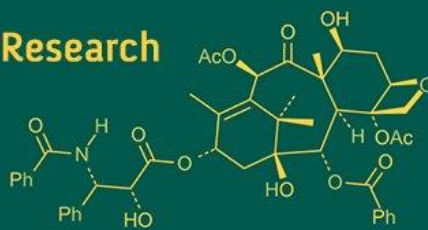


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Influence of seed priming on crop establishment, pheno-physiological and yield attributing traits in greengram [*Vigna radiata* (L.) R. Wilczek]

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Abstract

The field experiment was conducted during *kharif* 2025 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka, to assess the influence of different seed priming treatments on crop establishment, phenological, physiological attributes and productivity traits in greengram [*Vigna radiata* (L.) R. Wilczek] cv. DGGV 2. Twelve treatments, comprising an untreated control, hydropriming, nutrient priming with sodium molybdate dihydrate, hormonal priming with salicylic acid and gibberellic acid, halopriming with calcium chloride, potassium chloride and potassium nitrate, and biopriming with Rhizobium, phosphorus solubilizing bacteria, mycorrhiza and a rhizosphere-based consortium, were evaluated in a Randomized Complete Block Design with three replications. Seed priming significantly improved field emergence, plant height, relative chlorophyll content, number of branches per plant and all the yield attributing characters studied, whereas days to anthesis, days to 50 per cent flowering and days to physiological maturity remained statistically unaffected. Hormonal priming with gibberellic acid @ 100 ppm for 8 hours recorded the highest field emergence (89.40%), plant height at harvest (57.63 cm), number of branches per plant (6.50), number of pods per plant (29.93), number of seeds per pod (15.00), pod length (13.56 cm), seed yield per plant (13.25 g), seed yield (999 kg ha⁻¹), harvest index (28.39%) and test weight (thousand seed weight) (59.91 g), and remained statistically at par with potassium nitrate halopriming and rhizosphere-consortium biopriming for most of these characters. The untreated control recorded the lowest values for all the characters studied, and seed yield was improved by 16.7 per cent under gibberellic acid priming over the untreated control. The study revealed that hormonal priming with gibberellic acid, followed closely by potassium nitrate halopriming and biopriming with a rhizosphere-based consortium, effectively enhanced crop establishment, vegetative growth and productivity. This may be an effective pre-sowing seed enhancement strategy for improving productivity.

Keywords: Field emergence, gibberellic acid, greengram, seed priming, yield attributes

Introduction

Pulse crops occupy a vital position in global agriculture owing to their contribution to food and nutritional security, particularly in developing nations with predominantly vegetarian dietary patterns. The ability of pulses to fix atmospheric nitrogen through symbiotic association with soil microorganisms improves soil fertility and reduces dependence on synthetic nitrogen fertilizers. Greengram [*Vigna radiata* (L.) R. Wilczek] is a short-duration, warm-season pulse crop of the family Fabaceae that is widely cultivated across the tropical and subtropical regions of Asia, Africa and Australia, and its adaptability to diverse cropping systems makes it an important component of sustainable and resource-efficient farming (Keatinge *et al.*, 2011) ^[1]. Its short duration of 60-90 days renders it highly suitable for intensive and sequential cropping systems such as cereal-pulse rotations (Nair *et al.*, 2013) ^[2]. India contributes nearly 70 per cent of the global greengram production, with Karnataka being one of the leading producing states; however, the average national productivity of about 1009 kg ha⁻¹ remains considerably below the crop's potential (Anonymous, 2024) ^[3]. Climatic instability, particularly irregular rainfall and moisture fluctuations at the time of sowing, is one of the major constraints affecting field emergence and stand establishment of greengram in rainfed tracts, and moisture stress or heat stress during the reproductive phase further reduces pod set and seed yield (Prasad *et al.*, 2017) ^[4].

