



# **Effect of Liquid Organic Formulations on Productivity and Profitability of Mung-bean crop under Semi Arid Environment of Rajasthan**

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## **ABSTRACT**

**Aims:** The increasing cost and unavailability of fertilizers, poor soil health, growing ecological concern, consumer health problems and the government's interest in promoting the organic farming have forced to try new methods of application of nutrients in the form of liquid organic formulations. Hence, the present investigation was aimed to know the effect of liquid organic formulations on productivity and profitability of mungbean crop under semi-arid environment of Rajasthan.

**Methods:** The field experiment was conducted at Agronomy farm, School of Agriculture, OPJS University Churu, Rajasthan. This experiment was laid out in a randomized block design with three replications, consist of twelve treatments namely Control, Water spray, Panchgavya (2 spray), Vermiwash (2 spray), Cow urine (2 spray), Matka khad (2 spray), Panchgavya + Vermiwash, Panchgavya + Cow urine, Panchgavya + Matka khad, Vermiwash + Cow urine, Vermiwash + Matka khad and Cow urine + Matka khad.

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**Results:** The results revealed that independent two spray of panchgavya and spray of panchgavya+ vermiwash (one spray of each) resulted significantly higher crop growth attributes, yield attributes and yields as well as net returns of mungbean. The said treatments recorded highest grain yields (1128 and 1051 kg/ha), net return (55576 and 49361 Rs/ha) and benefit cost ratio (2.30 and 2.07) which was significant over rest of the treatments. According to our findings independent two spray of panchgavya at 25 and 45 DAS and combined spray of panchgavya + vermiwash (one spray of each) is recommended for higher productivity with more economic returns.

**Keywords:** *Panchgavya; vermiwash; matkakhad; LAI; CGR; RGR.*

## 1. INTRODUCTION

Pulses are an important source of protein for the poor as well as for the vegetarian which contributes on an average about 14 percent of the total protein in Indian diets [1]. Pulses have been considered best choice for diversification and intensification of agriculture across the world because of their essential values such as high protein source (20-25%), ability to fix atmospheric nitrogen (30-150 kg/ha), grow well in adverse environmental condition and consistent source of income and employment to small and marginal farmers. Globally, India is the largest producer (25%), consumer (27%) and importer (14%) of pulses [2]. Presently in India, about 31.03 million hectares of land is covered under pulse crops producing 27.69 million tonnes and productivity of 892 kg/ha annually [3]. Madhya Pradesh, Maharashtra, Rajasthan, Gujarat, Uttar Pradesh and Karnataka are the apex 5 pulses producing states. Productivity of pulses (892 kg/ha) is less than the global average and the per capita availability [3]. The low productivity of pulses is due to the low input conditions associated with the complex socio-economic and agro climatic problems of rainfed agriculture.

Among pulses, mungbean is cultivated since momentous times in India and is native to the Indian sub-continent. It is broadly cultivated all over the Asia continent including India, Myanmar, Pakistan, Bangladesh, Sri-Lanka, Thailand, Cambodia, Vietnam, Indonesia, Kenya, Malaysia, China, Tanzania and Formosa countries outstanding to being a significant food and economic crop in the rice-based farming systems [4].

India is the largest producer of mungbean globally [5]. It occupies 64.56 lakh hectare areas with 4.05 million tonnes of production in India [3] and stands third position among pulses by accounting for 10 percent in production and 16 percent in area. The leading contributors to

mungbean cultivation in terms of area and production are Rajasthan (46% and 45% respectively), Madhya Pradesh, Maharashtra, Karnataka, Odisha, Bihar, Tamil Nadu, Gujarat, Andhra Pradesh and Telangana also playing considerable function. In Rajasthan, mungbean crop covers about 23.26 lakh hectare area and production of 9.06 lakh tonnes with productivity of 354 during 2021-22kg/ha [3].

Mungbean crop is mostly cultivated in arid and semi-arid districts of Rajasthan including Jaipur, Nagaur, Jodhpur, Sikar, Jhunjhunu, Pali and Ajmer. Although, its average productivity is quite low as compared to its production potential due to moisture stress and poor soil quality in the state which is a matter of severe concern. Being a drought tolerant crop, it is outstanding source of high quality protein (24.5%) with tryptophan, lysine, fibres and minerals [6]. It also contains thiamine, riboflavin and has a significant amount of ascorbic acid when sprouted [7-8]. Owing to a short duration crop, it may be grown as green manure purpose or fodder crop for animals after picking of pods and well suited in intercropping systems.

