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Comparative Evaluation of Germination Traits of Hybrid and Open Pollinated Tomato Varieties under Potassium Nitrate Seed Priming

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ABSTRACT

In order to assess the performance of two tomato varieties, Srijana and Suman, under seed priming with potassium nitrate (KNO_3) at four different concentrations 0%, 0.5%, 1%, and 1.5% the experiment was conducted in the Agronomy Laboratory of the College of Natural Resource Management, Bardibas, Mahottari. Three replications of the two types were set up in a completely randomized design. A number of metrics, such as germination percentage, mean germination rate, mean germination duration, root and shoot length, root-to-shoot ratio, and vigor index, were used to evaluate seed performance. Two-way ANOVA was used to evaluate the data. The length of the roots and shoots varied significantly across treatments, according to the data. The Srijana variety performed better than the others overall, with a germination rate of 90.67%, a mean germination duration of 4.67 days, a root length of 4.88 cm, and a shoot length of 6.43 cm. The best priming treatments were 0.5% and 1% KNO_3. These findings demonstrate how many tomato cultivars respond to seed priming and demonstrate how KNO_3 priming can improve early seedling growth and germination, ultimately leading to higher tomato output.

Keywords: Tomato, Seed priming, KNO_3, Performance

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INTRODUCTION

Tomatoes (*Lycopersicum esculentum*), a commercial vegetable crop in Nepal, are primarily grown in open fields in the foothills, inner Terai, and Terai during the winter and as an off-season crop inside covered structures like plastic tunnels during the summer and rainy seasons in the mid-hills (Wagle et al 2024). With a total cultivated area of 22,911 hectares, tomatoes are the third most popular fresh vegetable crop in Nepal, behind cauliflower and cabbage (MoALD 2023). For commercial production, tomato seeds are sown directly in the field rather than being transplanted (Seth 2023). For annual crops like tomatoes, rapid and consistent field emergence is essential to boosting production quality and ensuring profit. Numerous factors, including temperature, salt, dryness, heavy metals, and others, affect seedling germination and emergence (Thapa et al 2020).The key factor limiting tomato seed germination is the endosperm, which must weaken and rupture before germination can start. Therefore, improving the physiological condition of seeds is crucial for improving germination and the following growth of seedlings (Sushma et al 2023). Seed priming is a pre-sowing technique that boosts germination and produces strong, homogeneous seedlings resistant to field stresses (Gyawali et al 2025). Seed priming is a simple, economical, and effective way to increase crop germination and yield (Adhikari et al 2021). The exogenous administration of priming compounds to the seeds greatly aids in the pre-sowing achievement of germination stages. Furthermore, it has been demonstrated that seed priming is an effective way to influence certain aspects related to photosynthesis, an essential stage in plant growth and development (Habibi et al 2024).

While seed priming has been shown to improve tomato germination, nothing is known about Nepalese varietal reactions to potassium nitrate priming. Many studies have been done and published in the past regarding the effects of priming agents on tomato seed germination and growth. However, there aren't many studies conducted in Nepal on priming agents like KNO_3 on vegetables like tomato. Therefore, the present study was conducted to

close this gap and evaluate the effects of exogenously applied KNO_3 (0%, 0.5%, 1.0%, and 1.5%) as seed priming agent in two different tomato cultivars, Srijana and Suman.

MATERIALS AND METHODS

Experimental site

This experiment was conducted in the laboratory of College of Natural Resource Management, Bardibas, Mahottari in July, 2023.

Plant materials

Hybrid variety, Srijana and an open pollinated variety, Suman was used for the study. Srijana is the single hybrid variety of tomato developed through cross between HRD- 1 (female line) and HRD-17 (male line). The varieties were collected from one of the agrovet of Bardibas, Mahottari. The tomato cultivars Srijana and Suman were chosen due to its wide cultivation in Nepalese farming system. However, their early development behavior and seed vigor are different. These two cultivars made it possible to compare the effects of seed priming alone on early seedling development and germination performance.

