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EVALUATION OF EARLY GROWTH AND YIELD OF WHEAT AS INFLUENCED BY SEED INVIGORATION TECHNIQUES

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ABSTRACT

The experiment was conducted to find out the influence of different seed invigoration techniques viz., control, hydropriming for 24h, priming with 2% H_2O_2 solution for 6h, hardening for 12h (one cycle), priming with 2% KCl for 12h, priming with KH_2PO_4 0.5% for 12h, priming with 20% PEG for 24h, priming with 1.6% NaCl for 12h and priming with 2.2% $CaCl_2$ for 12h to improve early dry matter accumulation in seedling and yield of two wheat varieties (Shatabdi and Bijoy). Different seed invigoration treatments had significant effects on seedling emergence, early dry matter accumulation, plant height, yield contributing characters as well as yield of two wheat varieties. KCl primed seeds showed better performance in wheat variety Shatabdi in respect to early growth, yield contributing characters (spikes per plant, grains per spike, grain weight per plant, straw weight per plant and individual seed size) and yield whereas in Bijoy, better performance was found from hydroprimed seeds. So, priming of seeds of wheat variety Shatabdi with 2.0% KCl and hydropriming of seeds of wheat variety Bijoy for 24h can successfully be integrated for early growth and yield enhancement.

Key words: *Seed invigoration, growth, yield and wheat*

INTRODUCTION

Wheat *(Triticum aestivum* L.) is an important cereal crop and ranks first globally and second in Bangladesh both in terms of production and acreage (Anonymous, 2005b). Despite of its higher yield potential, average yield (2.0 t/ha) in Bangladesh is less than that of the most wheat growing countries of the world. Among various constraints limiting wheat productivity in Bangladesh, poor stand establishment and late sowing are of prime importance.

"Seed invigoration" is the technique of applying beneficial treatments on the seeds after harvest, but prior to sowing in order to improve the germination, seedling growth as well as yield of different crops including wheat (Taylor *et al*., 1998; Ugale and Mungse, 2001; Pal *et al*., 2001; Mujtaba *et al*., 2005 and Arif *et al*., 2008)**.** Many seed invigoration treatments are being used in many parts of the world to improve the germination or to get synchronized germination and less mean germination time **(**Lee and Kim, 2000**).** These include water soaking **(**Rudrapal and Naukamura, 1988**),** hardening **(**Nath *et al.*, 1991; Adam, 1999**;** Lee and Kim, 2000**)** and seed priming (Khan, 1992; Lee *et al*, 1998a)**.** The seed hardening also called wetting and drying and performed by repeated soaking and drying. The beneficial effects of seed hardening are primarily due to pre-enlargement of the embryo **(**Austin *et. al***,** 1969**),** biochemical changes like enzyme activation (Villiers and Edgcumbe, 1975), and improvement of germination rate particularly in old seeds (Gray and Steckel, 1977; Lee *et al.*, 1998a). It was originally proposed that dehydration was responsible for the hardening effect (Henkel, 1964), but Hanson (1973) showed that the effective invigoration of the seed occurs in the imbibitions period and is subsequently fixed by drying. Seed priming is a pre-germination seed treatment in which seeds are held at water potential that allows imbibition, but prevents radicle extension (Bradford, 1986). Osmo-conditioning is a special type of seed invigoration in which seeds are hydrated slowly in accurate solution having low water potential (Bradford, 1986), achieved using such compounds as poly-ethylene glycol (PEG), KNO_3, KH_2PO_4, NaCl and $CaCl_2$. But invigoration techniques for wheat seeds under our local ecological conditions and genetic materials were not yet evaluated. Therefore, the present investigation was undertaken to find out the influence of different seed invigoration techniques to improve early growth and yield of two wheat varieties.

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MATERIALS AND METHODS

The study was conducted in Crop Physiology and Ecology laboratory, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during August 2007 to March 2008. The experiment was conducted in two factors completely randomized design with three replications. The treatment factors were-

Factor A: Two wheat varieties (Shatabdi and Bijoy)

Factor B: Different seed invigoration techniques, such as-

T_1 = Control;

T_2 = Hydropriming for 24h;

T_3 = Priming with 2% H_2O_2 solution for 6h;

T_4 = Hardening for 12h (one cycle);

T_5 = Priming with 2.0% KCl for 12h;

T_6 = Priming with KH_2PO_4 0.5% for 12h;

T_7 = Priming with 20% PEG 6000 for 24h;

T_8 = Priming with 1.6% NaCl for 12h and

T_9 = Priming with 2.2% $CaCl_2$ for 12h.

