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Effect of Hormonal, Chemical and Hydropriming on Seed Yield and Growth Parameters of Late Sown Wheat (*Triticum Aestivum* L.)

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ABSTRACT

To evaluate the effect of different seed primings technique on seed yield and growth parameters of late sown Wheat (Triticum aestivum L.*)" variety K-9423 (Unnat Halna) and experiment was conducted in 2012-13 and 2013-14 at Experimental Research farm Nawabganj, C.S. Azad University of Agriculture and Technology, Kanpur by using Nested block design. Seeds were primed for 12, 18, 24 and 30 hrs in four priming media (Water, $CaCl_2$ 1 %, KNO_3 1 %, GA_3 50 ppm) and unprimed as control. Highest leaf area index at 30 DAS (1.669) chlorophyll intensity percent (48.025),earliest maturity (93.538) and number of spikelet's spike^{-1} (18.54) were observed when seed primed by $GA_3$50 ppm for 18 hrs and highest leaf area index at 60 DAS (3.155), days to 50 % heading (55.66) when primed for 24 hrs. Highest plant height (74.37 cm) was observed when seed primed by GA_3 50 ppm for 30 hrs similarly highest specific leaf weight (6.40) was observed when seed primed by $CaCl_2$ 1 % for 18 hrs and highest spike length (8.56 cm) was recorded with water primed seed for 18 hrs. Highest seed yield both Kg plot^{-1} (3.42) and q ha^{-1} (43.29) were recorded with GA_3 50 ppm for 18 hrs, 24 hrs. Thus it is concluded that application of GA_3 50 ppm was found most suitable for harvesting the highest seed yield as well as earliest days to maturity in 18 hrs. Significantly positive as well as negative desired traits associated with yield and growth parameters might be used to improve the yield and growth of wheat.*

***Key Words*:** Hormonal, Chemical, Hydropriming, growth parameters, Yield, Wheat.

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is an important cereal in many developed and developing countries of the world. It is widely used for animal feed and industrial raw material beside food in the developed countries where as the developing countries it is generally used for food. It is the second important food crop being next to rice. India is the second largest producer of wheat in the world next only to China and the crop has registered fastest growth to Indian agriculture. In world, wheat is cultivated over an area of 304.18 m ha with total production and productivity of 92.29 million tonnes and 3.03 t ha^{-1}, respectively. However in India, it is cultivated an area of 30.40 m ha with total production and productivity of 94.88 mt and 3.18 t ha^{-1}, respectively. In Uttar Pradesh, the acreages, production and productivity of wheat is about 9.67 m ha, 30.01 mt and 3.11 t ha^{-1}, respectively [1]. [2] defined seed priming as a pre-sowing treatment in osmotic solution,

which allows seeds to imbibe water to proceed to the first stage of germination but prevents radicle protrusion through the seed coat. Seed priming can be included halo-priming, hydro-priming, osmo-priming, osmo-conditioning, osmo-hardening, hormo-priming, hardening, matri-priming and others. Halo-priming and hydro-priming defined as soaking seeds in salt solutions and water respectively. Since primed seeds are usually lose their storage life, thus they should be sown immediately after priming [3].

Rapid and uniform field emergence is an important factor to achieve high yield with respect to both quality and quantity in annual crops. For achieving this specific physiological need, 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's on germination and growth rate of crops. Recently, there has been renewed interest in seed priming (also known as hydro-priming) to improve establishment. This approach consists of soaking seeds in water (usually overnight), surface drying and planting the same day. This decreases the time that the seed spends in the seedbed simply imbibing water. Once sown, seeds spend significant amounts of time just absorbing water from the soil. So, by reducing the imbibition time to minimum (through seed priming), germination rate of seed can be increased and seedlings emergence improved [4].

In recent years, seed priming 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 and Chickpea (*Cicer arietinum*) [5]. It has been reported that seed soaked with 2.5 % KCL for 16 hrs reduced both coleoptiles and radical length of wheat. It has also been found that if seed is soaked in 2.5 % potassium chloride (KCl) for 12 hrs before sowing increases wheat yield by 15 %. Furthermore, in previous studies, it has also been recorded that seed soaking with 0.5 to 1% solution of KCl or potassium sulfate (K_2SO_4) significantly increased plant height, yield attributes, and seed yield in wheat. Earlier studies showed that the success of seed priming is affected by the complex interaction of factors including priming agent, plant species, priming duration, temperature, seed vigour and dehydration, and also storage conditions of the primed seed. It has been established that pyridoxine (vitamin B_6) enhance the growth of root system which helps is better seedling establishment, and higher nutrient and water uptake. The work with regard to seed soaking treatment with pyridoxine has been proved promising in mustard, lentil, mung and wheat. Seed priming techniques have been used to increase germination characteristics and improve germination uniformity in more field crops under stressed conditions [6]. Seed priming can be taken to counteract the adverse effects of abiotic stress. Seed priming increases seed reserve utilization, seedling dry weight and seed reserve depletion percentage in mountain rye and wheat [7].

