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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, germentions

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 Philipse, 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 under taken 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;

T_1= Control
T_2= Hydro-Priming for 24 hrs
T_3= Potassium Chloride @ 2% for 24 hrs
T_4= Water (20 L) + Compost (5 kg) + Raw Sugar (4 kg) for 08 hrs
T_5= Water (20 L) + Compost (5 kg) + Raw Sugar (4 kg) + Cow Urine (4 L) for 08 hrs
T_6= 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 times 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 m^{-2} 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 m^{-2}) of wheat. As for 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 m^{-2} 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 (m^{-2}) 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 p≤0.05**	Time (1.912) and time × treatment (3.425)		Time (1.569) and time × treatment (3.449)		Time (NS) and time × treatment (NS)	

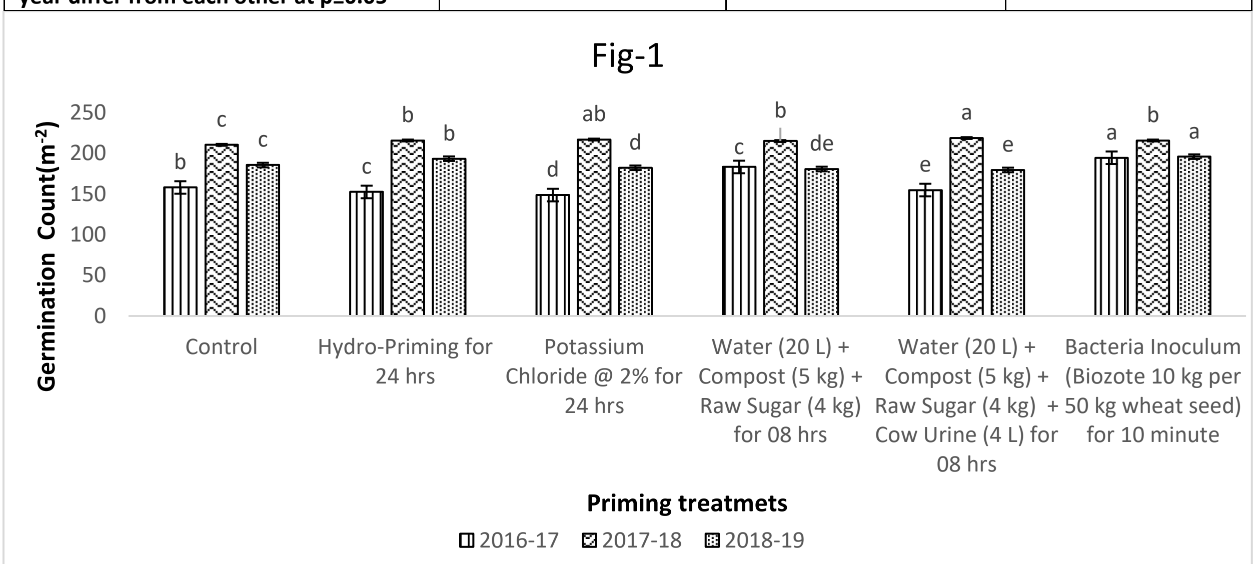

Fig. 1. Effect of different priming materials on germination count (m^{-2}) of wheat during Rabi (2016-17, 2017-18 and 2018-19)
The bars for a year having different letters differ from each other at p≤0.05
LSD p≤0.05 for 2016-17 (2.422), 2017(2.125) and 2018-19 (2.027)

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. 106.00 cm (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	106.67cd	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**	Time (NS) and time × treatment (2.670)		Time (1.216) and time × treatment (2.837)		Time (NS) and time × treatment (2.770)	

