Seed Quality Enhancement through different Priming ~~methods~~Treatmentsin Onion (*Allium cepa* L.)

ABSTRACT

In a meticulously executed experiment at the Department of Horticulture, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, during the *Rabi* season of 2022-23. **In the experiment, treatments were arranged in**a Factorial Randomized Block Design (FRBD) ~~was employed~~**with two factors concepts**. ~~to investigate the influence of~~**The first factor was mobilized with**twelvedistinct seed priming treatments ~~on onionThese treatments encompassed~~***i.e.*;**KNO_3~~at~~(2%), TiO_2~~at~~(500ppm), PEG ~~at~~(1MPa), Salicylic acid ~~at~~(50ppm), *Pseudomonas*~~at~~(1%), ~~and a control group using~~**along with water as a control treatment**. ~~One factor and~~**The second factor assigned to onion** varieties ***i.e.*,**Phule Samarth and B780. ~~) as second Factor~~Among the findings, the combination of B2A1 (TiO_2@ 500 ppm + Phule Samarth) significantly influenced radicle emergence time, while B2A2 (TiO_2 @500 ppm + B780) exhibited a noteworthy impact on initial germination counts and final germination counts. Moreover (TiO_2 @ 500ppm + B780) recorded distinct effects on plumule length and radicle length. In terms of vigour, variety A2 (B780) demonstrated the highest vigour I with TiO_2 @ 500ppm. The results highlighted TiO_2 @ 500ppm as the most effective priming agent, with PEG -1Mpa showing less efficacy in promoting seed Vigour II. Additionally, KNO_3 @ 2% emerged as a promising agent, and the Phule Samarth variety exhibited a slightly higher mean dry weight compared to B780. Notably, the combination B6A1 (Water + Phule Samarth) resulted in the highest mortality %, while B1A1 (KNO_3 @ 2% + Phule Samarth) was particularly associated with intensified pyruvic acid synthesis. Furthermore, the maximum TSS content was observed for B1A1 (KNO_3 @ 2% + Phule Samarth), underscoring the intricate interplay between priming and genetic factors.

INTRODUCTION

Onion (*Allium cepa* L.) is an important vegetable crop grown and consumed widely across the world. India is the second largest producer of onion in the world next to China and ranks third in export of fresh onions. It is an indispensable vegetable in every kitchen and has gained the importance of a cash crop in recent years because of its very high export potential. Indian onions are famous for their pungency due to the presence of a volatile oil 'Allyl propyl

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Comment [MZ2]: PEG: Is it PEG-6000 or what?

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So you need to write again the results according to the newest tables, or just comment on treatments from T1 to T12, as a combined treatment

disulphide' and are available round the year. It is used both in raw and mature bulb stage as vegetable and spices. It is valued for its characteristics flavour, pungent taste and medicinal importance (Padmini *et al*., 2007and Tyagi and Yadav., 2007)[11,18]. Seed priming is one of the best methods which show rapid and uniform germination, synchrony in growth, development and increased yield. Seedling establishment is an important factor in bulb production of onion and largely depends on the seed germination and vigour. Seed quality enhancement is possible through various seed priming techniques including hydro priming, halo priming, osmo priming, thermo priming, solid matrix priming, and bio priming (Ashraf and Foolad 2005; Venkatasubramanian and Umarani, 2007)[2,19]. ~~uniformity of seedling establishment is~~Seed priming ~~that~~ permits the preliminary process of germination but not the final phase of radicle emergence (Heydecker and Coolbear, 1977; Heydecker and Gibbins, 1978)[5,6]. Many researchers have studied theeffects of seed priming on enhancement of germination, morphological characters, yield, etc. (Thejeshwini et al., 2019; Muruli et al., 2016; Saranya, 2017; Patil and Manjare, 2013; Arin et al., 2011; Selvarani and Umarani, 2011; Nego et al., 2015)[17,9,14,12,1,15,10]. Onion seeds show poor germination with slow growth of seedling and it hasashort storage life. Hence, considering the above facts, the present study was undertaken to enhance the onionseed quality by priming treatments.