Since uniform and rapid emergence largely determines the efficiency with which a crop utilizes the available moisture, nutrients and radiation during the growing season, improving the physiological readiness of seed prior to sowing has become an important strategy for stabilizing productivity under such variable conditions. Seed priming, a pre-sowing hydration treatment followed by re-drying, activates metabolic repair processes and hastens germination (Singh *et al.*, 2015) [5]. Depending on the priming medium used, priming may be classified as hydropriming, nutrient priming, hormonal priming, halopriming or biopriming. Hormonal priming with growth regulators such as gibberellic acid and salicylic acid regulates the internal hormonal balance and enhances the synthesis of hydrolytic enzymes and antioxidant defence (Hayat *et al.*, 2010; Taiz *et al.*, 2015) [6, 7], halopriming with inorganic salts improves osmotic adjustment and membrane stability during imbibition (Farooq *et al.*, 2010) [8], while biopriming with beneficial microorganisms enhances early root colonization and nutrient solubilization, ultimately contributing towards better crop establishment (Patel *et al.*, 2018) [9].

Although several individual priming methods have been reported to improve germination and seedling vigour of greengram and other pulses, comparative information on their relative effectiveness on field emergence, vegetative growth and yield attributes under the specific agro-climatic conditions of northern Karnataka remains limited. Keeping this in view, the present investigation was undertaken to evaluate the influence of different seed priming treatments, comprising hydropriming, nutrient priming, hormonal priming, halopriming and biopriming, on crop establishment, pheno-physiological characters and yield attributing traits of greengram cv. DGGV 2, so as to identify the most effective and location-specific priming strategy for enhancing productivity of this important pulse crop.

Materials and Methods

A field experiment was conducted during *kharif* 2025 at Main Agricultural Research Station (MARS), University of Agricultural Sciences, Dharwad, Karnataka, situated in the Northern Transitional Zone (Zone 8) of Karnataka at 15° 49' N latitude and 74° 99' E longitude, at an altitude of 678 m above mean sea level. Fresh seeds of greengram variety DGGV 2 were obtained from AICRP on Kharif Pulses, MARS, UAS Dharwad. The experiment comprised twelve seed priming treatments (Table 1) and was laid out in a Randomized Complete Block Design (RCBD) with three replications. The recommended dose of fertilizer (25:30:0 N: P: K kg ha⁻¹) was applied through urea and diammonium phosphate, and seeds were sown at a spacing of 30 × 10 cm following recommended package of practices.

Seeds were subjected to the different priming treatments by soaking in the specified priming agent at a 1:2 (w/v) seed-to-solution ratio for the durations indicated in Table 1, after which they were surface dried with blotting paper and shade dried at room temperature (25-30 °C) for 24 hours to restore the original moisture content prior to sowing. The bioinoculants (Rhizobium, phosphorus solubilizing bacteria, mycorrhiza and rhizosphere-based consortium) were sourced from the Institute of Organic Farming, UAS Dharwad, while the chemical priming agents were obtained from the Department of Seed Science and Technology. Observations were recorded on field emergence (%) at 7 days after sowing (DAS); plant height (cm) at 30 DAS, 60

DAS and at harvest; relative chlorophyll content (SPAD Chlorophyll Meter Reading) at 30 and 60 DAS; days to anthesis, days to 50 per cent flowering and days to physiological maturity; number of branches per plant; and, after harvest, number of pods per plant, number of seeds per pod, pod length (cm), seed yield per plant (g), seed yield (kg ha⁻¹), harvest index (%) and test weight (g), following standard procedures. Field emergence was calculated as the percentage of seedlings emerged over the total number of seeds sown, and seed yield per hectare was computed from the net plot yield. Test weight was recorded on 1000 seeds per replication following ISTA procedure (ISTA, 2025) [11]. Data recorded from the field experiment were statistically analyzed by adopting Randomized Complete Block Design (Gomez and Gomez, 1984) [10], and treatment means were compared using the critical difference (CD) at 5 per cent level of significance.

