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Standardization of Halo-priming and Nutri-priming for enhancing seed quality parameters in wheat (*Triticum aestivum* L.)

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Abstract
An experiment was conducted under the Seed Testing Laboratory of the Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during Rabi season 2017-18 and 2018-19. Dry seed moisture 13% of wheat Kharchiya-65 and KRL-210 were primed with KNO_3 (1000 mg/l), CAN (2%), NaCl (50 ml), $CaCl_2$ (50 ml), K_2So_4 (200 mM), Na_2Sio_3 (40 mM), $C_7H_6O_3$ (25 mM), $C_7H_6O_3$ (50 mM) for 8, 16, and 24 hrs. Dehydrated seed (moisture 13%) of each treatment were *viz*. germination, root length, shoot length, seedling length, seedling dry weight, speed of germination, and seedling vigour index, were placed in BOD incubator at 22 ± °C and conducted in Factorial Completely Randomized Design (FCRD) with three replications. The maximum, root length (17.87 cm), shoot length (18.92cm), seedling length (35.29cm), seedling dry weight (0.18 mg), speed of germination (16.58) were obtained during 8 hrs and germination (88.83%) during 16 hrs primed with KNO_3(1000 mg/l)in Kharchiya-65 whereas the maximum seedling length (35.29cm), speed of germination (17.08) was obtained during 8 hrs and germination (90.50%), seedling vigour index (3045), shoot length (22.23 cm) primed with KNO_3(1000 mg/l)for in KRL-210. Besides the maximum result in root length (18.79 cm) with 8 hrs and seedling dry weight (0.24 g) with 16 hrs of priming with K_2So_4 (200 mM), was recorded in KRL-210. The influences of halo-priming as well as Nutri-priming treatments were recorded as per standard ISTA rule. The halo-priming KNO_3 (1000 mg/l) and nutria-priming K_2So_4 (200 mM), were successfully be exploited seed enhancement even in most suitable wheat varieties even developed for the alkaline-saline condition.

Keywords: KRL-210, kharchiya-65, halo-priming, Nutri-priming

Introduction
Wheat (*Triticum aestivum* L.) crop belongs to the family Poaceae (Graminae), is one of the oldest cereal crops. Generally, wheat is a self-pollinated and hexaploid plant. Three species, namely *Triticum astivum* L. (Bread wheat) *Triticum ducoccum* (*Emmer wheat*), and *Triticum durum*, (*Macroni or durum wheat*) are commonly cultivated at present. It provides edible grain which forms staple food for a large number of people across the world. Wheat is believed to have originated in the southwest part of Asia (Feldman, 2001) [9].

Priming is a pre-sowing treatment that offers the possibility to improve post-harvest seed quality and allow the release of dormancy leading to increased final germination as well as germination speed and uniformity. The technique involves the initiation of germination metabolism by controlling the hydration of seeds and activating various metabolic processes without allowing radical protrusion (Heydecker, 1973; Bradford, 1986 and Taylor *et al*., 1998) [12, 6, 24]. Various seed priming techniques have been developed which include hydro-priming, halo-priming, osmo-priming, and hormonal priming. Hydro-priming soaking the seeds in water before sowing and may or may not be followed by air drying of the seeds. Halo-priming refers to the soaking of seeds in a solution of inorganic salts i.e NaCl, KNO_3, $CaCl_2$, and $CaSO_4$, etc. Many studies have shown a significant improvement in seed germination, seedling emergence and establishment, and final crop yield in salt-affected soil in response to halo-priming. Khan *et al*., (2009) [18] evaluated the response of seeds primed with NaCl solution at different salinity levels 0, 3, 6, and 9 dSm-1 with early growth stage and concluded that seed priming with NaCl has found to be better treatment as compared to nonprime seeds.