The seeds of two wheat varieties were surface sterilized in 10% sodium hypochlorite solution for 10 minutes, then rinsed with sterilized water and air dried. Then different pre-sowing seed treatments were applied. A weighed quantity (250g) of wheat seeds was used in each treatment in plastic beakers containing 500ml of respective solution for specific time indicated in the treatments. After treatments, seeds were given three surface washings with distilled water (Khan, 1992) and re-dried to the original weight with forced air under shade. For hardening treatment, this cycle was repeated twice for 12h. These seeds were sealed in polythene bags and stored in a refrigerator at 7°C for further studies. The treated seeds were compared with control one for early growth, yield characters and yield in a pot experiment.

Total 54 pots (25cm x 30cm) were filled with 10kg of sandy loam soil and were fertilized at the rate of 140-175-75-18 kg/ha N-P-K-S in the form of Urea, TSP, MP and Gypsum. The whole quantity of TSP, MP, Gypsum and 1/3 of urea was given at the time of pot preparation. Remaining urea was top dressed into two equal splits at 21 and 50 DAS (Anonymous, 2005a). Thirty seeds of each treatment of the two varieties were sown in the earthen pot at the depth of 3cm. Three replications were used for each treatment. Intercultural operations like weeding, netting and Irrigation was done as per requirements.

At 5^{th} day, number of seedlings was counted in each replication to calculate emergence percentage. The above ground part of seedlings were collected at 7^{th} day after sowing and continued with an interval of 7 days up to 8 weeks. At each harvest 3 seedlings were collected randomly at the peripheral region in each pot. Then the seedlings were oven dried at 70°C temperature to get constant dry weight for studying early growth of wheat. The healthy plants in each pot were allowed to grow for evaluation of yield characters and yield of wheat. The findings were analyzed statistically using the analysis of variance (ANOVA) technique with the help computer by MSTAT-C program. The treatment means were compared by Duncun’s Multiple Range Test (Gomez and Gomez, 1984).