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MATERIALS AND METHODS

During the Rabi season of 2022-2023, a meticulous experiment was conducted on Onion crop (*Allium cepa* L.) at the Vegetable Research Centre, Maharajpur, Department of Horticulture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, College of Agriculture, Jabalpur, Madhya Pradesh. Employing a factorial experiment in a Randomized Complete Block Design (RCBD)~~a Factorial Randomized Block Design (FRBD) with~~includingthree replications and twelve distinct treatments, ~~the study delved into the intricate dynamics of onion cultivation~~. The crop, with a row spacing of 20 cm and a plant spacing of 15 cm, underwent a comprehensive assessment to discern the nuanced impact of various factors. Factor A, representing ~~diverse~~two onion varieties ~~such as;~~ Phule Samarth and B 780, each contributing unique characteristics, played a pivotal role. **Factor (B) was mobilized with seed-priming treatments** ~~The treatments,~~ denoted by unique notations **i.e., KNO_3 @ 2%, TiO_2 @ 500 ppm, PEG - 1Mpa, Salicylic acid 50ppm, *Pseudomonas* @ 1%, along with water as (a control treatment)** ~~(T1 to T12),included variations in priming agents and varieties, facilitating a detailed exploration of their impact on onion cultivation dynamics.~~ Treatment details from **T1 – T12resulting from the combination of the factors under study were as**

follows:T1: Phule Samarth + KNO_3 @ 2%, T2: Phule Samarth + TiO_2 @ 500 ppm, T3: Phule Samarth + PEG - 1Mpa, T4: Phule Samarth + Salicylic acid 50ppm, T5: Phule Samarth + *Pseudomonas* @ 1%, T6: Phule Samarth + Control, T7: B 780 + KNO_3 @ 2%, T8: B 780 + TiO_2 @ 500 ppm, T9: B 780 + PEG - 1Mpa, T10: B 780 + Salicylic acid 50ppm, T11: B 780 + *Pseudomonas* @ 1%, T12: B 780 + Control. ~~This structured experiment aimed at understanding the nuanced interactions between treatments and the inherent characteristics of different plant varieties, providing valuable insights for optimizing onion cultivation practices. Observations for essential parameters were meticulously recorded following standardized procedures, ensuring the reliability and robustness of the obtained data. (~~**This structured experiment aims to study the effects of the seed priming technique on germinability, seedling Vigor, and field establishment on two promising varieties of onion**.Paper towel method was utilized to evaluate the germination and seed vigour parameters. The germinated seeds were counted daily by unrolling the paper sheet carefully till 12 days which is the final count of onion seed.

Where is the method of seed priming technique?

Where is the procedure of the laboratory of field experiment?

Where are germination parameters as you mentioned in Results (Germination initial count, Final germination percentage, radical and shoot lengths)

Germination percentage (G%) was measured at the end of test period according to international seed testing association (ISTA, 1999);

$$G\ \% = \frac{\text{Total number of germinated seeds}}{\text{Total number of evaluated seeds}} \times 100$$

The seedling vigour index (SVI-I & II) were calculated according to Abdul-Baki and Anderson (1970) and Abdul-Baki and Anderson (1973) by the following formula;

~~**Vigour index I**~~**Seedling vigor index (SVI-I)**

~~Vigour Index-I = Radicle length (cm) + Plumule length (cm) × Germination%~~

$$\text{SVI-I} = \text{Seedling length (cm)} \times \text{Germination percentage}$$

~~**Vigour index II**~~**Seedling vigor index (SVI-II)**

~~Vigour Index-II = Seedling dry weight (g) × Germination percentage~~

$$\textbf{SVI-II} = \textbf{Seedling dry weight (g)} \times \textbf{Germination percentage}$$

Comment [MZ5]: understanding the nuanced interactions between treatments and the inherent characteristics of different plant varieties, It requires more in-depth studies and measuring many traits and characteristics, in addition to analyzing enzymes and the way genes work, and this is not available in research.

