Wheat, Triticum Aestivum L. Vigor Viability, and Productivity Maintenance

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Abstract:

To help our farmers maintain the vitality, viability, and field potential of stored wheat seeds, we undertook this study to create a simple and economical technique of seed invigoration therapy. As the pre-monsoon and monsoon rains began in late May and early June, the study found that the germination percentage and vigour of the seedlings, as determined by root and shoot length began to fall.

Keywords: Wheat, Vigor Viability, Triticum Aestivum L., Productivity Maintenance

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Introduction:

One of the most widely grown cereal crops is wheat (Triticum aestivum, L.). In addition, it is consumed daily by over 35% of the global population. Global average grain production has to improve from the present 2.5 t ha-1 to 3.8 t ha-1 with the introduction of Mexican semi-dwarf high yielding wheat types in order to keep up with rising demand. Several areas of traditional wheat belts had commendable productivity increases in the 1960s (Rajaram, 1999). Applying a much of fertiliser might cause this. Soil micronutrients were quickly depleted due to the massive rise in NPK fertiliser dosages, which are typically devoid of micronutrients.

Wheat is seeded in India in the months of October and November and harvested in the months of March and April; the crop is considered a Rabi crop. Major wheat-growing regions in India are located in Central India, Maharashtra, Gujarat, and Madhya Pradesh. India produced 92.30 MMT of wheat in 2011–2012, with Maharashtra contributing 1.32 MMT. The entire wheat harvest in Shrirampur takula, which is in the Ahmadnagar District of Maharashtra state, was 6831 tonnes in 2011-2012.

High levels of chemical fertiliser usage have degraded the soil in many wheat-growing regions throughout the globe, reducing crop yields. Wheat is also produced in wide parts of Asia and Africa with just a rainy climate and a limited water supply. Mineral nutrients, organic carbon, and rhizopheric activity are all deficient in the soil in these regions. Fertiliser application rates there are far lower than what is advised because of financial and risk considerations. As a result, wheat yields suffer. As a result, the selection of high and low input efficient wheat genotypes sensitive to bioinoculants and applied inorganic nutrients for diverse agro climatic zones is being prioritised in order to maximise global wheat production (Alam, et al., 2002).

Wheat (Triticum aestivum L.) must have its vitality, viability, and productivity preserved if it is to establish itself as a crop and provide its maximum possible yield. Wheat's vitality, viability, and production all depend on the following elements and practises.

1. High-Quality Seed: Start with high-quality wheat seeds that have high germination rates, good vigor, and low levels of diseases or pests. Proper seed selection, storage, and handling practices are essential to maintain seed quality.
2. Seed Treatment: Consider seed treatments such as fungicides, insecticides, or biological agents to protect seeds from soilborne diseases, pests, and fungal infections. Seed treatments can improve seedling establishment and vigor.
3. Crop Rotation: Implementing a diverse crop rotation system helps break pest and disease cycles specific to wheat. Rotating with non-host crops can reduce the build-up of pests and pathogens, enhancing the overall health and productivity of wheat plants.
4. Nutrient Management: Ensure proper nutrient management through soil testing and targeted fertilizer application. Adequate nutrient supply, especially for essential macronutrients like nitrogen, phosphorus, and potassium, supports vigorous growth, optimal development, and high productivity in wheat.
5. Water Management: Optimize irrigation practices to provide adequate and timely water supply to wheat plants. Proper water management helps prevent water stress, which can lead to reduced vigor, stunted growth, and decreased yield potential.
6. Weed Control: Effective weed control is essential for maintaining wheat vigor and productivity. Weeds compete with wheat plants for resources, including water, nutrients, and sunlight. Implement integrated weed management strategies, including herbicide application, cultural practices, and crop rotation, to minimize weed competition.
7. Disease and Pest Management: Regular scouting and monitoring for diseases and pests are crucial for early detection and prompt control measures. Implement integrated pest management (IPM) practices, including biological control agents, resistant varieties, and judicious pesticide use, to manage diseases and pests effectively.
8. Timely Harvest: Harvest wheat at the appropriate maturity stage to maintain seed quality and avoid losses due to shattering, lodging, or adverse weather conditions. Timely and proper harvest management can help preserve grain quality and maximize yields.