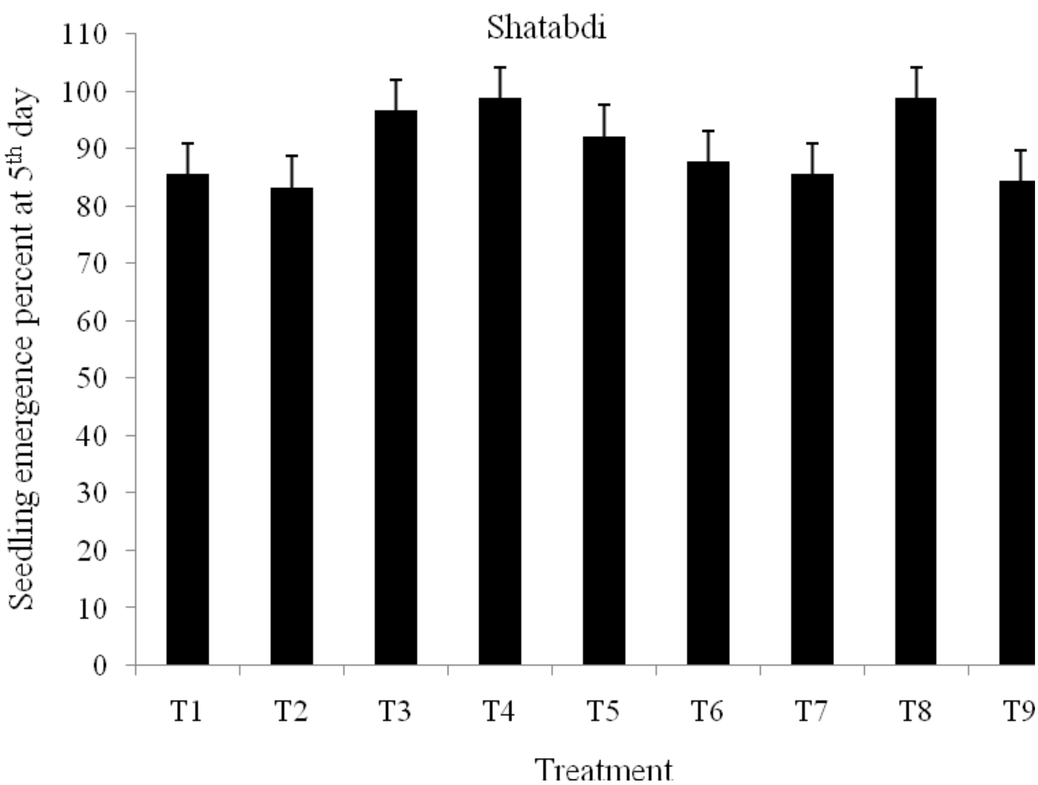
RESULTS AND DISCUSSION

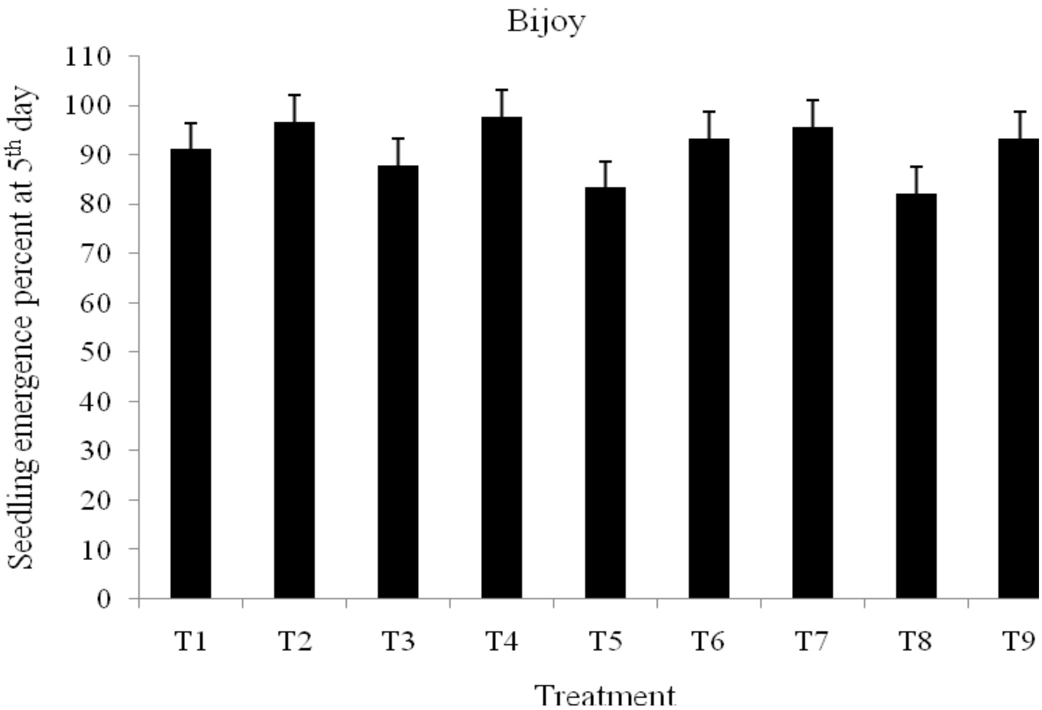
Seedling emergence

The effect of different seed invigoration treatments in two wheat varieties on seedling emergence day was distinct (Figure 1). In wheat variety Shatabdi, hardened seeds and NaCl primed seeds showed the highest seedling emergence percent (98.88%) which was followed by H_2O_2 primed seeds (96.66%) and KCl primed seeds (92.22%), whereas the lowest performance was found in hydroprimed seeds (83.33%) which was statistically at par with that (84.44%) obtained from $CaCl_2$ primed seeds. The other treatments including control showed the medium emergence percent (85.55 to 87.77%). On the other hand in wheat variety Bijoy, the highest seedling emergence percent was obtained from hardened seed (97.77%) which was statistically at par with that obtained from hydroprimed seed (96.66%) and PEG primed seed (95.55%), whereas the NaCl primed seed showed the lowest seedling emergence percent (82.22%) that was statistically at par with that obtained from KCl primed seed (83.33%). The other treatments including control showed the medium performance (87.77 to 93.33%). Ashraf and Iram (2002) observed that KCl primed seeds showed inhibitory effects on seedling growth of spring wheat. Andoh and Kobata (2001) reported that hydropriming of seeds for 24h increased the seedling emergence in wheat and rice. Results of those studies support the results of the present study.