Priming with NaCl and KCl helped remove the deleterious effects of salts (Iqbal *et al*., 2006) [14]. In sorghum seeds soaked in $CaCl_2$ or KNO_3 solution increased the activity of total amylase and proteases in germinating seeds under salt stress (Kadiri and Hussaini, 1999) [17]. In pigeon pea seed treatment with $CaCl_2$ or KNO_3 generally exhibited improvement in proteins, free amino acid, and soluble sugars during germinating under salt stress (Jyotsna and Srivastava, 1998) [16]. The purpose of seed priming is to a partially hydrated with water (hydropriming), various chemical solutions like polyethylene glycol (osmopriming), or salts like $CaCl_2$, $CaSo_4$, and NaCl (halo-priming) the seeds to a point where germination processes are begun but not completed (Ashraf and Foolad., 2005) [4], followed by drying of seeds to the original moisture level. Angadi *et al*. (2012) reported that seed priming can be taken to counteract the adverse effects of abiotic stress. Meena *et al*., (2013) [19] experimented for two consecutive years 2010-11 and 2011-12 to evaluate the influence of hydro-priming grain yield of wheat. Misra and Dwivedi (1980) [20] reported the positive effect of seed priming with potassium and distilled water on growth, dry matter accumulation, grain and straw yield in 12 wheat varieties under rainfed conditions. One of the newest priming methods, using micro or macronutrients for the seed treatment before sowing is called nutripriming (Rehman *et al*., 2012; Mirshekari, 2015) [23, 21]. In this regard, reported Nutri-priming with commercial fertilizers to improve crop yield was one of the big benefits of seed planting (Farooq *et al*., 2011) [8].

Materials and Methods

The experiment was conducted under Seed Testing Laboratory of the Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya U.P. During Rabi season 2017-18 and 2018-19. Variety Kharchiya-65 (V1), KRL-210 (V2) obtained from ANDUAT Kumarganj Ayodhya, and CSSIR Lucknow were used in this experiment. Following chemicals and their concentration were used for pre-sowing Both varieties primed with (T1) KNO_3 1000 mg/l, (T2) *CAN* 2%, (T3) *NaCl* 50 ml, (T4) $CaCl_2$ 50 *ml*, (T5) K_2So_4 (200 mM), (T6) Na_2Sio_3 (40 mM), (T7) $C_7H_6O_3$ (25 mM), (T8) $C_7H_6O_3$ (50 mM)) for three different duration 8, 16, 24 hrs after that treated seeds were dried in shade. Non-primed seeds were taken as control (T0) used in this experiment. Then the treated or primed seeds were dried in shade to maintain the seed moisture content of approximately 13%. An experiment was laid down in a Factorial Completely Randomized Design (FCRD), with three replications. The following Laboratory observations were recorded on seed quality parameter like germination, shoot length (cm), root length (cm), seedling length (cm) and dry weight (mg), seedling vigour Index, and speed of germination of the seed quality parameters were studied as described under the International rule for seed testing ISTA (2011) [13].

Seed germination (%)

The germinated seeds were evaluated into normal and abnormal seedlings and hard and dead seeds. Germination percentage was recorded based on normal seedlings only. Germination percentage was calculated following ISTA (2011) [13] protocol.

$$\text{Germination percentage} = \frac{\text{Total number of seed germinated}}{\text{Total number of seed planted}} \times 100$$

Speed of germination

The numbers of normal seedlings were counted daily from the first day after placing in germination medium till germination was completed and the speed of germination was calculated as:

N1/1 + N2-N1/2 + …… + Nn-Nn-1 / Final day

Where, N1= Total Number of seeds germinated on day1;
N2 = Total Number of seeds germinated on day 2 and so on till Nn = Total number of seeds germinated on final day (Maguire, 1962) [22].

$$\text{SG} = \frac{Number\ of\ normal\ seedings}{days\ of\ 1st\ count} + \frac{\text{Number of normal seedlings}}{\text{Days of final count}}$$

Root length (cm)

On the day of the final count of the germination test, twenty normal seedlings were selected from each treatment and in each replication. Root length was mean was measured by using the scale from collar point to tip of the root and finally averaged.

Shoot length (cm)

Twenty normal seedlings used for Shoot length measurement were also used for the measurement of shoot length. The shoot length was measured from collar point to tip of upper first leaf and mean shoot length is expressed in centimeter.

