Effect of different seed priming techniques on germination and yield of wheat at different sowing dates

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ABSTRACT
A field experiment for 3 consecutive years was conducted at Adaptive Research Farm, Sheikhupura during Rabi (2016-17, 2017-18 and 2018-19) to mitigate the yield reduction in wheat due to late sowing through the application of different priming materials. The experiment comprised the different priming materials including (control, hydro-priming, potassium chloride @2% for 24 hours, Water (20 L) + Compost (5 kg) + Raw Sugar (4 kg) for 08 hours, Water (20 L) + Compost (5 kg) + Raw Sugar (4 kg) + Cow Urine (4 L) for 08 hours and Bacteria Inoculum (Biozote 10 kg per 50 kg wheat seed) for 10 minute applied to early and late sown wheat each year. The experiment was arranged in Randomized complete block design (Split plot) with 03 replications. Data regarding germination count, plant height, number of tillers, 1000-grain weight and grain yield was recorded. The statistical analysis of data revealed that the application of different priming materials for seed treatment significantly enhanced the germination count, number of tillers, 1000-grain weight and the grain yield of wheat. So, it is recommended that in rice wheat cropping system, wheat seed should be sown after treatment with bacterial inoculum or raw sugar and compost to ensure a speedy germination and uniform crop establishment even if the obstacle of late sowing is present. It compensates the yield losses well due to delayed sowing.

Keywords: Priming, biozote, bacterial inoculum, sugar, germinations

INTRODUCTION
Pakistan is primarily an agricultural country growing wheat, rice, cotton and sugar cane as major crops. These crops account for 33% of value added in agriculture, 82% of value added in the crop sector and 7% of GDP. Wheat is the staple food of Pakistan and according to the Ministry of Finance (GOP, 2020) it solely accounts for 8.7% of value added in agriculture and provides 1.7% of the country’s GDP. In Pakistan, wheat is grown on 8.8 million ha that is 39% of total cultivated area of Pakistan. Almost, 80% of the farmers in the country grow wheat every year. Moreover, Pakistan is 7th largest wheat producing country in the world (FAO, 2008) and produces an average of 20 to 24 million tons of wheat annually. National yield of wheat in Pakistan is far less than many other countries of the world (Brown, 2011). Owing to inappropriate variety selection, less seed rate, late sowing, improper sowing method, nutrient deficient soils, water shortage and incidence of disease and pest attack etc. Among all these factors, the sowing time is the most important factor and especially in the rice wheat cropping system due to late harvesting of fine rice varieties (Nakano and Morita, 2009; Kabesh et al., 2009). Any deviation from the normal sowing time causes serious reductions in the final yields of a crop through poor crop establishments. In rice wheat cropping system, particularly after the harvesting of fine rice varieties like super basmati, the time window for sowing of wheat is very narrow. Any delay at that time causes severe reductions in the yield. Moreover, timely sown wheat crop avails a longer crop duration than the late sown. This longer duration provides not only better crop establishment but also higher crop growth opportunities through enhanced leaf area and more number of fertile tillers. When wheat crop is sown late, the first issue being recoded is less germination and poor crop establishment. This set back lasts for the whole season in terms of poor crop growth phase synchronization with the environment, lower plant population and a lesser number of fertile tillers ultimately reducing the crop yield at the end of the growth season.

In addition to it, soils of under developed countries like Pakistan are a heterogeneous media for the plant emergence and growth. They have uneven germination with unbalanced seedling growth and differential growth patterns for even uniform seeds grown together at the same time under the same environmental conditions (Roa and Phillipse, 1993). Different physical techniques like preparing a fine and pulverized seed bed, maintaining proper moisture in the soil and treating the seed or sowing material with some chemical or physical agent to ensure optimum germination are being employed in the world to have a uniform germination of seeds. Any treatment of seed or seeding material with chemical or physical agent is called seed priming. Actual mechanism behind seed priming is controlled hydration in which seeds get an opportunity to imbibe well before radicle protrusion (Bradford, 1986). Seed priming creates such an environment in which a seed can absorb adequate moisture for
accelerating the germination process. The ultimate purpose of seed priming is to enhance the germination, thus reducing the time for germination for mitigating the delayed sowing of the crop (Ashraf and Foolad, 2005). At later stages, it improves the growth and vigor of plant so that plant can thrive best under abnormal conditions (Farooq et al., 2008). It allows metabolic processes necessary for germination to occur prior to germination, hence accelerating the actual germination process. In seed priming, the osmotic pressure and the period for which the seeds are maintained in contact with the membrane are well enough to allow pre-germinative metabolic processes to take place within the seeds up to a level limited to that immediately preceding radicle emergence. Seed priming technique has been practiced in many countries including Pakistan, China and Australia and a large number of associated investigations are in process to evaluate the performance of priming in almost all crops.