MATERIALS AND METHODS

The present investigation was carried out for two consecutive years 2012-13 and 2013-14 at Chandra Shekhar Azad University of Agriculture & Technology, Kanpur. Geographically, Kanpur is situated in sub tropical zone at $25^0 26'$ and $26^0 58'$ N latitude and $79^0 32'$ and $80^0 34'$ E longitude with an altitude of 125.90 m above Mean Sea Level. The mean annual rainfall is about 816 mm. The composition of soil of the experimental site is alluvial in nature having fine sand 62.20 and 62.50 %, silt 24.00 and 23.80 %, clay 13.70 and 13.80 %, pH 8.52 and 8.54, organic carbon 0.47 (Low) and 0.44 % (Low), EC 0.42 and 0.41 ds m^{-1}, available N 225 (Low) and 221 kg ha^{-1} (Low), available P 20 (Medium) and 19 kg ha^{-1} (Medium), available K 249 (Medium) and 245 kg ha^{-1} (Medium), available zinc 0.9 (Low) and 1.0 kg ha^{-1} (Low) and available iron 9.2 (Normal) and 9.4 kg ha^{-1} (Normal) during 2012-13 and 2013-14, respectively. Experimental materials for the experimentation were consisted of wheat variety K-9423 (Unnat Halna) by using Nested block design.

Preparation of Solution:

- For the preparation of 1% solution of KNO_3, 10 gram KNO_3 was weighted and put into a measuring flask and poured the distilled water up to 1000 ml.
- Likewise, for $CaCl_2$ (1%) solution 10 gram $CaCl_2$ was taken in a measuring flask and made up to 1000 ml of distilled water.
- For the preparation of the growth regulator 1 gram chemical was taken in an individual neat and clean beaker. This chemical was dissolved separately in a few drop of alcohol.

- The alcoholic solution added to 500 ml of distilled water with constant stirring the volume of solution finally constituted to one liter. This was the 1000 ppm stock solution of GA_3. The flask containing GA_3 solution was covered with muslin cloth to avoid any contamination.
- For preparation of 50 ppm for growth regulator 50 ml of solution from the stock solution was taken in a well cleaned measuring flask and water is added to constitute to 1000 ml. for 50 ppm, 50 mg of chemical was used to make 1000 ml solution.

Soaking of the seed in solution: After preparation of solution KNO_3, $CaCl_2$, GA_3 along with water Seed of wheat variety was soaked in desired solution for 12 hrs, 18 hrs, 24 hrs and 30 hrs at room temperature, simultaneously a control, in which seeds were without soaking.

The feeder dose of NPK @ of 120:60:40 Kg ha^{-1} was also applied. Standard procedure for experimentation was followed. Observations were recorded on yield and growth characters viz. Leaf Area Index at 60 DAS, LAI 90 DAS, Specific Leaf Weight (mg cm^{-2}), Chlorophyll Intensity (%), Number of productive tillers (m^{-2}), Early days to 50 % heading, Plant height (cm), Spike length (cm), No. of Spikelet's $Spike^{-1}$, Days to Maturity, Canopy Temperature Depression (^0C), and Seed yield (q ha^{-1}). The various statistical techniques were used for calculation of the data suggested by [8]. Canopy Temperature Depression and Chlorophyll Intensity was measured by Chlorophyll meter i.e. SPAD 502. Leaf Area Index was calculated by formula given by [9].

$$LAI = \frac{LA}{P}$$

Where, LA = Leaf Area and P = Occupied Land Area

$$SLW \text{ (Specific Leaf Weight)} = \frac{\text{Leaf Dry Weight}}{\text{Leaf Area}}$$

