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INFLUENCE OF SEED PRIMING AND BIO-FORMULATIONS ON GROWTH AND YIELD OF MUNGBEAN (*Vigna radiata* L. Wilczek)

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ABSTRACT

The present investigation was conducted during the *Kharif* seasons of 2023 and 2024 in sandy loam in texture at the Agronomy Farm, SKNCOA, Jobner (Rajasthan) to evaluate the effect of seed priming and foliar spray of bioformulations on growth and yield performance of mungbean [*Vigna radiata* (L.) Wilczek]. The experiment was laid out in a split plot design with three replications. The experiment consisted of two mungbean varieties *viz*., RMG-975 and RMG-492 and four seed priming treatments *viz*., control (no priming), hydro-priming with water, osmo-priming with KNO_3 @ 1% and hormonal priming with GA_3 @ 100 ppm in main plot, along with three foliar spray treatments *viz*., control (water spray), Panchgavya and Jeevamrit in sub plot. The results revealed that variety RMG-975 recorded significantly higher plant height, dry matter accumulation and leaf area at 50 DAS, pods plant^{-1} and seed yield (880 kg ha^{-1}) over RMG-492 in pooled analysis. Among seed priming treatments, hormonal priming with GA_3 @ 100 ppm recorded significantly higher plant stand (13.88 plants m^{-1} row length) at 25 DAS, plant height, dry matter accumulation and leaf area at 50 DAS, pods plant^{-1} and seed yield (929 kg ha^{-1}), which remained statistically at par with osmo-priming using KNO_3 @ 1%. Foliar spray of Panchgavya significantly improved growth and yield parameters and seed yield (871 kg ha^{-1}) over control and Jeevamrit.
***Keywords* :** Mungbean, GA_3, KNO_3, Panchgavya, Jeevamrit and seed yield

Introduction

Mungbean [*Vigna radiata* (L.) Wilczek] is one of the most important pulse crops cultivated in tropical and subtropical regions of the world. India is the largest producer and consumer of mungbean, where it occupies a prominent place in the pulse-based cropping system due to its short duration, drought tolerance and nitrogen-fixing ability. Mungbean seeds contain about 20–25% protein, 60–65% carbohydrates and appreciable quantities of vitamins and minerals, making it an important source of dietary protein for the vegetarian population (Nair *et al*., 2019). Besides nutritional importance, mungbean improves soil fertility through symbiotic nitrogen fixation and incorporation of crop residues into the soil.

Despite its significance, the productivity of mungbean in India remains low compared to its potential yield owing to poor crop establishment, erratic rainfall, moisture stress, nutrient deficiencies and inadequate crop management practices. Therefore, adoption of suitable agronomic interventions for improving germination, vegetative growth and yield attributes is essential for enhancing mungbean productivity under semi-arid conditions.

Seed priming is an effective pre-sowing technique that improves germination, seedling vigour and stress tolerance by controlled hydration of seeds prior to sowing. Primed seeds exhibit faster and more uniform emergence due to activation of metabolic processes and enhanced enzymatic activity during the initial phase of germination (Paparella *et al*., 2015). Among different priming techniques, hydro-priming, osmo-priming and hormonal priming have been widely reported to improve crop growth and productivity in pulse crops. Hormonal priming with gibberellic acid (GA_3) enhances seed germination, cell elongation, nutrient mobilization and photosynthetic efficiency, thereby promoting better vegetative growth and yield formation (Islam *et al*., 2021). Similarly, osmo-priming with potassium nitrate (KNO_3) improves water uptake, membrane stability and seed metabolic activity, leading to enhanced crop establishment and productivity.

In recent years, organic bioformulations such as Panchgavya and Jeevamrit have gained considerable importance in sustainable agriculture due to their eco-friendly nature and beneficial effects on soil health and crop productivity. Panchgavya is a fermented organic formulation prepared from cow-derived products including cow dung, cow urine, milk, curd and ghee. It contains essential nutrients, beneficial microorganisms, enzymes and growth-promoting substances such as auxins, gibberellins and cytokinins (Sreenivasa *et al.*, 2010). Jeevamrit is another fermented microbial culture prepared using cow dung, cow urine, pulse flour and jaggery, which enhances microbial activity and nutrient availability in soil. Foliar application of these bioformulations has been reported to improve plant growth, chlorophyll content, dry matter accumulation and yield attributes in pulse crops through enhanced physiological and biochemical activities. Therefore, the present investigation was undertaken to evaluate the effect of seed priming and foliar spray of bioformulations on growth parameters, yield attributes and seed yield of mungbean varieties under semi-arid conditions of Rajasthan.