A three year study was conducted at Adaptive Research Farm, Sheikhupura on the assumption that in the rice wheat cropping system, the negative effects of the delayed sowing of wheat in terms of poor germination and crop establishment could be minimized using the seed priming technique. It was hypothesized that a primed seed will ensure better germination and a healthier crop establishment than a non-treated seed of wheat even if the former is sown late.

MATERIALS AND METHODS
Site description:
The study was undertaken at Adaptive Research Farm, Sheikhupura, located between latitude 31° – 42° N and longitude 73° – 59° E on the globe having an altitude of 209.57 m from the sea level. The climate falls in moist sub-humid category and the annual precipitation in this area ranges from 250 to 500 mm. Generally, rice-wheat cropping system is adapted by the majority of the farmers in Sheikhupura and neighboring areas. Soil sample taken from a maximum depth of 30 cm (in composite) was analyzed for its physio-chemical characteristics. It was found that the soil was loamy in nature as categorized by the international textural triangle (Moodie et al., 1959) with relative proportion of 14%, 70% and 16% of sand, silt and clay, respectively. The soil had pH 8.4 with 0.07% total nitrogen, 10.4 ppm available P and 204 ppm K, 0.8% organic matter and 10.1% total soluble salts for all three years with ±1-2% variations.

Crop husbandry:
Wheat variety Galaxy-2013 was sown using hand drill with a seed rate of 125 kg ha⁻¹ for all the years. Phosphorous and Potassium @ 101 and 62 kg ha⁻¹ respectively as recommended by Department of Agriculture, Punjab was applied to all experimental units at the time of puddling every year. DAP and SOP were the sources of phosphorous and potassium respectively for the whole period of study. Urea was applied in 3 splits (tillering, beginning of spike formation and flowering stage) in equal doses according to treatment structure to all the experimental units. Nitrogen supplied by DAP was also taken into account while applying the treatments. Urea and DAP purchased from Fauji Fertilizer Limited Pakistan were used as source of nitrogen. The crop was irrigated when needed based upon the crop condition as well as the climatic conditions. In short, irrigation was applied to the crop at all the critical growth stages including the before sowing irrigation, tillering stage, milking stage and grain filling stage. Rest of the agronomic operations like soil preparation and weed management etc. were kept alike for all experimental units every year. Harvesting and threshing was done manually every year from all the experimental units individually.

Experimental Design and Treatments:
Randomized Complete Block Design (split plot arrangement) was employed to investigate the different priming materials (hydro priming, Potassium chloride @2%, cow urine, raw sugar and bacterial inoculum) for early and late sown wheat. The details of treatments are as following;
T₁= Control
T₂= Hydro-Priming for 24 hrs
T₃= Potassium Chloride @ 2% for 24 hrs
T₄= Water (20 L) + Compost (5 kg) + Raw Sugar (4 kg) for 08 hrs
T₅= Water (20 L) + Compost (5 kg) + Raw Sugar (4 kg) + Cow Urine (4 L) for 08 hrs
T₆= Bacteria Inoculum (Biozote 10 kg per 50 kg wheat seed) for 10 minute

Each year, the net plot size was 3.778 m × 3.12 m for each experimental unit. Sowing time was the main plot factor and different priming materials were applied to the sub-plots as per the treatment structure.

