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# PRE-SOWING AERATED AND NON-AERATED HYDRATION TREATMENTS FOR IMPROVED FIELD PERFORMANCE OF WHEAT

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## SUMMARY

**Pre-sowing hydration of wheat (*Triticum aestivum* L.) seeds (high-medium vigour) for 6-8h with or without aeration significantly improved field emergence and yield of the crop per unit area over untreated control. Prolonged soaking showed adverse effect on germinability, field performance and productivity. A marginal beneficial effect on yield and yield attributes was noted in the aerated hydration treatment for 6-8h over the non-aerated hydration treatment (6-8h). Among the aerated hydration treatment, 8-12h proved more effective in improving field performance and productivity. The efficacy of aeration (oxygen) on field emergence and yield was more prominent in the long-term soaking duration (24-72h) but never surpassed the value of short-term (6-8h) non-aerated hydration. It may be pointed out that if the storage conditions are reasonably good then short-term pre-sowing hydration for 6-8h with or without aeration followed by light air-drying to facilitate sowing in the field may be suggested for the improvement of crop performances.**

***Key words:*** **Aerated, germinability, hydration, pre-sowing, productivity, wheat**

## INTRODUCTION

In eastern India, storage of wheat (*Triticum aestivum* L.) under warm-humid conditions is a serious problem. High atmospheric humidity coupled with prevailing high temperatures during a major part of the seed storage period greatly hastens seed ageing. Mid-storage hydration-dehydration treatments are very effective for the maintenance of vigour and viability (Basu 1976, 1994, Mandal and Basu 1983). But hydration-dehydration treatment of large seed stocks has one disadvantage in terms of drying back to the original moisture content, which is essential for restorage of the seed until the sowing time. In such a situation, pre-sowing water soaking treatment of stored seed, which does not require thorough drying back, may help our farmers to get better field stand. Heydecker and Coolbear (1977) made an extensive survey of the work on pre-sowing wetting-drying treatments and concluded that the seeds could be invigorated successfully for improving seedling vigour and better crop stand. The literature on pre-sowing treatments have shown that pre-sowing soaking of seed in water for 6-8h at room temperature (28±1°C) is effective in improving field performance and productivity of several agricultural crop seeds (Roy 1982, Chatterjee and Singh 1983, Mandal and Basu 1987). The beneficial effects of pre-sowing treatment on grain yield of wheat has also been reported by Falkenstein and Steiner (1985).

In pre-sowing treatment, normally longer soaking durations (6-8 h or more) are practised to improve field performance than in short-term (2-4h) soaking for the

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viability maintenance in mid-term treatments. But with longer durations, there is a possibility that oxygen tension may occur during prolonged soaking. Therefore, addition of oxygen (supply of fresh air by aeration) to the water during imbibition of seed may further improve field performance and productivity. With the aforesaid background in view, aerated hydration treatments were taken up to evaluate the treatment effects on yield and other yield attributes.

## MATERIALS AND METHODS

Harvest-fresh wheat (cv. Sonalika) seeds were collected from the Agricultural Experimental Farm of Calcutta University at Baruipur, 24-Parganas (South), West Bengal. Seeds were cleaned and thoroughly dried in the sun for 4-5 days to a moisture content of 9.5% and then stored in 2.5 litre-capacity rubber-stoppered glass bottles in the laboratory under ambient conditions (73.8±2.9% RH and 30.4±0.5ºC temperature for 8 months) till sowing in the field.

Pre-sowing treatments were given to 8-month-old seeds (prior to sowing in the field) which were stored in the rubber stoppered glass bottles under ambient conditions. Seeds were soaked in double volume of water for 4, 6, 8, 12, 16, 24, 36, 48 and 72h respectively at room temperature (28±1ºC). Similarly, another set of soaking treatments (with same soaking duration as before) were done with continuous aeration. The aeration (supply of fresh air) during soaking of seed was done artificially by an aerator. The objective was to reduce oxygen tension during prolonged hydration of seed. After the stipulated periods, in both the cases, water was decanted off and seeds were lightly air-dried to facilitate sowing in the field. The control seeds were not soaked but air-dried along with the treated seeds. Immediately after treatment, treated and untreated seeds were placed for germination as a pre-sowing germination test following the method of Punjabi and Basu (1982) with minor modifications. Data were recorded after 5 days of germination at 23±1.5ºC.