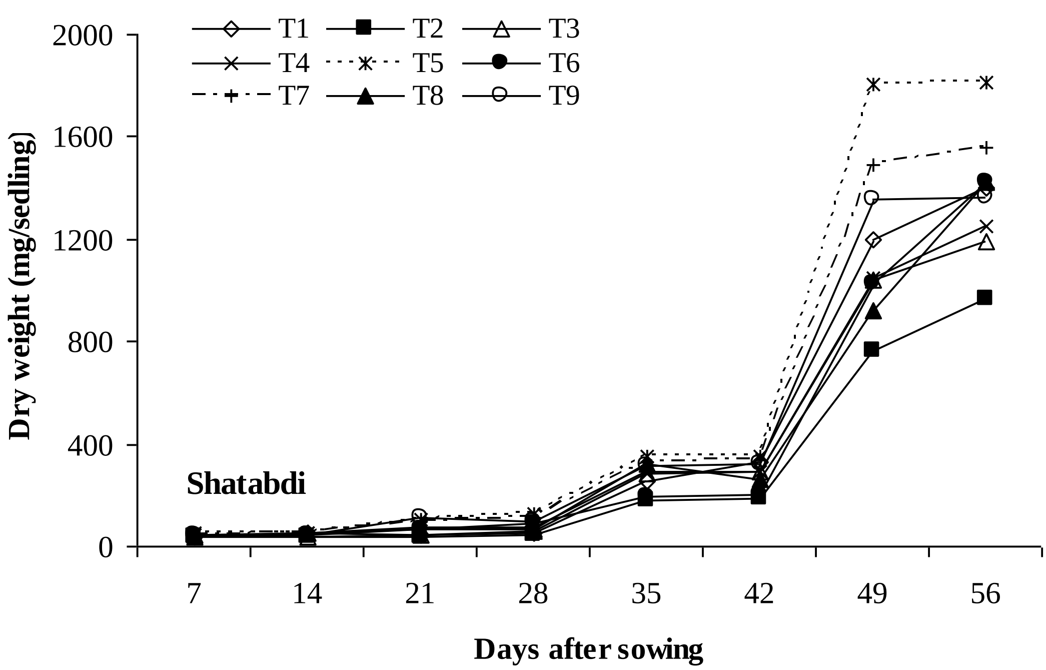
Early dry matter accumulation

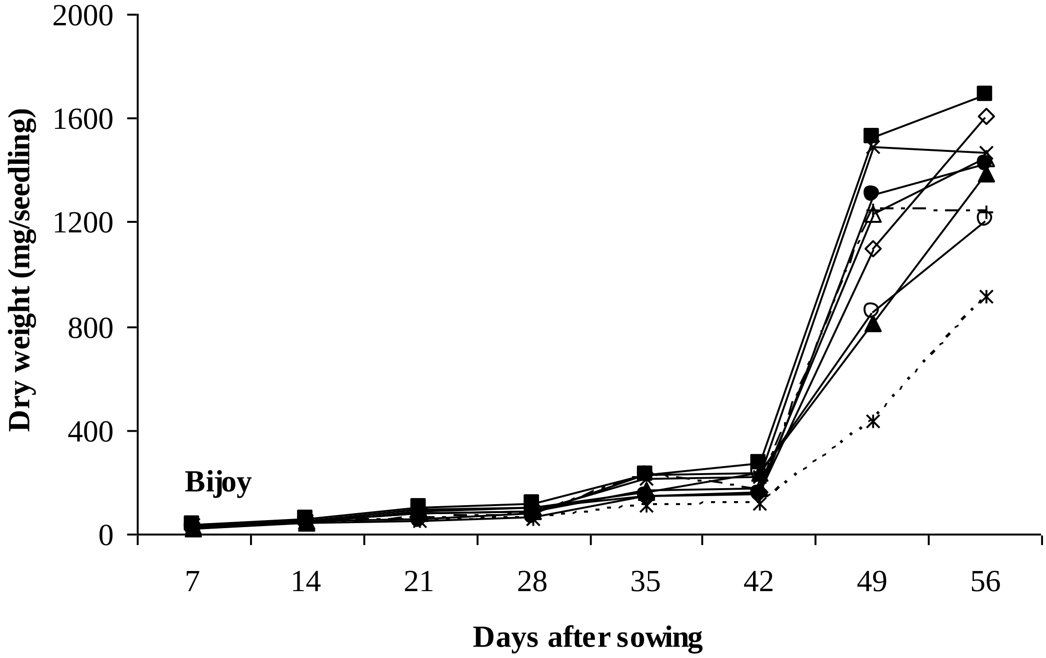
The effect of different seed invigoration treatments and two wheat varieties on early dry matter accumulation was distinct (Figure 2). In wheat variety Shatabdi, KCl and PEG primed seeds showed better early dry matter accumulation compared to control, whereas with other treatments early dry matter accumulation of wheat was hampared compared to control seed. Among them hydroprimed seed was affected most compared to all other treatments. In Bijoy, the early dry matter accumulation of wheat from hydroprimed seed was the best and it was most affected from KCl primed seed. The other treatments showed moderate early dry matter accumulation up 56 to days after sowing. Misra and Dwibedi (1980) reported that KCl primed seeds showed good potential to enhance seedling growth of wheat. But Ashraf and Iram (2002) observed that KCl primed seeds showed inhibitory effect on seedling growth of spring wheat. Basra *et al.* (2005) reported maximum seedling dry weight from hydroprimed seeds of wheat.