Data Collection and Statistical analysis:
Data regarding the germination count was taken just after the completion of germination in each experimental unit. Whereas data regarding different agronomic parameters like plant height at maturity, productive tillers m⁻², number of grain per spike, grain weight index (1000-grain weight) and grain yield was recorded using the standard procedures. The collected data was analysed statistically by employing the Fisher’s analysis of variance technique. The significance of treatment means was tested using least significance difference (LSD) test at 5% probability level (Steel et al., 1997).
RESULTS

Germination Count (m²): Data presented in Table 1 and Fig. 1 shows that the sowing time affected the germination count of wheat each year. However, the significant effect of sowing time was observed during 2016-17 and 2017-18 only (Table 1). During 2018-19 no statistically significant effect of sowing time was observed for germination count of wheat. In general every year, the early sown wheat had higher germination count as compared to late sown wheat (Table 1). Different seed priming materials also significantly enhanced the germination count of wheat every year (Fig-1). Among different materials used for priming, the highest response (194.33, 215.5 and 195.67 m² for 2016-17, 2017-18 and 2018-19, respectively) in terms of germination enhancement was observed with the bacterial inoculum and raw sugar in combination with the cow urine. Only during 2018-19, the raw sugar and cow urine had the poor effect on the germination count (179.33 m²) of wheat. As far as the interaction of sowing times and priming techniques are concerned, the early sown wheat when coupled with the bacterial inoculum or raw sugar and cow urine, showed the highest germination count(217.00, 216.00 and 196.00 m² for 2016-17, 2017-18 and 2018-19, respectively) every year. Moreover, it was interesting to observe that late sown wheat, when treated with these two priming materials, were statistically at par with the control treatment of the early sown wheat every year (Table 1).

Table 1. Effect of different sowing times and priming materials on germination count (m²) of wheat during Rabi (2016-17, 2017-18 and 2018-19)

| Treatments                                      | 2016-17 | 2017-18 | 2018-19 |
|------------------------------------------------|---------|---------|---------|
|                                                 | Early   | Late    | Early   | Late    | Early   | Late    |
| Control                                         | 170.33b*| 145.33f | 213.67b | 206.67c | 185.67  | 185.00  |
| Hydro-Priming for 24 hrs                        | 166.00c | 186.67g | 216.00b | 215.00b | 193.33  | 193.00  |
| Potassium Chloride @ 2% for 24 hrs              | 158.00e | 139.00g | 217.00b | 216.33b | 182.00  | 182.00  |
| Water (20 L) + Compost (5 kg) + Raw Sugar (4 kg) for 08 hrs | 136.67g | 129.33h | 216.00b | 213.67b | 178.33  | 182.67  |
| Water (20 L) + Compost (5 kg) + Raw Sugar (4 kg) + Cow Urine (4 L) for 08 hrs | 162.33d | 147.00f | 221.67a | 215.33b | 183.67  | 175.00  |
| Bacteria Inoculum (Biozote 10 kg per 50 kg wheat seed) for 10 minute | 217.00a | 171.67b | 216.00b | 215.00b | 196.00  | 195.33  |
| Mean                                            | 168.39a*| 145.17b | 216.72a | 213.67b | 186.50  | 185.50  |

LSD (p≤0.05) *Means not sharing the same letter with in an interaction grid or mean row for a year differ from each other at ps0.05

Time (1.912) and time × treatment (3.425)
Time (1.569) and time × treatment (3.449)
Time (NS) and time × treatment (NS)

Fig-1

Fig. 1. Effect of different priming materials on germination count (m²) of wheat during Rabi (2016-17, 2017-18 and 2018-19) The bars for a year having different letters differ from each other at ps0.05
LSD ps0.05 for 2016-17 (2.422), 2017(2.125) and 2018-19 (2.027)
Plant Height (cm):

Data presented in Table-2 and Fig-2 shows that the sowing time affected the plant height only during 2nd year i.e. 2017-18 whereas during 1st and 3rd year 2016-17 & 2018-19, the sowing time had no significant effect on the height of wheat plant. However, the different seed priming materials significantly enhanced the plant height of wheat (Fig-2). The highest plant height (95.83, 109.83 and 91.67 cm for 2016-17, 2017-18 and 2018-19, respectively) was observed with the application of bacterial inoculum and raw sugar in combination with the cow urine (Fig. 2). Whereas the minimum plant height (90.83, 96.67 and 86.50 cm for 2016-17, 2017-18 and 2018-19, respectively) was observed when no seed priming was done (Fig-2). While studying the interaction of seed priming and sowing times, the highest plant height (97.00, 110.67 and 91.00 cm for 2016-17, 2017-18 and 2018-19, respectively) during each year was observed with the application of bacterial inoculum or raw sugar along with the cow urine as priming agent in early sown wheat (Table 2). The priming of the seed with the bacterial inoculum or with the raw sugar each year had higher plant height of late sown wheat as compared to non-primed early sown wheat crop.

