

Effect on Productivity and Profitability of Mungbean [*Vigna radiate* (L). Wilczek] through Foliar Spray of Stress Mitigation Chemicals and Seed Priming

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ABSTRACT

A field experiment was carried out at the experimental Farm, College of Agriculture, Jodhpur (Rajasthan) in the Kharif season 2022. The field experiment was laid out in Factorial Randomized Block Design (FRBD) with twelve treatment combinations and replicated thrice. The treatment combinations comprised with two varieties MH 421 and GM 7 (Factor A) and six stress mitigating chemicals (Factor B) namely control, seed priming with thiourea @ 500 ppm, seed priming with salicylic acid @ 75 ppm, seed priming with thiourea @ 500 ppm + foliar spray @ 500 ppm, seed priming with salicylic acid @ 75 ppm + foliar spray @ 75 ppm, seed priming with salicylic acid @ 75 ppm + foliar spray @ 75 ppm + 2% urea (FS) etc. Among the treatments mungbean variety 'MH-421' and stress mitigating chemicals thiourea @ 500 ppm + foliar spray @ 500 ppm at flower initiation stage (C3) had performed prominently with respect to growth, yield and economics.

Keywords: Mungbean, Variety, Stress mitigating chemicals, Thiourea

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INTRODUCTION

Pulses are a major protein source, especially for vegetarians. Mungbean, also known as golden gram or green gram, is widely cultivated in India's arid and semi-arid regions. Globally, it is the third most important pulse after chickpea and pigeon pea, and plays a key role in nutritional security in India. Mungbean is a short-duration legume grown in spring and kharif seasons and well suited under diverse cropping systems. It thrives under rainfed conditions, tolerates low humidity & high temperatures (27–30°C), and enhances soil fertility by fixing atmospheric nitrogen (Bangar et al., 2019). It is rich in protein (25%), carbohydrates, fibre, minerals, and essential amino acids such as lysine (460 mg/g) and tryptophan (60 mg/g). The major mungbean growing states include Rajasthan, Madhya Pradesh, Uttar Pradesh, Punjab, Haryana, Maharashtra, Andhra Pradesh, and Tamil Nadu. Rajasthan is the largest contributor (26%) of India's mungbean production, with 2.16 million ha area, 1.32 million tonnes production, and 610 kg/ha productivity (DES, 2022). Mungbean producing districts in Rajasthan are Nagaur, Jodhpur, Jaipur, Ajmer, Pali, Jalore, Sri Ganganagar, Tonk, Churu, Barmer, and Bikaner. In Western Rajasthan, abiotic stresses such as high temperature, low moisture, salinity, and poor soil fertility—limit productivity. Sandy loam soils, common in the kharif season, store little moisture and heat rapidly.

The arid region of western Rajasthan presents a unique challenge for mungbean cultivation due to nutrient deficiencies exacerbated by limited water availability and high temperatures. Addressing these challenges, foliar nutrition emerges as a potential solution to enhance nutrient

uptake efficiency and mitigate the impact of abiotic stress factors (Mehriya et al., 2025). Therefore, the objective of this study was to assess the effect of foliar nutrition on productivity and profitability of mungbean. Foliar feeding is often the most effective and economical way to improve plant nutrient deficiency. Supplemental nutrition plays a crucial role in increasing seed yield in pulses. Foliar application of nutrients is considered to be an efficient and economic method of supplementing the nutrient requirement of the crop which in turn leads to enhanced yield. Among stress-mitigating compounds, salicylic acid (SA) is an important phenolic phytohormone involved in signalling and defence responses against drought and diseases. Salicylic acid enhances seed germination, growth, photosynthesis, respiration, nodulation, and yield. Foliar application of SA improves stomatal regulation, dry matter accumulation, and chlorophyll content (Pandey and Lal, 2018), and acts as a key hormone and signal transmitter under abiotic stress. At flowering stage, if the abiotic stress is incurred, the crop automatically failed due to denature of protein which is used by the plant as an energy source (Al-Chammaa et al., 2019). Seed priming has high potential to promote crop resilience to climate change. At its most basic level, seed priming involves soaking seeds in water to promote germination. Seed germination is a crucial part of a plant's life cycle and is particularly susceptible to environmental stress. Priming seeds improves germination, emergence, field uniformity, and seed vigor. Seed priming is a method where seeds imbibe water, typically in the presence of a priming agent or other specifically imposed conditions (Farooq et al., 2019; Johnson et al. 2021). The method is relatively short in duration,

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allowing a seed to reach a pre-germinative metabolism but stops before reaching full germination.