Seedling Length (cm)

Twenty normal seedlings used for root length and shoot length measurement were used for the measurement of seedling length. The seedling length was measured from the tip of the primary root to the tip of the primary leaf and the mean length is expressed in centimeters.

Seedling-dry weight (mg)

Twenty normal seedlings used for measuring the seedling length were put in the butter paper bag and dried in a hot air oven maintained at 80^0C+10C for 12 hours. The dry weights of such seedlings were measured by an electronic weighing balance in milligram.

Seedling vigour index

Seedling vigour index was calculated by adopting the method suggested by Abdul- Baki, and Anderson (1973) [1] and expressed in the whole number

Vigour index = Germination (%) × Shoot length (cm) + Root length (cm)

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 in 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) [10], Hamidi *et al.* 2013 [11], and Tian *et al.* (2014) [25]. Many research workers primed the seeds with gibberellic acid which is the most important growth regulator used for seed germination, mobilization of food in a seed storage cell, cell elongation, permeability of cell membrane, apical bud

dormancy, flowering, and fruiting growth. Besides these GA3 induce synthesis of the hydrolytic enzyme, primed corn, and wheat seed respectively by Barsa *et al.* (1989) [5]. Potassium nitrate (KNO3) is the most commonly known chemical for promoting seed germination. It may interact with temperature and influencing the seed physiology finally, germination and vigour are improved Ajirloo *et al.* (2013) [3]. Significant effect of various pre-sowing seed priming treatments (control), *KNO3* 1000 mg/l, *CAN* 2%, *CaCl2* 50 ml, K_2So_4 (200 mM), K_2So_4 (200 mM), $C_7H_6O_3$ (25 mM), $C_7H_6O_3$ (50 mM) were found on seed quality in terms of germination percentage, shoot length, root length, seedling length, seedling dry weight, seed vigour index, and speed of germination of wheat. The seed germination % of wheat varieties as affected by various priming durations and treatments are shown in Table-1. Results showed that germination percentage (87.73%) recorded in the case of KRL-210 whereas the minimum germination percentage (83.43%) recorded in Khrchiya-65.The maximum germination percentage (84.01%) recorded in 16 hrs. The maximum germination percentage (87.72%) recorded when seed treated with KNO_3 1000 mg/l and the minimum germination percentage (82.00%) was recorded with control. The mean interaction effect of varieties, duration, and treatment recorded on germination percentage (90.50%) in KRL-210 when treated in 16 hrs with KNO3 1000 mg/l whereas in the case of KH-65 the maximum germination percentage (88.83%) when treated in 16 hrs with KNO_3 1000 mg/l. Root length of wheat varieties as affected by various priming durations and treatments are shown in Table-1. Results showed that root length (14.68 cm) was recorded in the case of KRL-210 whereas the minimum root length (13.02 cm) was recorded in KH-65. The maximum root length (14.96 cm) was recorded in 8 hrs. The maximum root length (15.87cm) was recorded when the seed treated with KNO3 1000 mg/l and the minimum root length (11.79 cm) recorded with control. The mean interaction effect of varieties, duration, and treatment recorded on root length (18.79 cm) in KRL-210 when treated in 8 hrs with KNO_3 1000 mg/l whereas in the case of Kharchiya-65 the maximum root length (17.87 cm) when treated in 8 hrs with K_2So_4 (200 mM).

Table 1: Mean performance of variety, duration, and treatment on germination, root length, seedling dry weight, seedling length, Seedling Vigour Index, shoot length, and Speed of germination in wheat 2017-18 and 2018-19