Table 2. Effect of different sowing times and priming materials on plant height (cm) of wheat during Rabi (2016-17, 2017-18 and 2018-19)

| Treatments                                      | 2016-17 | 2017-18 | 2018-19 |
|------------------------------------------------|---------|---------|---------|
|                                                 | Early   | Late    | Early   | Late    | Early   | Late    |
| Control                                         | 89.67f* | 92.00def| 98.00f  | 95.33f  | 88.67bc | 88.67bc |
| Hydro-Priming for 24 hrs                         | 91.67ef | 93.00cde| 101.67e | 97.00f  | 84.33a  | 87.00c  |
| Potassium Chloride @ 2% for 24 hrs               | 94.00cd | 92.67cde| 106.67c | 97.33f  | 92.67a  | 91.00ab |
| Water (20 L) + Compost (5 kg) + Raw Sugar (4 kg) for 08 hrs | 94.33cd | 93.67cde| 108.00bc| 102.00c | 91.67a  | 92.00a  |
| Water (20 L) + Compost (5 kg) + Raw Sugar (4 kg) + Cow Urine (4 L) for 08 hrs | 98.67a  | 93.00cde| 111.00a | 104.33de| 92.33a  | 92.00a  |
| Bacteria Inoculum (Biozote 10 kg per 50 kg wheat seed) for 10 minute | 97.00ab | 94.67bc | 110.67ab| 109.00abc| 91.00a  | 92.33a  |
| Mean                                            | 94.22*  | 93.17   | 106.00a | 100.83b | 90.83   | 89.77   |

*LSD (p≤0.05)*

*Means not sharing the same letter with in an interaction grid or mean row for a year differ from each other at p≤0.05

![Fig-2](image)

**Fig-2**

Effect of different priming materials on plant height (cm) of wheat during Rabi (2016-17, 2017-18 and 2018-19)

The bars for a year having different letters differ from each other at ps0.05

LSD ps0.05 for 2016-17 (1.635), 2017(1.901) and 2018-19 (1.344)
Number of tillers (m²):
Data presented in Table 3 and Fig. 3 shows that the sowing times significantly affected the number of tillers of wheat during all the years (Table 3). Every year, the early sown wheat had more number of tillers as compared to the late sown wheat. Different seed priming materials significantly enhanced the number of tillers of wheat every year (Fig. 3). The use of compost and raw sugar alone and in combination with cow urine enhanced the tillering of wheat in both the early and late sown every year. The use of bacterial inoculum also enhanced the tillering of wheat every year. The interaction of sowing times and the priming agents revealed that the tillering was significantly affected by both of them. The maximum number of tillers (389.00, 240.00 and 251.00 m² for 2016-17, 2017-18 and 2018-19, respectively) every year were recorded for the early sown wheat when primed with the compost and raw sugar alone and in combination with cow urine (Fig. 3). It was interesting to record that the late sown wheat when treated with the different priming materials had higher number tillers (365.00, 232.00 and 239.00 m² for 2016-17, 2017-8 and 2018-19, respectively) than the control treatment (203.67, 220.00 and 205.33 m² for 2016-17, 2017-18 and 2018-19, respectively) of the early sown wheat crop (Table 3).

Table 3. Effect of different sowing times and priming materials on number of tillers (m²) of wheat during Rabi (2016-17, 2017-18 and 2018-19)

| Treatments                                                                 | 2016-17 | 2017-18 | 2018-19 |
|---------------------------------------------------------------------------|---------|---------|---------|
|                                                                           | Early   | Late    | Early   | Late    | Early   | Late    |
| Control                                                                   | 203.67k*| 195.00l | 220.00g | 215.67h | 205.33h | 203.00h |
| Hydro-Priming for 24 hrs                                                  | 233.00i | 215.00j | 229.00c | 218.67g | 231.00f | 209.33g |
| Potassium Chloride @ 2% for 24 hrs                                        | 272.33g | 250.33h | 228.00e | 224.00f | 237.67d | 234.00ef|
| Water (20 L) + Compost (5 kg) + Raw Sugar (4 kg) for 08 hrs               | 382.33b | 305.00e | 237.00c | 227.00e | 242.67c | 232.00f |
| Water (20 L) + Compost (5 kg) + Raw Sugar (4 kg) + Cow Urine (4 L) for 08 hrs | 389.00a | 365.00c | 240.33b | 232.00d | 251.67b | 239.00d |
| Bacteria Inoculum (Biozote 10 kg per 50 kg wheat seed) for 10 minute      | 310.33d | 285.00f | 245.00a | 237.67bc| 258.00a | 236.00d |
| Mean                                                                      | 298.44a*| 269.22b | 233.22a | 225.83b | 237.72a | 225.565b|