It is important to note that specific recommendations may vary depending on local conditions, cultivars, and management practices. Consulting local agricultural extension services or agronomists can provide region-specific guidance for maintaining vigor, viability, and productivity in wheat cultivation (Bacillio, et al., 2003).

Methodology:

Two wheat (Triticum aestivum L.) cultivars, UP 262 and PBW 343, were used in the study.

In this experiment, we utilised newly harvested wheat seeds. Wheat seeds from two different cultivars (cv. UP 262 and cv. PBW 343) were collected from the Agricultural Experimental Farm, University of Calcutta in Baruipur, South 24-parganas, cleaned, dried to a moisture content of 9.1% and 9.3%, respectively, and stored in glass bottles with rubber stoppers of a capacity of 2.5 litres until they were used for treatments.

Wheat seeds (500g) were stored in four different containers (a gunny bag, a polythene bag, a metal tin, and a glass bottle) and left out in ambient conditions for varying amounts of time to see how the seeds degraded with time. Samples of seeds were taken from several containers monthly for germination testing, as described by Punjabi and Basu (1982).

Dry seed treatment and wet seed treatment are the two main types of seed treatments available. At the Agricultural Experimental Farm of Calcutta University in Baruipur, three replications of each treatment were tested in order to confirm the positive effect of the preand mid-storage treatments on the field performance and productivity of the wheat crops in the rabi season.

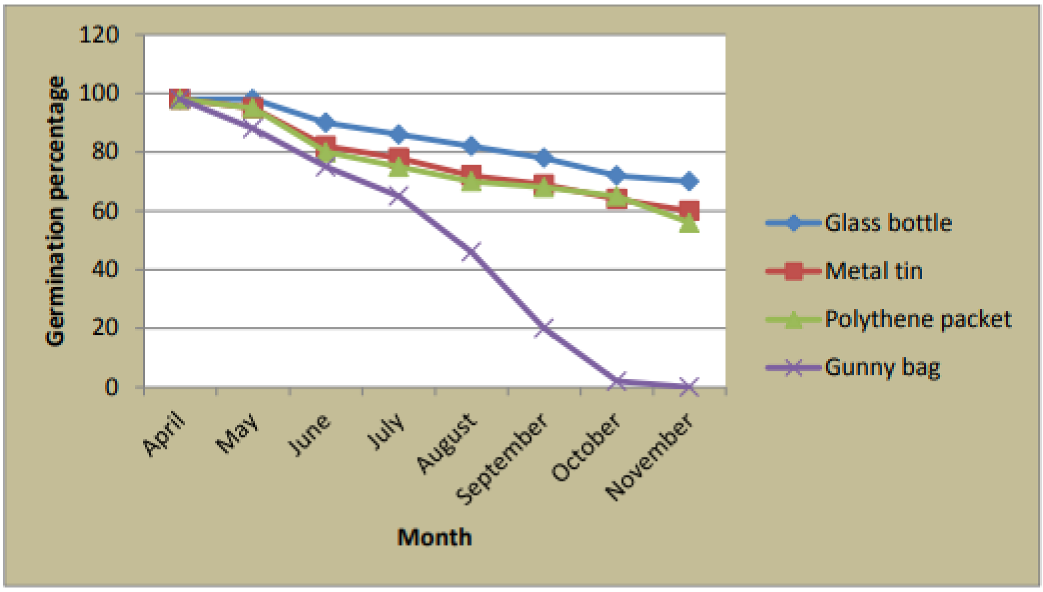
The method of action of seed treatment on the preservation of viability was investigated by measuring membrane permeability, conducting enzymatic investigations, and estimating volatile aldehyde levels.

Following the variance procedures of Fisher (1948), the results of the laboratory germination test, the field tests, and the biochemical test were statistically analyzed to determine the impact of the treatments on the preservation of viability. Germination % data was changed to arc-sin angle before statistical analysis, and the same was done with seedling length data. The vigour index was determined by multiplying the germination rate by the seedling height.