Experimental design and treatment details

Prior to priming, one hundred tomato seed from each cultivar were counted and then primed with 0.5%, 1%, 1.5% (weight/volume) KNO_3 for 24 hours at room temperature and 25 seeds remained unprimed. Following the priming with KNO_3 concentrations, the filter paper was placed over the clean petridishes. After priming for the prescribed duration, the seeds were dried back under shaded conditions for 1 hour in room temperature and the seeds were made ready for further use. For each KNO_3 treatment combination, the 75 seeds were divided into 3 groups (25 each) and used as replication for each treatment. Non primed tomato seeds were maintained as the controlled for comparison making the total of 24 experimental units. Each of 25 seeds were s placed on Petri dishes over the moist filter papers at room temperature.

A 24-factorial experiment with 2 tomato varieties (Srijana and Suman) and 3 levels, 0.5%, 1%, 1.5% (weight/volume) of KNO_3 alongside a controlled (non-primed) comprising of total of 8 treatments combination was conducted. The laboratory experiment was laid out in a Completely Randomized Design (CRD) with 3 replications.

Table 1. Interaction between varieties (V1) and Priming with KNO_3 concentration (P)

Components	0.5 % concentration (P1)	1% Concentration (P2)	1.5% concentration (P3)	Controlled/ non-primed (P4)
Variety (V1) Srijana	V1P1	V1P2	V1P3	V1P4
Variety (V2) Suman	V2P1	V2P2	V2P3	V2P4

Table 2: Treatment details

Treatment (V×P)	Rep 1	Rep 2	Rep 3
V1P1= 1	1	7	8
V1P2=2	2	8	7
V1P3=3	3	6	5
V1P4=4	4	2	6
V2P1=5	5	1	4
V2P2=6	6	3	2
V2P3=7	7	4	1
V2P4=8	8	5	3

Data collection

Germination Test

Germination was observed daily and data were collected on 3 days interval. Germination percentage/final germination percentage/germinability (GP%) measures the germination capacity and was computed as shown below (Adhikari et al 2021)

$GP\% = Ng/Nt$ …….. (Eq.1)

Where Ng is the number of germinated seeds and Nt is the total number of seeds.

Mean germination Time (MGT) (day): Mean Germination Time was calculated according to the equation (Adhikari et al. 2021):

$MGT\ (day) = \sum Dn/\sum n$ …….(Eq.2)

where n is the number of seeds, which were germinated on day D and D is the number of days counted from the beginning of germination.

Mean Germination Rate (MGR/days): Measures the germination rate and was computed according to the formula as suggested by:
MGR/day = 1/MGT ……. (Eq.3)
It is the inverse of mean germination time MGT (Ranal et al 2009). .

Shoot length (SL) (mm): Shoot length was measured for each experimental unit from five randomly selected emerged seedlings on the last count. The main of the five plants was used for statistical analysis (Mebratu 2022)

Root length (RL) (mm): Root length was measured for each experimental unit from five randomly selected emerged seedlings on the last count. The main of the five plants was used for statistical analysis (Mebratu 2022)

Root to Shoot Ratio: The root to shoot ratio is the measurement of the amount of plant tissue with supportive function (root) compare to the amount of plant tissue with growth function.

Vigor Index (VI): The sum total of those properties of seed which determine the level of activity and performance of the seed or seed lot during germination and seedling emergence (Hyder et al. 2020). It is calculated as:

VI= (Shoot length+ Root Length) × GP% …….. (Eq. 4)

Statistical analysis
Data on germination parameters and measured attributes were subjected to a two-way analysis of variance (ANOVA) (2 varieties × 4 KNO_3 levels) using Genstat (15th edition). Treatment mean comparison was carried out using the procedure of least significant difference (LSD) test at 5% level of probability.

RESULTS AND DISCUSSION

Tomato variety, Srijana showed better performance with GP% (90.67%), MGT with (4.667), RL with 4.875cm, SL (6.425 cm) and VI with 10.23 than variety Suman. However, variety Suman had higher MGR with: 0.22 days than variety Srijana (Table 3). Tomato seeds primed with 1%KNO_3 (94.67) showed better germination performance followed by 0.5%, 1.5% and control. Seeds primed with 0.5%KNO_3 showed shorter MGT followed by control, 1% and 1.5% concentration. Potassium Nitrate concentration at 0.5% showed higher means for MGR values than the rest of the treatments. An increase in Root length and Shoot length as a result of seed priming with 1% KNO_3 has been reported in different varieties of tomato. The seeds primed with 1%KNO_3 showed the highest SL followed by 0.5%, control and 1.5%. The RL:SL was found to be the highest in seeds primed with 0.5% followed by 1%, 1.5% and control. Similarly, VI was highest in seeds primed with 1% followed by 0.5%, 1.5% and control (Table 3). Furthermore, the vigor and germination potential of tomato seeds treated with 50 millimoles of KNO_3 significantly improved (Ali et al 2020).