RESULTS AND DISCUSSION

Growth Parameters

The pooled data given in Table 1 on leaf area index (60 DAS) revealed that A_4 (GA_3 50 ppm) was found to be best contributor by scoring highest leaf area index (3.155) it was closely followed by $CaCl_2$1% (3.109), water (2.895) and $KNO_3$1% (2.893) were found to be at par contributor for LAI at 60 DAS. The overall least performance (2.820) was recorded with unprimed seed. Priming duration B_1 (12hrs), B_2(18hrs), B_3(24hrs) and B_4(30hrs) for leaf area index at (60DAS) revealed that B_3 treatment was found to be most conducive for enhancing the highest leaf area index (3.064) which was closely followed by B_2 treatment(18hrs soaking period) (3.055), B_1 and B_4 were found at par for this trait. Water priming was found best in A_1 treatment (2.940) while $CaCl_2$1% in B_3 (3.190), $KNO_3$1% in B_2 (2.975) and GA_3 50ppm in B_3 (3.230), pooled data also revealed that GA_3 50ppm contributed overall highest leaf area index (3.230) in (24 hrs primed duration) [10].

The data given in Table 1 on leaf area index (90 DAS) revealed the significant best performance (3.888) contributed by $GA_3$50ppm followed by $CaCl_2$1% (3.133), $KNo_3$1% (2.965) treatments. Least contribution (2.838) in respect of this trait was recorded with water priming. Unprimed seeds treated as control exhibited overall least leaf area index (2.770) at 90 DAS. In pooled data overall highest leaf area index (3.930) at (90DAS) was recorded with GA_3 (50ppm) in 24hrs priming duration followed by 18hrs priming (3.905) duration. Water priming was found to be least effective (2.765) for this trait in 30hrs priming period, it was found to be inferior with control (2.770). Priming durations used in study (B_1, B_2, B_3, and B_4) for leaf area index (90DAS) given in Table 1 divulged that 24hrs soaking duration (B_3) was found to be most conductive for achieving the highest leaf area index (3.253) followed by B_2 (3.223), B_1 (3.213) and B_4 (3.137). Among different treatments, water priming was found most suitable (2.910) with B_1, $CaCl_2$ 1% with B_3 (3.210), $KNO_3$1% with B_2 (3.010) and GA_3 50ppm with B_3 (3.930).

Early heading is pre requisite character in most of the crops. The data revealed that $GA_3$50ppm A_4 took least days (55.663) for days to 50% heading. It was followed by factor

$KNO_3$1% which took (56.763) days, factor $CaCl_2$ 57.075 days for 50% heading. Water primed seed took the maximum days (57.562) to attain the 50% heading. Unprimed seed took overall highest days (59.550) to attain the 50% heading. Whereas the performance of different treatments in respect to priming hours are concerned, A_1 treatment exhibited the least days (57.100) in B_1 A_2 treatments in B_3 (56.850), A_3 treatments with B_4 (56.250) and A_4 treatment in B_3 (56.200). Study also revealed that GA_3 treatment in B_3 (24hrs) took the overall least days (56.200) to attain the 50% heading in wheat variety K-9423. The data pertaining to priming hours is given Table 1 revealed significant variation among the priming durations. B_3 (24hrs) was found to be most conducive to take the least days (56.638) to attain the 50% heading followed by B_4-30hrs (56.775), B_1-12hrs (57.387) and highest days (57.763) was recorded with B_2 (18hrs) treatment to attain the 50% heading. Whereas different priming hours are concerned, individually B_1 took the least days (57.100) with A_1, B_2 in A_3 (56.800) B_3 in A_4 (56.200), B_4 in A_3 (56.250) treatments [11].

The significant variation was recorded with among the factors as well as individual factors A_1, A_3 and A_4 in both the years as well as pooled data. The perusal of data given in Table 2 in respect of plant height (cm) revealed the non significant variation between control V/S treatments. Numerically A_4 ($GA_3$50ppm) treatment was found to be superior by scoring (74.37cm) highest height followed by A_1 (73.88cm), A_3 (73.83cm) and A_2 (73.36cm) treatment. Overall highest plant height (75.200cm) was recorded with GA_3 in B_3 treatment. The pooled data also revealed that overall least height (73.000cm) was recorded in $CaCl_2$ (A_2) with B_4 treatment. Whereas performance of individual treatment in respect to priming durations is concerned A_1 treatment scored the highest plant height with B_1 (74.700cm), A_2 with B_2 (73.600cm) A_3 with B_3 (74.550cm) and A_4 with B_3 (75.200cm). The perusal of pooled data given in Table 2 revealed the significant variation of priming hours for plant height, highest plant height (75.478cm) was recorded with B_4 (30hrs) followed by B_2 (18hrs) (74.188cm) and B_1 (12hrs) (73.88cm) treatments. The least height (73.875cm) was recorded with B_3 in which seeds were primed for 24hrs. Whereas individual performance of the priming hours in respect to different treatments are concerned B_1 scored the highest height (74.700cm), with A_1, B_2 with both A_3 and A_4 (74.550cm) B_3 with A_4 (74.200cm) and B_4 with A_4 (74.478cm) [12].