Pulses are important components of organic farming systems in India. Organic farming is a production system which mainly excludes or avoid the use of synthetic compounds (fertilizers, growth regulators, pesticides and livestock feed extracts etc) and rely on crop rotation, green manure, vermicompost, biofertilizers etc. The economic, social and environmental sustainability are the key aims of organic farming. The earlier reports suggest that the cumulative cost and unavailability of fertilizers, rising ecological concern and the government interest in promoting the organic farming have forced us to try novel methods of application of nutrients in the form of panchgavya, vermiwash, cow urine, matka khad etc. [9]. Use of liquid organic formulations instead of synthetic or inorganic fertilizers is known to increase plant growth and yield through the supply of essential plant

nutrients, maintaining soil biodiversity and help to reduce the environmental concerns that ultimately enhance soil health [10].

At present, the use of fermented panchgavya, vermiwash, matka khad and cow urine is getting adaptive popularity in Indian agriculture mainly through the efforts of small groups of farmers [11]. Organic formulations have been identified as an alternative to chemical fertilizer to increase soil fertility and crop production in sustainable farming. The study focuses on the use of potential organic formulations or biological fertilizers that could prove beneficial in the productivity and sustainability of soil health and also guard the environment as eco-friendly and cost effective inputs for the farmers [12-13].

## 2. MATERIALS AND METHODS

The field experiment of a mungbean crop was conducted during *kharif* season at Agronomy farm, School of Agriculture, OPJS University, Churu (Rajasthan) to evaluate the effect of liquid organic formulations on productivity and profitability of mungbean crop under semi-arid environment of Rajasthan. Geographically, this site of field comes under Agro-climatic Zone IIA (Transitional plain of inland Draining) of Rajasthan. The climate of this region is a typically semi-arid, characterized by extremes of temperature during summers and cooler in winters. The experimental soil was loamy sand in texture with pH (8.20). The soil was low in fertility status with low organic carbon (0.21%) and available nitrogen (121.7 kg/ha), medium available phosphorus (16.12 kg/ha) and potassium (153.24 kg/ha). The field experiment was laid out in randomized block design by using twelve treatment combinations (Control, water spray (2 spray), panchgavya (2 spray), vermiwash (2 spray), cow urine (2 spray), matka khad (2 spray), panchgavya + vermiwash (one spray of each), panchgavya + cow urine (one spray of each), panchgavya + matka khad (one spray of each), vermiwash + cow urine (one spray of each), vermiwash + matka khad (one spray of each) and Cow urine + matka khad (one spray of each)) and replicated thrice. Foliar applications of liquid organic formulations (3% panchgavya, 10% vermiwash, 10% cow urine and 10% matka khad each) were done at 25 and 45 days after sowing as per treatments. Mungbean variety IPM-02-03 was sown at 30 X 20cm row to plant spacing by *Khera* method using the recommended seed rate of 15 kg/ha. The crop was fertilized with full recommended

dose of nitrogen and phosphorus as basal just before sowing the seed through urea and DAP. All agronomic practices were adopted as per need of the crop. Observations on growth, yield attributes and yield of mungbean were recorded.

Crop growth rate ( $\text{g m}^{-2} \text{ day}^{-1}$ ), relative growth rate ( $\text{mg g}^{-1} \text{ day}^{-1}$ ), chlorophyll content in leaf and leaf area index at different growth stages of mungbean crop was calculated by using the following formula as described by Hunt [14], Gardner et al. [15], Arnon [16] and Watson [17], respectively.

$$\text{Crop Growth Rate} = \frac{W_2 - W_1}{t_2 - t_1}$$

$$\text{Relative Growth Rate} = \frac{(\log_e W_2 - \log_e W_1)}{t_2 - t_1}$$

$$\text{Total chlorophyll content (mg/g)} = \frac{A(652) \times 29 \times \text{Total volume (ml)}}{\alpha \times 1000 \times \text{weight of sample (g)}}$$

where,  $\alpha$  is the path length = 1 cm, & 29 is constant

$$\text{Leaf Area Index} = \frac{\text{Leaf Area (cm}^2\text{)}}{\text{Ground Area (cm}^2\text{)}}$$

Where:  $W_2$  and  $W_1$  was the dry weight of plant and  $t_2$  and  $t_1$  was times of sampling,  $\log_e$  value = 0.4342945.