Another stress mitigating chemical is thiourea belonging to a sulphhydryl compound, which has one –SH group and known for stimulating germination and also improving growth, yield attributes and water use efficiency of food grain crops under arid and semi-arid conditions (Waqas et al., 2019). Thiourea is an important molecule that can scavenge superoxide radicals (Jhansi and Dhingra, 2018). Thiourea contains sulphur (42.10%) and nitrogen (36.80%). Seeds priming and foliar spray of thiourea have been reported that not only enhance crop growth and development, but also improve dry matter partitioning in to final yield and also increase nutrient uptakes.

Thus, for efficient utilization of inherent potential of mungbean varieties up to the economic maxima with low cost technology including stress mitigating chemicals are the important deciding factors.

MATERIALS AND METHODS

Study Area

The experiment was carried out at Experimental Farm, College of Agriculture, Jodhpur (Rajasthan) which is situated at a distance of about 10 km from Jodhpur railway station. Geographically, it is located between 26o 15' N to 26o 45' N latitude and 73o 00' E to 73o 29' E longitude at an altitude of 231 meter above mean sea level (MSL). This region falls under agro-climatic zone IA (Arid Western Plains Zone) of Rajasthan. The soil of the experimental field was sandy-loam in texture, slightly alkaline in reaction (pH 8.1), non-saline in conductivity (EC 0.12 dS/m), low in organic carbon (0.17%) and available nitrogen (165.0 kg/ha), while medium in available phosphorus (22.0 kg P₂O₅/ha) and potassium (310 kg K₂O/ha). However, soil having medium range of pH and EC that favoured better crop management during the year of experimentation. The maximum and minimum temperature during crop growing season varied between 29.20 to 36.67°C and 20.59 to 25.31°C, respectively. The cumulative rainfall was 521.5 mm which has been received in 23 rainy days between 29th MW (July) to 39th MW (September), 2022. At initial stage of the crop, heavy pour of rainfall was occurred between 23rd to 29th July, 2022 (30th MW), but it did not affect the crop due to better drainage facilities available at the farm.

Experimental Layout

A field experiment was laid out in Factorial Randomized Block Design (FRBD) with twelve treatment combinations and replicated thrice with thirty six plots. The treatment combinations comprised with two varieties MH 421 and GM 7 (Factor A) and six stress mitigating chemicals (Factor B) namely Control (C0), Seed priming with thiourea @ 500 ppm (C1), Seed priming with salicylic acid @ 75 ppm (C2), Seed priming with thiourea @ 500 ppm + foliar spray @ 500 ppm (C3), Seed priming with salicylic acid @ 75 ppm + foliar spray @ 75 ppm (C4), Seed priming with salicylic acid @ 75 ppm + foliar spray @ 75 ppm + 2% urea (FS) (C5) etc.

Chemical analysis of plant

Table 1: Methods for determination of N, P and K concentration

Plant analysis	Method of analysis and reference
Nitrogen content (%)	Microkjeldhal Automatic Nitrogen Analyser (Kjelplus Calssic-DX VA) unit using Kjeldahl Method (Piper, 1966)
Phosphorus content (%)	Vanadomolybdo-phosphoric acid yellow colour method (Jackson, 1973)
Potassium content (%)	Flame photometer method (Bhargava and Raghupathi, 1993)