The pooled data given in Table 2 revealed the non significant variation among different treatments but numerically $GA_3$50ppm (A_4) scored the highest number of productive tillers (362.875m^{-2}) followed by $CaCl_2$1%-A_2 (358.375 m^{-2}), water-A_1 (357.625 m^{-2}) and least value (354.000 m^{-2}) for this trait was recorded with $KNO_3$1%-A_3. All the factors A_1, A_2, A_3 and A_4 were found highly significant superior over control. Overall highest number of productive tillers/m^{-2} (366.500 m^{-2}) was recorded with $Ga_3$50ppm in while seed were soaked for 24hrs. Likewise least number of productive tillers was obtained (351.500 m^{-2}) in $KNO_3$1% with 30hrs soaking period. Whereas performance of individual treatments (A_1, A_2, A_3 and A_4) in respect of their priming duration for number of productive tillers m^{-1} are concerned A_1, A_2 and A_3 treatments scored the highest number of productive tillers in (12hrs soaking period), A_4 treatments ($GA_3$50ppm) was found best in B_3 priming hours (366.500m^{-2}). The perusal of pooled data given in Table 2 revealed the significant variation among different priming hours in respect of number of productive tillers/m^{-2}. Among the different priming hours B_1 was found to be superior by scoring highest number (359.750) of productive tillers followed by B_3 (359.125). B_2 (358.750) and least number (356.500) of productive tillers were recorded with B_4. Whereas performance of individual priming hours are concerned B_1 was found most suitable with A_2 (362.000), B_2 with A_4 (363.000), B_3 with $GA_3$50ppm (366.500) and B_4 with GA_3 (360.500) [13].

Data given in Table 2 for spike length (cm) revealed the significant variation between the treatments & control highest pooled mean value (8.563cm) for spike length was recorded with water (A_1) followed by $Ga_3$50ppm -A_4 (8.512cm) and $KNO_3$1% (8.496cm) least spike length (8.838) was recorded with $CaCl_2$1% treatment. Among the treatment factors water primed seed contributed highest spike length (9.150cm) in B_1 priming hours similarly least spike length (8.050cm) was recorded with $GA_3$50ppm in B_4 priming hours whereas performance of different treatment in respect of priming hours are concerned water priming in B_1 (9.150cm), $CaCl_2$1% in B_2 (9.100cm), $KNO_3$1% in B_2 (9.050cm) and $GA_3$50ppm in B_3 (9.250cm) scored the highest spike length. The pooled data of different priming durations given in Table 2 revealed the highest spike length (8.750cm) inB_2 followed by B_1 (8.625cm)

and B_3 (8.525cm). The least spike length (8.109cm) was observed with B_4 priming hours whereas a performance of individual priming hours are concerned B_1 excelled highest (9.150cm) performance with A_1, B_2 with A_2 (9.100cm), B_3 with A_4 (9.250cm) and B_4 with A_3 (8.184cm) [14].