Seed and stover yields were recorded per plot and converted into kg/ha. The economics of different treatment was worked out separately by taking into account the existing price of various inputs, so that the most remunerative treatment could be recommended. The investment on fertilizer, labour and power for performing different operations such as ploughing, weeding, picking/ harvesting were considered as per rate prevalent at local market. The cost of cultivation was taken into account for calculating economics of treatments and to work out net returns and benefit cost ratio using the formula given below and expressed in rupees per hectare.

$$\text{Net returns (Rs/ha)} = \text{Gross returns} - \text{Cost of cultivation (Rs/ha)}$$

$$\text{B : C ratio} = \frac{\text{Net returns (Rs/ha)}}{\text{Cost of Cultivation (Rs/ha)}}$$

The observations recorded on different parameters were statistically analyzed by

following the analysis of variance technique as suggested by Gomez and Gomez [18] for randomized block design to draw a valid conclusion. To evaluate the significant difference between treatment means, least significant difference (LSD) at 5 percent level of significance was calculated.

## **2.1 Preparation of Panchgavya**

Panchgavya is an liquid organic formulation prepared by using five products of cow like cow dung, cow urine, milk, curd, ghee in the ratio of 10 : 7: 3 : 2 : 1, respectively. Cow dung and cow ghee were added to wide mouth plastic drum and mixed the ingredients thoroughly both in morning and evening for half hour and incubated for three days. After 3 days, rest ingredients (cow urine, cow milk, cow curd, coconut water, jiggery and well ripened banana) were blended into the drum and incubated for 30 days. The content was stirred twice a day in morning and evening for half hour. After 30 days of fermentation, mixture was filtered through a cotton cloth. The stock solution was used for the preparation of 3 per cent solution of panchgavya (3 litre panchgavya in 100 litre of water).

## **2.2 Preparation of Vermiwash**

Vermiwash is a liquid bio-formulation, having brown colored extract of organic composts, generally the wash of earthworms present in the medium collected after the passage of water through the different layers of worm culture unit [19] from the increased moisture content due to heat generated during vermicompost. It contains several enzymes, plant growth hormones (IAA, Cytokinin, GA3), vitamins, macro and micro nutrients [20] along with excretory substances and mucus secretion of earthworms [21]. Vermiwash may be collected from the vermicompost units as a by-product liquid extract. A 10% solution of vermiwash was used for spray as per treatments.

## **2.3 Preparation of Matka Khad**

Matka khad was organic formulation prepared by using 5 liter cow urine, 5 kg fresh cow dung, 250g jiggery, 250 g pulse flour. All ingredients were blended thoroughly in a big size earthen pot and kept for 7-10 day to fermentation and development of best quality microbes. The content was stirred twice a day for half hour. After that 10 per cent solution of the prepared

matka khad was used for spay on mungbean crop as per treatments.

## **2.4 Cow Urine**

Cow urine is a liquid by product of metabolism in cows. It contains 95% water, 2.5% urea, 2.5% minerals, hormones and enzymes. It also contains iron, calcium, phosphorus, carbonic acid, potash, nitrogen, manganese, iron, sulfur, phosphates, potassium, urea, uric acid, amino acids, enzymes, cytokine and lactose [22]. It was collected from desi cow house anda10% solution of one day cow urine was used for spray on crop as per treatments.

## **3. RESULTS AND DISCUSSION**

### **3.1 Growth Attributes**

It is evident from the Tables 1-2 that plant height, dry matter accumulation, number of branches, crop growth rate, relative growth rate, chlorophyll content, and leaf area index of crop at different crop stages were significantly increased by foliar application of organic formulations as compared to control and water spray treatment. Plan height continued with the advancement of age of mungbean crop. At 30 DAS, maximum plant of 23.73 cm was observed with two spray of panchgavya being at par with panchgavya + vermiwash (22.95 cm) significant over the rest of treatments. Foliar two sprays of vermiwash (21.09 cm) was also found significant than rest of the other treatment but remained at par with panchgavya + cow urine spray. Further, taller plant height (49.12 and 68.02 cm at 50 DAS and at harvest, respectively) was recorded when two spray of panchgavya applied and significantly superior to the rest of the treatments. However, foliar application of panchgavya + vermiwash (46.38 and 63.95 cm at 50 DAS and at harvest, respectively) and vermiwash (43.67 and 60.22 cm at 50DAS and at harvest, respectively) were found significant to each other and over the rest of the treatments but two spray of vermiwash statistically remained at par with panchgavya + cow urine spray. Panchgavya and vermiwash contains plant hormones (IAA, cytokinin, GA3) which enhanced the cell division and elongation of cell and also supplies essential plant nutrients and vitamins for better growth and development of a plant that resulted increase in the plant height. This result is confirmed by Maheshwari et al .[23], Patel et al. [24] and Prajapati et al. [25].