Materials and Methods

The present investigation was conducted during the *Kharif* seasons of 2023 and 2024 at the Agronomy Farm, SKNCOA, Jobner (Rajasthan) to evaluate the effect of seed priming and foliar spray of bioformulations on growth and yield performance of mungbean [*Vigna radiata* (L.) Wilczek]. The experimental soil was sandy loam in texture, low in available nitrogen (128.68 and 131.72 kg ha^{-1}), medium in phosphorus (14.55 and 14.43 kg ha^{-1}) and potassium (148.64 and 149.0 kg ha^{-1}) with slightly alkaline reaction. The experiment was laid out in a split plot design with three replications. The experiment consisted of two mungbean varieties *viz*., RMG-975 and RMG-492 and four seed priming treatments *viz.*, control (no priming), hydro-priming with water, osmo-priming with KNO_3 @ 1% and hormonal priming with GA_3 @ 100 ppm in main plot, along with three foliar spray treatments *viz*., control (water spray), Panchgavya and Jeevamrit in sub plot.

Seed priming was carried out prior to sowing by soaking seeds in respective solutions for a predetermined duration followed by shade drying to attain original moisture content. The experimental field was prepared after pre-monsoon rainfall by ploughing, harrowing and leveling to ensure proper soil conditions. Recommended doses of nitrogen and phosphorus fertilizers were applied through urea and DAP. Seed priming treatments included KNO_3, GA_3 and water soaking, while seeds were also treated with Rhizobium, PSB and Trichoderma viride before sowing. Foliar application of Panchgavya and Jeevamrit was carried out at 30 DAS using a knapsack sprayer. In control plots, only water spray was applied. Mungbean varieties RMG-492 and RMG-975 were sown manually at a seed rate of 20 kg/ha with 30 cm row spacing. Necessary intercultural operations such as gap filling, thinning, hoeing and weeding were carried out to maintain optimum plant population and reduce weed competition. One life-saving irrigation was applied during the first year, whereas no irrigation was needed in the second year due to adequate rainfall. Foliar sprays of panchgavya (3%) and jeevamrit (7.5%) were applied at 30 DAS using a knapsack sprayer. The crop was harvested at maturity from the net plot area after excluding border rows. Biological yield, seed yield and haulm yield were recorded after threshing and winnowing.

Observations on growth parameters such as plant stand was counted at 25 DAS, while plant height, dry matter accumulation and leaf area were recorded at 50 DAS from five randomly selected plants. Leaf area was calculated using leaf length × maximum width × correction factor. Number of pods $plant^{-1}$ was counted at harvest and averaged. Seed yield was recorded plot-wise after threshing and converted into kg ha^{-1}.

The experimental data were statistically analyzed using analysis of variance (ANOVA) appropriate for split plot design as suggested by Gomez and Gomez (1984). The significance of treatment effects was tested at 5 per cent probability level and critical difference (CD) values were calculated for comparison of treatment means.

Result and Discussion

Growth Parameters

Effect of varieties

Among the varieties, RMG-975 recorded significantly higher plant height (43.16 cm pooled), dry matter accumulation (10.34 g plant^{-1} pooled) and leaf area (1515 cm² plant^{-1} pooled) at 50 DAS over RMG-492. However, plant stand m^{-1} row length at 25 DAS remained statistically non-significant during both the years as well as pooled analysis. The superiority of RMG-975 may be attributed to its better genetic potential, efficient nutrient absorption and higher photosynthetic efficiency, which ultimately enhanced vegetative growth and biomass production. The better performance of variety RMG-975 with respect to plant height, dry matter accumulation and leaf area clearly demonstrated its superior growth behaviour under the experimental conditions. The varietal superiority might be due to inherent genetic characteristics that enabled the plants to utilize available resources more efficiently (Kumar *et al.,* 2020). Greater leaf area in RMG-975 possibly enhanced light interception and photosynthetic activity, resulting in higher accumulation of assimilates and dry matter production (Taiz and Zeiger, 2010 and Meena *et al.,* 2015). In addition, the vigorous vegetative growth of this variety may have contributed to improved nutrient uptake and translocation within the plant system, ultimately leading to better biomass accumulation and crop growth (Ali *et al.,* 2014). Similar observations regarding varietal variation in growth parameters of mungbean were also reported by Patel *et al.* (2017), Kumar *et al.* (2020).