The data given Table 3 for number of spikelet's spike revealed the significant variation among different treatments for the said character $GA_3$50ppm (A_4 was found to be best contributor for scoring highest number of spikelet's spike (18.549) followed by $CaCl_2$1% -A_3 (18.282) and water A_1 (18.279). $KNO_3$1% was found the least contributor of number of spikelet's spike by scoring (18.229) value of this character. Overall least value (17.665) for the said character was recorded with control. Among the treatments factors $GA_3$50ppm primed seed contributed the highest number of spikelet's spike (19.065) in B_3 (24hrs) priming hours similarly least number of spikelet's spike (17.520) was recorded with B_4 (30hrs) priming duration. Whereas performance of different treatments in respect of priming are concerned A_1 treatment (water) excelled the highest performance (18.935) on number of spikelet's spike in B_1 priming hours, A_2 ($CaCl_2$1%) and A_3 ($KNO_3$1%) both in B_2-18hrs (18.825, 18.880) respectively and A_4 ($GA_3$50ppm) in B_3-24hrs (19.065). The pooled data of different priming duration given in Table 3 revealed the significant variation among different priming hours, B_2 (18hrs soaking) was found to be best contributor in achieving the highest number of spikelet's spike^{-1} (18.779) followed by B_1 (12hrs soaking- 18.437) and B_3 (24hrs soaking-18.407), B_4 (30hrs soaking was found to be least contributor (17.702) achieving the number of spikelet's spike^{-1}. Whereas performance of individual priming hours in respect of different treatments are concerned B_1 (12hrs soaking) scored the highest number of spikelet's spike^{-1} in A_1, while B_2 (18hrs soaking), B_3 (24hrs soaking) B_4 (30hrs soaking) scored the highest number of spikelet's spike^{-1} 18.930, 19.065 and 18.100 respectively in A_4 ($GA_3$50ppm) treatment [15].

Data given in Table 3 in Chlorophyll intensity (%) revealed the best performance recorded with GA_3 (50ppm) in both the years and pooled mean value (48.025%). $KNo_3$1% scored the second position by contributing 47.914 % chlorophyll intensity followed by water priming (45.807 %). Among the treatment factors $CaCl_2$ was found to be least contributor (44.557%) for this trait. Unprimed treatment was found to be overall least performer (42.070%) for the said trait. Whereas, performance of individual treatment in respect of priming hours is concerned, water priming in B_1 (47.670%), $CaCl_2$ in B_3 (46.350%), KNO_3 B_2 (51.630%) and GA_3 in B_3 (51.850%) scored the highest value for the said character. Study also revealed that seed primed with $GA_3$50ppm for 24hrs, exhibited overall highest (51.850%) pooled value for this trait. Priming durations, B_1 (12hrs), B_2 (18hrs), B_3 (24hrs) and B_4 (30hrs) for Chlorophyll intensity (%) are given in Table 3, revealed the highest chlorophyll intensity (48.271%) in B_2 followed by B_3 (47.957%), B_1 (46.407%) and B_4 (43.720%), treatments B_1 treatment hours was found to be best in water (A_1) and B_3 in both $CaCl_2$ (A_2) and $GA_3$50ppm (A_4) and B_2 in KNO_3 (A_3) treatments [16].

The pooled mean value on specific leaf weight given in Table 3 revealed the significant variation among different treatments. Highest specific leaf weight (6.401mg) was recorded with $CaCl_2$ (A2) treatment followed by KNO_3-A_3 (6.360), water-A_1(6.304) and GA_3-A_4 (6.299). Overall least pooled mean value (6.050) was recorded with unprimed seed. Overall highest value (6.535) was recorded with $CaCl_2$ (A_2) in 18hrs priming duration B_2. Whereas performance of individual treatment in respect of priming hours are concerned B_1 treatment contributed the highest specific leaf weight (6.455) with B_1, both $CaCl_2$ (6.535) and KNO_3 (6.505) in B_2 and GA_3(A_4) (6.530) in B_3 treatment scored the highest values for the character under study. The pooled mean value of specific leaf weight is given in Table 3. The pooled mean data of different priming hours B_1 (12hrs), B_2 (18hrs), B_3 (24hrs) and B_4 (30hrs) exhibited the highest specific leaf weight (6.479mg) with B_2 treatment where seeds were primed for 18hrs followed by B_3 (6.445mg), B_1 (6.368mg) and B_4 (6.164) treatments. Significant variation was also recorded with control where priming duration was null. Polled data also revealed that highest specific leaf weight (6.535mg) with B_2 (18hrs primed duration) while B_3 treatment (24hrs primed duration) was found as closely successor (6.530mg) of this trait 30hrs priming period was found least effective in all the treatments [17].

Table 4 revealed the highly significant variation between control V/S treatment. Study revealed that least number of days to maturity (92.887) were taken in $Ga_3$50ppm (A_4)

followed by $KNO_3$1% (93.538) days and $CaCl_2$1% (94.513). Among the treatments highest number of days for to maturity was recorded with water (A_1) unprimed seeds took overall highest number of days (96.550) for this trait. Overall least number of days (92.800) for this trait was recorded with $GA_3$50ppm at 18hrs soaking duration (B_2). Whereas performance of individual treatments in respect of different priming hours are concerned, being non significant hence no need to discussion. The pooled data of different priming durations given in Table 4 revealed variation among the different priming hours for this character B_2 priming duration was found to be most superior by taking least number of (93.787) least number of days to attain the maturity. It was followed by B_1 priming hours (93.825) B_3 priming hours (93.863) and highest number of days (94.675) for this character was recorded with B_4 priming hours. Overall least number of days (92.800) were recorded with both B_1 & B_2 soaking hours similarly highest number of days (96.300) were recorded with A_1 priming hours [18].