Field experiment was carried out in three consecutive year during *Rabi* season (October-November to April-May) at the Agricultural Experimental Farm of Calcutta University, using completely randomised block design with 3 replications for each treatment. The plot was divided into 3 blocks and each block contained 10 subplots, each measuring 10 sqm (4m×2.5m) in size. Seeds were sown at the rate 100kg/ha giving a space of 25 cm between the two rows. Fertilizer at the rate of 100 kg nitrogen, 40 kg phosphorus, 40 kg potassium per hectare was applied. During final land preparation, 50% of the total nitrogen and entire amount of phosphorus and potassium were added, the rest of the nitrogen was supplied in two equal split doses, one at crown root initiation stage and another at the peak tillering stage. A post-sowing irrigation was made on the same date. Except post-sowing irrigation, three more irrigations were given to the crop; one each at crown root initiation stage, peak tillering stage and grain filling stage. Besides, normal cultural practices were done throughout the cropping period. Data on plant population were recorded after 15 days of sowing. Number of effective tillers and height of plants were recorded at the grain filling stage. After harvest, data on grain yield per plot and other yield attributes were recorded replication-wise for each treatment.

## RESULTS AND DISCUSSION

Data on germination percentage (arc-sin transformation of germination percentage values) immediately after soaking treatment are presented in Table 1. Non-aerated soaking (without supply of air) for 6 and 8h showed significant improvement on germination percentage over control. But prolonged non-aerated soaking (24, 36, 48 and 72h) showed adverse effect on germination percentage (Table 1). Aerated hydration (soaking in presence of fresh air) treatment for 12h and 16h were effective in improving germinability over control (Table 1). Aerated soaking for long durations (36, 48 and 72h) showed adverse effect on germination percentage compared to the untreated control. But the long duration aerated soaking for 36, 48 and 72h showed better germinability than the non-aerated long duration soaking for 36, 48 and 72h (Table 1). Long duration aerated soaking, especially 12 and 16h, showed greater improvement on germination percentage over 12 and 16h non-aerated soaking. In general, long duration aerated hydration treatment was significantly better than long

**Table 1.** Effect of pre-sowing hydration treatments of stored seeds of wheat (cv. Sonalika) on the germination percentage (arc-sin transformations of germination percentage value).

| Duration of hydration (h) | Mode of hydration treatment | | Mean |
|---|---|---|---|
| | Non-aerated | Aerated | |
| 0 (Control) | 71.6 | 69.7 | 70.6 |
| 4 | 69.7 | 67.2 | 68.4 |
| 6 | 78.5 | 78.5 | 78.5 |
| 8 | 77.1 | 75.8 | 76.4 |
| 12 | 75.8 | 81.9 | 78.8 |
| 16 | 71.6 | 81.9 | 76.7 |
| 24 | 68.0 | 71.6 | 69.8 |
| 36 | 47.9 | 54.3 | 51.1 |
| 48 | 40.9 | 51.9 | 46.4 |
| 72 | 30.0 | 50.8 | 40.4 |
| Mean | 63.1 | 68.4 | - |
| **L.S.D. values for mean effects** | **Probability level** | | |
| | **0.05P** | **0.01P** | |
| Duration of hydration | 4.5 | 6.0 | |
| Mode of hydration treatments | 2.0 | NS | |
| Interaction | 6.4 | 8.6 | |

After harvest, seeds were stored in rubber stoppered glass bottle under ambient conditions for 8 months.

Pre-sowing hydration treatments were done with and without aeration prior to sowing in the field.

Data were recorded after 5 days of germination at 23±1.5ºC temperature.

NS=Not significant.

duration non-aerated hydration for the enhancement of germination. Similar trends of results were obtained in seedling length as measured by root and shoot length (Table 2).