Comment [MZ6]: You need to reset the material. You mentioned factor A, but you did not mention factor B. You wrote that the treatments are 12 and in the table there are only 6. The material should not be written like this. You must first write the factors at their levels, and then after that, if you want to create ancombination treatments between the factors, you must List them in all tables from first 1 to 12

Comment [MZ7]: The control treatment should be (unprimed seed = dry seed)
Priming with water = hydropriming
So you don not have control treatment in your study

Comment [MZ8]: This procedure is not sufficient at all. Where is the method of preparing the seeds, where is the technique for preparing the seeds and the treatments?
Where was the experiment conducted? Was it a laboratory experiment or a field experiment? I mentioned both methods and did not specify which method
Did you conduct a laboratory experiment or a field experiment, and where is the procedure done?

Comment [MZ9]: ISTA (1999). International Rules for Seed Testing. Seed Science and Technology, 27:1-333.

Comment [MZ10]: Abdul-Baki, A.A. and J.D. Anderson (1970). Viability and leaching of sugars from germinating barley. Crop Sci., 10: 31-34.

Comment [MZ11]: Abdul-baki, A.A. and J.D. Anderson (1973). Vigor determination in soybean seed by multiplication. Crop Sci., 3: 630-633.

The seedling dry weight was determined by placing ten normal **fresh**seedlings, used for root and shoot length measurements, in a hot air oven at 50 ± 1°C for 24 hours until a constant weight was achieved. The recorded dry weight of the seedlings was expressed in grams.

Mortality%

The percentage of seeds that fails to germinate or established into viable seedling.

$$\text{Mortality (\%)} = \frac{\text{Number of non germinated seeds}}{\text{Total number of seed sown}} \times 100$$

Where is the reference

TSS estimation

Utilizing a refractometer, total soluble solids or TSS are measured. This instrument is used to determine the amount of dissolved solids, which are frequently sugars, in a liquid sample.

Where is the reference

Pyruvic acid estimation

To quantify pyruvic acid concentration, 0.5 ml of onion extract was combined with 1.5 ml of 5% TCA and 18 ml of distilled water. Subsequently, 1 ml of this mixture was incubated at 37ºC for 10 minutes after the addition of 1 ml each of 2,4-DNPH and distilled water. Following incubation, 5 ml of 0.6 N NaOH was added, and the absorbance was measured at 420 nanometres using a Spectrophotometer to establish a standard curve.

Where is the reference for this method

Where is statistical analysis

RESULTS AND DISCUSSION

The analysis of Table 1 and Figure 1 reveals a subtle difference in radicle emergence times between onion varieties A1 (Phule Samarth) and A2 (B780). Phule Samarth exhibited a slightly quicker mean emergence time of 48.23 hours compared to B780 at 48.58 hours, emphasizing its faster germination. TiO_2 at 500 ppm demonstrated the fastest radicle emergence time at 46.84 hours. Water priming showed the longest emergence time at 49.59 hours (Table 1 and Figure 1). The interaction effect between Factors A and B was significant, with B2A1 (TiO_2 at 500 ppm + Phule Samarth) influencing radicle emergence time most prominently at 46.80 hours. KNO_3 at 2% priming treatment promotes faster radicle emergence, while PEG at -1MPa and water treatments exhibit longer times. The marginal difference between Phule Samarth and B780 suggests genetic or physiological disparities. The study aligns with Levent et al. (2011)[8].

First, you should present the main effects of the factors under study.

So, just present the effects of combined treatments (T1, T2, and so on) and compare it each other,

Or if you want to present the mean effects, you should make the table like this below;

The table of main Effects of factors under Study

	G%	Seedling Length	Seedling Vigor
Factor A (Varieties)			
1			
2			
Mean			
C.D.			
SE			
Factor B (Seed-priming)			
1			
2			
3			
4			
5			
6			
Mean			
C.D.			
S.E			

As you talk about treatments in material and methods (T1, T2, T3, and so on), you should present the results in T1, T2 and so on, like this;

The table of interaction or combined treatments should be like this

Combined treatments	G%	Seedling Length	Seedling Vigor
T1			
T2			
T3			
T4			
T5			
T6			

T7			
T8			
T9			
T10			
T11			
T12			
Mean			
C.D.			
S.E			

In the comparison of onion varieties, Phule Samarth (A1) recorded a mean germination percentage of 63.28%, slightly lower than B780 (A2) at 68.78%, indicating B780's enhanced early germination ability. TiO_2 at 500 ppm exhibited the highest mean germination percentage at 71.5%, emphasizing its potential for facilitating favourable germination pathways. The control treatment with water showed the least effectiveness at 61.85% (Table 1 and Figure 1). Other priming agents, including KNO_3 at 2%, PEG - 1MPa, Salicylic acid at 50ppm, and *Pseudomonas* at 1%, exhibited intermediate results. The significant interaction effect between seed priming agents and onion varieties, particularly with B2A2 (TiO_2 at 500 ppm + B780), influences initial germination counts. This study aligns with Haghighi et al. (2014)[4].