Results

Seed priming exerted a significant and positive influence on crop establishment parameters, viz., field emergence and plant height at different growth stages of the crop (Table 2). Field emergence ranged from 72.80 per cent in the untreated control (T₁) to 90.98 per cent in potassium nitrate halopriming (T₈), with a mean of 83.33 per cent; potassium nitrate priming (T₈) recorded the highest field emergence, followed by gibberellic acid priming (T₅, 89.40%) and calcium chloride halopriming (T₆, 87.70%), an improvement of 25.0 per cent over the untreated control. Plant height followed a similar trend, with gibberellic acid priming (T₅) producing the tallest plants at 30 DAS (30.97 cm), 60 DAS (50.93 cm) and at harvest (57.63 cm), remaining statistically on par with the rhizosphere-consortium (T₁₂) and Rhizobium (T₉) biopriming treatments, while the untreated control recorded the shortest plants at all the stages, plant height at harvest being 21.3 per cent lower than in T₅.

Days to anthesis, days to 50 per cent flowering and days to physiological maturity were not significantly influenced by seed priming, although plants raised from gibberellic acid and potassium nitrate primed seed showed a marginal numerical advancement (30, 35 and 73 days, respectively) over the untreated control (32, 38 and 75 days) (Table 3). Relative chlorophyll content (SPAD), in contrast, was significantly enhanced by seed priming at both the growth stages studied, the highest SPAD values at 30 DAS (45.69) and 60 DAS (55.33) being recorded under biopriming with phosphorus solubilizing bacteria (T₁₀), representing an improvement of 28.9 and 24.1 per cent, respectively, over the untreated control.

Yield attributing characters, viz., number of branches per plant, number of pods per plant, number of seeds per pod and pod length, were all significantly influenced by the seed priming treatments (Table 4). Gibberellic acid priming (T₅) recorded the maximum number of branches per plant (6.50, 79.1% higher than the control), the maximum number of pods per plant (29.93) and, together with potassium nitrate priming (T₈), the maximum number of seeds per pod (15.00), while the longest pods (13.93 cm) were recorded under potassium nitrate priming (T₈).

Seed yield per plant, seed yield per hectare, harvest index and test weight were all significantly influenced by the seed priming treatments (Table 5). Gibberellic acid priming (T₅) recorded the highest seed yield per plant (13.25 g), seed yield (999 kg ha⁻¹), harvest index (28.39%) and test weight

(59.91 g), and remained statistically at par with potassium nitrate (T₈) and rhizosphere-consortium (T₁₂) biopriming for most of these traits. The untreated control recorded the lowest values for all four characters, and gibberellic acid priming improved seed yield by 16.7 per cent over the untreated control.

Discussion

Field emergence was greatly improved by seed priming, with potassium nitrate recording the highest value, followed closely by gibberellic acid and calcium chloride priming, while the untreated control recorded the lowest emergence. The superior field emergence under potassium nitrate priming may be attributed to nitrate ions acting as signalling molecules that promote germination, together with potassium helping to maintain cellular osmotic balance and improve water uptake during imbibition, findings that are in close accordance with those reported for potassium nitrate and calcium chloride priming in soybean (Jadhav *et al.*, 2017) [12] and for gibberellic acid priming in field pea (Vijay Raj *et al.*, 2021) [13].

Plant height at all the growth stages studied was consistently greater in plants raised from gibberellic-acid-primed seed, and biopriming with the rhizosphere consortium and Rhizobium also produced comparably tall plants. The pronounced increase in plant height under gibberellic acid priming may be attributed to its well-established role in stimulating cell division and elongation, together with improved mobilization of seed reserves during germination, a response comparable with earlier reports in field pea and mungbean (Vijay Raj *et al.*, 2021; Nandan *et al.*, 2021) [13, 14]. The favourable performance of biopriming treatments is likely associated with enhanced nutrient solubilization and increased production of plant growth-promoting substances by the beneficial microorganisms in the rhizosphere (Shete *et al.*, 2021) [15].

