – germination Priming Treatments.

| Treatment | Rate of germination | Total germination rate | Percentage of normal seedlings |
|---|---|---|---|
| Distilled water for 8 hrs | 22.11 $^{a}$ | 95.33 $^{a}$ | 95.33 $^{a}$ |
| PEG 5% for 8 hrs | 20.82 $^{ab}$ | 94.67 $^{a}$ | 92.67 $^{a}$ |
| PEG 10% 8 hrs | 17.28 $^{abcd}$ | 77.33 $^{abc}$ | 76.00 $^{abc}$ |
| PEG 15% for 8 hrs | 17.54 $^{abcd}$ | 81.33 $^{abc}$ | 78.67 $^{abc}$ |
| KNO3 1% for 8 hrs | 18.20 $^{abcd}$ | 83.33 $^{abc}$ | 82.00 $^{abc}$ |
| KNO3 2% for 8 hrs | 15.23 $^{abcd}$ | 73.00 $^{abc}$ | 73.33 $^{abc}$ |
| KNO3 3% for 8 hrs | 12.17 $^{de}$ | 56.00 $^{cd}$ | 55.33 $^{cd}$ |
| KCL 1% 8 hrs | 19.46 $^{abcd}$ | 90.67 $^{ab}$ | 88.67 $^{abc}$ |
| KCL 2% for 8 hrs | 16.87 $^{abcd}$ | 85.33 $^{abc}$ | 82.67 $^{abc}$ |
| KCL 4% for 8 hrs | 12.77 $^{cde}$ | 56.67 $^{bcd}$ | 56.00 $^{bcd}$ |
| Distilled water for 8 hrs | 20.58 $^{ab}$ | 100.00 $^{a}$ | 100.00 $^{a}$ |
| PEG 5% for 16 hrs | 21.11 $^{ab}$ | 92.00 $^{a}$ | 89.$^{abc}$ |
| PEG 10% for 16 hrs | 17.34 $^{abcd}$ | 96.00 $^{aa}$ | 92.67 $^{a}$ |
| PEG 15% for 16 hrs | 16.94 $^{abcd}$ | 92.67 $^{a}$ | 90.00 $^{ab}$ |
| KNO3 1% for 16 hrs | 19.71 $^{abcd}$ | 97.33 $^{a}$ | 96.67 $^{a}$ |
| KNO3 2% for 16 hrs | 14.19 $^{bcde}$ | 74.00 $^{abc}$ | 72.67 $^{abc}$ |
| KNO3 3% for 16 hrs | 20.25 $^{abc}$ | 95.33 $^{a}$ | 93.33$^{a}$ |
| KCL 1% for 16 hrs | 15.19 $^{abcd}$ | 84.00 $^{abc}$ | 80.67 $^{abc}$ |
| KCL 2% for 16 hrs | 17.60 $^{abcd}$ | 91.33 $^{a}$ | 90.67 $^{a}$ |
| KCL 4% for 16 hrs | 7.61 $^{e}$ | 40.67 $^{d}$ | 40.00 $^{d}$ |

The numbers in each column that have at least one letter in common are not significantly different at the five percent probability level according to Duncan's multiple range test.

### 3.4. The length of radicles

Results of analysis of the data obtained in the experiment (Table 3) suggested that differences in the lengths of the radicles were statistically significant at the one percent probability level. Comparison of the means of the data indicated that the maximum length of radicles was achieved in treatments using distilled water (10.55 cm) and five percent PEG (10.65 cm) at 16 hrs, and the minimum (3.59 cm) in the 8 hrs treatment with three percent KNO3 (Table 4).

### 3.5. The length of sprouts

Results of analysis of the experimental data (Table 3) showed that the differences in the lengths of sprouts were statistically significant at the one percent probability level, the maximum length of sprouts (15.1 cm) was

observed in the 16 hrs treatment with 5 percent PEG, and the minimum (9.27 cm) was that of the 8 hrs treatment using 3% KNO3 (Table 4).

### 3.6. The ratio of the length of the radicles to the length of the sprouts (r/s)

Analysis of the variance of the data (Table 3) revealed that the differences in the length ratios of R/S were statistically significant at the one percent probability level, the largest length ratio of R/S (0.76) was observed in the 16 hrs treatment with distilled water, and the lowest (0.38) in the 8 hrs treatment using 3% KNO3 (Table 4).