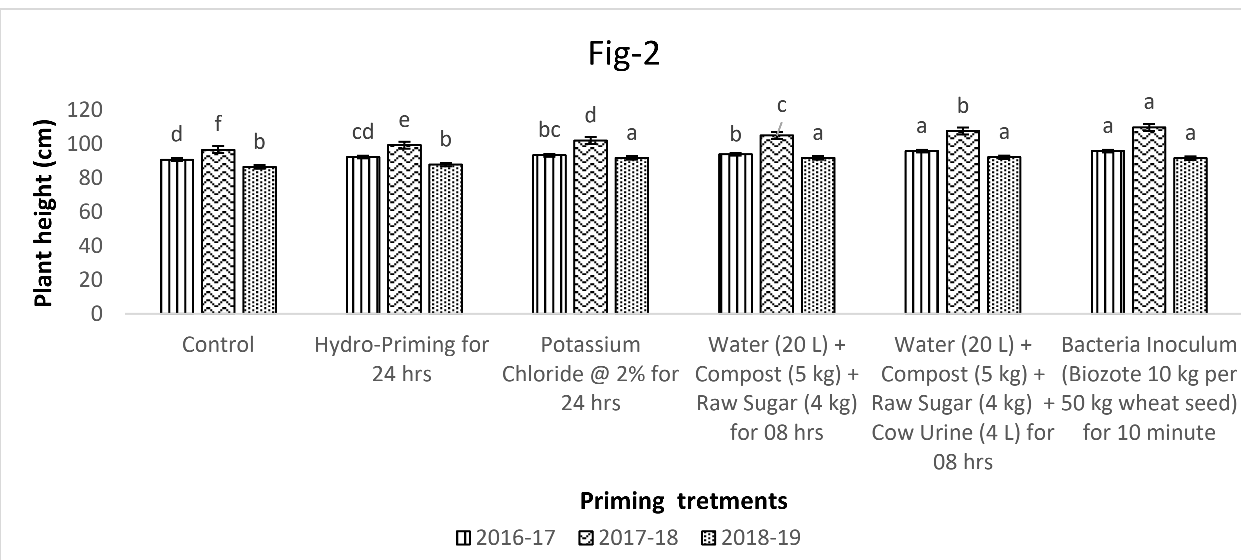

Fig. 2. Effect of different priming materials on plant height (cm) of wheat during Rabi (2016-17, 2017-18 and 2018-19)
The bars for a year having different letters differ from each other at p≤0.05
LSD p≤0.05 for 2016-17 (1.635), 2017(1.901) and 2018-19 (1.344)

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 m^{-2} 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 m^{-2} for 2016-17, 2017-8 and 2018-19, respectively) than the control treatment (203.67, 220.00 and 205.33 m^{-2} 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 p≤0.05**	Time (4.084) and time × treatment (5.254)		Time (0.898) and time × treatment (2.7354)		Time (1.434) and time × treatment (3.221)	