LSD (p≤0.05)
*Means not sharing the same letter with in an interaction grid or mean row for a year differ from each other at ps0.05
Time (4.084) and time × treatment (5.254)
Time (0.898) and time × treatment (2.7354)
Time (1.434) and time × treatment (3.221)

Fig. 3. Effect of different priming materials on number of tillers (m²) of wheat during Rabi (2016-17, 2017-18 and 2018-19)
The bars for a year having different letters differ from each other at ps0.05
LSD ps0.05 for 2016-17 (2.939), 2017(2.251) and 2018-19 (2.301)
1000-grain weight (g):
Data presented in Table 4 shows that the sowing times significantly affected the grain weight of wheat during all 3 years. Every year, the early sown wheat had higher 1000-grain weight as compared to the late sown wheat (Table 4). Different seed priming materials also affected the 1000-grain weight of wheat during both the early and late sown wheat crop (Fig. 4). The use of compost+ raw sugar and cow urine had the highest 1000-grain weight every year. The minimum 1000-grain weight (38.20 and 36.67 for 1st year, 40.30 & 39.20 for 2nd year and 31.07 and 30.23 for 3rd year) in both the early and late sown wheat respectively was observed when no seed treatment was done (Fig-4). The interaction study of sowing times and the different priming agents showed that the application of priming for late sown wheat could compensate for the time gap as compared to the early sown wheat (Fig-4).

Table 4. Effect of different sowing times and priming materials on 1000-grain weight (g) of wheat during Rabi (2016-17, 2017-18 and 2018-19)

| Treatments                                                   | 2016-17       | 2017-18      | 2018-19      |
|--------------------------------------------------------------|--------------|--------------|--------------|
|                                                              | Early        | Late         | Early        | Late         | Early        | Late         |
| Control                                                     | 38.20bc*     | 36.67de      | 40.30cdef    | 39.20f       | 31.07bc      | 30.23c       |
| Hydro-Priming for 24 hrs                                     | 38.73bc      | 37.60cd      | 41.00abcd    | 39.00f       | 32.03ab      | 31.23bc      |
| Potassium Chloride @ 2% for 24 hrs                           | 39.70ab      | 35.87e       | 41.57abc     | 39.60ef      | 33.53a       | 31.23bc      |
| Water (20 L) + Compost (5 kg) + Raw Sugar (4 kg) for 08 hrs  | 39.10b       | 38.23bc      | 41.70ab      | 40.07def     | 32.07ab      | 32.07ab      |
| Water (20 L) + Compost (5 kg) + Raw Sugar (4 kg) + Cow Urine (4 L) for 08 hrs | 40.93a       | 39.63ab      | 42.23a       | 40.07def     | 32.30ab      | 31.20bc      |
| Bacteria Inoculum (Biozote 10 kg per 50 kg wheat seed) for 10 minute | 40.70a       | 38.73bc      | 41.83ab      | 40.80bcde    | 33.00a       | 32.37ab      |
| Mean                                                        | 39.56a*      | 37.79b       | 41.42a       | 39.79b       | 32.33a       | 31.22b       |
| LSD (p≤0.05) *Means not sharing the same letter with in an interaction grid or mean row for a year differ from each other at ps0.05 |              |              |              |              |              |              |

Fig-4

Grain yield (t ha\(^{-1}\)):
Data presented in Table 5 and Fig. 5 revealed that the sowing time of wheat significantly affected the grain yield of wheat every year. The early sown wheat every year had a higher yield as compared to the late sown wheat crop. The priming agents also enhanced the yield of wheat every year. The highest yield was recorded with the application of bacterial inoculum or the compost
in combination with the raw sugar and the cow urine (Fig-5). As for the interaction is concerned the highest yield (2.6, 3.673 and 3.317 for 1\textsuperscript{st}, 2\textsuperscript{nd} and 3\textsuperscript{rd} year, respectively) was recorded in early sown wheat with the application of bacterial inoculum. It was also observed that the application of priming materials for late sown wheat compensated the yield when compared with the non-primed early sown wheat (Table 5).