### 3.7. The length of the seedlings

Results of analysis of the variance (Table 3) indicated that the differences in the lengths of the seedlings were statistically significant at the one percent probability level, the longest seedlings (25.72 cm) belonged to the 16 hrs treatment with five percent PEG, and the shortest (12.87 cm) belonged to the 8 hrs treatment using three percent KNO3 (Table 4).

**Table 3**
Mean Squares of the Features in Pre – germination Treatments.

| Source of change | Degree of freedom | Length of radicles | Length of sprouts | Ratio of the length of radicles to sprouts | Length of seedlings |
|---|---|---|---|---|---|
| Treatment | 19 | 12.36 ** | 8.87 ** | 3.38 ** | 39.38 ** |
| Error | 40 | 2.93 | 2.36 | 1.13 | 10.15 |
| Coefficient of Variation (%) | - | 24.31 | 12.33 | 19.14 | 16.37 |

The symbols * and ** refer to significant differences at the levels of 5 and 1 percent probability levels, respectively.

**Table 4**
Comparison of the Means of the Features in Pre – germination Treatments.

| Treatment | Length of the radicles (cm) | Length of the sprouts (cm) | Ratio of length of radicles to sprouts | Length of the seedling (cm) |
|---|---|---|---|---|
| Distilled water for 8 hrs | 7.38 $^{a-e}$ | 12.25 $^{a-f}$ | 0.60 $^{a-e}$ | 19.19 $^{b-g}$ |
| PEG 5% for 8 hrs | 7.99 $^{a-d}$ | 13.16 $^{a-e}$ | 0.60 $^{a-e}$ | 21.16 $^{a-f}$ |
| PEG 10% 8 hrs | 4.42 $^{e-f}$ | 9.80 $^{fg}$ | 0.45 $^{def}$ | 14.22 $^{gh}$ |
| PEG 15% for 8 hrs | 6.02 $^{b-f}$ | 10.54 $^{efg}$ | 0.56 $^{a-f}$ | 16.37 $^{d-h}$ |
| KNO3 1% for 8 hrs | 6.97 $^{b-e}$ | 11.57 $^{b-g}$ | 0.59 $^{a-f}$ | 18.54 $^{b-h}$ |
| KNO3 2% for 8 hrs | 4.39 $^{ef}$ | 10.88 $^{d-g}$ | 0.39 $^{f}$ | 15.28 $^{fgh}$ |
| KNO3 3% for 8 hrs | 3.59 $^{f}$ | 9.27 $^{g}$ | 0.38 $^{f}$ | 12.87 $^{h}$ |
| KCL 1% 8 hrs | 5.83 $^{c-f}$ | 11.86 $^{b-g}$ | 0.49 $^{c-f}$ | 17.69 $^{c-h}$ |
| KCL 2% for 8 hrs | 6.16 $^{b-f}$ | 12.40 $^{a-f}$ | 0.49 $^{b-f}$ | 18.56 $^{b-h}$ |
| KCL 4% for 8 hrs | 4.51 $^{ef}$ | 11.18 $^{c-g}$ | 0.40 $^{ef}$ | 15.60 $^{fgh}$ |
| Distilled water for 8 hrs | 10.55 $^{a}$ | 13.69 $^{a-d}$ | 0.76 $^{a}$ | 24.24 $^{ab}$ |
| PEG 5% for 16 hrs | 10.65 $^{a}$ | 15.10 $^{a}$ | 0.70 $^{ab}$ | 25.72 $^{a}$ |
| PEG 10% for 16 hrs | 8.42 $^{a-d}$ | 14.03 $^{abc}$ | 0.58 $^{a-f}$ | 22.47 $^{a-d}$ |
| PEG 15% for 16 hrs | 9.20 $^{ab}$ | 14.34 $^{ab}$ | 0.64 $^{a-d}$ | 23.53 $^{abc}$ |
| KNO3 1% for 16 hrs | 8.8 $^{abc}$ | 14.51 $^{ab}$ | 0.61 $^{a-d}$ | 23.31 $^{abc}$ |
| KNO3 2% for 16 hrs | 8.58 $^{abc}$ | 12.52 $^{a-}$f | 0.69 $^{abc}$ | 21.07 $^{a-f}$ |
| KNO3 3% for 16 hrs | 6.59 $^{a-e}$ | 12.19 $^{a-g}$ | 0.62 $^{a-}$d | 19.75 $^{a-g}$ |
| KCL 1% for 16 hrs | 6.96 $^{b-e}$ | 14.52 $^{ab}$ | 0.47 $^{def}$ | 21.49 $^{a-f}$ |
| KCL 2% for 16 hrs | 7.72 $^{a-e}$ | 14.44 $^{ab}$ | 0.53 $^{b-f}$ | 22.16 $^{a-e}$ |
| KCL 4% for 16 hrs | 5.10 $^{def}$ | 10.86 $^{d-g}$ | 0.49 $^{c-f}$ | 15.97 $^{e-h}$ |