Similar research indicated that cucumber seeds pretreated with KNO_3 can protect plants from moisture stress and increase their tolerance to dehydration. The germination rate, reproductive parameters, and yield of rapeseed were changed by hydro and KNO_3 priming (Thapa et al 2025). In comparison to other priming techniques performed by Choudhury and Bordolui (2022), the results show that seed priming with 100 ppm KNO_3 for 8 hours was the most successful treatment, resulting in superior germination, improved seedling growth, higher vigor, and a shorter time to germination.

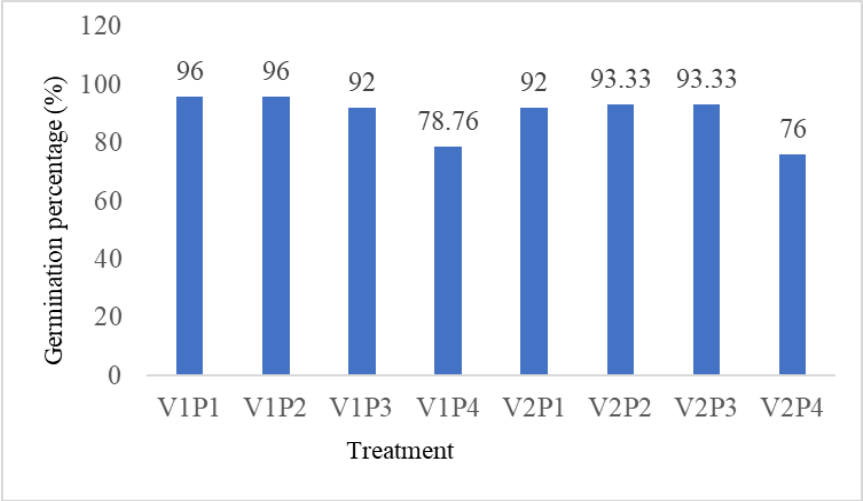
Tomato seed priming with KNO_3 affected the germination percentage, RL, SL, VI of the seed. Seed primed with KNO_3 performed better than non-primed /control. This indicates that the seed priming is very important factor that affects the germination parameters. The result showed that seed priming under 0.5% and 1% concentration of KNO_3 performed well on both of the varieties (Srijana and Suman). Our findings are similar to other studies, in which the tomato seeds primed with 1% KNO_3 performed better than other concentration and control (Mebratu 2022) Likewise, the effect of seed priming on different concentration of KNO_3 on pattern of seed imbibitions and germination of rice improved seed germination and increased both the speed and uniformity at 1% KNO_3 concentration (Ruttanaruangboworn et al 2017).

Table 3: Effect of priming with KNO_3 on germination parameters, shoot length and root length of tomato varieties