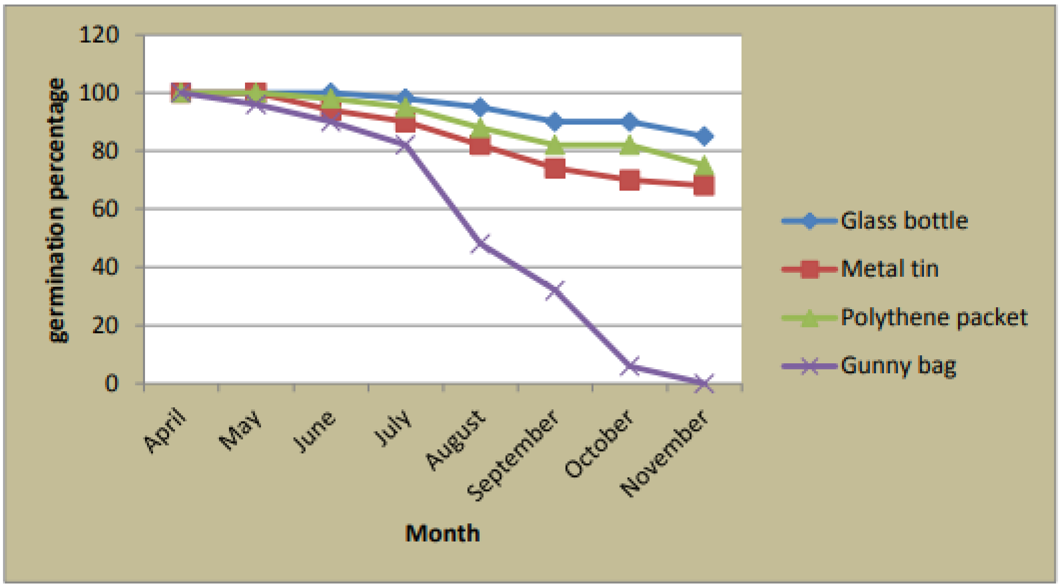
Result:

Studies of decline in vigour and viability on the pattern of different wheat cultivars under different storage containers

Wheat (cv. UP 262 and PBW 343) seed was tested from April through November for germination and seedling length in four different storage containers (gunny bag, polythene packets, metal tin, and glass bottle). As the relative humidity increased with the arrival of the pre-monsoon and monsoon rains in May and June, the germination percentage and vigour of the seedlings began to decrease. During the monsoon months (July-August), seeds stored in a gunny bag absorb a lot of moisture from the humid environment, reducing the germination percentage to half of the original value and causing a loss of vigour (Figure 1).

