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# Assessing the potential of cow-based organic amendments for improving summer mungbean (*Vigna radiata)* yield and sustainability in rice fallow

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**Abstract**
Organic farming practices including the use of cow-based nutrient sources FYM, Panchagvya, Beejamrutha, Jeevamrutha and cow urine have gained significant attention due to their potential to enhance soil fertility, crop productivity, and reduce chemical input dependency. Hence, in order to study the influence of cow based organic nutrient sources on growth and yield a field experiment entitled "Assessing the Potential of Cow-Based Organic Amendments for Improving Summer Mungbean (*Vigna radiata)* Yield and Sustainability in Rice Fallow" was conducted during summer season of the year 2022 at experiment farm of College of Post Graduate Studies in Agricultural Sciences (CAU, Imphal). The experiment was laid out in randomized block design with three replications having 8 treatments *viz*., $T_1$ Control (no inputs), $T_2$ Seed priming with cow urine, $T_3$ FYM 5t $ha^{-1}$, $T_4$ Seed priming with cow urine+ FYM 5t $ha^{-1}$, $T_5$ Seed treatment with Beejamrutha, $T_6$ Seed treatment Beejamrutha +Jeevamrutha (15 days interval), $T_7$ FYM@ 2.5t $ha^{-1}$ + Jeevamrutha spray at (15 days interval), $T_8$ FYM@2.5t $ha^{-1}$+Beejamrutha + Jeevamrutha (15 Days interval). Experimental findings revealed that the growth parameters such as plant height, leaf area index, dry shoot wt., dry root wt., no. of root nodules, CGR, NAR, recorded highest in treatment $T_8$ and was at par with treatment $T_7$, $T_6$ and $T_5$ but significantly high over $T_1$, $T_2$, $T_3$, $T_4$. Further, treatment $T_8$ which was being at par with $T_7$, $T_6$, $T_5$, reported significantly more grain and biological yield over the treatments $T_1$, $T_2$, $T_3$, $T_4$. The magnitude of yield increases in treatment $T_8$ was 46.2,29.6,25,20.3, 26.8, 20.3, 8.3% high over the treatment $T_1$, $T_2$, $T_4$, $T_3$, $T_5$, $T_6$, $T_7$ respectively.

**Keywords:** Beejamrutha, Jeevamrutha, mungbean, yield, soil properties and rice fallows

## Introduction
Around 65% of the net sown area, 100% of the forest, and 66% of the cattle in India are contributed by rainfed agro-ecologies, which also offer means of subsistence, income, and job security. Without irrigation, the country produces between 84 and 87 percent of pulses/minor millets, 80 percent of horticultural crops, 77 percent of oilseeds, 66 percent of cotton, and 50 percent of grains.

There are 22.3 million hectares of suitable rice-fallow regions in South Asia, with 88.3% of those in India, 8.7% in Bangladesh, 1.4% in Nepal, 1.1% in Sri Lanka, 0.5% in Pakistan, and 0.02% in Bhutan (Gumma *et al*. 2016) [10]. In India, the states of Assam, Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, and Odisha account for 82% of the 11.7 million ha of fallow land after the rice harvest (Ghosh *et al.*, 2016) [8]. When pulse crops-which need minimal water and little input are planted in these areas (rice fallows), they have a tremendous growth potential. Further, 70% of the 3.5 million acres of rice-planted land in the NER (Northeastern Region) lie fallow throughout the winter (Ghosh *et al.*, 2016) [8]. The areas that have been left fallow are suitable for crop intensification with short-season (less than three months), water-efficient grain legumes such chickpeas, lentils, black gramme, green gramme, and oilseeds (Ali *et al.*, 2014) [1].

In India, a common mono-crop rice-based system known as rice-fallow has long been used. The low-input candidate crops for rice fallows that are the favoured choice for enhancing the rice-fallow production system are lentil, lentil, urdbean, mungbean, and peas.

The key barriers in boosting pulse productivity and production in NEH states are declining land holdings, increased population pressure, rising food and pulse demand, and most crucially, poor soil health. As a result, pulse production in the NEH region developed substantially more slowly due to a range of complicated underlying issues ranging from technological and extension-related challenges to soil and climate related restrictions. Upland crops, especially pulses, frequently aren't able to grow and develop as they should, because of an unfavourable microclimate, unhealthy soil, aluminium toxicity, an acidic pH (heavy rainfall causes the majority of cations to be leached from the soil), undulating topography, and sloppy terrain.

The area planted with pulses in 2016-17 is 29.45 M ha, of which 2.71 lakh hectares come from Northeast India. In India, the average pulse productivity for the 2016-17 crop year was 786 kg $ha^{-1}$ (DASE. 2018) [3]. Nonetheless, the average productivity of pulses in Northeast India in the 2016-17 crop year was 888.52 kg $ha^{-1}$, which is higher than the national average and has enormous potential for producing the pulses. Meghalaya has the highest productivity among the states (1446 kg $ha^{-1}$), followed by Mizoram with 1352 kg $ha^{-1}$. Arunachal Pradesh, Assam, Manipur, and Tripura are the key states contributing to the cultivation of moong, one of the important pulses grown in the area for many years.