Effect of seed priming

Seed priming treatments significantly improved all growth parameters of mungbean over control during both years and pooled analysis. Hormonal priming with GA_3 @ 100 ppm recorded the highest plant stand (13.88 plants m^{-1} row length pooled), plant height (45.56 cm pooled), dry matter accumulation (11.07 g plant^{-1} pooled) and leaf area (1600 cm² plant^{-1} pooled), which remained statistically at par with osmo-priming using KNO_3 1% for most of the parameters. The lowest values were observed under control treatment. As compared to control, hormonal priming increased plant height, dry matter accumulation and leaf area by 35.43, 38.03 and 42.35 per cent, respectively, on pooled basis. Improvement in growth parameters due to priming treatments may be attributed to faster and uniform germination, activation of metabolic activities, enhanced enzyme activity and better nutrient mobilization during early crop growth stages.

Seed priming treatments substantially improved crop establishment and vegetative growth compared to untreated seeds. Primed seeds generally absorb water in a controlled manner, which activates pre-germinative metabolic processes without actual radicle emergence. This physiological advancement enables rapid germination and uniform seedling emergence under field conditions. The enhanced plant stand observed under priming treatments might therefore be associated with improved seed vigor and better synchronization of germination.

Among the priming treatments, GA_3 priming proved most effective in enhancing growth parameters. Gibberellic acid plays a vital role in stimulating hydrolytic enzymes such as α-amylase, which accelerate the breakdown of stored food materials into simpler compounds required for embryo growth. Enhanced enzyme activity and mobilization of seed reserves may have promoted rapid cell division and elongation, leading to taller plants and greater biomass accumulation (Khan *et al.,* 2009). Moreover, GA_3 is known to improve membrane permeability and nutrient absorption, which could have contributed to increased dry matter production and leaf expansion (Taiz and Zeiger, 2010). The larger leaf area under hormonal priming might have enhanced photosynthetic efficiency and carbohydrate synthesis, thereby supporting vigorous crop growth throughout the growing period (Basra *et al.,* 2005).

Osmo-priming with KNO_3 also significantly improved growth attributes over control. Potassium nitrate acts both as a nutrient source and osmotic agent, helping seeds maintain better hydration and metabolic activity during germination (Harris *et al*., 2001). Nitrogen supplied through KNO_3 may have promoted chlorophyll formation and vegetative growth, while potassium regulates stomatal activity and enzyme activation. These physiological processes might have collectively enhanced seedling vigor and vegetative growth of mungbean (Ashraf and Foolad, 2005). These physiological functions collectively improved plant growth and biomass accumulation. Similar beneficial effects of seed priming on crop growth and seedling vigor were reported by Harris *et al.* (2001) and Farooq *et al*. (2019).

Effect of bio-formulations

Foliar spray of bio-formulations also exerted significant influence on growth attributes except plant stand, which remained non-significant. Among the bio-formulations, foliar spray of Panchgavya recorded significantly higher plant height (43.56 cm), dry matter accumulation (10.40 g plant^{-1}) and leaf area (1506 cm² plant^{-1}) on pooled basis at 60 DAS over control and Jeevamrit. The lowest values were recorded under control treatment. The experimental data indicated that varieties did not exert significant influence on plant stand m^{-1} row length during both years and pooled analysis. Enhancement in growth parameters under

Panchgavya application may be due to the presence of growth-promoting substances, micronutrients, beneficial microorganisms and naturally occurring hormones, which improved physiological activities and vegetative growth of mungbean plants (Somasundaram *et al*., 2007; Yadav and Lourduraj, 2006; Devakumar *et al.*, 2014).