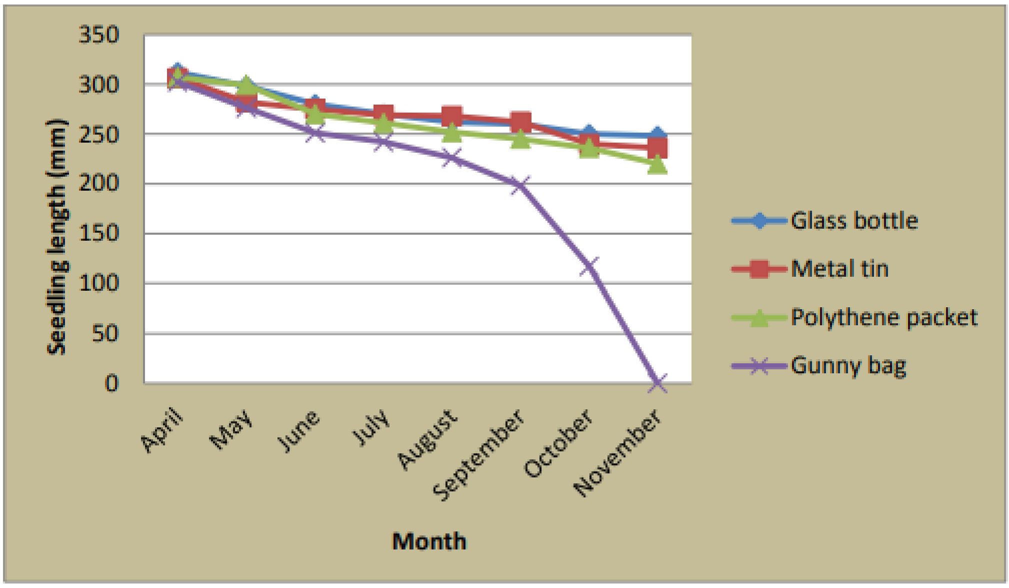


(a) cv. UP 262

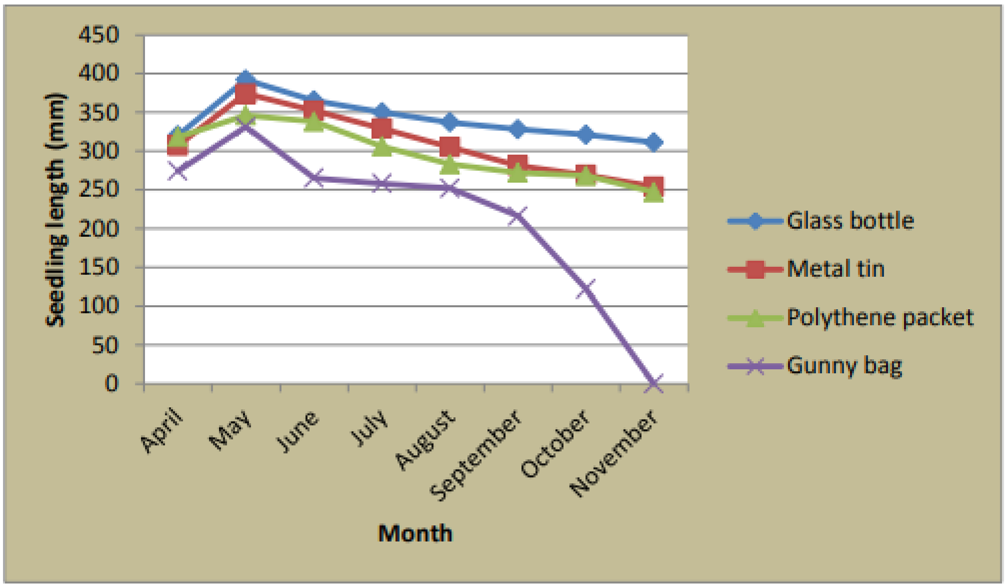


(b) cv. PBW 343

Figure 1: Decline Pattern for various duration (Germination %) of wheat seed (cv. UP 262 and cv. PBW 343) stored in viability in different containers under ambient condition



(a) cv. UP 262



(b) cv. PBW 343

Figure 2: Decline Pattern in vigour in different containers under ambient condition of wheat seed (cv. UP 262 and cv. PBW 343) stored for various duration (Seedling length)

Improved storability and field performance efficacy of pre-storage seed invigoration treatments (cv. UP 262 and PBW 343) of wheat

When tested for germination immediately after treatment, treated seeds from both wheat cultivars (cv. UP 262 and PBW 343) did not significantly outperform untreated control. However, majority of the treated seeds exhibited considerable improvement in germination percentage and seedling length as evaluated by root and shoot length after accelerated ageing at 98% RH and 400C for 12 days and 100% RH and 40oC for 7 days.

Soaking-drying and aspirin therapy, in particular, has been found to increase germinability relative to the control. Natural ageing for 4 months under ambient circumstances and storage in an open glass container for 12 months yielded similar trends for both treated and untreated seeds (Tables 1, 2).