One of the most significant food legumes in India is the Mungbean (*Vigna radiata*), which accounts for 90% of current global production in the Asian region. One of the most significant and resilient crops among the pulses is the mungbean and it contains 51% carbohydrates, 25–26% protein, and 3% vitamins (Mondal *et al.*, 2012) [13]. Mungbean production in India in 2017-18 was 2.01 M t from 2.93 M ha of land (DASE 2018) [3] with average productivity is around 436 kg $ha^{-1}$.

Modern agriculture primarily relies on artificial fertilizers to meet the needs of an expanding population. Constant usage of inorganic fertilizers endangers the health of the soil in observance of the soil's physical, chemical, and biological characteristics. The population of helpful organisms' declines, and the soil's ability to naturally regenerate nutrients stop, making it barren and infertile. To reduce the use of inorganic fertilizers, it is required to replace them with organic inputs. In terms of seed germination, crop growth, and yield, many organic manures including compost, vermicompost, green manures and dry leaf powder, etc., demonstrated superior performance (Ghadge *et al.,* 2013) [7]. In addition, being widely known for their germicidal and therapeutic characteristics, cow dung and cow urine have been employed in India for many organic formulations and other remedies since ancient times (Palekar, 2006) [17]. Several historic Indian treaties, including the Charak Samhita, Sushrut, Vagbhaat, Nighantu, Ratnakar, etc., describe the usage of these in sustainable agriculture.

In organic farming, liquid formulations like Panchagvya, Beejamrutha, and Jeevamrutha are utilized for nourishing the crops. They are abundant sources of healthy microflora that promote plant growth, improve vegetative growth, and produce high-quality crops (Devakumar *et al.,* 2014) [5]. Beejamrutha is a method of treating seeds with ingredients that are readily available in the area. During the early stages of germination and establishment, it safeguards the crop against harmful soil-borne and seed-borne pathogens. Beejamrutha is a preparation made from cow dung and urine that is applied to seeds before planting (Devakumar *et al.* (2008) [4] and Sreenivasa *et al.* (2010) [22], noticed the presence of the beneficial microorganisms like actinomycetes, fungi, nitrogen fixers, and phosphorus solubilizers in Jeevamrutha and Beejamrutha. They are among the key elements of Zero Budget Natural Farming (ZBNF). Jeevamrutha is quite economical for cultivator (FAO, 2018). Jeevamrutha is organic liquid manure that is a great source of the micronutrients that plants need, including nitrogen, phosphorus, potassium, natural carbon, and many more. Its application boosts the number of beneficial bacteria and microorganisms and also the number of earthworms in the soil (Lyngdoh *et al.,* 2017) [12]. Earthworms promote soil aeration and water retention capacity while also increasing the soil's porosity. It can absorb minerals from the deepest soil layer.

## Martials and Methods

### Experimental site and location

The investigation was conducted in the experimental research field which lies in the lowland Agronomy farm of the College of Post Graduate Studies in Agricultural Sciences (CAU-Imphal), Umiam in the Ri-Bhoi district of Meghalaya during the Summer of 2022. The experimental site is situated in the North-east hill region of India at 25º 41'N latitude, 91º 54'E longitude with an elevation of 950 m above the mean sea level (Panda, 2020) [18]. The monsoon normally sets in this area in the first fortnight of June and extends up to the end of September. Withdrawal of monsoon takes place in October's first week with a decreasing rainfall trend from September onwards. During investigation, the experimental crop received 39.07 mm of maximum rainfall, Maximum and minimum temperatures ranged from 24.66 to 27.7ºC and 13.85 to 18.87ºC, respectively.