The positive response of mungbean to foliar application of Panchgavya may be attributed to its rich composition of nutrients, beneficial microorganisms and naturally occurring plant growth regulators. Panchgavya contains auxins, gibberellins, amino acids, vitamins and enzymes that stimulate physiological and biochemical activities in plants (Devakumar *et al*., 2014). Foliar application ensures rapid absorption of these substances through leaf surfaces, thereby improving metabolic efficiency and vegetative growth. Increased plant height and leaf area under Panchgavya treatment might be due to enhanced chlorophyll synthesis and improved photosynthetic activity, which ultimately resulted in greater dry matter accumulation (Somasundaram *et al.*, 2007 and Natarajan, 2007).

Panchgavya application could be the stimulation of microbial activity around the phyllosphere and rhizosphere, leading to better nutrient availability and uptake. The organic compounds present in Panchgavya may also improve hormonal balance within plants, resulting in enhanced cell multiplication and tissue development, as reported by Selvaraj (2003) and Swaminathan *et al*. (2007). Jeevamrit also showed improvement over control because of its microbial richness and nutrient content; however, its effect was comparatively lower than Panchgavya, possibly due to differences in nutrient concentration and growth-promoting substances. Similar findings regarding the beneficial influence of liquid organic formulations on crop growth and nutrient uptake were also reported by Gore and Sreenivasa (2011). The findings of the present investigation are in close conformity with the reports of Somasundaram *et al*. (2007), who observed increased vegetative growth and biomass production in mungbean with Panchgavya application. Similar results were also documented by Yadav and Lourduraj (2006), who reported enhanced crop growth due to organic bio-formulations.

Pods/plant and seed yield

Effect of varieties

Among the varieties, RMG-975 recorded significantly higher number of pods plant^{-1} (21.23 pooled) over RMG-492 (18.26 pooled). The higher number of pods plant^{-1} in variety RMG-975 might be due to its superior genetic potential and better translocation of photosynthates towards reproductive structures (Kumar *et al.,* 2020). Another possible reason could be the enhanced vegetative growth and larger leaf area, which improved photosynthetic efficiency and supported greater flower and pod formation (Taiz and Zeiger, 2010).

Among the varieties, RMG-975 recorded significantly higher seed yield (880 kg ha^{-1} pooled) compared to RMG-492 (760 kg ha^{-1} pooled). The significantly higher seed yield recorded under variety RMG-975 might be due to its better genetic potential and superior yield attributes, particularly higher pod production and efficient assimilate translocation towards seeds (Ali *et al*., 2014). Another possible reason could be improved nutrient uptake and greater dry matter accumulation, which ultimately enhanced reproductive efficiency and seed filling (Patel *et al*., 2017).

Effect of seed priming

Among seed priming treatments, hormonal priming with GA_3 @ 100 ppm recorded the maximum number of pods plant^{-1} (22.27), which remained statistically at par with osmo-priming using KNO_3 1% (21.64). The minimum number of pods plant^{-1} (16.18) was recorded under control treatment. The increase in pods plant^{-1} under seed priming treatments may be attributed to better germination, vigorous seedling establishment and enhanced physiological activities throughout the crop growth period (Farooq *et al.,* 2019). Hormonal priming with GA_3 proved superior because gibberellic acid stimulates cell division, flowering and assimilate mobilization, which ultimately enhanced pod setting and reproductive growth (Bewley and Black, 1994; Basra *et al.,* 2005). Another possible reason for increased pod formation under GA_3 priming could be improved photosynthetic activity and efficient source-to-sink translocation of metabolites (Khan *et al.,* 2009).

Osmo-priming with KNO_3 also significantly improved pods plant^{-1} over control. Potassium nitrate enhances seed metabolism, chlorophyll synthesis and nutrient uptake during early growth stages, which positively influences reproductive development (Ashraf and Foolad, 2005). In addition, potassium regulates enzyme activation and translocation of assimilates, thereby improving pod formation and reproductive efficiency (Marschner, 2012).