Traits	Germination (%)	Root length (cm)	Seedling dry weight	Seedling length (cm)	Seedling Vigour Index	Shoot length	Speed of germination
Variety							
KH-65	83.43	13.02	0.14	25.74	2158	12.72	13.28
KRL-210	83.73	14.68	0.16	30.68	2594	16.01	14.11
Mean	83.58	13.85	0.15	28.21	2376	14.36	13.69
S.Em±	0.10	0.54	0.1	0.15	13	0.1	0.11
CD at 5%	0.28	0.32	0.01	0.41	37	0.29	0.32
Duration (Hour)							
8 hrs	84.01	14.96	0.15	30.24	2553	15.23	14.1
16 hrs	84.09	14.00	0.15	28.29	2403	14.36	13.81
24 hrs	82.68	12.60	0.16	26.09	2168	13.49	13.17
Mean	83.59	13.85	0.15	28.21	2375	14.36	13.69
S.Em±	0.17	0.24	0	0.31	28	0.22	0.24
CD at 5%	0.46	0.68	0.01	0.87	80	0.6	0.66
Chemical/Biological							
control	82.00	11.79	0.12	24.44	2078	12.73	13.55
KNO_3 1000 mg/l	87.72	15.87	0.19	34.78	2863	18.81	15.06
CAN 2%	86.39	14.81	0.16	30.43	2386	15.79	14.77
NaCl 50 ml	75.22	12.51	0.12	22.96	2171	10.38	10.92
$Cacl_2$ 50 ml	86.94	14.09	0.16	31.87	2467	16.14	14.74
K_2So_4 (200 mM),	85.72	15.66	0.18	28.57	2522	14.7	13.47
Na_2Sio_3 (40 mM)	76.28	12.82	0.15	23.55	1963	10.68	12.05
$C_7H_6O_3$ (25 mM),	85.83	13.61	0.15	29.61	2564	16.08	13.81
$C_7H_6O_3$ (50 mM)	86.11	13.52	0.14	27.69	2252	13.98	14.94
Mean	83.58	13.85	0.15	28.21	2363	14.37	13.7
S.Em±	0.17	0.14	0.003	0.18	17	0.12	0.14
CD at 5%	0.48	0.39	0.005	0.5	46	0.35	0.38

The seedling dry weight of wheat varieties as affected by various priming durations and treatments are shown in Table-1. Results showed that seedling dry weight (0.16 g) was recorded in the case of KRL-210 whereas the minimum seedling dry weight (0.14 g) was recorded in KH-65. The maximum seedling dry weight (0.16 g) was recorded in 24 hrs. The maximum seedling dry weight (0.19 g) was recorded when the seed treated with KNO_3 1000 mg/l and the minimum seedling dry weight (0.12 g) recorded with control. The mean interaction effect of varieties, duration, and treatment recorded on seedling dry weight (0.24 g) in KRL-210 when treated in 24 hrs with K_2So_4 (200 mM) whereas in the case of Kharchiya-65 the maximum seedling dry weight (0.18g) when treated in 8 hrs with KNO_3 1000 mg/l. The seedling length of wheat varieties as affected by various priming durations and treatments are shown in Table-1. Results showed that seedling length (30.68cm) was recorded in the case of KRL-210 whereas the minimum seedling length (25.74) was recorded in KH-65. The maximum seedling length (30.24 cm) was recorded in 8 hrs. The maximum seedling length (31.87cm) was recorded when the seed was treated with Cacl2 50 ml and the minimum seedling length (24.44cm) recorded with control. The mean interaction effect of varieties, duration, and treatment recorded on seedling length (36.33 cm) in KRL-210 when treated in 8 hrs with KNO_3 1000 mg/l whereas in the case of KH-65 the maximum