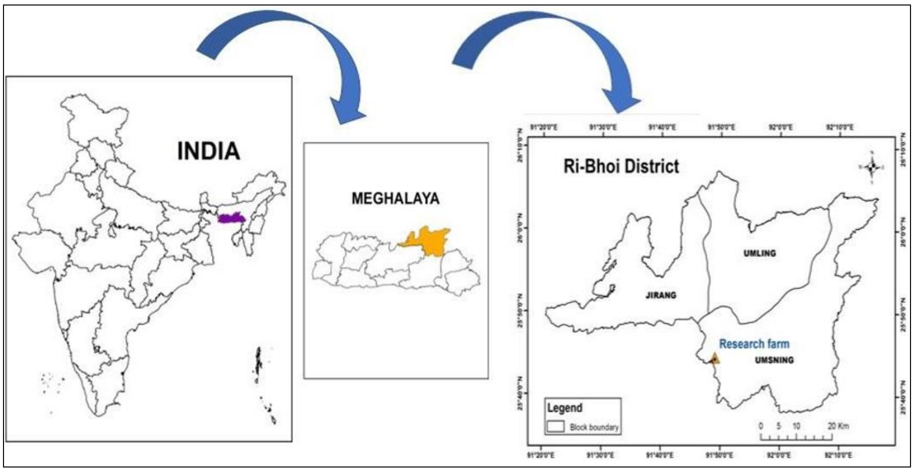


**Fig 1:** Location of experimental site

**Experimental design**
The experiment was laid out in randomized block design with three replications having 8 treatments *viz*., $T_1$ Control (no inputs), $T_2$ Seed priming with cow urine, $T_3$ FYM 5t ha$^{-1}$, $T_4$ Seed priming with cow urine+ FYM 5t ha$^{-1}$, $T_5$ Seed treatment with Beejamrutha, $T_6$ Seed treatment Beejamrutha +Jeevamrutha (15 days interval), $T_7$ FYM@ 2.5t ha$^{-1}$ + Jeevamrutha spray at (15 days interval), $T_8$ FYM@2.5t ha$^{-1}$+Beejamrutha + Jeevamrutha (15 Days interval). The mungbean variety Pusa Vishal developed out of a collaborative program between IARI and AVRDC in Taiwan. Pusa Vishal is a short growth duration. Plants are erect and bushy. Its average seed yield will be 1500-1700 kg ha$^{-1}$. Seed-to-seed duration is approximately 70-75 days. Sowing of Mungbean was done on April 4$^{th}$, 2022 with a row distance of 30 cm and plant-to-plant distance of 10 cm.
The methodologies used in recording various observations are described in subsequent sections. To evaluate the emergence percentage, the plant population was recorded at 8-10 DAS (Days after sowing). Plant population was counted per meter row length from the three central rows in each plot. The ratio of no. of seeds sown to the number of plants that emerged was calculated and used as the emergence (%).

**Plant height (cm)**
The plant height was measured from the base of the plant to the growing tip of five tagged plants at 30, 45, and 60 DAS and harvest in cm.

**Leaf area index**
Leaf area and leaf area index was recorded at 30, 45, and 60 days after sowing. Leaf area per plant was calculated by measuring the length and width of the leaves in the respective plots from the tagged plants which give rough leaf area.

$$\text{LAI} = \frac{\text{Leaf area (cm2) x number of leaves x factor}}{\text{Ground area (cm2)}} \times 100$$

**Dry matter production (g plant$^{-1}$)**
Five plants were selected randomly from each plot and cut at the base to the ground level at 30, 45, and 60 DAS and harvested. The destructed samples were cleaned properly, separated into leaves, stem, and root, and then air dried in a hot air oven.

**Crop growth rate (CGR) (g cm$^{-2}$ day$^{-1}$)**
The rate of crop growth per unit land area was determined by calculated crop growth rate and expressed in g cm$^{-2}$ day$^{-1}$ by using the formula given below

$$\text{CGR} = \frac{(W2 - W1)}{P \ x\ (t2 - t1)}$$

**Relative growth rate (RGR) (g g$^{-1}$ day$^{-1}$)**
Relative growth rate indicates the rate of growth per unit increase in dry matter and expressed in g g$^{-1}$ day$^{-1}$ by using the formula given below

$$\text{RGR} = \frac{(\log w2 - \log w1)}{t2 - t1}$$

**Net assimilation rate (NAR) (mg cm$^{-2}$ day$^{-1}$)**
NAR indirectly indicates the net photosynthesis ratio i.e., the gram of dry matter produced per unit leaf area in a day and expressed in mg cm$^{-2}$ day$^{-1}$ by using the formula given below

$$\text{NAR} = \frac{(w2 - w1)(\log l2 - \log l1)}{(t2 - t1)(l2 - l1)}$$

**Days taken to attend developmental stages**
1. Days taken to 50% emergence
2. Days taken to 50% heading
3. Days taken to 50% physiological maturity

**Yield attributes and yield**
Yield attributes, *viz*., number of pods per plant, number of grains per pod, and grain weight per plant were recorded at harvest from the five randomly tagged plants in the net plot area.

**Number of pods plant$^{-1}$**
The number of pods per plant was recorded from five randomly selected tagged plants were counted and summed up and the average value was calculated. Their mean is expressed as the number of pods per plant

**Pod length (cm)**
The pod's length was measured from tagged plants from different plots and the mean value was expressed in cm.

**Number of seeds pod$^{-1}$**
The seeds collected from pods of five tagged plants were counted separately and the mean value was expressed as the number of seeds per pod.

**Seeds plant$^{-1}$**
The seeds collected from five tagged plants were counted separately and the mean value was expressed as the number of seeds per plant**.**

**Test weight**
After threshing and cleaning, a thousand seeds were randomly counted and weighed for each treatment.

**Biological yield**
Biological yield i.e., the total above-ground dry matter accumulation including grain and Straw yield per unit land area was recorded for each treatment from net plot area as explained above after crop harvest.

**Grain yield (kg ha$^{-1}$)**
Grain yield plot$^{-1}$ for each treatment from the net plot area was calculated after the threshing of biological yield. Before recording the grain yield plot$^{-1}$ the grains were cleaned and dried to bring the moisture content around 10-12%.

**Stover yield (kg ha$^{-1}$)**
Stover yield (kg ha$^{-1}$) was recorded by subtracting the grain yield (kg ha$^{-1}$ from the biological yield (kg ha$^{-1}$).