Among seed priming treatments, hormonal priming with GA_3 @ 100 ppm produced significantly higher seed yield (929 kg ha^{-1} pooled), which remained statistically at par with osmo-priming using KNO_3 1% (902 kg ha^{-1} pooled). The lowest seed yield (665 kg ha^{-}

[1] pooled) was recorded under control treatment. The improvement in seed yield due to seed priming treatments may be attributed to enhanced seed vigor, better crop establishment and improved growth parameters throughout the growing season (Farooq *et al.*, 2019). Hormonal priming with GA_3 recorded the highest seed yield because gibberellic acid promotes enzyme activity, cell elongation and mobilization of stored metabolites, leading to improved flowering, pod development and seed filling (Basra *et al.*, 2005; Taiz and Zeiger, 2010). Another possible reason could be enhanced photosynthetic efficiency and effective translocation of assimilates from source to sink under GA_3 priming (Khan *et al.*, 2009). Higher seed yield under osmo-priming with KNO_3 might be due to improved nutrient availability and enhanced chlorophyll synthesis, which promoted better vegetative and reproductive growth (Ashraf and Foolad, 2005). Potassium also plays an important role in carbohydrate translocation and enzyme activation, thereby improving seed development and final yield (Marschner, 2012).

Effect of bio-formulations

Foliar spray of Panchgavya produced significantly higher number of pods plant^{-1} (21.01) over control (18.49), while Jeevamrit recorded intermediate values (19.73). Foliar application of Panchgavya significantly increased number of pods plant^{-1}. This might be due to the presence of naturally occurring growth regulators, nutrients, amino acids and beneficial microorganisms in Panchgavya, which stimulate flowering and reproductive growth (Natarajan, 2007). Another possible reason could be improved chlorophyll synthesis and photosynthetic activity, resulting in better assimilate partitioning towards pod development (Somasundaram *et al*., 2007; Selvaraj, 2003).

Foliar application of Panchgavya recorded significantly higher seed yield (871 kg ha^{-1}) over control (768 kg ha^{-1}), whereas Jeevamrit produced intermediate seed yield (820 kg ha^{-1}). The significant increase in seed yield under Panchgavya application might be due to the presence of growth-promoting substances, micronutrients and beneficial microorganisms that enhanced physiological and biochemical activities in plants (Swaminathan *et al.*, 2007). Another possible reason could be improved nutrient availability, enhanced flowering and better partitioning of assimilates towards reproductive organs, which ultimately resulted in higher seed yield (Gore and Sreenivasa, 2011).

Conclusion

Based on the pooled analysis of two years, it may be concluded that variety RMG-975 performed significantly better than RMG-492 with respect to growth parameters and seed yield of mungbean. Among seed priming treatments, hormonal priming with GA_3 @ 100 ppm proved most effective and recorded significantly higher plant height, dry matter accumulation, leaf area, pods plant^{-1} and seed yield, which remained statistically at par with osmo-priming using KNO_3 @ 1%. Hormonal priming with GA_3 increased seed yield by 39.70 per cent over control. Among foliar spray treatments, Panchgavya recorded significantly superior growth and yield attributes over Jeevamrit and control. Panchgavya enhanced seed yield by 13.41 per cent over control.

Therefore, cultivation of mungbean variety RMG-975 along with seed priming using GA_3 @ 100 ppm and foliar spray of Panchgavya may be recommended for obtaining higher productivity of mungbean under semi-arid conditions of Rajasthan.

Table 1 : Effect of seed priming and bioformulations on growth parameters of mungbean

Treatments	Growth parameters											
	Plant stand (m^{-1} row length)			Plant height (cm)			Dry matter accumulation (g plant^{-1})			Leaf area (cm^2 plant^{-1})		
	2023	2024	Pooled	2023	2024	Pooled	2023	2024	Pooled	2023	2024	Pooled
Varieties												
RMG-975	12.29	12.32	12.30	43.74	42.58	43.16	10.50	10.18	10.34	1521	1509	1515
RMG-492	12.34	12.21	12.27	39.09	38.42	38.76	9.44	9.01	9.23	1297	1285	1291
SEm±	0.22	0.19	0.15	0.79	0.75	0.55	0.14	0.14	0.10	27	27	19
CD (P=0.05)	NS	NS	NS	2.39	2.29	1.58	0.41	0.42	0.28	83	83	56
Seed Priming												
Control	9.99	10.10	10.04	33.89	33.38	33.64	8.22	7.82	8.02	1130	1118	1124
Hydro-priming (Water)	11.84	11.80	11.82	39.82	39.02	39.42	9.53	9.14	9.34	1343	1330	1337
Osmo-priming (KNO_3 1%)	13.51	13.31	13.41	45.77	44.69	45.23	10.90	10.50	10.70	1557	1546	1551
Hormonal-priming (GA_3 100 ppm)	13.91	13.85	13.88	46.19	44.94	45.56	11.24	10.91	11.07	1607	1594	1600
SEm±	0.31	0.28	0.21	1.11	1.07	0.77	0.19	0.20	0.14	39	39	27
CD (P=0.05)	0.95	0.83	0.60	3.38	3.24	2.24	0.58	0.60	0.40	118	118	80