seedling length (35.29cm) when treated in 8 hrs with KNO_3 1000 mg/l. The seedling vigour index of wheat varieties as affected by various priming durations and treatments is shown in Table-1. Results showed that the seedling vigour index (2594) was recorded in the case of KRL-210 whereas the minimum seedling vigour index (2158) was recorded in KH-65. The maximum seedling vigour index (2533) was recorded in 8 hrs. The maximum seedling vigour index (2863) was recorded when the seed treated with KNO3 1000 mg/l and the minimum seedling vigour index (2278) recorded with control. The mean interaction effect of varieties, duration, and treatment recorded on seedling vigour index (3461) in KRL-210 when treated in 16 hrs with KNO_3 1000 mg/l whereas in the case of KH-65 the maximum seedling vigour index (3231) when treated in 8 hrs with KNO_3 1000 mg/l. The shoot length of wheat varieties as affected by various priming durations and treatments are shown in Table-1. Results showed that shoot length (16.01 cm) was recorded in the case of KRL-210 whereas the minimum shoot length (12.72 cm) was recorded in KH-65. The maximum shoot length (15.23 cm) was recorded in 8 hrs. The maximum shoot length (18.81 cm) was recorded when seed treated with KNO_3 1000 mg/l and the minimum shoot length (12.73 cm) recorded with control. The mean interaction effect of varieties, duration, and treatment recorded on shoot length (22.23 cm) in KRL-210 when treated in 16 hrs with KNO_3 1000 mg/l whereas in the case of KH-65 the maximum shoot length (18.92 cm) when treated in 8 hrs with KNO_3 1000 mg/l. The speed of germination of wheat varieties as affected by various priming durations and treatments are shown in Table-1. Results showed that the speed of germination (14.11) was recorded in the case of KRL-210 whereas the minimum speed of germination (13.28) was recorded in KH-65. The maximum speed of germination (14.10) was recorded in 8 hrs. The maximum speed of germination (15.06) was recorded when seed treated with KNO_3 1000 mg/l and the minimum shoot length (13.55) recorded with control. The mean interaction effect of varieties, duration, and treatment recorded on the speed of germination (17.04) in KRL-210 when treated in 8 hrs with KNO_3 1000 mg/l whereas in the case of KH-65 the maximum speed of germination (16.58) when treated in 8 hrs with KNO_3 1000 mg/l. Priming with NaCl and KCl helped remove the deleterious effects of salts (Iqbal *et al*., 2006) [14].

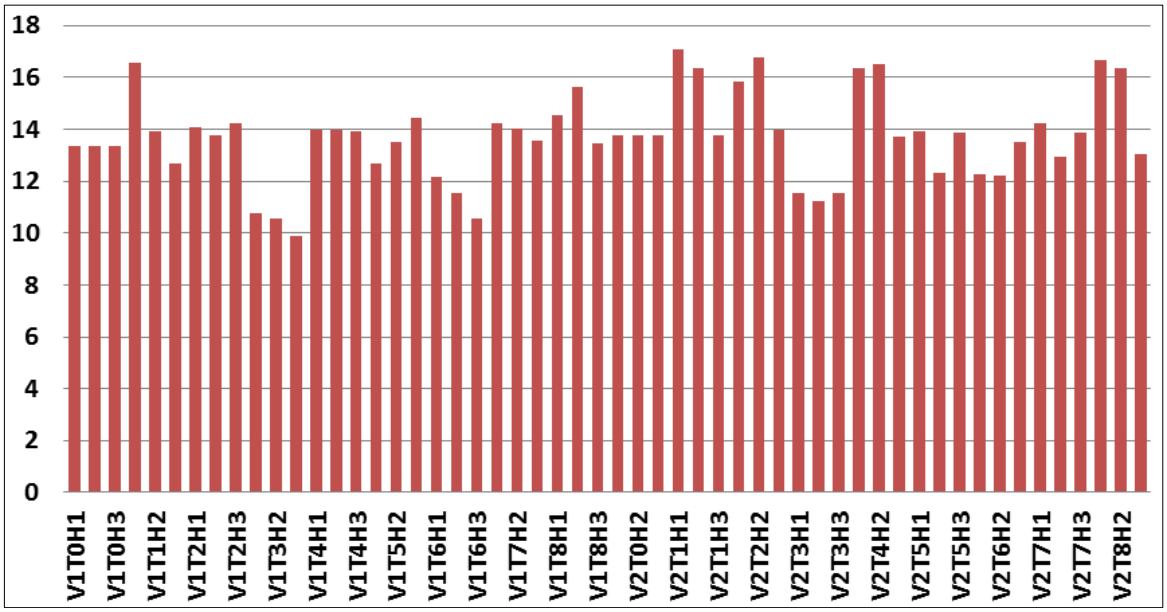

Fig 1: Interaction effect among variety, treatment, and duration on germination (%) in wheat