**Harvest index (%)**
The harvest index was calculated by dividing the economic yield with the biological yield and is expressed in percentage by using the equation.

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

**Statistical analysis**

Its statistically analyzed by using the technique of analysis of variance for randomized block design. The difference between the treatment means was tested for their statistical significance with an appropriate critical difference (C.D) value at a 5% level of significance Gomez and Gomez (1984).

**Growth attributes**

Plant height did not differ significantly at 30 DAS, but it varies significantly at 45 DAS, 60 DAS, and at harvest. among all treatments, ($T_8$) FYM + Beejamrutha + Jeevamrutha recorded the highest plant height and leaf area index not affected significantly due to different treatment at any stage of the growth periods but highest value of LAI recorded at 30 DAS (0.71), 45 DAS (1.96) and at 60 DAS (3.57) in treatment $T_8$. However, the lowest Value of LAI and Plant height was recorded in $T_1$. Application FYM + Beejamrutha + Jeevamrutha ($T_8$) significantly increased the accumulation of dry weight in shoot and root dry weight of mungbean plants at all the stage of experiment as compare to control and the treatments. significantly higher root nodules per plant was recorded in $T_8$ (FYM +Beejamrutha +Jeevamrutha) as compared to other treatments and the lowest in control. The reason due behind the maximum dry matter accumulation may be due to fermented liquid organic manures are rich carriers of microbial load and substances that promote plant growth, metabolic activities, and disease and pest resistance, in addition to nutrients (Lanka, 2018) [11]. This may be due to the nutrients that have been soluble in the soil and accumulated have made them available to plants all through their growth cycle, leading to an increase in growth attributes due to Jeevamrutha application (Chaithra and Sujith, 2021) [2].

**Plant population and mortality**

Plant population and mortality did not show any significant difference among the cow-based nutrients treatments that the higher plant population was reported in $T_3$ FYM@5t ha$^{-1}$ at 30 DAS but the lowest plant population was found at 30 DAS in treatment $T_4$ Seed priming with cow urine FYM@ 5t ha$^{-1}$ and highest percentage of mortality was observed in ($T_1$) Control. While, the minimum mortality percentage was reported in ($T_8$) FYM 2.5t ha$^{-1}$ +Beejamrutha +Jeevamrutha, these results are in line with Panda *et al.* (2020) [18].

**Physiological Parameters**

It was observed that all treatment influenced CGR significantly at 0-30 DAS, 30-45 DAS and at maturity stage but it found non-significant at 45-60 DAS. The maximum value of CGR was estimated in ($T_8$) FYM 2.5t ha$^{-1}$ +Beejamrutha+ Jeevamrutha at 0-30 DAS (1.58g), 30-45 days (9.27g), 45-60 DAS (12.86g) However, the lowest value of CGR was recorded in treatment $T_1$ (control) and maximum relative growth rate was no significant in $T_5$ Seed treatment with Beejamrutha at 30-45 DAS, 45-60DAS and harvest, minimum RGR was reported in $T_1$ Control at 30-45 DAS, 45-60DAS and harvest and maximum net assimilation rate was recorded significant difference only at 30-45 DAS (3.97 mg cm$^{-2}$ day$^{-1}$) with treatment found superior to rest of the treatment. However, the minimum NAR was recorded in treatment $T_1$ at 30-45 DAS. The result is similar with Singh *et al.*, (2023) [20].

**Phenological Parameters**

The result found to be non-significant among all over the treatments in days taken to emergence, days taken to flowering, days taken to pod formation and days taken to 50% maturity, maximum days taken to emergence and days taken to 50% flowering (37 days) was recorded in treatment $T_6$- Seed treatment with Beejamrutha + Jeevamrutha (15 days interval) (8.33 days) and the highest days (64.33) taken to maturity was reported in treatment $T_7$ FYM@ 2.5t ha$^{-1}$ +Jeevamrutha spray at (15 days interval) and lower days (48.67 days) taken to pod formation was reported in treatment $T_8$-FYM @2.5t ha$^{-1}$+Beejamrutha+Jeevamrutha (15 days interval). This might be due to the presence of microorganisms and enzymes in Jeevamrutha can help break down organic matter and make nutrients more available for seedling growth. Healthy plants are more likely to develop a strong root system and vigorous vegetative growth, which can contribute to optimal flowering. These results are in conformity with the finding of Swati (2020) [24] and Nipanshu (2021) [15].

**Yield Attributes and Yield**

Significantly higher number of pods per plant (12.73), maximum grain weight (7.36g), higher no. of grains per pods (13.17) and maximum shelling percentage (65.48%) was recorded in $T_8$ (FYM +Beejamrutha+ Jeevamrutha) and found to be superior rest over the treatments and maximum pod weight per plant of (11.34g) followed by $T_3$ (10.16g) and $T_5$ (10.37g) superior over rest of the treatment. However, the minimum no. pod per grains (9.67), minimum pod weight (8.14g) and No. of pod plant$^{-1}$ (8.41) was recorded in $T_1$. The test weight not affected significantly among the eight treatments. However, it ranged from 31.08 g in $T_1$ to 36.18g in $T_8$. The result is accordance with Reshma (2016) [19] she also reported significant difference among Jeevamrutha and grain weight. The test wt.(gm), and shelling percentage showed no significant differences and no correlation between the test weight, shelling and treatments. Similar outcomes were found in cowpea by Sutar *et al.* (2018) [23], who found that Jeevamrutha led to noticeably higher number of pods per plant. Nitin, S.U. (2014) [16].