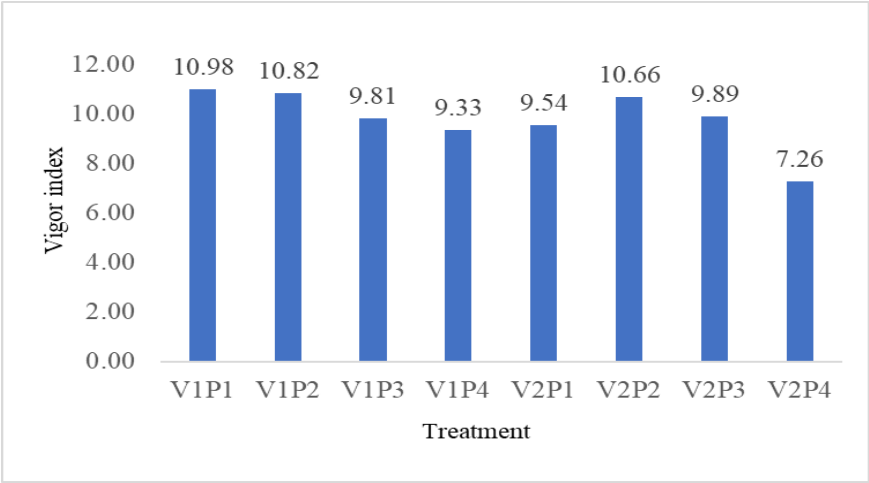
Main effect Variety (V)	GP%	MGT	MGR	SL	RL	RL:SL	VI
V1	90.67	4.667	0.21	6.425	4.875	0.763	10.23
V2	88.67	4.608	0.22	6.230	4.255	0.682	9.34
SEm(±)	0.577	0.0603	0.0027	0.1388	0.0732	0.025	0.185
LSD (5%)	1.731*	NS	NS	NS	0.219***	0.053**	0.555**
Priming with KNO_3 (P)							
Control	77.33b	4.524a	o.2211a	6.25a	4.44b	0.708a	8.29c
0.5%	94a	4.597a	0.2179a	6.3a	4.6ab	0.734a	10.26ab
1%	94.67a	4.631a	0.2166a	6.56a	4.78a	0.729a	10.74a
1.5%	92.37a	4.797a	0.2086a	6.19a	4.43b	0.718a	9.85b
SEm(±)	0.816	0.085	0.0038	0.196a	0.103	0.035	0.262
LSD (5%)	2.448***	NS	NS	NS	NS	NS	0.785***
V×P	3.462	NS	NS	NS	0.4387***	0.1067**	1.11*
CV%	2.2%	4.5%	4.4%	7.6	5.6	8.5	6.6%
Grand Mean	89.67	4.64	0.2161	6.327	4.565	0.723	9.79

Treatments mean followed by the common letter (s) are non-significantly different with each other based on DMRT at 5% level of significance. NS = Not significant, * = Significant at p<0.05, ,** = Significant at p<0.01,*** = Significant at p<0.001), LSD= Least significant difference, CV= Coefficient of variation, GP% =Germination Percent), MGT= Mean Germination Time, MGR =Mean Germination Rate, RL = Root Length (mm) , SL=Shoot Length (mm), VI =Vigor Index.