**Table 5.** Effect of different sowing times and priming materials on grain yield (t ha\textsuperscript{-1}) of wheat during Rabi (2016-17, 2017-18 and 2018-19)

| Treatments                                                                 | 2016-17   | 2017-18   | 2018-19   |
|----------------------------------------------------------------------------|-----------|-----------|-----------|
|                                                                            | Early     | Late      | Early     | Late      | Early     | Late      |
| Control                                                                    | 2.010h*   | 1.930i    | 3.030g    | 2.750i    | 2.977h    | 2.937i    |
| Hydro-Priming for 24 hrs                                                  | 2.200d    | 2.100f    | 3.153f    | 2.950h    | 3.123fg   | 3.120g    |
| Potassium Chloride @ 2% for 24 hrs                                        | 2.430b    | 2.300c    | 3.220e    | 3.160f    | 3.203cd   | 3.153ef   |
| Water (20 L) + Compost (5 kg) + Raw Sugar (4 kg) for 08 hrs               | 2.270c    | 2.100f    | 3.447c    | 3.200e    | 3.227c    | 3.170de   |
| Water (20 L) + Compost (5 kg) + Raw Sugar (4 kg) + Cow Urine (4 L) for 08 hrs | 2.150e    | 2.050g    | 3.597b    | 3.317d    | 3.277b    | 3.160e    |
| Bacteria Inoculum (Biozote 10 kg per 50 kg wheat seed) for 10 minute      | 2.600a    | 2.410b    | 3.673a    | 3.457c    | 3.203cd   | 3.173de   |
| Mean                                                                       | 2.277a*   | 2.148b    | 3.353a    | 3.139b    | 3.187a    | 3.119b    |
| LSD (p≤0.05)                                                               |           |           |           |           |           |           |
| *Means not sharing the same letter with in an interaction grid or mean row for a year differ from each other at ps0.05 | Time (0.0149) and time × treatment (0.0351) | Time (0.0204) and time × treatment (0.0348) | Time (0.0219) and time × treatment (0.0359) |

DISCUSSION

Now a day the exogenous application of plant growth regulators is receiving worldwide attention of the people (Golubkina et al., 2018). These plant growth regulators can be used in many different ways for increasing the crop yields. When they are used as priming agents, they accelerate the early crop growth processes specially the germination of the seeds (Mehboob et al., 2017).

The increased rate of germination in treatments where the priming agents were used may be due to better imbibition process that caused the seed coat to rupture easily and hence and associated enzymes were activated owing to priming agent (Jena et al., 2016). Moreover, it was also revealed that priming agent produce germination metabolites at faster rate subsequently causing early emergence of field crop (Basra et al., 2005). Our study is quite in line with those of Zheng et al. (2016) and Khan et
al. (2019) both clearly stated that seed priming improves emergence and vigour of seedling. Actually, priming initiates a series of biochemical reactions that triggers the pre-germination process. This series of reactions include hydrolysis, imbibition and activation of enzymes (Ajouri et al., 2004). Treatment of wheat seed with ascorbic acid before sowing enhanced the emergence and viability of seed (Dolatabadian and Modarresanavy, 2008). So, application of any suitable seed priming agent, enhances the rate of germination, viability of seedling and its vigor. Moreover, it also reduces the total time for germination (Rowse, 1995) hence, speeding up the process of germination. The difference in emergence rate for different years could be due to climatic difference among the years (Jokhan et al., 2011). Moreover, during the 2016-17, there was high temperature at the time of grain formation that promoted the rust attack on crop at the national level and it was enhanced by rain near the crop maturity stage. It could be taken as a reason of lower crop yield and all the associated parameters during the year 2016-17.

Tillers are the result of final germination percentage. In late sown conditions, the plants have a shorter life span with lesser number of germinated plants (Farooq et al., 2008; Yu et al., 2003). Due to shorter life span, there is always a high risk of heat induced losses at the reproductive stage (Wang et al., 2008). So, in late sown crop, there are few tillers per unit area, lower height of plants and consequently low final yield. There is an evidence by Akhtar et al., (2006) that, if a crop is sown late, there is environmental non-synchronization at tillering stage that leads to poor tiller development in wheat. So, plant can adapt itself to any harsh or abnormal conditions (Torres et al., 2006). Moreover, it also caused deterioration in the crop quality (Liu et al., 2010; Sattar et al., 2010).