Table 1: Pre-storage seed treatments effect of wheat (cv. UP 262)on the germinability after natural ageing under ambient conditions for 4 months

Treatments	Germination		Mean root length (mm)	Mean shoot length (mm)	Mean total seedling length (mm)	Vigour Index
	(%)	Arc- sin value				
Control (untreated)	82	64.9	174	32	206	16892
Neem leaf powder	88	69.7	191	38	229	20152
Red chilli powder	85	67.2	187	36	223	18955
Bleaching powder	94	75.8	199	40	239	22466
Aspirin	96	78.5	203	43	246	23616
MSC-D	93	74.5	196	40	236	21948
S-D	92	73.6	194	41	235	21620
L.S.D. at 0.05 P	-	2.8	8.3	3.0	-	-
L.S.D. at 0.01 P	-	3.9	12.5	4.2	-	-

Table 2: Pre-storage seed treatments effect of wheat (cv. UP 262) on the germinability after storage in unsealed glass bottle for 12 months

Treatments	Germination		Mean root length (mm)	Mean shoot length (mm)	Mean total seedling length (mm)	Vigour Index
	(%)	Arc- sin value				
Control (untreated)	84	66.4	148	35	183	15372
Neem leaf powder	93	74.7	180	43	223	20379
Red chilli powder	97	80.0	161	41	202	19594

Bleaching powder	96	78.4	167	41	208	19968
Aspirin	94	75.8	182	40	222	20868
MSC-D	90	71.6	201	36	237	21330
S-D	92	73.6	225	40	265	24380
L.S.D. at 0.05 P	-	5.3	20.5	3.0	-	-
L.S.D. at 0.01 P	-	7.4	28.7	4.2	-	-

Stored wheat seed (cv. UP 262 and PBW 343) Mid-storage seed treatment effect for improved germinability and field performance

Both UP 262 and PBW 343 wheat cv. 5-month-old seed housed in rubber-stoppered glass bottles at room temperature were treated with seed invigoration mid-way through storage. In the materials and methods, we discuss the specifics of the therapy. Germination tests performed on treated and untreated wheat seeds immediately after treatment showed no discernible difference in the treated seeds' vigour and viability (Tables 3 and 4).

Table 3: Mid-storage seed treatments effect on the germinability of wheat(cv. UP 262) immediately after treatment (before ageing)

Treatments	Germination		Mean root length (mm)	Mean shoot length (mm)	Mean total seedling length (mm)	Vigour Index
	(%)	Arc-sin value				
Control (untreated)	82	64.9	290	51	341	27962
Neem leaf powder	85	67.2	316	60	376	31960
Red chilli powder	84	66.4	306	62	368	30912
Bleaching powder	92	73.6	324	64	388	35696
Aspirin	95	77.0	331	66	397	37715
MSC-D	88	69.7	326	62	388	34144
S-D	90	71.6	328	65	393	35370
L.S.D. at 0.05 P	-	NS	NS	NS	-	-

L.S.D. at 0.01 P	-	NS	NS	NS	-	-

Table 4: Effect of mid-storage seed treatments on the germinability of wheat (cv.PBW343) immediately after treatments (before ageing)

Treatments	Germination		Mean root length (mm)	Mean shoot length (mm)	Mean total seedling length (mm)	VigourIndex
	(%)	Arc-sin value				
Control (untreated)	84	66.4	258	55	313	26292
Neem leaf powder	89	70.6	276	64	340	30260
Red chilli powder	85	67.2	290	62	352	29920
Bleaching powder	87	68.9	288	60	348	30276
Aspirin	91	72.5	291	67	358	32578
MSC-D	86	58.0	286	62	348	29928
S-D	89	70.6	277	63	340	30260
L.S.D. at 0.05 P	-	NS	NS	NS	-	-
L.S.D. at 0.01 P	-	NS	NS	NS	-	-

Compatibility of pre-storage seed invigoration treatments with foliar application of micronutrients for improved yield and seed performances of wheat (cv. UP 262)

Yield and most of the other yield attributes (viz. length of panicle, number of seeds per panicle, 1000-seed weight, and immediate germination percentage after harvest etc.) were significantly improved by the dry and wet treated seeds over control (Table 5) in a crop grown from pre-storage treated and untreated wheat seeds (cv. UP 262).