Comment [MZ12]:

The comparative analysis of onion varieties indicates that B780 (A2) has a slightly higher mean germination percentage of 84.85% compared to Phule Samarth (A1) at 82.95%, suggesting inherent advantages for improved germination. Among seed priming agents, TiO_2 at 500 ppm proved most effective with a mean germination percentage of 86.84%, while the control treatment with water resulted in the lowest at 81.17%. Other priming agents showed varying efficacy. The interaction effect between seed priming agents and onion varieties was notably significant, with B2A2 (TiO_2 at 500 ppm + B780) having the most distinct impact on germination final count at 91.67% (Table 1 and Figure 1). This study emphasizes the influence of priming agents on final germination count, with TiO_2 at 500 ppm being particularly effective. The interaction between variety and priming agent underscores the complex interplay between external treatments and genetic attributes. B2A2 (TiO_2 at 500 ppm + B780) demonstrated a distinctive effect on germination final count, aligning with findings by Haghighi et al. (2014)[4].

In comparing plumule length between onion varieties A1 (Phule Samarth) and A2 (B780), A2 showed a slightly longer mean length at 8.26 cm compared to A1 at 8.11 cm. Seed priming with TiO_2 at 500ppm proved most effective, resulting in a mean plumule length of 8.9 cm. The interaction effect showed B2A2 (TiO_2 at 500ppm + B780) had a distinct impact at 9.89 cm, emphasizing the genetic influence(Table 1 and Figure 1). This study underscores the varied effects of seed priming agents on plumule length, with TiO_2 notably enhancing growth. B780 outperforms Phule Samarth, and the interaction between seed variety and priming agent reveals the intricate interplay of genetics and the environment, with B2A2 having a distinct effect on plumule length. These findings align with Paul et al. (2020)[13].

AnalysingTable1 and Figure1 data reveals significant influences on radicle length by onion variety (Factor A) and seed priming agents (Factor B). A2 (B780) surpasses A1 (Phule Samarth), with radicle lengths of 6.90 cm and 5.52 cm, respectively. Among priming agents, TiO_2 at 500 ppm exhibits the most promising results at 7.15 cm, Water, the least effective agent, yields 5.17 cm. The interaction effect (A × B) emphasizes the agent's efficacy depends on the variety. B2A2 (TiO_2 at 500 ppm + B780) shows the maximum radicle length (7.93 cm), followed by B5A2 (*Pseudomonas* + B780) at 7.61 cm, while B6A1 (Water + Phule Samarth) records the minimum at 4.35 cm. Tailored strategies considering both seed variety and priming agent are crucial for optimal results. The combination B2A2 (TiO_2 at 500 ppm + B780) is particularly effective, as observed by Paul et al. (2020)[13].

Analysing onion variety influence (Factor A), A2 (B780) exhibited superior seed vigour I, with a mean vigour index I of 1310.63, surpassing A1 (Phule Samarth) at 1149.41. Regarding seed priming agents (Factor B), TiO_2 at 500 ppm recordedthe highest vigour index I (1349.45), followed by KNO_3 at 2% (1339.34), while the control (Water) had the lowest (1051.15). The interaction (A × B) emphasized variety-specific responses, with B780 reaching its highest vigour with TiO_2 at 500 ppm (1529.53) and the lowest for B6A1 (Water + Phule Samarth) at 1035.03(Table 2 and Figure 2). The Critical Difference (C.D.) at the 1% level (115.00) highlights significant variations in the vigour index I due to priming and variety interactions. Seed priming treatments, especially TiO_2 at 500 ppm, enhance seed physiological and metabolic activities, contributing to improved germination and vigour. The diverse roles of priming agents suggest specific metabolic pathways, with variety-specific responses emphasizing the need for tailored agronomic approaches. Shah et al. (2021)[16] corroborate these findings.