The figures in each column which have at least one letter in common are not significantly different at the 5% probability level according to Duncan's multiple range tests.

### 3.8. The dry weight of radicles

Analysis of variance of the experimental data (Table 5) showed that differences in the dry weight of radicles were statistically significant at the one percent probability level. Comparison of the means of the data also suggested that the maximum dry weight of radicles (0.05 g) was observed in the 16 hrs treatment using KCL 4%, and the minimums (0.01 g) was at that of the 26 hrs treatment with three percent KNO3 (Table 6).

### 3.9. Sprout dry weight

Results of analysis of the data indicated that the differences in the dry weight of the sprouts weren't statistically significant (Table 5). Comparison of the means of the data revealed that the maximums of dry weight of sprouts (0.11 g) was at 16 hrs treatment using KNO3 2%, and the minimum (0.04 g) belonged to the 8 hrs treatment with KNO3 2% (Table 6).

### 3.10. Ratio of the dry weight of the radicles to the dry weight of the sprouts (R/S)

Analysis of the variance of the data suggested that differences in the weight ratios (R/S) were statistically significant at the one percent probability rate (Table 5). The highest ratio belonged to the 16 hrs treatment using four percent KCL (0.65) and 8 hrs treatment using two percent KNO3 (0.64), and the lowest (0.17) was that of the 16 hrs treatment using three percent KNO3 (Table 6).

The experiment conducted by Pourkolhar et al (2009) on corn seeds revealed that differences in the dry weight R/S ratios of the treatments were not significant but that the highest ratios belonged to the 36 hour treatment using five percent PEG, and the lowest to the 24 hour treatment with 0.5 percent KNO3.

Results of experiments conducted by Mohseni et al (2010) on corn seeds suggested that the maximum dry weight ratios of R/S were those of the one percent KNO3 and two percent KCL treatments, and the minimum dry weight ratios of R/S belonged to the two percent KNO3 and the four percent KCL treatments. These results confirm those obtained by us.

One of the main causes that explain the reduction in the dry weight of the sprouts at high potentials is the mobility of food materials and their transfer from the cotyledons to the embryonic axis. Factors that affect the rate of growth of the embryonic axis can influence the mobility of food materials and their transfer from the cotyledons to the embryonic axis (Bagheri et al., 2000). Seed germination is not necessarily accompanied by the production of strong stems; and the rate and percentage of germination can be high, while the roots and stems produced may not be strong. Weak seedlings will not be able to produce a desirable number of tillers and vegetative organs in the later stages of growth either. One of the probable causes of the production of weak seedlings under dry conditions is the presence of weak roots and stems in the early stages of the growth of the plants (Kafi and Goldani, 2000). Pourkolhar et al (2009) also, in their study of the effects of priming edible onion seeds on their germination features under salinity stress, indicated that the dry weight of seedlings is not affected by osmo-priming with sodium chloride. It is possible that, if seed masses with low germination ability are planted, more favorable environmental conditions are created for a smaller number of seedlings to be produced; and these seedlings may have more dry weight and can be less affected by osmo-priming the seeds. Khodadadi et al (2003) also, in their studies concerning the effects of priming edible onions on germination features of these seeds under conditions of salinity stress, indicated that seedling dry weight was not affected by osmo-priming with NaCl. It is possible that, if seed masses with low germination ability are planted, more favorable conditions are created for the production of fewer seedlings; and these seedlings may have more dry weight and can be less affected.