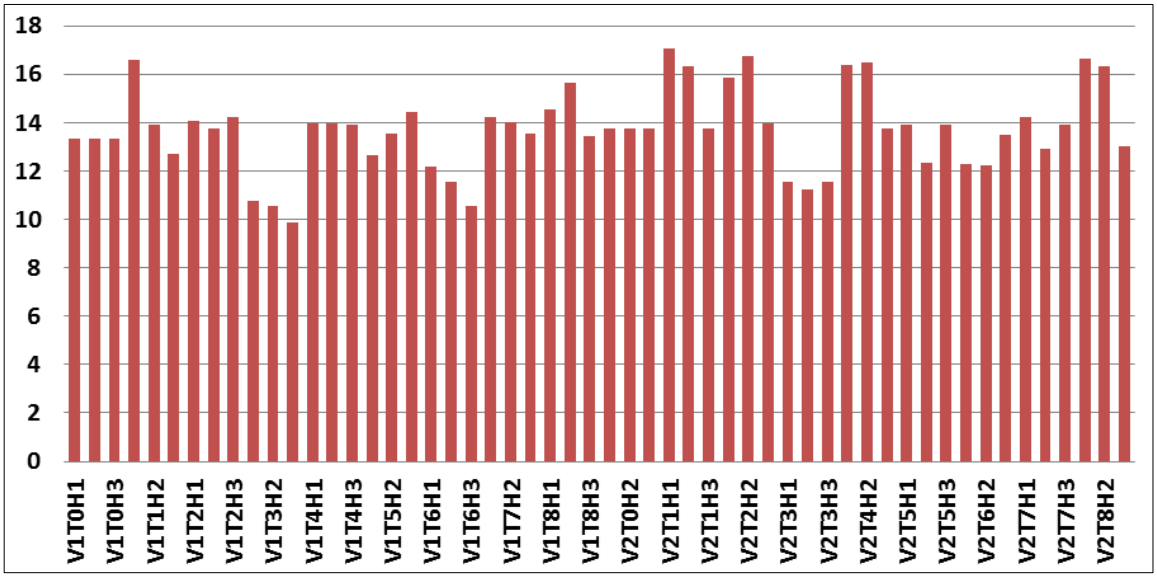

Fig 2: Interaction effect among variety, treatment, and duration on root length (cm) in wheat