Assessing onion variety impact (Factor A), Phule Samarth (A1) slightly outperforms B780 (A2) with a mean vigour index II of 1.33 compared to 1.28. However, the difference is minor, emphasizing their overall similarity in vigour index II without considering priming treatments. Exploring seed priming agents (Factor B) reveals significant variation, with TiO_2 at 500 ppm achieving the highest mean vigour index II of 1.53 and water the lowest at 1.13 (Table 2 and Figure 2). Other treatments, including PEG -1MPa, salicylic acid, and *Pseudomonas*, show moderate efficacy. The interaction between Factors A and B is not statistically significant at the 5% level, suggesting their combined impact on vigour index II is not substantial. TiO_2 at 500 ppm's efficacy aligns with previous research on nanoparticles' role in enhancing seed vigour, while PEG's lower vigour may be attributed to concentration or osmotic stress. Variability between onion varieties implies genetic factors in treatment response, emphasizing the need for tailored seed enhancement strategies. Overall, both seed variety and priming agents have individual effects, but their combined impact on vigour index II remains relatively consistent. Shah et al. (2021)[16] support these findings.

In assessing onion variety impact (Factor A) on seedling dry weight, Phule Samarth (A1) slightly outperforms B780 (A2), with mean weights of 0.016g and 0.015g, indicating Phule Samarth's responsiveness to priming. Examining seed priming agents (Factor B) shows subtle differences, with KNO_3 at 2% (B1) having the highest mean weight at 0.018g (Table 2 and Figure 2). The interaction effect (Factor A × B) is not significant at the 1% level, indicating that combined effects on seedling dry weight are not substantial. This study highlights KNO_3 at 2% as an effective priming agent, potentially enhancing seedling biomass through improved nutrient uptake and metabolic pathways. Conversely, PEG -1MPa and Salicylic acid treatments show lower seedling dry weight, possibly due to osmotic or hormonal effects. The slightly better performance of Phule Samarth suggests genetic or physiological advantages in responding to priming-induced growth. However, the interaction between variety and priming agents does not significantly influence seedling dry weight. Brar et al. (2019) and Jima et al. (2015)[3,7] support these findings.

In assessing onion variety impact (Factor A) on seed mortality, Phule Samarth (A1) exhibited 17.05%, and B780 (A2) showed 15.15%, reflecting genetic factors' influence. For seed priming agents (Factor B), TiO_2 @ 500ppm had the lowest mortality at 13.17%, while water had the highest at 18.84%. Interaction effects (Factor A × B) revealed B2A2 (TiO_2 @ 500ppm + B780) with the lowest mortality at 8.33% (Table 2 and Figure 2). Different priming agents have varying efficacy, with TiO_2 @ 500ppm notably enhancing seed viability. Water priming resulted in the highest mortality, emphasizing the need for priming agents offering more than hydration. The distinct response of Phule Samarth and B780 highlights genetic and physiological differences. These findings resonate with the broader consensus, with the combination B6A1 (Water + Phule Samarth) demonstrating the highest mortality percentage. Haghighi et al. (2014)[4] support these results.

Table 1. Effect of seed priming agents, Varieties and their interactions on time taken for radicle emergence, Initial germination count, final germination count and seedling length of onion