Both aerated and non-aerated hydration (soaking) of seeds for 6 and 8h showed higher field emergence per unit area over untreated control (Table 3). But long duration non-aerated soaking (36, 48 and 72h) showed adverse effect on field emergence per unit area. The

**Table 2.** Effect of pre-sowing hydration treatments of stored seeds of wheat (cv. Sonalika) on seedling length (mm).

| Duration of hydration (h) | Mode of hydration treatment | | Mean |
|---|---|---|---|
| | Non-aerated | Aerated | |
| 0 (Control) | 252 | 248 | 250 |
| 4 | 292 | 270 | 281 |
| 6 | 282 | 287 | 284 |
| 8 | 300 | 285 | 292 |
| 12 | 266 | 297 | 281 |
| 16 | 237 | 275 | 256 |
| 24 | 229 | 267 | 248 |
| 36 | 197 | 223 | 210 |
| 48 | 151 | 187 | 169 |
| 72 | 131 | 167 | 149 |
| Mean | 234 | 251 | - |
| **L.S.D. values for mean effects** | **Probability level** | | |
| | **0.05P** | **0.01P** | |
| Duration of hydration | 12 | 17 | |
| Mode of hydration treatments | 6 | NS | |
| Interaction | 18 | 24 | |

The details are same as Table 1.

plant population per unit area was maximum in the 8h aerated hydration treatment than the other aerated and non-aerated hydration treatments (Table 3). Aerated hydration showed better field emergence than non-aerated hydration, specially in case of longer durations (24, 36, 48 and 72h) of soaking. But in short duration, aerated hydration showed only marginal improvement on plant population per unit area than non-aerated hydration (Table 3). Grain yield per unit area was significantly higher in the pre-sowing aerated and non-aerated hydration treatments for 6-12h than untreated control (Table 4). Aerated hydration treatments showed higher yield per unit area than non-aerated hydration treatment especially in case of prolonged soaking durations. But in short duration soaking, this difference was virtually marginal. Among the aerated hydration treatment, 8h showed better results in improving grain yield per unit area (Table 4). The usually stable character like 1000-

**Table 3.** Effect of pre-sowing hydration treatments of stored seeds of wheat (cv. Sonalika) on field emergence (per $m^2$).

| Duration of hydration (h) | Mode of hydration treatment | | Mean |
|---|---|---|---|
| | Non-aerated | Aerated | |
| 0 (Control | 158 | 153 | 155 |
| 4 | 155 | 161 | 158 |
| 6 | 197 | 195 | 196 |
| 8 | 167 | 202 | 184 |
| 12 | 162 | 186 | 174 |
| 16 | 176 | 179 | 177 |
| 24 | 167 | 183 | 175 |
| 36 | 114 | 174 | 144 |
| 48 | 47 | 165 | 106 |
| 72 | 16 | 154 | 85 |
| Mean | 136 | 175 | - |

| L.S.D. values for mean effects | Probability level | |
|---|---|---|
| | 0.05P | 0.01P |
| Duration of hydration | 21 | 28 |
| Mode of hydration treatments | 9 | 12 |
| Interaction | 29 | 39 |

After hydration, seeds were lightly air-dried to facilitate sowing in the field.

Other details are same as Table 1.

**Table 4.** Effect of pre-sowing hydration treatments of stored seeds of wheat (cv. Sonalika) on grain yield (g $m^{-2}$).

| Duration of hydration (h) | Mode of hydration treatment | | Mean |
|---|---|---|---|
| | Non-aerated | Aerated | |
| 0 (Control) | 223 | 222 | 222 |
| 4 | 229 | 224 | 226 |
| 6 | 247 | 243 | 245 |
| 8 | 236 | 257 | 246 |
| 12 | 214 | 253 | 233 |
| 16 | 211 | 244 | 227 |
| 24 | 209 | 224 | 216 |
| 36 | 189 | 214 | 201 |
| 48 | 109 | 211 | 160 |
| 72 | 65 | 162 | 113 |
| Mean | 193 | 225 | - |

| L.S.D. values for mean effects | Probability level | |
|---|---|---|
| | 0.05P | 0.01P |
| Duration of hydration | 9 | 14 |
| Mode of hydration treatments | 4 | 6 |
| Interaction | 13 | 19 |

Other details are same as Table 1 and 3.

seed weight also increased in the 6-12h pre-sowing aerated and non-aerated hydration treatment than the untreated control (Table 5). There was, however, no significant difference between short duration aerated and non-aerated hydration in improving 1000-seed weight. But long duration aerated hydration showed better results in improving 1000-seed weight over long duration non-aerated hydration. Among the aerated hydration treatments, 8h proved better in improving 1000-seed weight than the other durations.