: Seedling emergence percent (mean ± lsd) of wheat as influenced by the interaction effect of seed invigoration techniques and varieties (T_1= Control, T_2= Hydropriming, T_3= Priming with 2% H_2O_2, T_4= Hardening, T_5= Priming with 2% KCl, T_6= Priming with 0.5% KH_2PO_4, T_7= Priming with 20% PEG, T_8= Priming with 16% NaCl and T_9= Priming with 2.2% $CaCl_2$).





Early dry matter accumulation in wheat seedling as influenced by the interaction effect of seed invigoration techniques and varieties. Each value is the mean of three replications. (T_1= Control, T_2= Hydropriming, T_3= Priming with 2% H_2O_2, T_4= Hardening, T_5= Priming with 2% KCl, T_6= Priming with 0.5% KH_2PO_4, T_7= Priming with 20% PEG, T_8= Priming with 16% NaCl and T_9= Priming with 2.2% $CaCl_2$).

Plant height and yield components

Plant height and yield components of wheat as influenced by seed invigoration treatments and varieties are presented in Table 1. Different seed invigoration treatments and two wheat varieties interacted significantly for plant height, spike length and yield characters of wheat. The highest plant height (82.77cm) was found from hydroprimed seed in Bijoy which was statistically at par with the plant height obtained from hardened, KCl primed, PEG primed, NaCl primed & $CaCl_2$ primed seeds of Shatabdi and control, hardened, KH_2PO_4 primed, PEG primed & $CaCl_2$ primed seeds of Bijoy. The hydroprimed seed in Shatabdi produced the lowest plant height (57.88cm) compare to all other treatments. Other treatments like control, H_2O_2 primed & KH_2PO_4 primed seeds of Shatabdi and H_2O_2, KCl & NaCl primed seeds of Bijoy produced moderate plant height (70.77 to 74.66 cm). The highest number spikes per plant (2.44) was found from KCl primed seed of Shatabdi which was statistically identical with the spike number per plant obtained from H_2O_2, KH_2PO_4, PEG & $CaCl_2$ primed seeds of Shatabdi as well as control, hydroprimed, H_2O_2 primed, hardened, KH_2PO_4 primed, PEG primed, NaCl primed & $CaCl_2$ primed seeds of Bijoy. The hydroprimed seed in Shatabdi produced the lowest number of spike per plant (1.11) which was statistically identical with the spike number per plant obtained from control, hydroprimed, hardened & NaCl primed seeds of Shatabdi and KCl primed seed of Bijoy. The highest spike length (10.61cm) was found from hydroprimed seed in Bijoy which was statistically identical with the spike length obtained from control, H_2O_2 primed, hardened, KCl primed, KH_2PO_4 primed, PEG primed, NaCl primed and $CaCl_2$ primed seeds in both the varieties Shatabdi and Bijoy. The hydroprimed seed in Shatabdi produced the lowest spike length (8.49cm) compared to all other treatments in both Shatabdi and Bijoy. The highest number of grains per spike (39.88) was found from KCl primed seed of Shatabdi which was statistically identical with H_2O_2 primed, hardened, KH_2PO_4 primed, PEG primed, NaCl primed & $CaCl_2$ primed

Table 1: Plant height and yield components of wheat as influenced by the interaction effect of seed invigoration techniques and varieties

Variety	Treatment	Plant height (cm)	Spikes plant^{-1} (No.)	Spike length (cm)	Grains spike^{-1} (No.)	Seed size (mg/seed)