S. No.	Priming	Time taken for maximum radicle emergence			Germination Initial Count			Germination Final count (%)			Plumule length (cm)			Radicle length (cm)		
		A1 (Phule Samarth)	A2 (B780)	Mean B	A1 (Phule Samarth)	A2 (B780)	Mean B	A1 (Phule Samarth)	A2 (B780)	Mean B	A1 (Phule Samarth)	A2 (B780)	Mean B	A1 (Phule Samarth)	A2 (B780)	Mean B
1	B1 (KNO_3 @ 2%)	47.23	48.33	47.78	65.00	65.00	65.00	84.67	83.33	84.00	8.66	8.75	8.71	5.37	6.81	6.09
2	B2 (TiO_2 @ 500ppm)	46.80	46.88	46.84	66.70	76.30	71.50	82.00	91.67	86.84	7.91	9.89	8.90	6.36	7.93	7.15
3	B3 (PEG - 1MPa)	48.94	49.27	49.11	62.30	66.00	64.15	81.67	83.43	82.55	8.40	7.77	8.09	4.68	6.87	5.78
4	B4 (Salicylic acid @ 50ppm)	47.96	48.91	48.43	63.00	69.70	66.35	83.67	87.33	85.50	8.55	7.58	8.07	6.21	6.18	6.20
5	B5 (*Psuedomonas* @1%)	48.44	48.91	48.68	62.00	72.70	67.35	85.67	81.00	83.34	7.41	8.22	7.82	6.15	7.61	6.88
6	B6 (Water)	50.00	49.19	49.59	60.70	63.00	61.85	80.00	82.33	81.17	7.73	7.36	7.55	4.35	5.99	5.17
	Mean A	48.23	48.58		63.28	68.78		82.95	84.85		8.11	8.26		5.52		
	C.D. @ 1% level	0.30	0.52	0.74	1.95	3.38	4.79	1.49	2.58	3.65	NA	0.49	0.69	0.25	0.44	0.62
	S.E.(m)	0.10	0.17	0.25	0.66	1.14	1.62	0.5	0.87	1.23	0.09	0.16	0.23	0.08	0.15	0.21

Comment [MZ13]: Where is (T1 To T2) which mentioned in material and methods,
Factors and treatments must be the same in material and results.

Table 2. Effect of seed priming agents, Varieties and their interactions on Vigour Index, Seedling dry weight and Mortality % of onion

S. No.	Priming	Vigour index I			Vigour Index II			Seedling dry weight (g)			Mortality (%)		
		A1 (Phule Samarth)	A2 (B780)	Mean B	A1 (Phule Samarth)	A2 (B780)	Mean B	A1 (Phule Samarth)	A2 (B780)	Mean B	A1 (Phule Samarth)	A2 (B780)	Mean B
1	B1 (KNO_3 @ 2%)	1202.77	1475.90	1339.34	1.31	1.42	1.37	0.02	0.02	0.02	15.33	16.67	16.00
2	B2 (TiO_2 @ 500ppm)	1169.37	1529.53	1349.45	1.51	1.54	1.53	0.02	0.02	0.02	18.00	8.33	13.17
3	B3 (PEG - 1MPa)	1059.10	1206.07	1132.59	1.18	1.18	1.18	0.02	0.01	0.01	18.33	16.57	17.45
4	B4 (Salicylic acid @ 50ppm)	1295.47	1155.13	1225.30	1.50	1.12	1.31	0.02	0.01	0.01	16.33	12.67	14.50
5	B5 (*Psuedomonas* @1%)	1134.73	1429.87	1282.30	1.24	1.38	1.31	0.02	0.02	0.02	14.33	19.00	16.67
6	B6 (Water)	1035.03	1067.27	1051.15	1.25	1.01	1.13	0.02	0.01	0.02	20.00	17.67	18.84
	Mean A	1149.41	1310.63		1.33	1.28		0.02	0.02		17.05	15.15	
	C.D. @ 1% level	46.96	81.25	115	NA	0.23	NA	NA	NA	NA	1.49	2.58	3.65
	S.E.(m)	15.90	87.50	38.97	0.04	0.07	0.11	0.001	0.001	0.001	0.5	0.87	1.23