### 3.11. Seedling dry weight

Results obtained revealed that differences in seedling dry weight wasn't statistically significant at the one percent probability level (Table 5), the maximum seedling dry weight was observed in the 16 hrs treatment using one and two percent KNO3 (0.13 and 0.15 g) respectively, while the minimum (0.07 g) was observed at those of KCL 1 %, KNO3 2 %, PEG 10 % at 8 hrs (Table 6).

**Table 5**
Means of Squares of features in pre – germination Treatments.

| Source of change | Degree of freedom | Radicles Dry Weight (g) | Sprouts Dry Weight (g) | Ratio of radicles weight to sprouts | Seedlings Dry weight (g) |
|---|---|---|---|---|---|
| Treatment | 19 | 2.51 ** | 8.00 | 5.62 ** | 0.12 |
| Error | 40 | 0.80 | 4.50 | 1.20 | 0.07 |
| Coefficient of Variation (%) | - | 29.16 | 27.25 | 26.54 | 25.43 |

The symbols * and ** indicate significant differences at the one percent and five percent levels of probability, respectively.

**Table 6**
Comparison of the Means of the Features in Pre – germination Treatments.

| Treatment | Radicles Dry Weight (g) | Sprouts Dry Weight (g) | Ratio of radicles weight to sprouts weight | Seedlings Dry weight (g) |
|---|---|---|---|---|
| Distilled water for 8 hrs | 0.026 bcd | 0.08 abcd | 0.31 c-f | 0.11 ab |
| PEG 5% for 8 hrs | 0.036 abc | 0.07 abcd | 0.46 a-d | 0.11 ab |
| PEG 10% 8 hrs | 0.016 de | 0.06 bcd | 0.28 def | 0.07 b |
| PEG 15% for 8 hrs | 0.033 abcd | 0.09 abc | 0.36 c-f | 0.12 ab |
| KNO3 1% for 8 hrs | 0.036 abc | 0.08 abcd | 0.45 a-d | 0.12 ab |
| KNO3 2% for 8 hrs | 0.030 bcd | 0.04 d | 0.64 a | 0.07 b |
| KNO3 3% for 8 hrs | 0.030 bcd | 0.06 bcd | 0.52 abc | 0.09 ab |
| KCL 1% 8 hrs | 0.020 cde | Cd 0.05 | 0.37 c-f | 0.07 b |
| KCL 2% for 8 hrs | 0.020 cde | 0.09 abc | 0.20 fe | 0.11 ab |
| KCL 4% for 8 hrs | 0.033 abcd | 0.07 bcd | 0.50 abc | 0.10 ab |
| Distilled water for 8 hrs | 0.036 abc | 0.08 abcd | 0.45 a-d | 0.11 ab |
| PEG 5% for 16 hrs | 0.033 abcd | 0.08 abcd | 0.41 b-e | 0.11 ab |
| PEG 10% for 16 hrs | 0.023 bcde | 0.07 abcd | 0.31 c-f | 0.10 ab |
| PEG 15% for 16 hrs | 0.033 abcd | 0.06 bcd | 0.51 abc | 0.10 ab |
| KNO3 1% for 16 hrs | 0.036 abc | 0.10 ab | 0.36 c-f | 0.13 a |
| KNO3 2% for 16 hrs | 0.030 bcd | 0.11 a | 0.26 def | 0.14 a |
| KNO3 3% for 16 hrs | 0.010 e | 0.07 bcd | 0.17 f | 0.08 b |
| KCL 1% for 16 hrs | 0.040 ab | 0.06 bcd | 0.61 ab | 0.10 ab |
| KCL 2% for 16 hrs | 0.036 abc | 0.09 abc | 0.41 b-e | 0.13 ab |
| KCL 4% for 16 hrs | 0.050 a | 0.08 abcd | 0.65 a | 0.13 ab |

Figures in each column which have at least one letter in common are not significantly different at the five percent probability level according to Duncan's multiple range test.

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