Data given in Table 4 for canopy temperature depression (^{0}C) revealed that GA_3(50ppm) scored the highest mean value (5.153) for the said trait in both the years as well as in pooled data followed by KNO_3(A_3) (5.030) $CaCl_2$(a_2)(4.657). Among the different treatments water primed seed were found to be least scorer (4.409) for this trait. Whereas performance of different treatments in respect of priming hours are concerned water primed (A_1) scored the highest value in B_1 (4.880), $CaCl_2$ (A_2) in B_3 (5.715), KNO_1(A_3) in B_2 (5.225) and $GA_3$50ppm(A_4) in B_3(5.330) treatments. Study also revealed that seed primed with GA_3 for 24 hrs, exhibited overall highest (5.330) pooled value for the character under study. Non significant variation reported between control V/S treatments. Different priming hours B_1 (12hrs), B_2 (18hrs), B_3 (24hrs) and B_4 (30hrs) for canopy temperature depression are given in Table 4. The pooled mean data revealed the highest temperature depression (5.044^{0}C) with seed primed for 18hrs (B_2) followed by 24hrs soaking-B_3 (5.040)12hrs soaking-B_1 (4.746). Least value (4.419) was recorded with 30hrs (B_4) soaking treatment [19].

Seed Yield

The data on seed yield q ha^{-1} given in Table 4 revealed the significant variation among different treatments and in between control v/s treatment. A4 (GA3) was found to be best in achieving the highest mean seed yield (43.290 q ha^{-1}) followed by A2 CaCl2 (42.388 and A1 water (40.661 q ha^{-1}). A3 (KNO_3) was found to be least effective in enhancing the yield as it scored (40.075 q ha^{-1}) seed yield. Highest seed yield among different priming hours was recorded with (44.683) B3 treatment and lowest (36.265 q ha^{-1}) was recorded with B4 (30 hrs) treatment. Whereas individual performance of different priming hours are concerned B_1, B_2, B_3 and B_4 treatments scored its superiority with A_4 (GA_3) by 43.417, 44.050, 44.683 and 41.012 q ha^{-1} seed yield respectively. The performance of different priming hours given in Table 4 revealed the significant variation for seed yield q ha^{-1} the mean pooled value (43.113 q ha^{-1}) of B_3 was found best for the said trait B_2 (18 hrs – 42.736) and B1 (41.616 q ha^{-1}). The lowest seed yield (38.950) was scored with B_4 (30 hrs) treatment overall the highest [20].

Matrix correlation (r) between seed yield and growth parameters.

The correlation of coefficient (r) between seed yield and yield attributing traits are concerned seed yield reflected the highly significant positive correlation with leaf area index at 60 DAS (0.81770), 90 DAS (0.60918), specific leaf weight (0.8125 mg cm^{-1}), chlorophyll intensity % (0.52726), number of productive tillers m^{-1} (0.76486), number of spikelet's spike^{-1} (0.67375), spike length (0.51705). It is also evident the table 5 that highly significant but negative correlation was recorded with seed yield and days to 50% heading (-0.51500) and days to maturity (-0.54639). Only positive significant correlation was noticed between seed yield and canopy temperature depression on (0.39735).

CONCLUSION

Thus it is concluded that application of GA_3 50 ppm was found most suitable for harvesting the highest seed yield as well as growth parameters and earliest days to maturity in 18 hrs. Significantly positive as well as negative desired traits associated with yield and growth parameters might be used to improve the yield.

Table-1: Effect of different seed primings technique on seed yield and growth parameters of late sown Wheat (pooled data of two years).