Dry matter accumulation increased with the advancement of crop age and higher increase was observed between 50 days after sowing and at harvest (Table 1). Maximum dry matter accumulation of 72.28 g/metre row length at 50 DAS and 168.32 g/metre row length at harvest was recorded when two spray of panchgavya applied and significantly superior to the rest of other treatments. Dry matter accumulation of 68.23 and 157.78 g/metre row length and 64.25 and 148.58 g/metre row length were recorded at 50 DAS and at harvest with panchgavya + vermiwash and two spray of vermiwash, respectively. However, these were significant to each other and over the rest of the treatments. Similar trend was recorded in number of branches per plant as dry matter. Higher number of branches per plant (11.40 and 11.76 at 50 DAS and at harvest, respectively) recorded with the application of two foliar spray of panchgavya which was significant over the rest of the treatments. Similarly foliar spray of panchgavya + vermiwash and two spray of verimwash considerably also noted the more number of branches per plant (11.03 and 11.23 at 50 DAS and 10.14 and 10.46 at harvest, respectively). The probable reason for higher dry matter production and number of branches might be due the application of fermented panchgavya and vermiwash which contains various amount of N, P, K, S, microbial activity as well as micronutrients in plant available form. For this reason, availability of these nutrients to plants helps to enhance photosynthetic efficiency and higher dry matter accumulation in plant parts as source that resulted in the higher dry matter production in plants. The Presence of growth enzymes in panchgavya also favored rapid cell division and multiplication which resulted higher dry matter production and branches [26]. Similar results are reported by Patel et al. [24] and Prajapati et al. [25].

The data presented in Table 2 showed that organic formulations considerably enhanced the CGR, RGR, leaf area index and chlorophyll content of leaves at different growth stages. Maximum crop growth rate (6.30 and 12.88 g/metre row length/day between 30-50 DAS and 50 DAS to at harvest, respectively) of crop was recorded when two sprays of panchgavya applied and significant over the rest of the treatments. Further, foliar application of panchgavya + vermiwash and two sprays of vermiwash also recorded a crop growth rate of 5.93 and 12.13 g/metre row length/day and 5.89 and 12.05 g/metre row length/day between 30-50

DAS and at harvest, respectively. These were significant to each other and over the rest of the treatments. Same trend in relative growth rate was obtained as in the crop growth rate of mungbean. Maximum RGR (39.02 and 17.84 mg/g/day between 30-50 DAS and 50 DAS to at harvest, respectively) was noted with two spray of panchgavya which was significant over the rest of the treatments. Treatment panchgavya + vermiwash spray and two spray of vermiwash were significant to each other. Highest relative growth rate of crop was observed between 30-50 days after sowing. This might be due to the fact that application of liquid manure improves overall growth of mungbean. The improvement in CGR and RGR might be owing to the higher and proper absorption of available major nutrients (NPK) through foliage seems to be having promoted development of morphological structure by virtue of multiplication of cell division which is well reflected through increased CGR, RGR and LAI. Significantly higher value of Leaf area index (5.76) and chlorophyll content (3.91 mg/g) of mungbean was noted with two spray of panchgavya and they were also significantly superior over the rest of the treatments. Foliar application of panchgavya + vermiwash and two spray of vermiwash recorded the value of LAI (5.44 and 5.13) and chlorophyll content (3.69 and 3.48 mg/g leaf) of crop was significant to each other and over rest of the remaining treatments. The improvement in chlorophyll content in leaves might have also resulted in better interception and utilization of radiant energy leading to higher photosynthetic rate and finally more dry matter accumulation by crop [27]. The positive effect of panchgavya on the CGR and leaf area index might be due to the fact that panchgavya as reported by Yadav and Lourduraj [28] is a source of macro and micronutrients, vitamin and growth hormones which enhanced leaf area resulting in higher photo assimilates. The outcome is in the line of conformity by Brindha et al. [29], Sudhagar Rao et al. [30] and Choudhary et al. [31].