CV (%)	10.77	9.52	10.16	11.42	11.18	11.31	8.13	8.73	8.42	11.68	11.81	11.74
Foliar Spray of Bioformulations												
Control	12.38	12.15	12.27	38.73	38.02	38.37	9.38	8.98	9.18	1308	1297	1303
Panchgavya	12.24	12.20	12.22	44.12	43.00	43.56	10.57	10.22	10.40	1515	1498	1506
Jeevamrit	12.31	12.45	12.38	41.40	40.49	40.95	9.96	9.59	9.77	1405	1395	1400
SEm±	0.22	0.22	0.13	0.90	0.82	0.50	0.16	0.15	0.09	33	33	19
CD (P=0.05)	NS	NS	NS	2.60	2.35	1.40	0.47	0.42	0.25	94	95	53
CV (%)	8.79	8.85	7.20	10.69	9.88	8.41	8.05	7.43	6.33	11.40	11.51	9.35

Table 2 : Effect of seed priming and bioformulations on pod plant^{-1} and seed yield of mungbean

Treatments	Yield attributes and yield					
	Pods plant^{-1}			Seed yield (kg ha^{-1})		
	2023	2023	2023	2023	2024	Pooled
Varieties						
RMG-975	21.33	21.13	21.23	904	855	880
RMG-492	18.38	18.13	18.26	777	742	760
SEm±	0.35	0.37	0.26	15	14	10
CD (P=0.05)	1.07	1.12	0.74	46	42	30
Seed Priming						
Control	16.38	15.97	16.18	687	644	665
Hydro-priming (Water)	19.04	18.74	18.89	801	763	782
Osmo-priming (KNO_3 1%)	21.71	21.58	21.64	926	878	902
Hormonal-priming (GA_3 100 ppm)	22.29	22.24	22.27	951	907	929
SEm±	0.50	0.52	0.36	22	20	15
CD (P=0.05)	1.52	1.58	1.05	65	60	42
CV (%)	10.69	11.25	10.97	10.85	10.49	10.68
Foliar Spray of Bioformulations						
Control	18.65	18.34	18.49	789	747	768
Panchgavya	21.07	20.95	21.01	893	850	871
Jeevamrit	19.85	19.61	19.73	841	798	820
SEm±	0.41	0.42	0.24	17	16	10
CD (P=0.05)	1.17	1.22	0.67	50	47	27
CV (%)	10.00	10.60	8.41	10.15	9.96	8.22

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References

Ali, E. A., Mahmoud, A. M. and El-Said, M. T. (2014). Effect of sowing dates and cultivars on yield and yield components of mungbean under newly reclaimed soil conditions. *Asian Journal of Crop Science*, ***6***(4), 346–357.

Ashraf, M. and Foolad, M. R. (2005). Pre-sowing seed treatment A shotgun approach to improve germination, plant growth and crop yield under saline and non-saline conditions. *Advances in Agronomy*, ***88***, 223–271.

Basra, S. M. A., Farooq, M., Tabassum, R. and Ahmad, N. (2005). Physiological and biochemical aspects of seed vigour enhancement treatments in fine rice (*Oryza sativa* L.). *Seed Science and Technology*, ***33***(3), 623–628.

Bewley, J. D. and Black, M. (1994). *Seeds: Physiology of development and germination* (2nd ed.). Plenum Press.

Devakumar, N., Rao, G. G. E., Shubha, S., Imrankhan, Nagaraj and Gowda, S. B. (2014). *Activities of Organic Farming Research Centre on bio-enhancers* (Bulletin No. 8, pp. 1–16). University of Agricultural Sciences.