Estimation of Harvest Index

$$HI = \frac{\text{Economic yield} \times 100}{\text{Biological yield}}$$

Estimation of chlorophyll content

Total chlorophyll content of leaves at 40 DAS was determined using the method advocated by Arnon (1949) by taking 10 mg fresh leaf material. Samples were grind with 80% acetone with help of mortar and pestle and centrifuged for 10 min at 2000 rpm and volume of supernatant was made to 10 ml. the resultant absorbance of clear supernatant was measured by spectrophotometer at 645 nm and 663 nm.

$$\text{Total chlorophyll (mg/g)} = \frac{20.20 (A_{645}) + 8.02 (A_{663}) \times \text{total volume (ml)}}{1000 \times \text{weight of sample (g)}}$$

RESULTS AND DISCUSSION

Effect of Varieties

Growth Attributes

A perusal of the data on plant height revealed to the different crop period recorded at 25, 50 DAS and at harvest stage (Fig. 1). Variety 'GM-7' (V1) attained the maximum plant height and dry matter accumulation (3.91, 14.55 and 25.73 g plant⁻³) at all the crop growth stages (12.6, 39.04 and 50.5 cm) at 25, 50 DAS and at harvest stage, which was significantly higher than 'MH-421' (V2). It was might be due to vertical expansion of crop canopy due to higher rate vertical meristematic division that attained more in height. Variety 'GM-7' (V1) was recorded higher plant height due to high heritability with moderate genetic advanced under the variety (Goyal et al., 2022). Dry mater accumulation was presented in Fig. 2 showed that dry matter accumulation/plant was significantly higher under variety 'MH-421' (V2) of mungbean at 25, 50 DAS and at harvest stage which was 12.03, 9.64 and 13.25 per cent higher over variety 'GM-7' (V1), respectively. Similarly, this was might be due to better rooting, synthesis of chlorophyll and assimilation of photosynthates and also due to efficient conversion of solar radiation and applied inputs in the form of assimilates that favour crop to attained more weight during trial. This finding is also supported by Pareek et al. (2022).

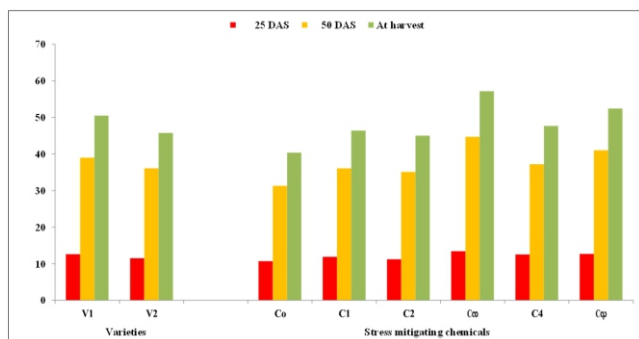


Fig. 1: Plant height (cm) of mungbean as influenced by varieties and stress mitigating chemicals

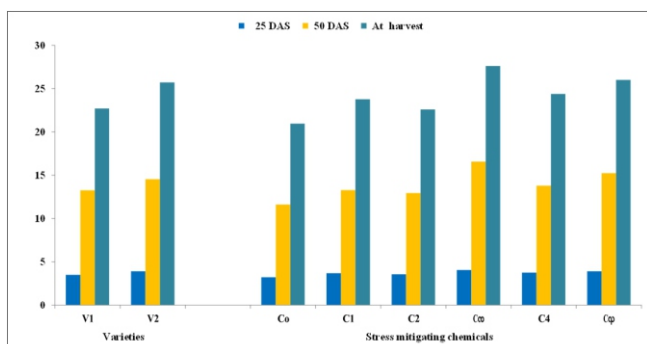


Fig. 2: Dry matter accumulation (g plant-1) of mungbean as influenced by varieties and stress mitigating chemicals