Table 5: Seed invigoration treatment effect of wheat (cv. UP 262) followed by foliarspray with micronutrients on plant population/m^2

Dry Treatment	Micronutrients (foliar applications)					Mean
	Control	Water	Boron	Zinc	Molybdenum	
Control	112	111	120	120	113	115.20

Neem leaf powder	115	109	123	118	113	115.60
Red chilli powder	120	113	113	120	119	117.00
Asprin	113	111	118	118	106	113.20
Bleaching powder	115	125	116	113	109	115.60
MSC-D	122	125	109	113	105	114.80
S-D	111	127	111	120	106	115.00
Mean	115.42	117.28	115.71	117.43	110.14	

Bioassay of seed vigour of invigorated and non-invigorated seed

Germination test conducted immediately after pre-storage treatment did not show any noticeable difference on germinability between treated and untreated seeds, neither in stock material (wheat) nor in bioassay (jute) material (Table 6).

Table 6: Jute (bioassay material) seeds seedling growth exposed to gaseousemanations of pre-storage treated wheat (stock material) seeds (cv. UP 262) immediately after treatment i.e. before ageing

Treatments	Stock material				Bioassay material			
	Germination		Mean root length (mm)	Mean shoot length (mm)	Germination		Mean root length (mm)	Mean shoot length (mm)
	(%)	Arc-sin value			(%)	Arc-sin value		
Control(untreated)	96	78.5	323	30	100	90.0	32	24
Aspirin	98	81.9	309	32	100	90.0	31	25
Bleaching powder	98	81.9	312	29	100	90.0	32	23
Neem leaf powder	100	90.0	316	32	100	90.0	32	24
Red chilli powder	100	90.0	305	31	100	90.0	31	23
Soaking-drying	98	81.9	296	32	100	90.0	32	24
Blank	-	-	-	-	100	90.0	33	25
LSD at 0.05 P	-	NS	NS	NS	-	-	-	-
LSD at 0.01 P	-	NS	NS	NS	-	-	-	-

Physiological and biochemical studies to elucidate the mode of action of seed invigoration treatments

Wheat (cv. UP 262) seeds were tested for germination percentage, membrane integrity (via electrolyte and sugar leaching), dehydrogenase enzyme activity, and volatile aldehyde production immediately following pre- and midstorage treatment (Tables 7 and 8).

Table 7: Effect of pre-storage seed treatments on membrane permeability and enzymeactivity and volatile aldehyde production of high medium vigour wheat (cv. UP 262) immediately after treatment i.e. before ageing

Treatments	Germination		Electrical conductan ce (µ mho)	Leakage of sugar (O.D at 580 nm)	Dehydrogenase activity (O.D at 470 nm)	Volatile aldehyde production (O.D. at 635 nm)
	(%)	Arc- sin value				
Control (untreated)	98	81.8	142	0.09	0.312	0.29
Neem leaf powder	100	90.0	139	0.04	0.325	0.30
Red chilli powder	100	90.0	137	0.09	0.314	0.28
Aspirin	98	81.9	141	0.06	0.313	0.30
Bleaching Powder	97	80.0	165	0.07	0.309	0.32
CD at 0.05 P	-	NS	NS	NS	NS	NS

Table 8: Effect of pre-storage seed treatments on membrane permeability and enzymeactivity and volatile aldehyde production of high medium vigour wheat (cv. UP 262) after accelerated ageing at 98% RH and 40° C for 7 days

Treatments	Germination		Electrical conductan ce (µ mho)	Leakage of sugar (O.D at 580 nm)	Dehydrogenase activity (O.D at 470 nm)	Volatile aldehyde production (O.D. at 635 nm)
	(%)	Arc- sin value				
Control	81	64.2	166	0.12	0.21	0.59

(untreated)						
Neem leaf powder	94	75.8	121	0.07	0.27	0.62
Red chilli powder	92	73.6	144	0.09	0.24	0.59
Aspirin	90	71.6	128	0.08	0.24	0.63
Bleaching powder	93	74.7	157	0.13	0.25	0.60
CD at 0.05 P	-	3.1	3.6	0.02	0.02	0.01

Discussion:

For better germination, field performance, and yield, it has been suggested that newly harvested wheat seeds (after only one month) be dry-dressed with finely powdered chemicals such as aspirin (at 50mg/kg of seed), bleaching powder (at 2g/kg of seed), and red chilli powder (at 1g/kg of seed).