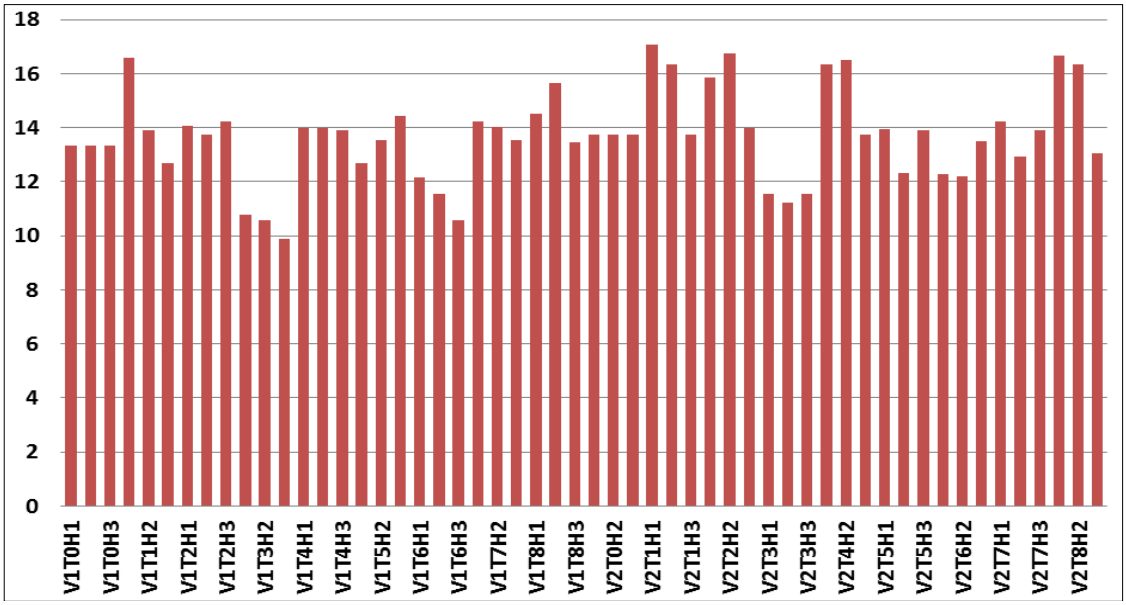

Fig 3: Interaction effect among of variety, treatment and duration on seedling dry weight in wheat

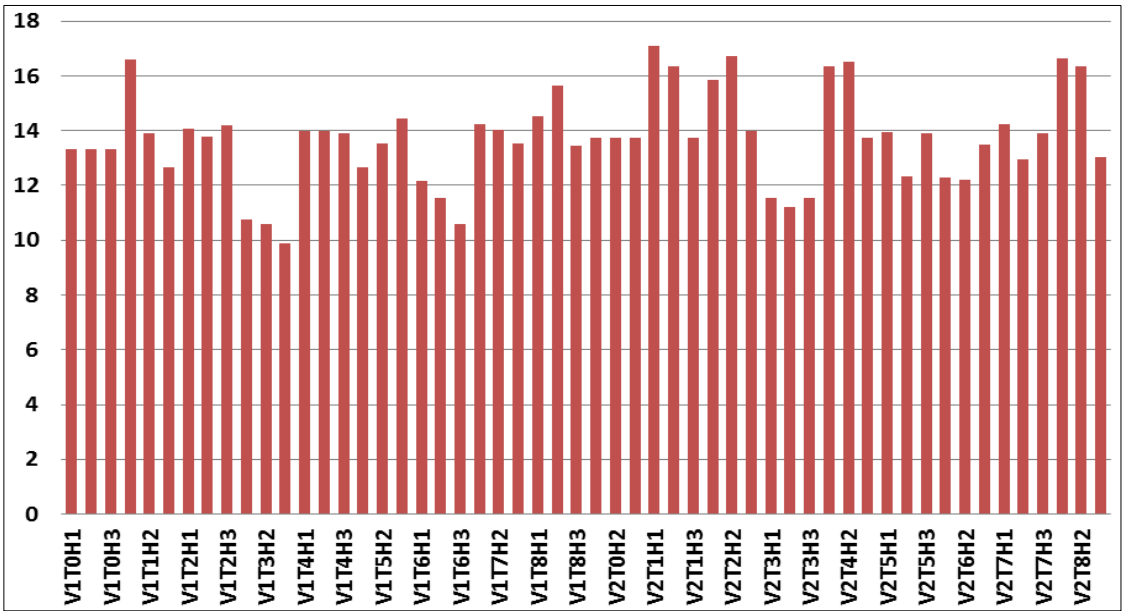

Fig 4: Interaction effect among of variety, treatment and duration on seedling length (cm) in wheat