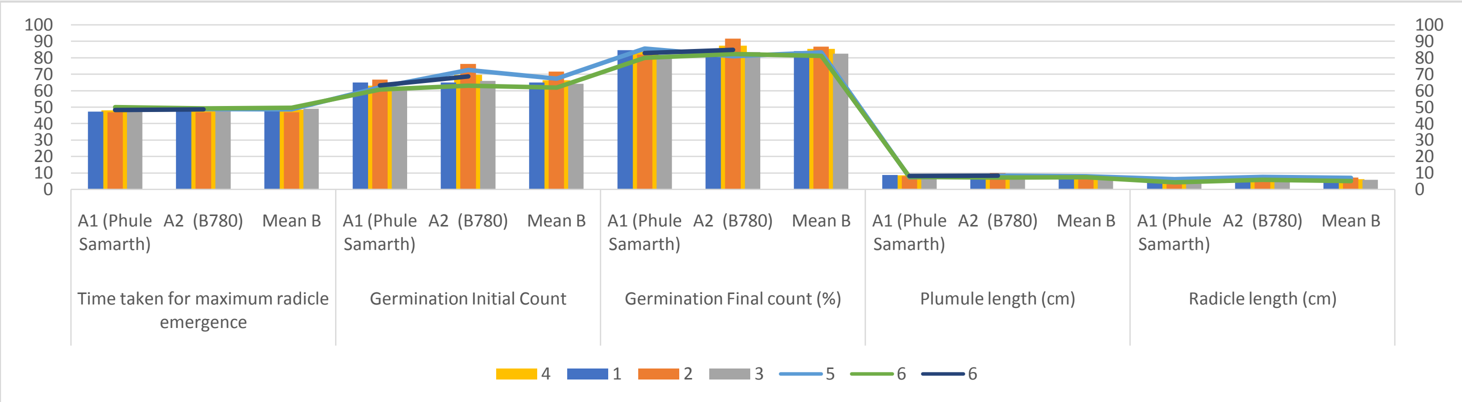

Figure 1.Influences of Seed Priming on Germination Parameters

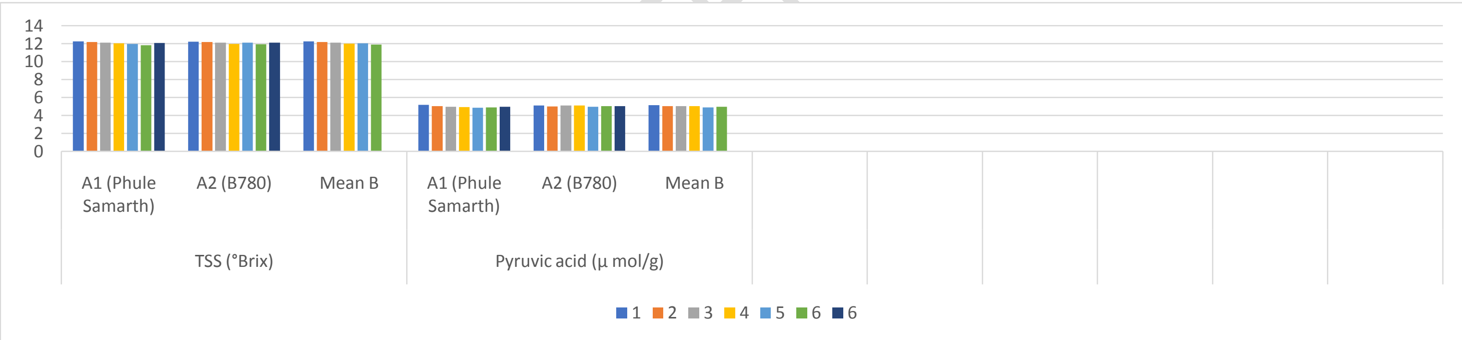

Figure 2. Impacts of Seed Priming on Germination Parameters

Quality parameters

TSS

The genetic makeup of onion varieties played a role in determining TSS (°Brix) values. A1 (Phule Samarth) and A2 (B780) exhibited minimal differences, with mean TSS values of 12.06 and 12.09 °Brix, respectively, suggesting similar potential. KNO_3 at 2% resulted in the highest TSS value of 12.25 °Brix, while water yielded the lowest at 11.88 °Brix (Table 3 and Figure 3). The interaction effect highlighted B1A1 (KNO_3 @ 2% + Phule Samarth) with the highest TSS at 12.26 °Brix. Seed priming agents subtly affect onion quality, and genetic differences influence TSS. The study aligns with Wakchaure et al. (2018)[20].