Days to anthesis, days to 50 per cent flowering and days to physiological maturity were not significantly influenced by seed priming, indicating that flowering and maturity of greengram cv. DGGV 2 are governed predominantly by the genetic makeup of the variety and prevailing environmental conditions, while the influence of seed priming was largely confined to seedling establishment and vegetative growth. A similar lack of significant response has been reported for hydropriming and related treatments, although some studies have recorded a numerical advancement in flowering under micronutrient priming in groundnut and calcium chloride priming in sunflower (Behera *et al.*, 2021; Narayanareddy and Biradarpatil, 2012) [16, 17].

Relative chlorophyll content was highest under biopriming with phosphorus solubilizing bacteria, which may be attributed to the ability of these bacteria to convert insoluble soil phosphorus into plant-available forms, thereby supporting chlorophyll biosynthesis and photosynthetic efficiency, a response consistent with the enhanced nutrient uptake reported following microbial inoculation of greengram (Choudhary *et al.*, 2019) [18]. The number of branches per plant, in contrast, was highest under gibberellic acid priming, likely on account of its stimulatory effect on cell division and elongation, a response similar to that reported for gibberellic-acid-primed blackgram (Gangaraju *et al.*, 2016) [19].

The number of pods per plant, number of seeds per pod and pod length were all significantly improved by seed priming, with gibberellic acid priming producing the highest number of pods and seeds per pod, and potassium nitrate priming producing the longest pods. The improvement in these yield-contributing characters under gibberellic acid priming may be attributed to enhanced vegetative growth and greater translocation of assimilates towards the developing reproductive structures, a response corroborated by similar findings in cowpea and mungbean (Arun *et al.*, 2020; Nandan *et al.*, 2021) [20, 14], whereas the superior pod length recorded under potassium nitrate priming may be linked to improved nutrient uptake and assimilate translocation, consistent with the beneficial role of nutrient-based priming reported in pigeonpea (Teggeili *et al.*, 2020) [21].

Seed yield, harvest index and test weight followed a similar trend, with the highest values consistently recorded under gibberellic acid priming, closely followed by potassium nitrate and rhizosphere-consortium biopriming, while the untreated control recorded the lowest values for all these characters. The improvement in seed yield can be viewed as the cumulative outcome of better field emergence, vigorous vegetative growth and superior yield-contributing characters recorded throughout the crop growth period, a pattern consistent with reports of enhanced yield under gibberellic acid priming in mungbean (Nandan *et al.*, 2021) [14] and Rhizobium biopriming in greengram (Jena *et al.*, 2026) [22]. The higher harvest index recorded under gibberellic acid priming reflects a greater proportion of total biomass being partitioned towards economic yield, a response also documented in gibberellic-acid-primed field pea (Vijay Raj *et al.*, 2021) [13], while hydropriming alone, which lacks hormonal, nutritional or microbial stimulation, failed to produce a measurable yield advantage over the untreated control, a response comparable to that observed in hydroprimed soybean (Aminu *et al.*, 2022) [23].

Table 1: Details in seed priming treatments followed.

Sl. No.	Treatments	Dosage	Duration (hr)
T ₁	Control	-	-
T ₂	Hydropriming	-	5
T ₃	Nutrient priming with sodium molybdate dihydrate	0.2 g L ⁻¹	5
T ₄	Hormonal priming with salicylic acid	10 ppm	5
T ₅	Hormonal priming with gibberellic acid	100 ppm	8
T ₆	Halopriming with calcium chloride	10 g L ⁻¹	14
T ₇	Halopriming with potassium chloride	10 g L ⁻¹	12
T ₈	Halopriming with potassium nitrate	10 g L ⁻¹	12
T ₉	Biopriming with Rhizobium	5 mL L ⁻¹	6
T ₁₀	Biopriming with phosphorus solubilizing bacteria	5 mL L ⁻¹	6
T ₁₁	Biopriming with mycorrhiza	10 g kg ⁻¹	4
T ₁₂	Biopriming with rhizosphere-based consortia	5 mL L ⁻¹	6