It was investigated that, grain yield, stover yield, harvest index and biological yield differed significantly due to different cow based nutrient sources (Table. 12). Significantly higher biological yield (3.43 t ha$^{-1}$), grain yield (1.08 t ha$^{-1}$), stover yield (2.35 t ha$^{-1}$), and harvest index (31.24 t ha$^{-1}$), of mungbean was noticed with application FYM + Beejamrutha + Jeevamrutha. The increase in yield studies of green gram due to cow based nutrient sources treatments could be due to better availability of nutrients throughout the crop growth which was ensured further by improved microbial activity in the soil. The results in yield obtained are in closed conformity with the experimental findings of Singh *et al.* (2020) [21], Nasratullah (2020) [14], Sutar *et al.* (2018) [23].

**Table 1:** Plant height of summer mungbean as influenced by cow based organic nutrients

| Treatment No. | Treatment description | Plant Height (cm) | | | |
|---|---|---|---|---|---|
| | | 30 DAS | 45 DAS | 60 DAS | Harvest |
| $T_1$ | Control (no inputs) | 9.69 | 15.37 | 17.07 | 24.39 |
| $T_2$ | Seed priming with cow urine | 9.81 | 13.65 | 20.16 | 30.24 |
| $T_3$ | FYM 5t $ha^{-1}$ | 9.67 | 19.03 | 20.41 | 31.15 |
| $T_4$ | Seed priming with cow urine+ FYM 5t $ha^{-1}$ | 10.22 | 16.73 | 22.01 | 26.92 |
| $T_5$ | Seed treatment with Beejamrutha | 10.27 | 14.95 | 21.70 | 24.60 |
| $T_6$ | Seed treatment Beejamrutha+Jeevamrutha(15 days interval) | 10.18 | 17.01 | 22.59 | 25.78 |
| $T_7$ | FYM@ 2.5t $ha^{-1}$ +Jeevamrutha spray at 15 days interval | 10.19 | 19.09 | 22.54 | 32.11 |
| $T_8$ | FYM@2.5t $ha^{-1}$ +Beejamrutha+Jeevamrutha(15 Days interval) | 10.81 | 20.70 | 17.07 | 33.44 |
| S.Em. ± | | 0.70 | 1.08 | 1.10 | 1.38 |
| CD (P=0.05) | | NS | 3.28 | 3.33 | 4.20 |

**Table 2:** LAI of summer mungbean as influenced by cow-based organic nutrients

| Treatment No. | Treatment description | | LAI | |
|---|---|---|---|---|
| | | 30 DAS | 45 DAS | 60 DAS |
| $T_1$ | Control (no inputs) | 0.44 | 1.19 | 2.29 |
| $T_2$ | Seed priming with cow urine | 0.53 | 1.47 | 2.68 |
| $T_3$ | FYM 5t $ha^{-1}$ | 0.60 | 1.62 | 2.93 |
| $T_4$ | Seed priming with cow urine+FYM5t $ha^{-1}$ | 0.58 | 1.57 | 2.77 |
| $T_5$ | Seed treatment with Beejamrutha | 0.57 | 1.55 | 2.92 |
| $T_6$ | Seed treatment Beejamrutha +Jeevamrutha (15 days interval) | 0.58 | 1.72 | 3.14 |
| $T_7$ | FYM@ 2.5t $ha^{-1}$ +Jeevamrutha spray at 15 days interval | 0.65 | 1.84 | 3.37 |
| $T_8$ | FYM@2.5t $ha^{-1}$+Beejamrutha+Jeevamrutha spray (15 Days interval) | 0.71 | 1.96 | 3.57 |
| S.Em. ± | | 0.028 | 0.044 | 0.110 |
| CD(P=0.05) | | NS | NS | NS |