Treatment		A (1) WATER	A (2) $CaCl_2$ (1%)	A (3) KNO_3 (1%)	A (4) GA_3 5(ppm)	Mean B	Control Mean	Factor	A	Cont. V/S Treat.
Leaf Area Index at 60 DAS	B (1) 12 hrs Soaking	2.940	3.085	2.880	3.065	2.993				
	B (2) 18 hrs Soaking	2.895	3.145	2.975	3.205	3.055				
	B (3) 24 hrs Soaking	2.930	3.190	2.905	3.230	3.064		SE (d)	0.052	0.039
	B (4) 30 hrs Soaking	2.815	3.015	2.810	3.120	2.939				
	Mean-A	2.895	3.109	2.893	3.155	3.013	2.820	CD (p=0.05)	0.103	0.077
Leaf Area Index at 90 DAS	B (1) 12 hrs Soaking	2.910	3.095	2.955	3.890	3.213				
	B (2) 18 hrs Soaking	2.795	3.180	3.010	3.905	3.223				
	B (3) 24 hrs Soaking	2.885	3.210	2.985	3.930	3.253		SE(d)	0.043	0.045
	B (4) 30 hrs Soaking	2.765	3.045	2.910	3.825	3.137				
	Mean-A	2.838	3.133	2.965	3.888	3.206	2.700	CD(p=0.05)	0.086	0.091
Days to 50% heading	B (1) 12 hrs Soaking	57.100	57.700	57.500	57.250	57.387				
	B (2) 18 hrs Soaking	58.150	57.150	56.950	56.800	57.763				
	B (3) 24 hrs Soaking	57.650	56.850	56.350	56.200	56.638		SE(d)	0.428	0.227
	B (4) 30 hrs Soaking	57.350	57.100	56.250	56.400	56.775				
	Mean-A	57.562	57.075	56.763	55.663	56.766	59.550	CD(p=0.05)	0.856	0.454

Table-2: Effect of different seed primings technique on seed yield and growth parameters of late sown Wheat (pooled data of two years).

Treatment		A (1) WATER	A (2) $CaCl_2$ (1%)	A (3) KNO_3 (1%)	A (4) GA_3 50 ppm)	Mean B	Control Mean	Factor	A	Cont. V/S Treat.
Plant Height (cm)	B (1) 12 hrs Soaking	74.700	73.300	74.100	73.450	73.888				
	B (2) 18 hrs Soaking	74.050	73.600	74.550	74.550	74.188				
	B (3) 24 hrs Soaking	73.600	73.550	73.150	75.200	73.875		SE(d)	0.250	0.188
	B (4) 30 hrs Soaking	73.200	73.000	73.550	74.350	75.478				
	Mean-A	73.888	73.363	73.838	74.375	73.866	73.650	CD(p=0.05)	0.501	N. S.
Number of productive Tillers (m^{-2})	B (1) 12 hrs Soaking	359.500	362.000	357.700	361.500	359.750				
	B (2) 18 hrs Soaking	357.000	361.000	354.000	363.000	358.750				
	B (3) 24 hrs Soaking	357.500	359.000	353.500	366.500	359.125		SE(d)	2.080	1.560
	B (4) 30 hrs Soaking	356.500	357.500	351.500	360.500	356.500				
	Mean-A	357.625	358.375	354.000	362.875	358.519	350.500	CD(p=0.05)	N. S.	3.120
Spike Length (cm)	B (1)12 hrs Soaking	9.150	8.350	8.500	8.500	8.625				
	B (2) 18 hrs Soaking	8.600	9.100	9.050	8.250	8.750				
	B (3) 24 hrs Soaking	8.400	8.200	8.250	9.250	8.525				
	B (4) 30 hrs Soaking	8.100	8.100	8.184	8.050	8.109		SE(d)	0.115	0.087
	Mean-A	8.563	8.438	8.496	8.512	8.502	8.100	CD(p=0.	0.231	0.173

Table-3: Effect of different seed primings technique on seed yield and growth parameters of late sown Wheat (pooled data of two years).