Table 2: Effect of various seed priming treatments on field emergence (%) and plant height (cm)

Treatment	Field emergence (%)	Plant height 30 DAS (cm)	Plant height 60 DAS (cm)	Plant height Harvest (cm)
T ₁	72.80 (58.56)	25.35	41.20	47.52
T ₂	78.77 (62.56)	26.23	41.47	49.13
T ₃	82.57 (65.32)	29.03	44.77	53.30
T ₄	81.53 (64.55)	27.93	43.33	51.13
T ₅	89.40 (71.00)	30.97	50.93	57.63
T ₆	87.70 (69.47)	28.73	46.30	52.80
T ₇	80.47 (63.77)	27.60	44.93	50.23
T ₈	90.98 (72.52)	28.23	45.23	51.87
T ₉	85.67 (67.76)	29.93	48.13	56.03
T ₁₀	83.63 (66.13)	29.33	47.63	53.87
T ₁₁	79.83 (63.31)	27.40	45.20	50.10
T ₁₂	86.63 (68.55)	30.33	48.47	56.33
Mean	83.33 (66.13)	28.42	45.63	52.47
S.Em±	2.65	1.09	1.75	2.01
CD at 5%	7.77	3.20	5.13	5.91

Figures in the parentheses indicate arcsine-transformed values; DAS: Days after sowing.

Table 3: Effect of various seed priming treatments on phenological and physiological traits.

Treatment	Days to anthesis	Days to 50% flowering	Days to physiological maturity	SPAD 30 DAS	SPAD 60 DAS
T ₁	32.00	38.00	75.00	35.45	44.59
T ₂	32.00	37.00	74.00	37.55	46.71
T ₃	31.00	36.00	74.00	45.51	52.11
T ₄	31.00	36.00	74.00	42.65	49.71
T ₅	30.00	35.00	73.00	45.11	50.96
T ₆	30.00	35.00	73.00	43.07	49.99
T ₇	31.00	36.00	74.00	41.11	49.43
T ₈	30.00	35.00	73.00	43.11	50.42
T ₉	30.00	35.00	73.00	45.51	52.90
T ₁₀	31.00	36.00	74.00	45.69	55.33
T ₁₁	31.00	36.00	75.00	37.98	48.95
T ₁₂	31.00	36.00	74.00	45.59	53.85
Mean	30.83	35.92	73.83	42.36	50.41
S.Em±	1.19	1.38	2.84	1.64	1.96
CD at 5%	NS	NS	NS	4.82	5.74

NS: Non-significant.

Table 4: Effect of various seed priming treatments on yield attributing traits.

Treatment	Branches per plant	Pods per plant	Seeds per pod	Pod length (cm)
T ₁	3.63	25.20	12.00	11.52
T ₂	4.07	25.48	12.20	12.08
T ₃	5.13	26.48	13.67	12.79
T ₄	4.93	26.22	13.33	11.92
T ₅	6.50	29.93	15.00	13.56
T ₆	5.07	27.08	14.07	13.32
T ₇	4.73	25.98	13.13	12.31
T ₈	4.93	29.57	15.00	13.93
T ₉	5.93	27.72	14.73	12.94
T ₁₀	5.80	26.48	13.93	11.78
T ₁₁	4.53	25.76	12.47	11.64
T ₁₂	6.20	28.35	14.87	13.71
Mean	5.12	27.02	13.70	12.63
S.Em±	0.21	1.04	0.53	0.49
CD at 5%	0.61	3.04	1.55	1.42

Table 5: Effect of various seed priming treatments on productivity and seed quality traits

Treatments	Seed yield per plant (g)	Seed yield (kg/ha)	Harvest index (%)	Test weight (g)
T ₁	11.27	856	24.89	53.35
T ₂	11.27	863	24.94	53.62
T ₃	11.47	869	27.63	55.63
T ₄	11.40	870	25.56	55.21
T ₅	13.25	999	28.39	59.91
T ₆	12.70	931	27.97	56.96
T ₇	12.30	866	25.21	54.40
T ₈	13.10	976	28.06	59.11