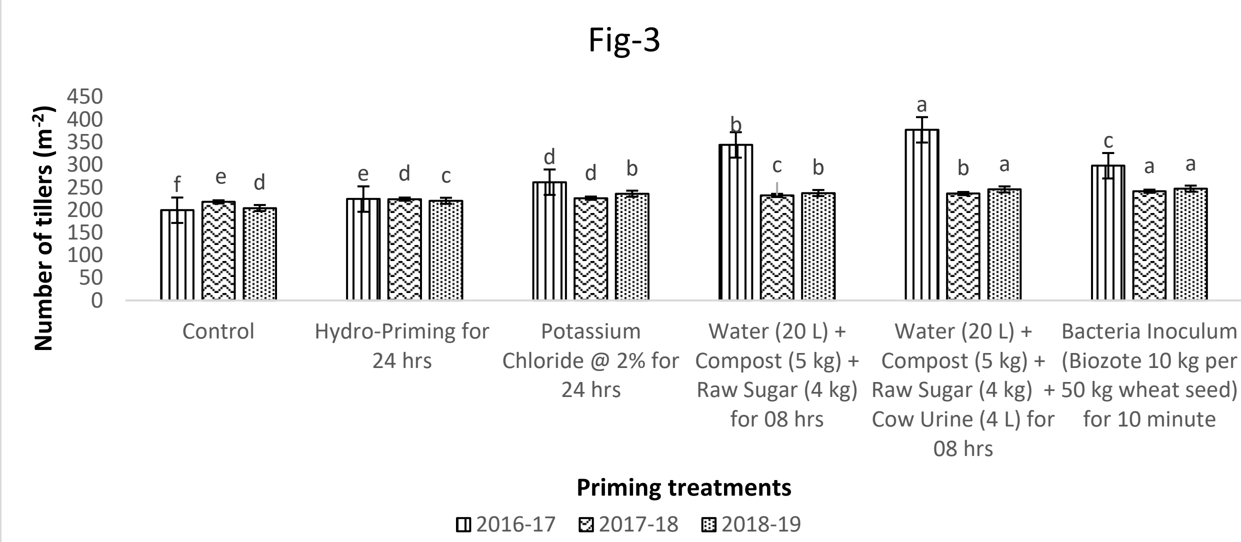

Fig. 3. Effect of different priming materials on number of tillers (m^{-2}) of wheat during Rabi (2016-17, 2017-18 and 2018-19)
The bars for a year having different letters differ from each other at p≤0.05
LSD p≤0.05 for 2016-17 (2.939), 2017(2.251) and 2018-19 (2.301)

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 wheat 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 p≤0.05**	Time (0.623) and time × treatment (1.497)		Time (0.580) and time × treatment (1.366)		Time (0.846) and time × treatment (1.595)	

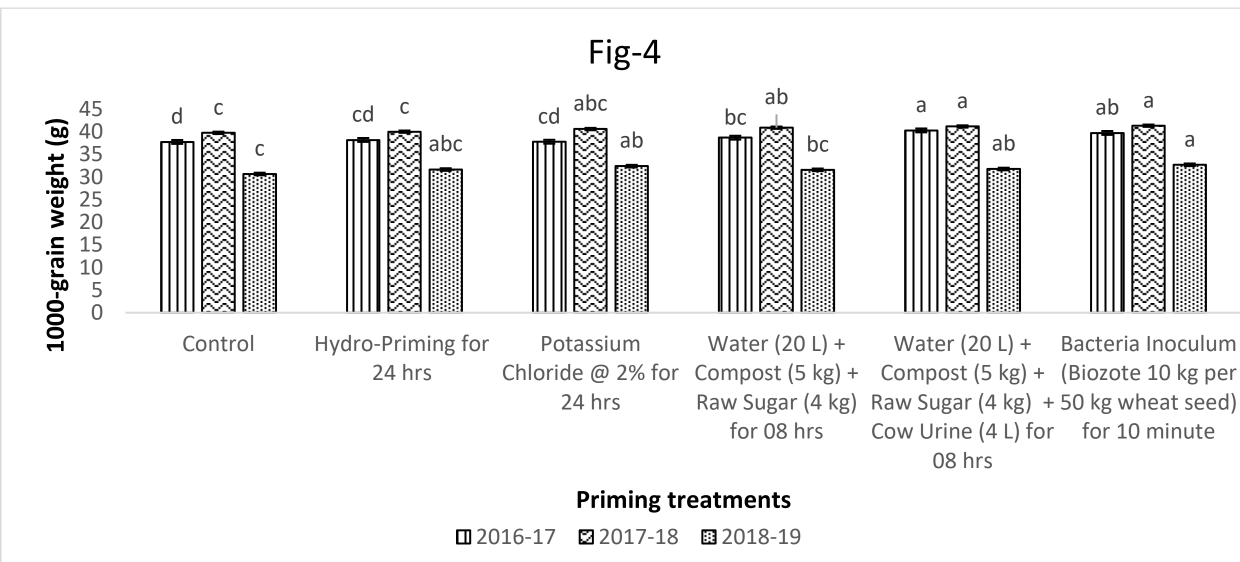

Fig. 5. Effect of different priming materials on 1000-grain weight (g) of wheat during Rabi (2016-17, 2017-18 and 2018-19)
The bars for a year having different letters differ from each other at p≤0.05
LSD p≤0.05 for 2016-17 (1.082), 2017(0.926) and 2018-19 (1.097)

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 1st, 2nd and 3rd 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^{-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	3.317a	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 p≤0.05**	Time (0.0149) and time × treatment (0.0351)		Time (0.0204) and time × treatment (0.0348)		Time (0.0219) and time × treatment (0.0359)	