Parameter	Treatment	A (1) WATER	A (2) $CaCl_2$ (1%)	A (3) KNO_3 (1%)	A (4) GA_3 50 ppm)	Mean B	Control Mean	Factor	A	Cont. V/S Treat.
Number of Spikelet's Spike-1	B (1) 12 hrs Soaking	18.935	18.535	18.175	18.100	18.437		SE(d)	0.249	0.187
	B (2) 18 hrs Soaking	18.485	18.825	18.880	18.930	18.779				
	B (3) 24 hrs Soaking	18.120	18.100	18.345	19.065	18.407		CD(p=0.05)	0.498	0.373
	B (4) 30 hrs Soaking	17.575	17.665	17.520	18.100	17.702				
	Mean-A	18.279	18.282	18.229	18.549	18.335	17.665			
Chlorophyll Intensity (%)	B (1) 12 hrs Soaking	47.670	43.805	46.705	47.450	46.407		SE(d)	0.782	0.586
	B (2) 18 hrs Soaking	45.810	45.525	51.630	50.120	48.271				
	B (3) 24 hrs Soaking	45.185	46.350	48.445	51.850	47.957				
	B (4) 30 hrs Soaking	44.775	42.550	44.875	42.680	43.720		CD(p=0.05)	1.564	1.173
	Mean-A	45.860	44.557	47.914	48.025	46.589	42.070			
Specific Leaf Weight	B (1) 12 hrs Soaking	6.455	6.320	6.360	6.335	6.368		SE(d)	0.097	0.072
	B (2) 18 hrs Soaking	6.390	6.535	6.505	6.485	6.479				
	B (3) 24 hrs Soaking	6.280	6.490	6.480	6.530	6.445				
	B (4) 30 hrs Soaking	6.090	6.260	6.095	6.210	6.164		CD(p=0.05)	0.193	0.145
	Mean-A	6.304	6.401	6.360	6.299	6.364	6.050			

Table-4: Effect of different seed primings technique on seed yield and growth parameters of late sown Wheat (pooled data of two years).

Treatment	Days to Maturity					Canopy Temperature Depression (^0C)					Seed Yield (q ha^{-1})				
	B (1) 12 hrs Soaking	B (2) 18 hrs Soaking	B (3) 24 hrs Soaking	B (4) 30 hrs Soaking	Mean-A	B (1) 12 hrs Soaking	B (2) 18 hrs Soaking	B (3) 24 hrs Soaking	B (4) 30 hrs Soaking	Mean-A	B (1) 12 hrs Soaking	B (2) 18 hrs Soaking	B (3) 24 hrs Soaking	B (4) 30 hrs Soaking	Mean-A
A (1) WATER	94.100	95.600	95.500	96.300	95.250	4.880	4.780	3.970	4.005	4.409	40.389	40.886	42.847	38.525	40.661
A (2) $CaCl_2$ (1%)	94.750	94.150	94.000	95.150	94.513	4.050	4.900	5.715	3.965	4.657	42.658	43.860	43.037	40.000	42.388
A (3) KNO_3 (1%)	93.650	93.300	93.600	93.850	93.538	4.955	5.225	5.145	4.795	5.030	40.000	42.151	41.886	36.265	40.075
A (4) GA_3 50 ppm	92.800	92.800	92.850	93.400	92.887	5.100	5.270	5.330	4.910	5.153	43.417	44.050	44.683	41.012	43.290
Mean B	93.825	93.787	93.863	94.675	94.047	4.746	5.044	5.040	4.419	4.813	41.616	42.736	43.113	38.950	41.603
Control Mean					96.550					4.615					37.030
Factor			SE(d)		CD(p=0.05)			SE(d)		CD(p=0.05)			SE(d)		CD(p=0.05)
A			0.582		1.164			0.214		0.427			0.875		1.749
Cont. V/S Treat.			0.436		0.873			0.160		N. S.			0.656		1.312

Table 5: Matrix correlation (r) between seed yield and growth parameters.

Observations	2012-13	2013-14	Pooled
Seed yield V/S Yield q/ha^{-1}	1.00000	1.00000	1.00000
Seed yield V/S plant height	.37896*	.43263*	.18233
Seed yield V/S days to 50% heading	-.51405**	-.54509**	-.51500**
Seed yield V/S leaf area index at 60 DAS	.82564**	.81812**	.81770**
Seed yield V/S leaf area index at 90 DAS	.60941**	.60894**	.60918**
Seed yield V/S specific leaf weight (mg cm^{-2})	.81244**	.80814**	.81258**
Seed yield V/S chlorophyll intensity(%)	.52740**	.52702**	.52726**
Seed yield V/S number of productive tillers (m^{-1})	.16260	-.24302	.76486**
Seed yield V/S number of spikelets spike $^{-1}$	.66259**	.69631**	.67375**
Seed yield V/S spike length (cm)	.55632**	.46786**	.51705**
Seed yield V/S days to maturity	-.51405**	-.54509**	-.54639**
Seed yield V/S canopy temperature depression ^{0}C	.39484*	.39361*	.39735*

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