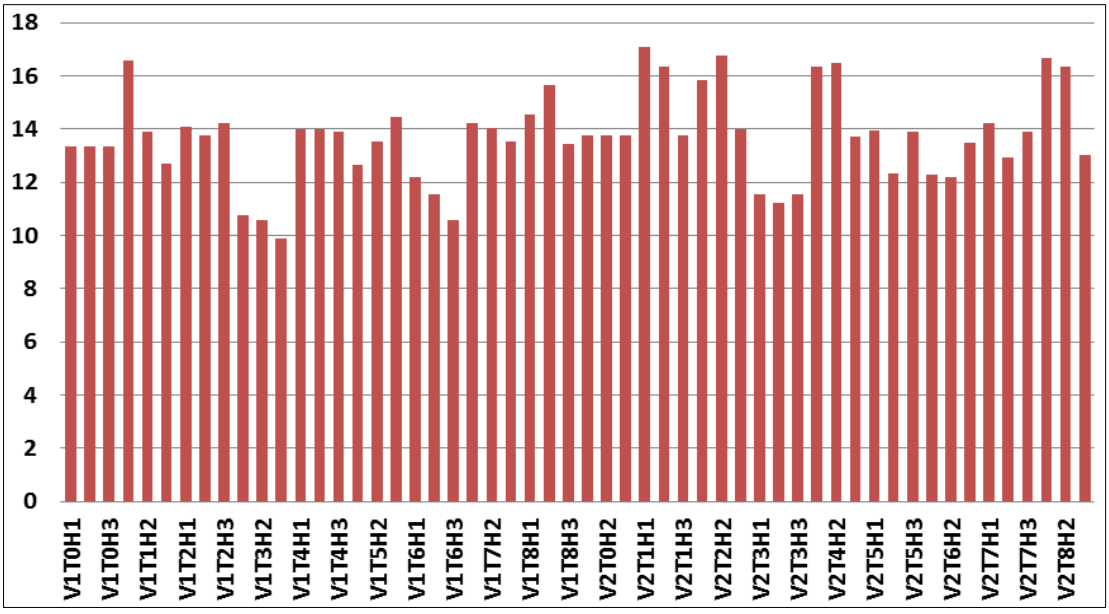

Fig 5: Interaction effect among of variety, treatment and duration on shoot length (cm) in wheat

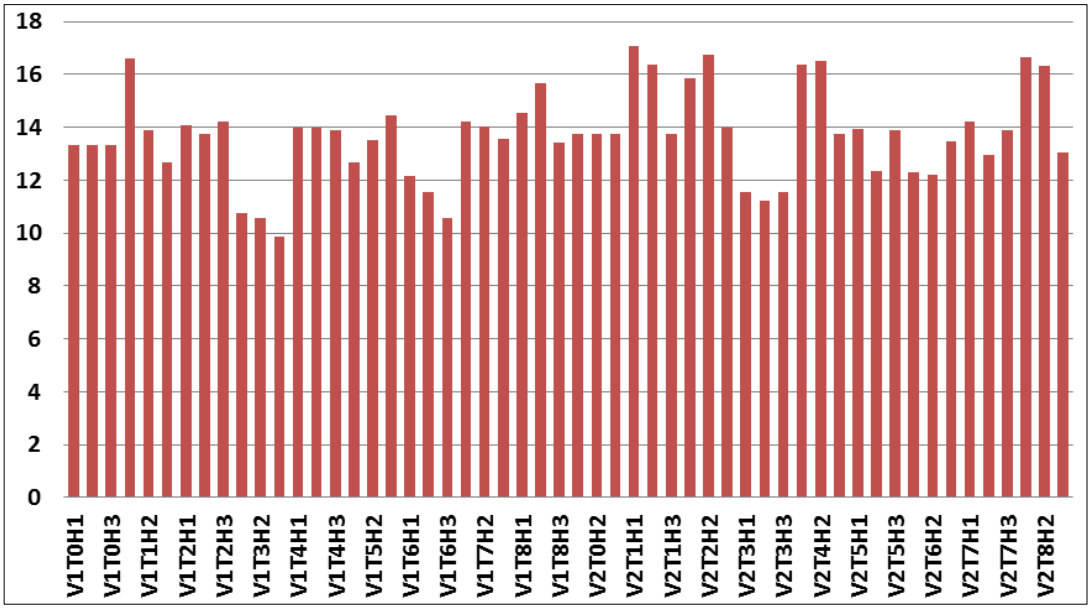

Fig 6: Interaction effect among of variety, treatment and duration on speed of germination in wheat

Conclusion

based on the present finding it is concluded that the seed of wheat varieties (kharchiya-65 and KRL-210) developed for alkaline saline condition could be successfully enhanced after priming with KNO3 (1000 mg/l) and K2So4 (200mm) either for 8 and 16 hrs.

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