T ₉	12.57	954	27.97	57.80
T ₁₀	12.23	871	27.77	56.30
T ₁₁	12.03	864	25.03	54.26
T ₁₂	12.83	955	28.01	58.35
Mean	12.20	906	26.79	56.24
S.Em±	0.48	34.75	0.99	1.03
CD at 5%	1.39	101.92	2.89	3.02

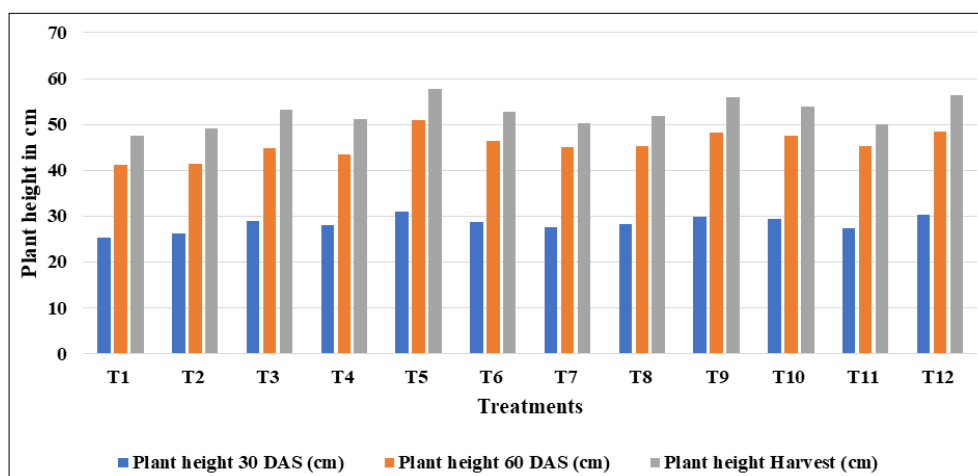


Fig 1: Influence of seed priming on plant height (cm)

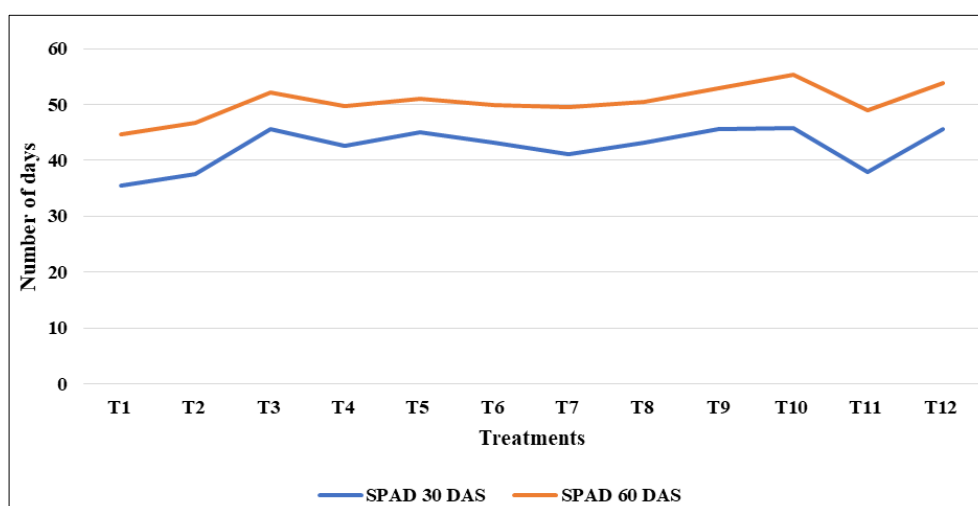


Fig 2: Influence of seed priming on relative chlorophyll content (SPAD value)