Pyruvic acid (μ mol/g)

The genetic aspect reveals that A2 (B780) exhibited a slightly higher mean pyruvic acid concentration of 5.05 µmol/g compared to A1 (Phule Samarth) at 4.98 µmol/g, indicating A2's predisposition to slightly more pronounced pungency. Among seed priming agents, KNO_3 at 2% resulted in the highest pyruvic acid content (5.15 µmol/g), while *Pseudomonas* at 1% had the lowest (4.91 µmol/g) (Table 3 and Figure 3). Seed priming distinctly influences onion pungency, with KNO_3 elevating pyruvic acid concentration. Interaction analysis highlighted B1A1 (KNO_3 at 2% + Phule Samarth) with the highest (5.18 µmol/g) and B5A1 (*Pseudomonas* + Phule Samarth) with the lowest (4.85 µmol/g) pyruvic acid concentration. A2 (B780) exhibits slightly higher pungency than A1 (Phule Samarth) due to genetic differences, emphasizing the intricate dynamics of priming agents and varietal genetics. The study aligns with Wakchaure et al. (2018)[20].

Table 3.Effect of seed priming agents, Varieties and their interactions on Quality parameters of onion

S. No.	Priming	TSS (°Brix)			Pyruvic acid (μ mol/g)		
		A1 (Phule Samarth)	A2 (B780)	Mean B	A1 (Phule Samarth)	A2 (B780)	Mean B
1	B1 (KNO_3 @ 2%)	12.26	12.23	12.25	5.18	5.12	5.15
2	B2 (TiO_2 @ 500ppm)	12.19	12.17	12.18	5.05	4.99	5.02
3	B3 (PEG - 1MPa)	12.12	12.09	12.11	4.98	5.09	5.04
4	B4 (Salicylic acid @ 50ppm)	12.03	11.97	12.00	4.94	5.11	5.03

5	B5 (*Psuedomonas* @1%)	11.96	12.12	12.04	4.85	4.97	4.91
6	B6 (Water)	11.82	11.93	11.88	4.90	5.02	4.96
	Mean A	12.06	12.09		4.98	5.05	
	C.D. @ 1% level	0.014	0.024	0.034	0.014	0.023	0.033
	S.E.(m)	0.005	0.008	0.012	0.005	0.008	0.011

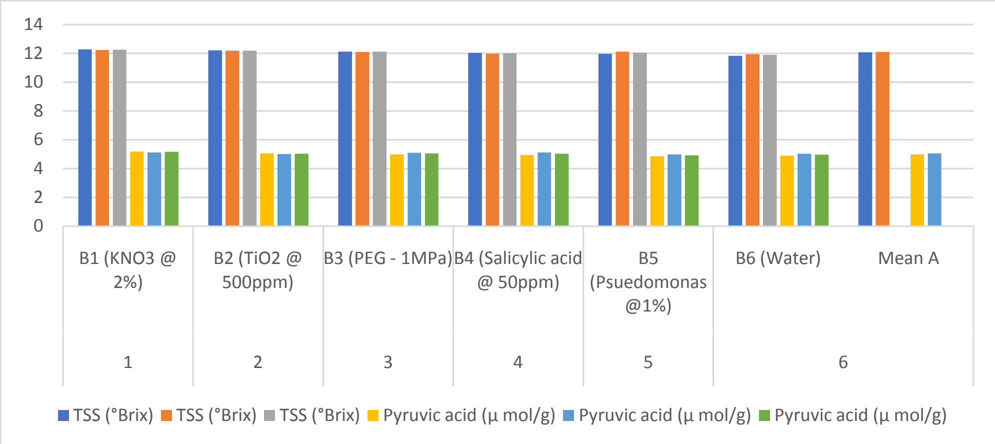

Figure 3. Influences of Seed Priming on Quality Parameters in Onion Cultivation

CONCLUSION

In this comprehensive study of priming effects on onion traits, several advantages were evident across various priming agents. TiO_2 @500ppm priming consistently outperformed in various aspects, including time for maximum radicle emergence, germination rates (both initial and final counts), plumule and radicle lengths, vigour index I and II, and mortality percentage. KNO_3 @2% priming, on the other hand, demonstrated its effectiveness in promoting seedling dry weight, TSS and pyruvic acid levels. These findings highlight the potential of tailored seed priming strategies to drive targeted enhancements in onion cultivation and yield.

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