Effect of stress mitigating chemicals

Seed priming with thiourea @ 500 ppm + foliar spray @ 500 ppm at flower initiation stage (C3) of mungbean recorded taller plants and dry matter accumulation/plant (16.56 and 27.62 g), to an extent of 44.7 and 57.2 cm at 50 DAS and at harvest, respectively of mungbean, during investigation and showed its significant superiority over rest of the treatment. Thereafter, treatment that had been seed priming with

salicylic acid @ 75 ppm + foliar spray @ 75 ppm + 2% urea (C5) at flower initiation stage also produced taller plants by 41.0 and 52.4 cm at 50 DAS and at harvest stage of mungbean, respectively and also showed significant superiority over rest of the treatments. This was might be due to fact that thiourea use in both adverse and normal circumstances may be the cause of growth-attributing character improvements. Their presence in the plant systems has started signal transduction during a dry spell under difficult circumstances and they have synthesized a variety of biochemical components, including amino acids that give plants the building blocks they need to keep growing under pressure. Consequences include increased cell division and elongation as well as enhanced photosynthetic pigmentation in the plant, which manifests as increased plant height and dry matter accumulation (Verma et al., 2017; Sabir et al., 2016).

Effect of Varieties

Yield

Data pertaining to grain yield are presented in Table 2 and clearly indicated that variety 'MH-421' (V2) significantly produced higher grain yield (1025 kg ha-1) over 'GM-7' (V1) variety. The corresponding increase in terms of percentage by variety 'MH-421' (V2) over 'GM-7' (V1) was 9.15. The differences in pod length, number of pods/plant, number of grains/pod and 1000 grains weight might have been caused due to varietal differences among the varieties. 1000-grains weight was recorded higher in 'MH-421' (V2) compared to 'GM-7' (V1) might be due to ability of varieties to partitioning higher dry matter towards seeds and showed greater sink capacity. The variety 'MH 421' (V2) is recorded higher grain yield, stover yield and harvest index by 9.16, 8.60 and 0.36 per cent over 'GM-7' (V1) variety. It was might be due to genetic characteristics of the variety that might have more formation of yield attributes resulted in producing more grain and stover yield. Similar results were reported by Meenu et al. (2021).

Table 2: Cost of cultivation, gross returns, net returns and B C ratio of mungbean as influenced by varieties and stress mitigating chemicals

Treatment	Cost of cultivation	Gross returns	Net BC returns	
(/ha)	(/ha)	(/ha)	(/ha)	ratio
A. Varieties				
V ₁ : GM-	23,509	85,983	62,474	3.66
V ₂ : MH-	23,509	93,629	70,120	3.98
B. Stress Mitigating Chemicals				
C ₀ :	22,976	74,400	51,424	3.24
C ₁ : SP with thiourea (500	23,287	89,044	65,757	3.82
C ₂ : SP with salicylic acid (75 ppm)	23,246	80,884	57,638	3.48
C ₃ : SP with thiourea (500 ppm) + FS	24,322	1,02,809	78,487	4.23
C ₄ : SP with salicylic acid (75 ppm)	23,582	94,048	70,466	3.99
C ₅ : SP with salicylic acid (75 ppm)	23,642	97,652	74,010	4.13

Effect of stress mitigating chemicals

It is quite evident from the data that seed priming with thiourea @ 500 ppm + foliar spray @ 500 ppm at flower initiation stage (C3) of mungbean significantly harvest huge tonnage of grain yield (1136 kg/ha) followed by the treatment applied through seed

priming with salicylic acid @ 75 ppm + foliar spray @ 75 ppm + 2% urea at flower initiation stage (C5), which accounted with the production of 1078 kg grain/ha during experimentation. Both the treatments (C3 and C5) proved their significant superiority over rest of the treatments including control and were found statistically at par with each other's. Furthermore, when seeds of mungbean crop priming salicylic acid @ 75 ppm + foliar spray @ 75 ppm at flower initiation (C4) also caused significant variations in producing a better harvest of grain yield (1029 kg/ha) over control (C0). The significant improvements in yield of mungbean might also be due to application of thiourea that marked valuable effects by enhancing total chlorophyll contents and production of starch in leaves of the crop. As it is well known that thiourea has contained 36.8 per cent nitrogen in its structural constituents, which play vital roles in the synthesis of chlorophyll in leaves that catalyses the process of photosynthesis results in formation of more number of growth and yield attributes. Harvest of huge tonnage from the crop is directly correlated with formation of yield attributes produced under thiourea treatment (Sahu, 2017; Arora, 2004).