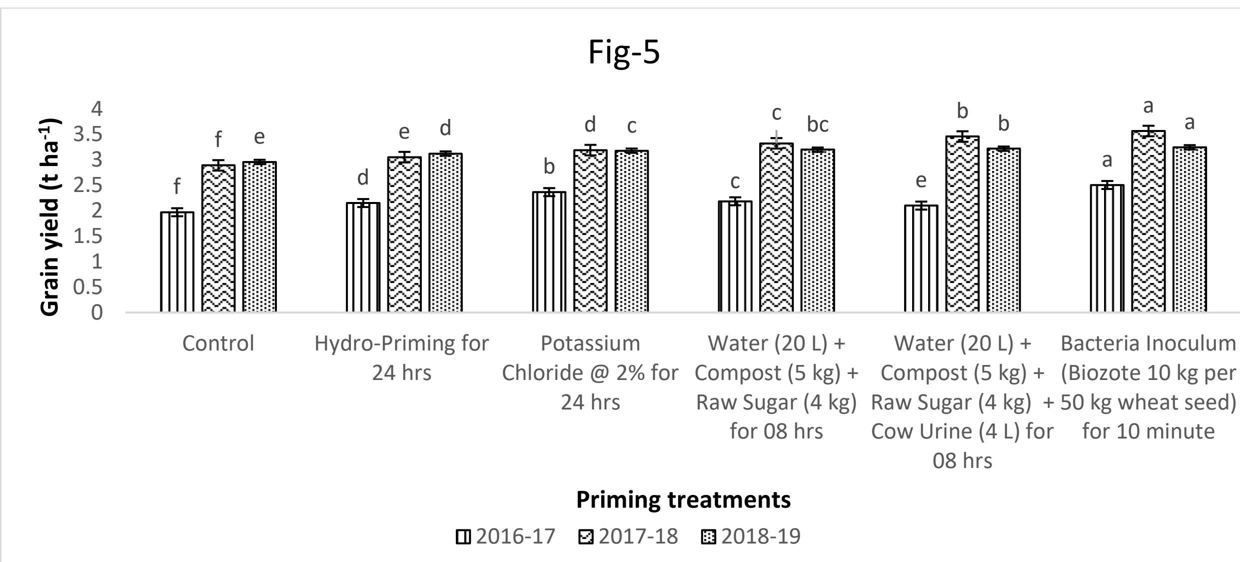

Fig-6: Effect of different priming materials on grain yield (t ha^{-1}) of wheat during Rabi (2016-17, 2017-18 and 2018-19)
The bars for a year having different letters differ from each other at p≤0.05
LSD p≤0.05 for 2016-17 (0.0231), 2017(0.0231) and 2018-19 (0.0235)

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 (Dolatabodian 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 (Keskilato *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 (kesiklato *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 2017-18 و 2018-19) 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 ، ماء (20 لتر)) + سماد (5 كجم) + سكر خام (4 كجم) + بول بقري (4 لتر) لمدة 08 ساعة وقاح بكتريا (Biozote 10 كجم لكل 50 كجم من بذور القمح) لمدة 10 دقائق يتم تطبيقها على القمح المزروع مبكرًا ومتأخرًا كل عام. تم ترتيب التجربة في تصميم القطاعات العشوائية الكاملة (قطعة الأرض المنقسمة) مع 03 مكررات. تتألف القسائم الرئيسية من فترتي بذر مختلفتين أي القمح الذي تم زرعه في 10 نوفمبر و 10 ديسمبر من كل عام ، بينما احتوت القطع الفرعية على المواد الأولية المختلفة المستخدمة في معاملة بذور القمح.تم تسجيل بيانات عن عدد الإنبات ، ارتفاع النبات ، عدد الحراثة ، عدد الحبوب في السنبلة ، وزن الألف حبة وحاصل الحبوب. أظهر التحليل الإحصائي للبيانات أن تطبيق مواد أولية مختلفة للبذور عزز العلاج بشكل كبير الجرثومة عدد الحبات ، عدد الحراثة ، عدد الحبوب في السنبلة ، وزن الألف حبة ومحصول حبوب القمح. لذلك ، يوصى في نظام محصول قمح الأرز بزراعة بذور القمح بعد المعالجة باللقاح البكتيري أو السكر الخام والسماد العضوي لضمان إنبات سريع وتكوين محصول موحد حتى في حالة وجود عقبة البذر المتأخر. إنه يعوض خسائر الغلة بشكل جيد بسبب تأخر البذر.

الكلمات المفتاحية : تقنيات تحضير البذور ، اللقاح البكتيري، نسبة الانبات