The beneficial effects of pre-sowing treatments have been suggested to be associated with the formation of more high energy compounds, increased DNA in the growing points, less active ribonuclease activity and active protein synthesis, higher mitochondrial activity and better preservation of cellular ultrastructure with allied sequential changes in the elasticity and viscosity of the protoplasm (Henckel 1972). Studies in the present laboratory (Basu and Dasgupta 1974, Mandal and Basu 1982) and those of several other workers (Roy 1982, Goldsworthy *et al.* 1982) suggested that the beneficial effects of short duration pre-sowing water soaking treatment improve the crop productivity. Falkenstein and Steiner (1985) also noted beneficial effect of some presprouting treatments on grain yield of winter and spring wheat.

Biochemical evidences in favour of germination advancement by hydration-dehydration pre-treatments have been demonstrated by Osborne and coworkers

**Table 5.** Effect of pre-sowing hydration treatments of stored seeds of wheat (cv. Sonalika) on 1000-seed weight (g).

| Duration of hydration (h) | Mode of hydration treatment | | Mean |
|---|---|---|---|
| | Non-aerated | Aerated | |
| 0 (Control) | 34.88 | 34.79 | 34.83 |
| 4 | 34.56 | 34.92 | 34.74 |
| 6 | 35.58 | 35.64 | 35.61 |
| 8 | 35.77 | 36.07 | 35.92 |
| 12 | 35.58 | 35.63 | 35.60 |
| 16 | 35.26 | 35.40 | 35.33 |
| 24 | 34.89 | 35.32 | 35.10 |
| 36 | 33.57 | 35.29 | 34.43 |
| 48 | 32.81 | 34.54 | 33.67 |
| 72 | 32.10 | 33.98 | 33.04 |
| Mean | 34.50 | 35.16 | - |

| L.S.D. values for mean effects | Probability level | |
|---|---|---|
| | 0.05P | 0.01P |
| Duration of hydration | 0.54 | 0.73 |
| Mode of hydration treatments | 0.24 | 0.32 |
| Interaction | 0.77 | 1.03 |

Other details are same as Table 1 and 3.

(Osborne *et al.* 1974). According to Sen and Osborne (1974) the rate of RNA and protein synthesis in wetted-dried rye embryos was similar to those in embryos continuously germinated for the same period of total hydration. Considerable evidence exists that repair of DNA, protein, membranes and enzymes occurs during imbibition and increasing seed moisture content hastens the repair processes (Ward and Powell 1983). Oxygen also improves the repair of high moisture lettuce (Ibrahim, *et al.* 1983) and high moisture wheat seeds (Petruzzelli 1986) suggesting that respiratory activity is an essential component of such repair processes.

Oxygen requirement for seed germination has been reviewed by different authors (Bewley and Black 1982, Come 1982, Mayer and Poljakoff-Mayber 1989) and in most of the species in plant kingdom, seeds fail to germinate when deprived of oxygen and restricted oxygen availability prevents seedling growth. Oxygen deprivation usually results in decreased energy charge and in the production of ethanol by fermentation (Pradet and Raymond 1983, Kennedy *et al.* 1992). Respiration of microorganisms growing on the surface of many seeds might also be involved in limiting oxygen diffusion to the embryo (Heydecker and Chetram 1971). During prolonged soaking of seeds, there is some advancement of germination and, as such, more oxygen is required. Perhaps, due to that reason aeration during relatively long duration soaking in the present study showed better germinability, field performance and productivity.

On the basis of the results obtained in the present study, it may be concluded that if the storage conditions are good then non-aerated pre-soaking treatments for 6-8h may be suggested for the improvement of field performance and productivity of stored wheat seeds. Besides, if aeration facilities are available then pre-sowing aerated hydration treatments may be practised especially for longer soaking durations, for the improvement of crop performances.

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