Shatabdi	Control	70.77d	1.22bc	9.55ab	30.11bd	40.00ac
	Hydropriming	57.88e	1.11c	8.49b	25.21d	38.33c
	Priming with 2% H_2O_2	74.66bd	1.44ac	9.88ab	35.99ac	40.83ab
	Hardening	75.94ad	1.33bc	9.66ab	31.88ad	39.87ac
	Priming with 2.0% KCl	82.55a	2.44a	10.27a	39.88a	41.33a
	Priming with 0.5% KH_2PO_4	73.61cd	1.44ac	10.05ab	33.33ad	40.66ac
	Priming with 20% PEG	79.83ac	2.22ab	10.38a	38.55ab	40.83ab
	Priming with 1.6% NaCl	74.88ad	1.22bc	9.77ab	33.21ad	39.10ac
	Priming with 2.2% $CaCl_2$	78.72ac	2.22ab	10.16ab	32.55ad	41.16a
Bijoy	Control	76.22ad	1.44ac	9.94ab	28.55cd	39.44ac
	Hydropriming	82.77a	2.10ac	10.61a	31.11ad	41.16a
	Priming with 2% H_2O_2	73.66cd	1.99ac	9.44ab	25.11d	39.39ac
	Hardening	82.66a	1.88ac	9.99ab	29.88bd	39.00ac
	Priming with 2.0% KCl	72.10cd	1.22bc	9.05ab	24.35d	38.55bc
	Priming with 0.5% KH_2PO_4	81.88ab	1.66ac	10.10ab	28.37cd	39.40ac
	Priming with 20% PEG	78.22ad	1.66ac	10.21a	28.11cd	39.42ac
	Priming with 1.6% NaCl	73.66cd	1.55ac	9.88ab	24.83d	40.16ac
	Priming with 2.2% $CaCl_2$	78.44ad	1.88ac	9.10ab	30.25bd	39.70ac
CV (%)		7.49	12.85	8.62	9.27	3.06

In a column, means followed by the same letter(s) did not differ significantly at 5% level by DMRT.

seeds of Shatabdi as well as hydroprimed seeds of Bijoy. The KCl primed seed in variety Bijoy produced the lowest number of grains per spike (24.35) which was statistically identical with control, H_2O_2 primed, hardened, KH_2PO_4 primed, PEG primed, NaCl primed and $CaCl_2$ primed seeds of Bijoy as well as control & hydroprimed seeds of Shatabdi. The highest individual seed size (41.33mg) was found from KCl primed seed of Shatabdi which was statistically identical with the seed size obtained from control, H_2O_2 primed, hardened, KH_2PO_4 primed, PEG primed, NaCl primed & $CaCl_2$ primed seeds of Shatabdi and also the seed size obtained from all the treatments in variety Bijoy except from KCl primed seed. The hydroprimed seed in variety Shatabdi produced the lowest individual seed size (38.33mg) which was statistically identical with the size obtained KCl primed seeds of wheat variety Bijoy.

Results from other studies like Bam *et al.* (2006) reported that KCl primed seeds produced taller plant in rice. Ugale and Mungse (2001) found that KCl treated seeds showed good potential to enhance yield and yield attributing components of wheat. Similar result was found by Misra and Dwibedi (1980) in wheat. Hussain *et al.* (2006) reported that hydropriming of seeds for 24h increased in plant height and yield contributing factors in sunflower. Geeta (2005) reported that hydropriming enhance the yield and yield attributing characteristics of wheat. Similar result was observed by Butter *et al.* (1999) in wheat. Results of these studies support the results of different parameters of the present study.

Grain and straw yield

Grain weight per plant significantly influenced by the interaction of seed invigoration treatments and wheat varieties (Table 2). The highest grain yield per plant (2.49 g) was obtained from hydroprimed seeds of Bijoy which was at par with the yield obtained from hardened, H_2O_2 primed, KCl primed, KH_2PO_4 primed, PEG primed, NaCl primed & $CaCl_2$ primed seeds of Shatabdi as well as control, hardened, KH_2PO_4 primed, PEG primed and NaCl primed seeds of Bijoy. The lowest grain weight per plant was obtained from KCl primed seed of Bijoy (1.24 g) which was statistically similar with the grain yield obtained from control, hydroprimed, H_2O_2 primed, hardened, KH_2PO_4 primed, PEG primed, NaCl primed & $CaCl_2$ primed seeds of Shatabdi and also obtained from control, H_2O_2 primed,

Table 2: Grain and straw yield of wheat as influenced by the interaction effect of seed invigoration techniques and varieties

Variety	**Treatment**	**Grain yield (g/plant)**	**Straw yield (g/plant)**
Shatabdi	Control	1.43cd	2.07 ef
	Hydropriming	1.26d	1.31 f