**Table 3:** Dry matter accumulation in shoots of summer mungbean as influenced by cow-based organic nutrients

| Treatment no. | Treatment description | Dry weight (g $plant^{-1}$) | | | |
|---|---|---|---|---|---|
| | | 30 DAS | 45 DAS | 60 DAS | Harvest |
| $T_1$ | Control (no inputs) | 0.94 | 2.65 | 7.26 | 9.50 |
| $T_2$ | Seed priming with cow urine | 1.01 | 2.97 | 8.16 | 11.15 |
| $T_3$ | FYM 5t $ha^{-1}$ | 1.07 | 3.35 | 8.74 | 13.46 |
| $T_4$ | Seed priming with cow urine+FYM5t $ha^{-1}$ | 1.06 | 3.02 | 8.49 | 14.72 |
| $T_5$ | Seed treatment with Beejamrutha | 1.13 | 4.30 | 9.37 | 16.36 |
| $T_6$ | Seed treatment Beejamrutha +Jeevamrutha (15 days interval) | 1.15 | 4.45 | 10.38 | 17.08 |
| $T_7$ | FYM@ 2.5t $ha^{-1}$ +Jeevamrutha spray at 15 days interval | 1.36 | 5.22 | 10.74 | 17.99 |
| $T_8$ | FYM@2.5t $ha^{-1}$ +Beejamrutha+Jeevamrutha(15 Days interval) | 1.42 | 5.60 | 11.38 | 18.57 |
| S. E.(m) ± | | 0.12 | 0.34 | 0.56 | 1.30 |
| CD(P=0.05) | | 0.38 | 1.04 | 1.70 | 3.96 |

**Table 4:** Dry matter accumulation in root of summer mungbean as influenced by cow-based organic nutrients

| Treatment no. | Treatment details | Root Dry Weight (g $plant^{-1}$ | | |
|---|---|---|---|---|
| | | 30 DAS | 45 DAS | 60 DAS |
| $T_1$ | Control (no inputs) | 0.38 | 0.73 | 1.19 |
| $T_2$ | Seed priming with cow urine | 0.42 | 0.73 | 1.53 |
| $T_3$ | FYM 5t $ha^{-1}$ | 0.56 | 0.83 | 1.83 |
| $T_4$ | Seed priming with cow urine+FYM5t $ha^{-1}$ | 0.56 | 0.75 | 1.66 |
| $T_5$ | Seed treatment with Beejamrutha | 0.69 | 0.77 | 1.41 |
| $T_6$ | Seed treatment Beejamrutha +Jeevamrutha (15 days interval) | 0.81 | 0.79 | 2.06 |
| $T_7$ | FYM@ 2.5t $ha^{-1}$ +Jeevamrutha spray at 15 days interval | 0.75 | 0.80 | 2.03 |
| $T_8$ | FYM@2.5t $ha^{-1}$ +Beejamrutha+Jeevamrutha(15 Days interval) | 0.82 | 0.87 | 2.32 |
| S.E.(m) ± | | 0.03 | 0.03 | 0.15 |
| CD(P=0.05) | | 0.09 | 0.09 | 0.46 |

**Table 5:** Root nodules of summer mungbean as influenced by cow-based organic nutrients

| Treatment no. | Treatment description | Number of root nodules | | |
|---|---|---|---|---|
| | | 30 DAS | 45 DAS | 60 DAS |
| $T_1$ | Control (no inputs) | 6.73 | 9.89 | 4.61 |
| $T_2$ | Seed priming with cow urine | 8.27 | 11.00 | 5.32 |
| $T_3$ | FYM 5t $ha^{-1}$ | 9.39 | 11.65 | 6.26 |
| $T_4$ | Seed priming with cow urine+FYM5t $ha^{-1}$ | 8.59 | 12.01 | 6.22 |
| $T_5$ | Seed treatment with Beejamrutha | 7.62 | 12.77 | 6.27 |
| $T_6$ | Seed treatment Beejamrutha +Jeevamrutha (15 days interval) | 8.67 | 15.39 | 6.33 |

| | | | | |
|---|---|---|---|---|
| $T_7$ | FYM@ 2.5t $ha^{-1}$ +Jeevamrutha spray at 15 days interval | 10.17 | 17.35 | 6.39 |
| $T_8$ | FYM@2.5t $ha^{-1}$+Beejamrutha+ Jeevamrutha (15 Days interval) | 11.32 | 18.18 | 7.49 |
| | S.E.(m) ± | 0.88 | 1.05 | 0.59 |
| | CD(P=0.05) | 2.69 | 3.21 | 1.79 |

**Table 6:** Plant population and Mortality of summer mungbean as influenced by cow-based organic nutrients

| Treatment no. | Treatment description | Plant population and Mortality | | |
|---|---|---|---|---|
| | | Plant population at 30 DAS (lac $ha^{-1}$) | Plant population at harvest (lac $ha^{-1}$) | Mortality (%) |
| $T_1$ | Control (no inputs) | 3.06 | 1.84 | 39.88 |
| $T_2$ | Seed priming with cow urine | 3.13 | 1.97 | 36.72 |
| $T_3$ | FYM 5t $ha^{-1}$ | 3.24 | 2.16 | 33.53 |
| $T_4$ | Seed priming with cow urine+FYM5t $ha^{-1}$ | 2.97 | 1.94 | 34.87 |
| $T_5$ | Seed treatment with Beejamrutha | 3.19 | 2.10 | 34.38 |
| $T_6$ | Seed treatment Beejamrutha +Jeevamrutha (15 days interval) | 2.98 | 1.89 | 36.79 |
| $T_7$ | FYM@ 2.5t $ha^{-1}$ +Jeevamrutha spray at 15 days interval | 3.16 | 2.22 | 29.19 |
| $T_8$ | FYM@2.5t $ha^{-1}$ +Beejamrutha+Jeevamrutha(15 Days interval) | 3.08 | 2.38 | 22.50 |
| S.E.(m) ± | | 0.09 | 0.16 | 5.27 |
| CD(P=0.05) | | NS | NS | NS |