Farooq, M., Usman, M., Nadeem, F., Rehman, H., Wahid, A., Basra, S. M. A. and Siddique, K. H. M. (2019). Seed priming in field crops: Potential benefits, adoption and challenges. *Crop and Pasture Science*, ***70***(9), 731–771.

Gomez, K. A. and Gomez, A. A. (1984). *Statistical procedures for agricultural research* (2nd ed.). John Wiley & Sons.

Gore, N. S. and Sreenivasa, M. N. (2011). Influence of liquid organic manures on growth, nutrient content and yield of tomato (*Lycopersicon esculentum* Mill.) in sterilized soil. *Karnataka Journal of Agricultural Sciences*, ***24***(2), 153–157.

Harris, D., Pathan, A. K., Gothkar, P., Joshi, A., Chivasa, W. and Nyamudeza, P. (2001). On-farm seed priming: Using participatory methods to revive and refine a key technology. *Agricultural Systems*, ***69***(1–2), 151–164.

Islam, M. S., Hasan, M. K., Islam, B., Renu, N. A., Hakim, M. A., Islam, M. R., Chowdhury, M. K., Ueda, A., Saneoka, H., Raza, M. A., Fahad, S., Barutçular, C., Çığ, F., Erman, M. and El Sabagh, A. (2021). Responses of water and pigments status, dry matter partitioning, seed production and yield traits to foliar application of GA_3 in mungbean

(*Vigna radiata* L.). *Frontiers in Agronomy*, ***2***, Article 596850.

Khan, H. A., Ayub, C. M., Pervez, M. A., Bilal, R. M., Shahid, M. A. and Ziaf, K. (2009). Effect of seed priming with NaCl on salinity tolerance of hot pepper (*Capsicum annuum* L.) at seedling stage. *Soil and Environment*, ***28***(1), 81–87.

Kumar, R., Meena, R. S. and Yadav, R. S. (2020). Performance of mungbean varieties under different agro-climatic conditions. *Legume Research*, ***43***(5), 690–694.

Marschner, P. (2012). *Marschner's mineral nutrition of higher plants* (3rd ed.). Academic Press.

Meena, R. S., Yadav, R. S. and Meena, V. S. (2015). Productivity and profitability of mungbean varieties under different management conditions. *Legume Research*, ***38***(3), 345–350.

Nair, R. M., Schafleitner, R., Kenyon, L., Srinivasan, R., Easdown, W. and Ebert, A. W. (2019). Genetic improvement of mungbean. *SABRAO Journal of Breeding and Genetics*, ***51***(1), 1–20.

Natarajan, K. (2007). Panchagavya for plant. In *Proceedings of the National Conference on Glory of Gomatha* (pp. 72–75). S. V. Veterinary University.

Paparella, S., Araújo, S. S., Rossi, G., Wijayasinghe, M., Carbonera, D. and Balestrazzi, A. (2015). Seed priming: State of the art and new perspectives. *Plant Cell Reports*, ***34***, 1281–1293.

Patel, J. S., Naik, M. R. and Patel, P. T. (2017). Performance of mungbean varieties under different fertility levels. *International Journal of Chemical Studies*, ***5***(4), 1234–1237.

Selvaraj, N. (2003). Panchagavya for plant. In *Proceedings of the National Conference on Glory of Gomatha* (pp. 72–75). S. V. Veterinary University.

Somasundaram, E., Sankaran, N., Meena, S., Thiyagarajan, T. M., Chandaragiri, K. and Panneerselvam, S. (2007). Response of mungbean to varied levels of Panchgavya (organic nutrition) foliar spray. *Madras Agricultural Journal*, ***94***(1–6), 169–172.

Sreenivasa, M. N., Naik, N. and Bhat, S. N. (2010). Beejamrutha: A source for beneficial bacteria. *Karnataka Journal of Agricultural Sciences*, ***17***(3), 72–77.

Swaminathan, C., Swaminathan, V. and Vijayalakshmi, K. (2007). *Panchagavya: Boon to organic farming* (pp. 20–28). International Book Distributing Co.

Taiz, L. and Zeiger, E. (2010). *Plant physiology* (5th ed.). Sinauer Associates.

Yadav, B. K. and Lourduraj, A. C. (2006). Effect of organic manures and Panchgavya spray on yield attributes, yield and economics of rice. *Crop Research*, ***31***(1), 1–5.