	Priming with 2% H_2O_2	1.80d	3.33 ae
	Hardening	1.84ad	3.01 bf
	Priming with 2.0% KCl	2.43ab	4.85 a
	Priming with 0.5% KH_2PO_4	1.74ad	3.01 bf
	Priming with 20% PEG	2.09ad	4.55 ab
	Priming with 1.6% NaCl	2.19ad	2.56 cf
	Priming with 2.2% $CaCl_2$	1.72ad	3.55 ae
Bijoy	Control	1.76ad	3.04 bf
	Hydropriming	2.49a	4.22 ac
	Priming with 2% H_2O_2	1.34cd	2.74 cf
	Hardening	2.26ac	3.98 ad
	Priming with 2.0% KCl	1.24d	2.40 df
	Priming with 0.5% KH_2PO_4	1.73ad	2.94 bf
	Priming with 20% PEG	2.07ad	2.57 cf
	Priming with 1.6% NaCl	1.55ad	2.68 cf
	Priming with 2.2% $CaCl_2$	1.42bd	3.91 ad
CV (%)		13.31	11.77

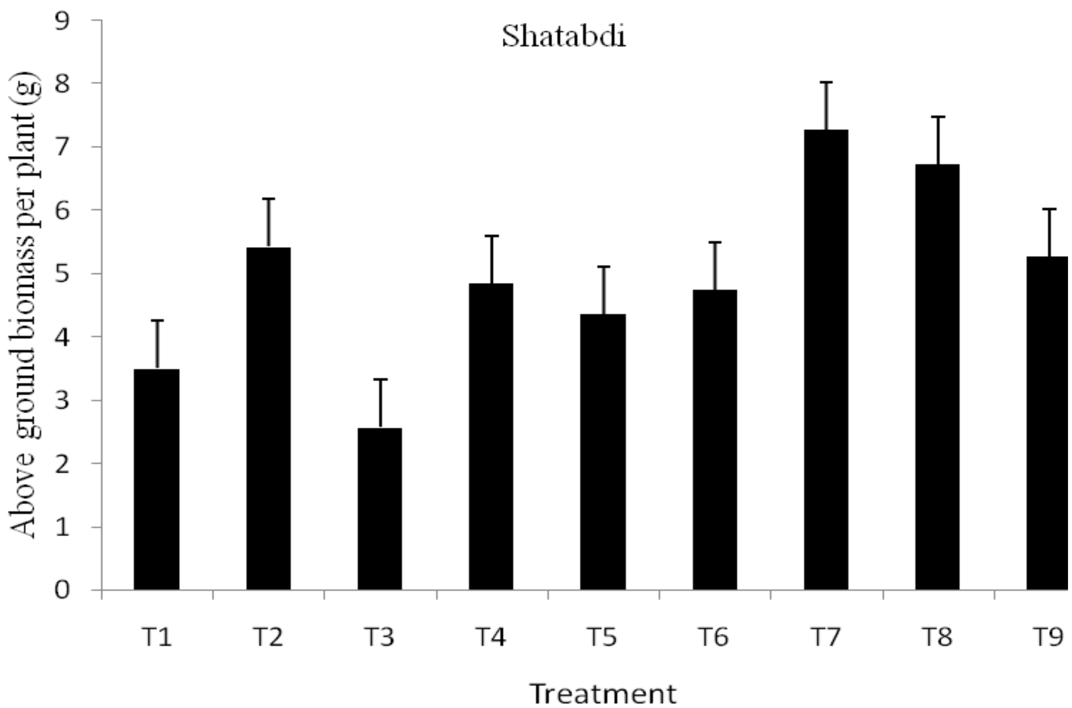
In a column, means followed by the same letter(s) did not differ significantly at 5% level by DMRT.

