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Effect of seed hardening and irrigation on economics of wheat (*Triticum aestivum* L.) cultivation

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Abstract
The experiment was conducted to study the performance of various seed hardening chemicals in late sown variety of wheat (*Triticum aestivum* L.) at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) The experiment comprise of 13 treatment within 3 replication laid out in a randomized block design to evaluate the performance of various seed hardening chemicals *viz*. Distilled water, KNO3 at 1000mg per liter, PEG at 15% and GA3 at 450 mg/ liter. The highest straw yield (45.15t), grain yield (3.52t) and harvest index (7.27) was observed in the treatment PEG at 15%+Three Irrigations at crown root initiation, jointing and anthesis stage. The highest cost of cultivation (₹50894.00), gross return (₹59678.00), net return (₹36801.00) and B:C ratio (1.723) is also observed inT9, respectively.

Keywords: Wheat, PEG, irrigation

Introduction
India, one of the greatest success stories of Green Revolution, is the second largest producer of wheat in the world with production hovering around 70-75 million tons in the past few years (Nagarajan, 2005). Three of the wheat producing states (Uttar Pradesh, Punjab, and Haryana) account for nearly 80% of the total wheat production (Chatrath *et al.*, 2006) [5]. The cultivated area under wheat at national level has shown increasing trend, from 29.04 million hectare to 30.54 million hectare with a magnitude of 1.5 million hectare (5%) net gain in terms of area.
However, in the past decade a general slowdown in increase in the productivity of wheat has been noticed (Nagarajan, 2005). Water deficit more than other abiotic stresses limits the growth and productivity of crop plants including wheat (Datta *et al*. 2011). The specific importance for crop plants is not whether rthey survive stress, but whether they show good yield sunder stress conditions (Bhargava and Sawant, 2013). Thus, there is a dire need to select wheat genotypes that can with stand water stress (Khan *et al*. 2010).
Seed priming is a cost effective technology that can enhance early crop growth leading to earlier and more uniform stand with yield associated benefits in many field crops (Rehman *et al.*, 2011).
Polyethylene glycol (PEG-6000) has long been used to simulate drought stress *in vitro* for plants as non- penetrating osmotic agents lowering the water potential in a way similar to soil drying (Larher *et al.,* 1993). A seed hardened with PEG treatment indicated a relationship between the pattern of water absorption, the reactivation of mitotic activity and the start and synchronization of germination. Thus, enhancing a better germination compared to the untreated seeds.
Priming of wheat seed in water has been observed to improve the germination and emergence (Ashraf and Abu-Shakra, 1978) and promote vigorous root growth (Carceller and Soriano 1972) under low soil water potential compared with untreated seeds. The rationale is that sowing soaked seed decreases the time needed for germination and may allow the seedling to escape deteriorating soil physical conditions. It had resulted in more germination speed especially in drought stress and low temperatures in various crops (Sivritepe *et al.*, 2003). Seed priming allows some of the metabolic processes necessary for germination to occur

without germination taking place. Treating the seed with chemicals or growth hormones like GA3 treatment, enhanced the vegetative growth by enhancing the deposition of Na+ and Cl- in both root and shoots. And also cause a significant increase in photosynthetic activity at the vegetative stage of the crops.

The hardening of the seeds or seed treatment with KNO3 solution increases yield, fruit size and improves quality in field and vegetables crops. Priming with KNO3 also results in enhancement of seed germination, mineral composition, proline, β-amylase and protein. Hence, the present experiment was carried out by keeping this in view, experiment was laid to evaluate "the effect of Seed Hardening and Irrigation on Economics of Wheat (*Triticum aestivum* L.)."

Materials and Methods

The experiment was conducted at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh which is located at 25˚ 24' 42" N latitude, 81˚ 50' 56" E longitude and at an altitude of 98 m above mean sea level. The experiment was conducted during the *Rabi* season 2019-2020.The experimental soil was sandy loam, with pH 7.2, Organic C (%) 0.49, low in available N (109.01 kg/ha) and medium in available P (21.80 kg/ha) and K (270.02 kg/ha). The experiment was laid out in a randomized block design, having 13 treatment combinations in 3 replicates. The treatments comprised of T1 -Distilled water +One Irrigation at crown root initiation stage, T2 -Distilled water +Two Irrigations at crown root initiation and jointing stage, T3 -Distilled water +Three Irrigations at crown root initiation, jointing and anthesis stage, T4 -KNO3 at 1000 mg/l +One Irrigation at crown root initiation stage, T5 - KNO3 at 1000 mg/l +Two Irrigations at crown root initiation and jointing stage, T6 - KNO3 at 1000 mg/l +Three Irrigations at crown root initiation, jointing and anthesis stage, T7 -PEG at 15%+One Irrigation at crown root initiation stage, T8 -PEG at 15%+Two Irrigations at crown root initiation and jointing stage, T9 -PEG at 15%+Three Irrigations at crown root initiation, jointing and anthesis stage, T10 -GA3 at 450 mg/l +One Irrigation at crown root initiation stage, T11 -GA3 at 450 mg/l +Two Irrigations at crown root initiation and jointing stage, T12 -GA3 at 450 mg/l +Three Irrigations at crown root initiation, jointing and anthesis stage, T13 – Control(no seed treatment).