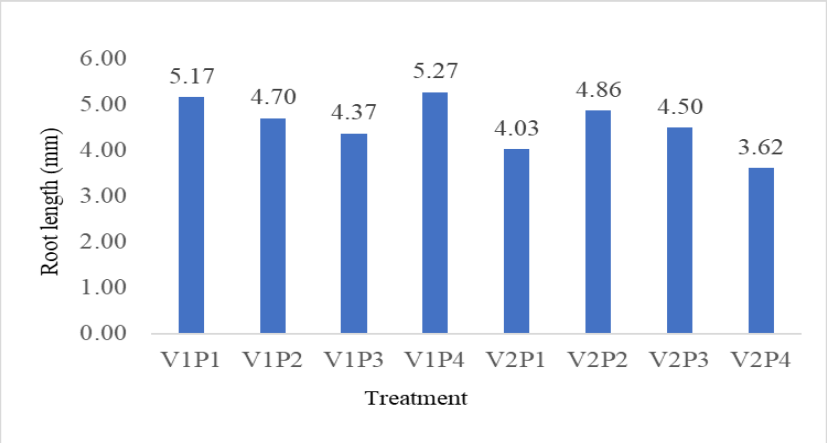
A. Treatments vs Germination percentage



B. Treatments vs Vigor Index



C. Treatments vs Root length



D. Treatment vs Root to shoot length

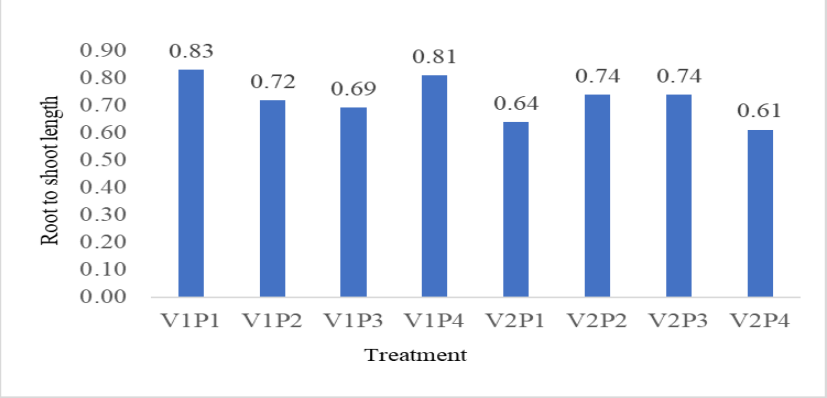


Fig 1. A. Interaction effect of different treatments on GP%, B. Interaction effect of different treatments on VI, C. Interaction effect of different treatments on RL:SL, D. Interaction effect of different treatments on RL)

The highest GP% (96%) was observed from the interaction of the Srijana variety with 0.5% concentration and was statistically at par with the interaction of the variety Srijana at 1% concentration. In contrast, the lowest GP% was observed from the interaction of variety Suman at control.

Table 4. Interaction effect of tomato varieties (V) and priming with KNO_3 concentration for germination percentage, root length and vigour index

Combination	GP%	RL:SL	VI	RL
Srijana+0.5%KNO_3 (V1P1)	96^{a}	0.831^{a}	10.976^{a}	5.167^{a}
Srijana+1% KNO_3 (V1P2)	96^{a}	0.718^{abcd}	10.816^{a}	4.7bc
Srijana+1.5% KNO_3 (V1P3)	92^{b}	0.693^{bcd}	9.813^{abc}	4.367^{cd}
Srijana+Control (V1P4)	78.67^{c}	0.808^{ab}	9.327^{c}	5.267^{a}
Suman+0.5%KNO_3 (V2P1)	92^{b}	0.638^{cd}	9.537^{bc}	4.033^{de}
Suman+1%KNO_3 (V2P2)	93.33^{ab}	0.740^{abc}	10.66^{ab}	4.86^{ab}
Suman+1.5%KNO_3 (V2P3)	93.33^{ab}	0.740^{abc}	9.888^{abc}	$4.5b^{c}$
Suman+Control (V2P4)	76^{c}	0.611^{d}	7.261^{d}	3.62^{e}
LSD (0.05)	NS	0.1067^{**}	1.11^{*}	0.4387^{***}

Treatments mean followed by the common letter (s) are non-significantly different with each other based on DMRT at 5% level of significance, LSD= Least significant difference. RL=Root length (mm), SL= Shoot length(mm), VI=Vigor index

The highest RL: SL (0.831) was observed from the interaction of the variety Srijana at 0.5% KNO_3 and the lowest RL: SL was observed from the interaction of varieties Suman at control. The highest VI (10.976) was observed from the interaction of the Srijana at 0.5% concentration and lowest VI was observed from the interaction of variety Suman at control. The highest RL (5.167) was observed from the interaction of Srijana at 0.5% concentration and lowest from the interaction of variety Suman at control. (Badu et al 2022) reported that KNO_3 0.5% was statistically on par with GA3 and hydropriming in the case of root length, it was found to be more effective in increasing the root and plumule length of cucumbers.

CONCLUSION

In conclusion, the varieties differed significantly in germinated parameters. Among the tested varieties, 'Srijana' exhibited superior performance, with GP% of 90.67%, MGT of 4.667 days, a Root Length of 4.87 cm, and a Shoot Length of 6.42 cm. Based on statistical analysis, the tomato seeds primed with 0.5% KNO_3 yielded the best results of germination traits, followed by 1% KNO_3. The study provides the existence of variation for tomato varieties in response to priming agents and indicated the possibility of enhancing seed germination in tomatoes for better productivity. A significant interaction effect was observed only for root length, root to shoot length ratio and vigor index, indicating that tomato varieties responded differently in root and shoot growth under varying rates of KNO_3.

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AUTHORS' CONTRIBUTION

Aishwarya, Alisha and Ankita conceptualized the study, conducted the laboratory experiment, collected data, and drafted the manuscript. Purnima, Shrisha and Rachana assisted in experimental work, data recording, and preliminary analysis. Abhishek Shrestha supervised the research, provided technical guidance, reviewed the methodology, and critically revised the manuscript for intellectual content. All the authors read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors have no any conflict of interest to disclose.

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