**Table 7:** CGR of summer mungbean as influenced by cow-based organic nutrients

| Treatment no. | Treatment description | CGR (g $m^{-2}day^{-1}$) | | | |
|---|---|---|---|---|---|
| | | 0-30 DAS | 30-45 DAS | 45-60 DAS | At Harvest |
| $T_1$ | Control (no inputs) | 1.05 | 3.79 | 10.25 | 4.99 |
| $T_2$ | Seed priming with cow urine | 1.13 | 4.36 | 11.52 | 6.66 |
| $T_3$ | FYM 5t $ha^{-1}$ | 1.19 | 5.05 | 11.97 | 10.51 |
| $T_4$ | Seed priming with cow urine+FYM5t $ha^{-1}$ | 1.18 | 4.36 | 12.16 | 13.84 |
| $T_5$ | Seed treatment with Beejamrutha | 1.26 | 7.04 | 11.27 | 15.52 |
| $T_6$ | Seed treatment Beejamrutha +Jeevamrutha (15 days interval) | 1.28 | 7.32 | 13.18 | 14.90 |
| $T_7$ | FYM@ 2.5t $ha^{-1}$ +Jeevamrutha spray at 15 days interval | 1.51 | 8.59 | 12.25 | 16.11 |
| $T_8$ | FYM@2.5t $ha^{-1}$ +Beejamrutha+Jeevamrutha(15 Days interval) | 1.58 | 9.27 | 12.86 | 15.97 |
| S.E.(m) ± | | 0.14 | 0.85 | 1.45 | 3.02 |
| CD(P=0.05) | | 0.42 | 2.58 | 4.40 | 9.16 |

**Table 8:** RGR of summer mungbean as influenced by cow-based organic nutrients

| Treatment no. | Treatment description | RGR (mg $gram^{-1}$ $day^{-1}$) | | |
|---|---|---|---|---|
| | | 30-45 DAS | 45-60 DAS | Harvest |
| $T_1$ | Control (no inputs) | 29.45 | 29.33 | 7.64 |
| $T_2$ | Seed priming with cow urine | 31.47 | 28.81 | 9.40 |
| $T_3$ | FYM 5t $ha^{-1}$ | 32.69 | 28.04 | 12.35 |
| $T_4$ | Seed priming with cow urine+FYM5t $ha^{-1}$ | 30.38 | 30.39 | 15.72 |
| $T_5$ | Seed treatment with Beejamrutha | 39.25 | 22.67 | 16.04 |
| $T_6$ | Seed treatment Beejamrutha +Jeevamrutha (15 days interval) | 38.78 | 24.83 | 14.02 |
| $T_7$ | FYM@ 2.5t $ha^{-1}$ +Jeevamrutha spray at 15 days interval | 39.93 | 20.95 | 14.84 |
| $T_8$ | FYM@2.5t $ha^{-1}$ +Beejamrutha+Jeevamrutha(15 Days interval) | 39.63 | 20.64 | 14.02 |
| S.E.(m) ± | | 4.561 | 3.530 | 3.264 |
| CD(P=0.05) | | NS | NS | NS |

**Table 9:** NAR of summer mungbean as influenced by cow-based organic nutrients

| Treatment no. | Treatment description | NAR (mg $cm^{-2}$ $day^{-1}$) | |
|---|---|---|---|
| | | 30-45 DAS | 45-60 DAS |
| $T_1$ | Control (no inputs) | 0.20 | 0.34 |
| $T_2$ | Seed priming with cow urine | 0.23 | 0.38 |
| $T_3$ | FYM 5t $ha^{-1}$ | 0.25 | 0.38 |
| $T_4$ | Seed priming with cow urine+FYM5t $ha^{-1}$ | 0.21 | 0.38 |
| $T_5$ | Seed treatment with Beejamrutha | 0.33 | 0.33 |
| $T_6$ | Seed treatment Beejamrutha +Jeevamrutha (15 days interval) | 0.34 | 0.38 |
| $T_7$ | FYM@ 2.5t $ha^{-1}$ +Jeevamrutha spray at 15 days interval | 0.38 | 0.35 |
| $T_8$ | FYM@2.5t $ha^{-1}$+Beejamrutha+Jeevamrutha (15 Days interval) | 0.40 | 0.35 |
| S.E.(m) ± | | 0.042 | 0.047 |
| CD (P = 0.05) | | 0.129 | NS |