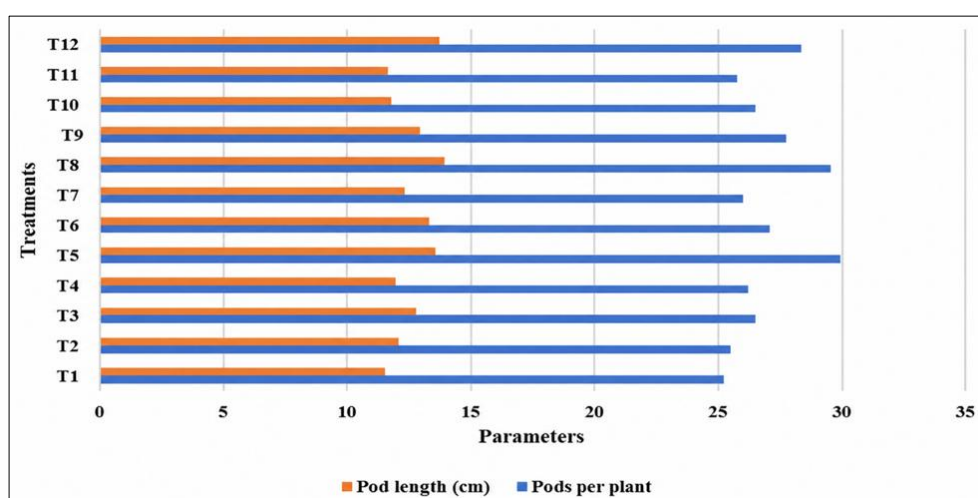


Fig 3: Influence of seed priming on number of pods and pod length (cm)

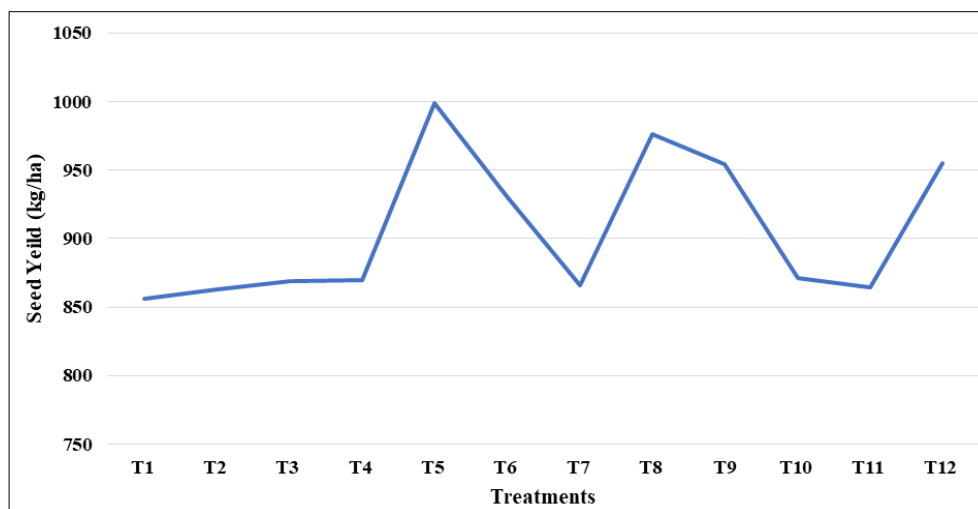


Fig 4: Influence of seed priming on seed yield (kg/ha)

Conclusion

The present investigation demonstrated that seed priming significantly improved field emergence, plant height, relative chlorophyll content, number of branches per plant and all the yield attributing characters of greengram cv. DGGV 2, without markedly altering its phenology. Hormonal priming with gibberellic acid @ 100 ppm for 8 hours was the most effective treatment, followed closely by halopriming with potassium nitrate @ 10 g L⁻¹ for 12 hours and biopriming with a rhizosphere-based consortium @ 5 mL L⁻¹ for 6 hours, resulting in an improvement of 16.7 per cent in seed yield over the untreated control. These treatments may be recommended as effective, low-cost, pre-sowing seed enhancement strategies to improve crop establishment and productivity of greengram under rainfed conditions of northern Karnataka.

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