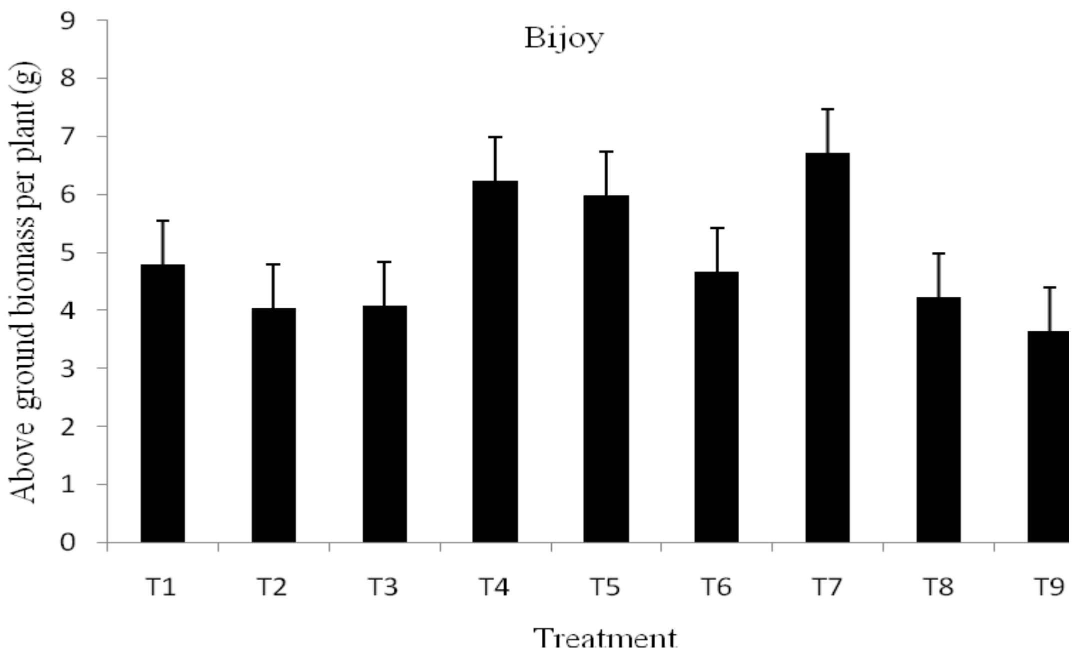
KH_2PO4 primed, PEG primed, NaCl primed and $CaCl_2$ primed seeds of Bijoy. The interaction effect of seed invigoration treatments and wheat varieties significantly influenced the straw yield per plant (Table 2). The highest straw yield was found from KCl primed seed of Shatabdi (4.85g) which was statistically similar with the straw yield obtained from PEG primed seed of Shatabdi (4.55g) and was followed by hydroprimed (4.22g), hardened (3.98g) & $CaCl_2$ primed (3.91g) seed of Bijoy and $CaCl_2$ primed (3.55g) & H_2O_2 primed (3.33g) seed of Shatabdi. The lowest straw yield was obtained from hydroprimed seed of Shatabdi (1.31g) which was followed by the straw yield obtained from control seed of Shatabdi (2.07g) and KCl primed seed of Bijoy (2.40g). Other treatment combinations produced moderate amount of straw (2.56 to 3.04g).

Above ground biomass

Seed invigoration treatments and wheat varieties interacted significantly to influence the above ground biomass per plant (Figure 3). The highest above ground biomass per plant was found from PEG primed seed of Shatabdi (7.28g) which was followed by the above ground biomass obtained from NaCl primed seed of Shatabdi (6.73g), PEG primed seed of Bijoy (6.71g) and hardened seed of Bijoy (6.24g). The lowest above ground biomass was obtained from H_2O_2 primed seed of Shatabdi (2.57g) which was followed by the above ground biomass obtained from control seed of Shatabdi (3.50g) and $CaCl_2$ primed seed of Bijoy (3.64g). Other treatment combinations produced moderate amount of above ground biomass (4.04 to 5.98g).

Results from other studies like Ugale and Mungse (2001) found that KCl treated seeds showed good potential to enhance yield and yield attributing components of wheat. Similar result was found by Misra and Dwibedi (1980) in wheat. Geeta (2005) reported that hydropriming enhance the yield and yield attributing characteristics of wheat. Similar result was observed by Butter *et al.* (1999) in wheat. Results of these studies partly support the results of different parameters of the present study.





Above ground biomass per plant (mean ± lsd) of wheat as influenced by the interaction effect of seed invigoration technique and varieties.

(T_1= Contorl, T_2= Hydropriming, T_3= Priming with 2% H_2O_2, T_4= Hardening, T_5= Priming with 2% KCl, T_6= Priming with 0.5% KH_2PO_4, T^7= Priming with 20% PEG, T^8= Priming with 16% NaCl and T_9= Priming with 2.2% $CaCl_2$).

CONCLUSION

From the overall results of the present study it might be concluded that priming of seeds with 2.0% KCl in wheat variety Shatabdi and hydropriming of seeds for 24h in wheat variety Bijoy can successfully be integrated for early growth and yield enhancement.

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