**Table 10:** Phenological studies of summer mungbean as influenced by cow-based organic nutrients

| Treatment No. | Treatment description | Phenological studies | | | |
|---|---|---|---|---|---|
| | | Days taken to Emergence | Days taken to Flowering | Days taken to Pod Formation | Days taken to 50% maturity |
| $T_1$ | Control (no inputs) | 7.33 | 35.67 | 50.00 | 64 |
| $T_2$ | Seed priming with cow urine | 8.00 | 35.33 | 50.33 | 64 |
| $T_3$ | FYM 5t ha$^{-1}$ | 7.33 | 36.00 | 50.67 | 63 |
| $T_4$ | Seed priming with cow urine+FYM5t ha$^{-1}$ | 7.67 | 37.00 | 48.00 | 63 |
| $T_5$ | Seed treatment with Beejamrutha | 7.00 | 37.00 | 48.67 | 64 |
| $T_6$ | Seed treatment Beejamrutha +Jeevamrutha (15 days interval) | 8.33 | 37.00 | 49.33 | 64 |
| $T_7$ | FYM@ 2.5t ha$^{-1}$ +Jeevamrutha spray at 15 days interval | 8.00 | 36.33 | 48.67 | 64 |
| $T_8$ | FYM@2.5t ha$^{-1}$ +Beejamrutha+Jeevamrutha(15 Days interval) | 7.33 | 36.33 | 48.67 | 62.67 |
| S.E.(m) ± | | 0.63 | 2.92 | 2.91 | 2.00 |
| CD (P = 0.05) | | NS | NS | NS | NS |

**Table 11:** Yield attributes of summer mungbean as influenced by cow-based organic nutrients

| Treatment no | Treatment description | Yield Attributes | | | | | |
|---|---|---|---|---|---|---|---|
| | | No. of pods pl$^{-1}$ | Pod wt. (g pl$^{-1}$ | No. of grains pod$^{-1}$ | Test weight (g) | Grain Weight (g plant$^{-1}$) | Shelling (%) |
| $T_1$ | Control (no inputs) | 8.41 | 9.79 | 9.02 | 31.08 | 5.24 | 54.02 |
| $T_2$ | Seed priming with cow urine | 8.65 | 10.2 | 9.16 | 32.32 | 5.79 | 56.91 |
| $T_3$ | FYM 5t ha$^{-1}$ | 10.9 | 11.4 | 11.27 | 33.58 | 6.18 | 53.84 |
| $T_4$ | Seed priming with cow urine+FYM5t ha$^{-1}$ | 11.25 | 10.7 | 11.33 | 33.72 | 6.69 | 62.36 |
| $T_5$ | Seed treatment with Beejamrutha | 9.73 | 11.74 | 10.13 | 32.88 | 5.88 | 49.61 |
| $T_6$ | Seed treatment Beejamrutha +Jeevamrutha (15 days interval) | 11.43 | 12.9 | 11.69 | 35.15 | 6.65 | 51.70 |
| $T_7$ | FYM@ 2.5t ha$^{-1}$ +Jeevamrutha spray at 15 days interval | 12.6 | 13.1 | 12.51 | 35.19 | 6.69 | 53.10 |
| $T_8$ | FYM@2.5t ha$^{-1}$ +Beejamrutha+Jeevamrutha(15 Days interval) | 13.5 | 13.6 | 13.46 | 36.18 | 8.83 | 65.48 |
| S.E.(m) ± | | 0.64 | 0.45 | 0.57 | 0.43 | 0.41 | 4.36 |
| CD(P=0.05) | | 2.85 | 1.35 | NS | NS | 1.22 | NS |

**Table 12:** Yields and HI in summer mungbean as influenced by cow-based organic nutrients

| Treatment no. | Treatment description | Yield | | | |
|---|---|---|---|---|---|
| | | Biological yield t (ha$^{-1}$) | Grain yield t (ha$^{-1}$) | Stover yield t (ha$^{-1}$) | Harvest Index (%) |
| $T_1$ | Control (no inputs) | 2.34 | 0.58 | 1.75 | 25.00 |
| $T_2$ | Seed priming with cow urine | 2.75 | 0.76 | 1.99 | 27.74 |
| $T_3$ | FYM 5t ha$^{-1}$ | 2.95 | 0.81 | 2.13 | 27.80 |
| $T_4$ | Seed priming with cow urine+FYM5t ha$^{-1}$ | 2.97 | 0.86 | 2.14 | 27.53 |
| $T_5$ | Seed treatment with Beejamrutha | 2.86 | 0.79 | 2.07 | 28.11 |
| $T_6$ | Seed treatment Beejamrutha +Jeevamrutha (15 days interval) | 3.03 | 0.86 | 2.17 | 28.66 |
| $T_7$ | FYM@ 2.5t ha$^{-1}$ +Jeevamrutha spray at 15 days interval | 3.17 | 0.99 | 2.18 | 31.30 |
| $T_8$ | FYM@2.5tha$^{-1}$ +Beejamrutha+Jeevamrutha(15 Days interval) | 3.43 | 1.08 | 2.35 | 31.24 |
| S.E.(m) ± | | 0.18 | 0.07 | 0.19 | 2.22 |
| CD(P=0.05) | | 0.57 | 0.21 | 0.58 | NS |

## Conclusion
The application of cow-based organic nutrients significantly enhanced the growth and productivity of summer mungbean, leading to substantial improvements in grain and stover yields. Although the timing of key developmental stages remained relatively consistent, the varied organic nutrient treatments exerted a profound impact on crop performance, underscoring the potential of these eco-friendly amendments to bolster summer mungbean production.

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