Effect of varieties

Economics

It was observed from the data presented in Table 3 and variety 'MH-421' (V2) caused marked achievement by fetching net return of Rs. 70,120/ha and B:C ratio (3.98) from mungbean compared to variety 'GM-7' (V1). Furthermore, it was noticed that variety 'GM-7' (V1) also recorded a profitable value as Rs. 62,474/ha during field trials. Moreover, 'MH-421' variety had registered a tune of increment as 12.24 per cent in net return and 8.77 per cent higher B:C ratio over 'GM-7' (V1) variety. Mungbean variety 'MH-421' (V2) yielded highest net returns and B:C ratio. Higher economic returns were generated by virtue of higher crop yields due to genetic makeup of mungbean varieties. Similar results were also reported by Patel et al. (2022) and Meenu et al. (2021).

Table 3: Yield of mungbean as influenced by varieties and stress mitigating chemicals and seed priming

Treatment	Grain yield	Stover yield	Biological yield	Harvest index
	(Kg/ha)	(Kg/ha)	(Kg/ha)	(%)
A. Varieties				
V ₁ : GM-7	939	2174	3113	29.57
V ₂ : MH- 421	1025	2361	3386	30.77
SEm±	16.35	44.55	62.05	0.18
CD (P=0.05)	47.94	130.65	181.98	0.52
B. Stress Mitigating Chemicals				
C ₀ : Control	798	2099	2897	27.54
C ₁ : SP with thiourea (500 ppm)	974	2262	3236	30.09
C ₂ : SP with salicylic acid (75 ppm)	878	2139	3017	29.10

Treatment	Grain yield	Stover yield	Biological yield	Harvest index
C ₃ : SP with thiourea (500 ppm) + FS (500 ppm)	1136	2456	3592	31.62
C ₄ : SP with salicylic acid (75 ppm) + FS (75 ppm)	1029	2297	3326	30.94
C ₅ : SP with salicylic acid (75 ppm) + FS (75 ppm) + 2% urea (FS)	1078	2348	3426	31.46
SEm±	28.31	77.16	107.47	0.31
CD (P=0.05)	83.04	226.30	315.20	0.90
CV (%)	7.06	8.33	8.10	6.47
Interaction(V × C) SEm±	40.04	109.12	151.98	0.43
CD (P=0.05)	117.44	NS	NS	NS

Effect of stress mitigating chemicals

Table 2 data revealed that seed priming with thiourea @ 500 ppm + foliar spray @ 500 ppm at flower initiation stage (C3) in mungbean approached higher net monetary advantage (Rs. 78,487/ha) and B: C ratio (4.22) over rest of the treatments followed by combined application of salicylic acid and urea i.e. seed priming with salicylic acid @ 75 ppm + foliar spray @ 75 ppm + 2% urea (C5) and showed its economic feasibility over rest of the treatments during the year of experimentation. Furthermore, combined application of salicylic acid and urea i.e. seed priming with salicylic acid @ 75 ppm + foliar spray @ 75 ppm + 2% urea at flower initiation stage (C5) also fetched significant profitability from mungbean and achieved B: C ratio of 4.13. The effective conversion of agro-inputs (stress mitigating chemicals) into viable economic returns by formation of more growth and yield attributes resulted in higher grain and stover yield of mungbean under application of thiourea, which improved the gross and net returns as well as the B: C ratio (Choudhary *et al.*, 2017). However, maximum expenditure was incurred due to slightly higher cost of cultivation under the treatment seed priming with thiourea @ 500 ppm + foliar spray @ 500 ppm at flower initiation stage (C3), but this treatment was best option among over rest of treatments due to higher grain yield, gross return, net return and B:C ratio. Hence, application of thiourea considered as most remunerative approach in sustaining production system.

CONCLUSION

The economic feasibility and viability point of view, seed priming with thiourea @ 500 ppm + foliar spray @ 500 ppm at flower initiation stage along with 'MH-421' variety of mungbean should be given priority over other treatments in mungbean. The results are based on one year experimentation, which needs to be validated through further experimentation to formulate a recommendation.

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