Dry-dressing of seeds with halogenated compound like bleaching powder and iodinated calcium carbonate has been shown to be effective in a variety of harvest fresh non-leguminous and leguminous crop seeds by Basu, Mandal, and their colleagues.

Depending on the kind of seed and the initial seed vigour level, the physiological seed treatments would greatly lengthen storability and increase eventual crop performance. You can only get good results with dry physiological treatments if you use them right after you've harvested some high- or medium-vigor seed. Seed degeneration may be slowed significantly by a moist treatment applied midway during storage.

A seed lot's viability and germination rate have an indirect effect on its yield. Slower and less uniform seedling emergence occurs in brussels sprouts and onions when seed vigour is diminished.

Conclusion:

The findings suggest that mid-storage soaking-drying (wet) treatments as well as pre-storage dry seed treatments with red chilli powder (@ 1g/kg of seed), aspirin (@ 50 mg/kg of seed) and bleaching powder (@ 2g/kg of seed) may be suggested in extending storability and improving field performance and productivity of stored wheat seed. Increased field performance and productivity are also advised by applying a foliar spray of Boron (at 0.5%) at the time of blooming to the standing crop grown from red chilli powder treated seeds.

References:

1. Alam M S, Cui Z J, Yamagishi T, Ishii R.2001. Grain yield and related physiological characteristics of rice plants (Oryza Sativa .L.) inoculated with free living rhizobacteria . plant, prod sci. 4:126-130.
2. Alam, S.S., Khalil, N., Ayub and Rashid, M., 2002. In vitro solubilization of inorganic phosphate by phosphate solubilizing microorganism (PSM) from maize rhizosphere. Intl. J. Agric. Biol; 4: 454-458.
3. Bacillio, M., Vazquez, P. and Bashan, Y., 2003. Allevation of noxious effect of cattle ranch composts on wheat seed germination by inoculation with Azospirillum spp.. Biology and Fertility of Soils. 38 4 : 261-266.
4. El-Hendawy, S., Al-Suhaibani, N., Al-Gaadi, K., El-Din, A., Hassan, W., & Singh, D. (2019). Wheat productivity in response to water management strategies: A review. Agronomy, 9(12), 860.
5. Foulkes, M. J., Sylvester-Bradley, R., Weightman, R., Snape, J. W., & Berry, P. M. (2007). Identifying physiological traits associated with improved drought resistance in winter wheat. Field Crops Research, 103(1), 11-24.
6. Gaju, O., Reynolds, M. P., Sparkes, D. L., Foulkes, M. J., & Pozniak, C. J. (2009). Relationships between large-spike phenotype, grain number, and yield potential in spring wheat. Crop Science, 49(3), 961-973.
7. Jafarzadeh, A. A., Mirdad, Z., Heidari, M., & Alizadeh, A. (2019). Improving wheat productivity by optimizing nitrogen management under different irrigation systems: A review. Agronomy, 9(12), 879.
8. Reynolds, M., Foulkes, J., Furbank, R., Griffiths, S., King, J., Murchie, E., ... & Parry, M. (2012). Achieving yield gains in wheat. Plant, Cell & Environment, 35(10), 1799-1823.
9. Richards, R. A., Rebetzke, G. J., Watt, M., Condon, A. G., Spielmeyer, W., & Dolferus, R. (2010). Breeding for improved water productivity in temperate cereals: phenotyping, quantitative trait loci, markers, and the selection environment. Functional Plant Biology, 37(2), 85-97.
10. Siddique, K. H., Regan, K. L., Tennant, D., Thomson, B. D., & Brennan, R. F. (1990). Water use and water-use efficiency of old and modern wheat cultivars in a Mediterranean-type environment. Australian Journal of Agricultural Research, 41(3), 431-447.
11. Zheng, B., Chenu, K., Dreccer, M. F., Chapman, S. C., & Dang, Y. P. (2020). Agronomic management options for improving rainfall-use efficiency in rainfed wheat cropping systems. Advances in Agronomy, 163, 157-204.