The seeds were soaked in different seed hardening chemicals for 12-14 hours and then dried using tissue papers to remove the excess moisture outside the seed coat. The sizes of each experimental plot were 4 m× 3 m. The wheat variety used in the experiment was Halna (K-7903). The seeds were sown by line sowing method with spacing of 22.5cmmanually with the seed rate of 125 kg/ha. N, P and K were applied at the rate of 120, 60 and 60 kg per ha, respectively. N was applied in split application, 50% at basal and 50% as top dressing, whereas P and K were applied as basal dose.

Results and Discussions

Yield attributes and yield (kg/ha)

The result concluded that the maximum grain yield (3.52t) was recorded with the application of PEG at 15% + Three irrigations (T9), whereas Distilled water+ Three Irrigations (T3), KNO3 at 1000 mg/l+Two Irrigations (T5), KNO3 at 1000 mg/l + Three Irrigations (T6) and PEG at 15% + Two Irrigations (T8) were found to be statistically at par with the highest. The increase in the yield by seed hardening with PEG-8000 and KNO3 may be due to improvement in yield components mainly seed yield plant^{-1} and harvest index. Haris *et al.*, (1999) observed 15% increase in grain yield by seed hardening and stated that success of hardening techniques depends on type of cultivar, osmotic potential solution, temperature, seed vigor, rate of seed re-drying and conditions during seed storage.

Stover yield

Maximum Straw yield (45.15t) was recorded with the application of PEG at 15% + Three irrigations (T9), whereas Distilled water +Three Irrigations (T3), KNO3 at 1000 mg/l + Two Irrigations (T5), KNO3 at 1000 mg/l +Three Irrigations (T6), PEG at 15% + one irrigation (T7), PEG at 15% + Two Irrigations (T8), GA3 at 450 mg/l + Two Irrigations (T11),GA3 at 450 mg/l + Three Irrigations (T12) and Control(T13) were found to be statistically at par with the highest. The increase in straw yield with pre sowing treatment was due to the expansion of leaves, which resulted in higher photosynthesis, assimilation and ultimately higher production of total dry matter. Misra and Dwibedi, (1980). Also reported 37% increase in yield of wheat due to pre-sowing techniques.

Economics

The maximum cost of production was recorded under the treatment with PEG at 15%+ Three irrigation(T9)₹50894.00 per ha followed by treatment with PEG at 15%+ Two irrigation (T8) ₹50294.00per ha and Distilled water + Three irrigations (T3) ₹49706.50 per ha. The highest gross return of wheat were obtained in treatment with PEG at 15% + Three irrigation (T9) ₹87695.00 per ha, followed by KNO3 at 1000mg/l + Three irrigation (T6) ₹82055.00 INR per ha. The highest net return of wheat were obtained in treatment with PEG at 15%+ Three irrigation (T9)₹36801.00 per ha followed by KNO3 at 1000mg/l + Three irrigations(T6) ₹33592.50 per ha. The maximum Benefit cost ratio (1.723) was also recorded in treatment with PEG at 15% + Three irrigations (T9) followed by B:C ratio (1.693) in treatment with KNO3 at 1000mg/l + Three irrigation (T6).

Table 1: Effect of seed hardening and irrigation on yield and economics

Treatments		Straw Yield (t/ha)	Grain yield (t/ha)	Cost of (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
T1:	Distilled water + 1 irrigation	36.04	1.76	48506.50	50580.00	02073.50	1.042
T2:	Distilled water + 2 irrigation	41.50	2.41	49106.50	65335.00	16228.50	1.330
T3:	Distilled water + 3 irrigation	42.19	3.04	49706.50	77335.00	27628.50	1.555
T4:	KNO3 at 1000mg/l + 1 irrigation	37.75	2.05	47262.50	56880.00	09617.50	1.203
T5:	KNO3 at 1000mg/l + 2 irrigation	43.04	3.18	47862.50	80350.00	32487.50	1.678
T6:	KNO3 at 1000mg/l + 3 irrigation	43.49	3.26	48462.50	82055.00	33592.50	1.693
T7:	PEG at 15%+ 1 irrigation	42.86	2.03	49694.00	58985.00	09291.00	1.186
T8:	PEG at 15%+ 2 irrigation	42.94	3.10	50294.00	78820.00	28526.00	1.567

T9:	PEG at 15%+ 3 irrigation	45.15	3.52	50894.00	87695.00	36801.00	1.723
T10:	GA3 at 450 mg/l + 1 irrigation	41.17	1.92	47808.00	56105.00	08297.00	1.173
T11:	GA3 at 450 mg/l + 2 irrigation	43.64	2.16	48408.00	61780.00	13372.00	1.276
T12:	GA3 at 450 mg/l + 3 irrigation	43.80	2.16	49008.00	61860.00	12852.00	1.262
	F- Test	S	S				
	S.Em	0.25	1.20				

Note: *1 irrigation at CRI stage
*2 irrigation at CRI and jointing stage
*3 irrigations at CRI stage, jointing stage, anthesis stage

Conclusion

It can be concluded that PEG at 15% + Three irrigations (T9) which recorded maximum yield, B:C ratio and net return performed better than the remaining treatments. Hence, found beneficial for farmer.

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