Plant height is the product of prevailing climatic conditions, genetic makeup of plant and available resources. When the climate is unfavourable or non-synchronized with crop growth stage due to late sowing, it results into dwarf plants. The application of different priming materials might have increased the accumulation of osmotic enzymes and promoted the anti-oxidant activity to alleviate the complex of stresses imposed by the late sowing. It resulted in enhancing the height of wheat plant (Chen et al., 2013). It is also well documented that the hydro-priming enhances the gene expression and transcription factor for iso-enzymes in wheat, improves anti-oxidant activity, accelerates the carbohydrate and nitrogen metabolism and improves the cell development (Hussain et al., 2016).

Different priming agents, specially ascorbic acid and hydrogen peroxide positively affect the stay green qualities of crops, thus increasing leaf area duration to capture more sunlight (Keskiliato et al., 2005). Seed priming agents also improves the root growth in plants leading towards better uptake of water and nutrient uptake through enhanced synthesis of gibberellins, auxins and cytokinins while a significant reduction in ethylene production also occurred due to priming agent (keskiliato et al., 2005). In addition, late sowing of wheat is always subjected to variable temperate regimes that extra-accelerate the crop development thus less solar radiation are being used by crop plant resulting in reduced final yield (Namakka et al., 2008).

CONCLUSION
From current study, it can be concluded that the treatment of wheat seed with the bacterial inoculum or the compost and raw sugar can significantly enhance the germination count, number of tillers, plant height, 1000-grain weight and the yield of wheat. Moreover, if wheat crop is sown late, the seed treatment with some priming agents can enhance the yield of wheat to compensate the yield losses due to delayed sowing.

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تأثير تقنيات تحضير البذور المختلفة على إنبات وحاصل القمح في مواعيد البذر المختلفة

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الملخص العربي

أجريت تجربة حقلية لمدة 3 سنوات متتالية في مزرعة البحوث التكيفية، شيخوبورا خلال ربيع (2016-2017 و 2017-2018 و 2018-2019) للتخفيف من انخفاض محصول القمح بسبب البذر المتأخر من خلال تطبيق مواد فتيلة مختلفة. اشتملت التجربة على مواد أولية مختلفة منها (التحكم، التحضير المائي، كلوريد البوتاسيوم بنسبة 2٪ لمدة 24 ساعة، ماء (20 لتر) + كومبوست (5 كجم) + سكر خام (4 كجم) لمدة 08 ساعة وفاج بكتريا Biozote 10 كجم لكل 50 كجم من بذور القمح) لمدة 10 دقائق تتم تطبيقها على القمح المزروع مبكرًا ومتأخرًا كل عام. تم ترتيب التحليجي في تصميم القطاعات العشوائية الكاملة (قطعة الأرض المنقسمة) مع 03 مكررات. تتألف القسائم الرئيسية من فترتين بذر مختلفة thôngي القمح الذي تم زرعه في 10 نوفمبر و 10 ديسمبر من كل عام، بينما احتوت القطاعات الفرعية على المواد الأولية المختلفة المستخدمة في معاملة بذور القمح. تم تسجيل بيانات عن عدد النباتات، ارتفاع النباتات، عدد الحراشات، عدد حبوب في السبلة، وزن الآلف حبة وحاصل الحبوب. أظهر التحليل الإحصائي للبيانات أن تطبيق مواد أولية مختلفة للبذور عزز العلاج بشكل كبير الجرثومة عدد الحبات، عدد الحراشات، عدد الحبوب في السبلة، وزن الآلف حبة ومحصول حبوب القمح. لذلك، يوصى بزراعة بذور القمح بعد المعالجة باللقاح البكتيري أو السكر الخام والسماد العضوي لضمان إنبات سريع وتكون محصول موحد حتى في حالة وجود عقبة البذر المتأخر. إنه يعود خسائر الغلة بشكل جيد بسبب تأخر البذر.

الكلمات المفتاحية: تقنيات تحضير البذور، اللقاح البكتيري، نسبة النباتات، إنبات القمح