### **3.2 Yield attributes**

The data presented in Table 3 showed that yield attributes like total number of nodules per plant, effective nodules per plant, fresh weight of nodules (mg), dry weight of nodules (mg), pods per plant, seeds per pod and test weight(g) of crop were significantly improved with the foliar application of a variety of organic formulations. Higher total number of nodules per plant (43.09) and effective nodule number per plant (39.76)

were obtained when two spray of panchgavya applied and significantly superior over rest of the treatments. Foliar application of panchgavya + vermiwash and two spray of vermiwash treatment recorded number of nodules per plant of 39.74 and 37.42 and effective nodules per plant of 37.53 and 35.34, respectively, which were significant over the rest of the treatments. However, spray of panchgavya + vermiwash and two spray of vermiwash were significant to each other. Similar trend was observed in fresh and dry weight of nodules. Two foliar application of panchgavya, panchgavya + vermiwash and two spray of vermiwash recorded higher fresh nodule weight (135.14, 126.91 and 119.51 mg) and dry nodule weight (78.89, 74.67 and 70.31 mg respectively), which were significant to each other and over the rest of the treatments. The easy transfer of nutrients to plants through foliar spray of panchgavya and vermiwash might be the reason for enhancement the total and effective nodules, fresh and dry weight of nodules. Somasundaram et al. [32] has about the increase in effective nodule by foliar spray of panchgavya. Leaf area index plays a major role in the formation of total and effective nodule, fresh and dry weight of nodules. Since, leaves are the main factors of photosynthesis and dry matter accumulation. Subramanian [33] resulted that the use of panchgavya as liquid manure resulted in the increase of nodule formation by almost 18% to 62%. Similarly type of result also reported by Kumaravelu and Kadamban [9], Prajapati et al. [25] and Choudhary et al. [31].

Considerably highest number of pods per plant (23.99) and seed per pod (10.09) of crop was obtained with two sprays of panchgavya and superior than rest of the treatments (Table 3). Foliar application of panchgavya + vermiwash and two spray of vermiwash recorded pods per plant of 22.65 and 21.33 and seed per pod of 9.35 and 8.80, respectively, which were significant over the rest of the treatments. However, Panchgavya + vermiwash and two spray of vermiwash were statistically significant to each other. In respect to test weight, maximum test weight of 45.30 g was recorded when two spray of panchgavya applied and significant over control and water spray. This increase in these attributes might be due to panchgavya application which helped in acceleration of various metabolic processes and better photosynthesis activity of the plant resulting enhanced biological efficiency [34]. Similar results are reported by Jadhav et al. [35], Kumaravelu and Kadamban [9], Gunasekar et al.

[36], Sudhagar Rao et al. [30], Sutar et al. [37] and choudhary et al. [31].

### 3.3 Yields

The perusal of data in Table 4 showed that grain, stover and biological yield of crop was improved when different organic formulations applied. Highest grain yield of 1128 kg/ha obtained with the two foliar application of panchgavya which was significant over the rest of the treatments. Foliar application of panchgavya + vermiwash was also found significant over the rest of the treatments but remained statistically at par with two spray of vermiwash and panchgavya + cow urine spray treatment. Considerable maximum stover yield (2402 kg/ha) and biological yield (3530 kg/ha) of crop was recorded with the two foliar spray of panchgavya treatment which was significant over rest of the treatments. However, foliar spray of panchgavya + vermiwash and two spray of vermiwash recorded higher stover yield (2221 and 2091 kg/ha) and biological yield (3272 and 3106 kg/ha) which were significant to each other and over rest of the treatments. Harvest index of crop was not influenced significantly with spray of organic formulations. It is a well known fact that grain yield is the function of yield attributing characters. Grain yield is considered to be the end product of many yield-contributing components, physiological and morphological processes taking place in plants during growth and development. Continuous supply of nutrients in balanced quantity throughout the growth stages by foliar spray of organic formulations enabled the plants to assimilate sufficient photosynthetic product causing increased dry matter accumulation and yield attributes. With increased dry matter and efficient photosynthetic products coupled with efficient translocation, higher number of pods and better number of grains was produced which ultimately resulted in higher grain yield. Panchgavya is known to extend stimulatory effect to plant through phytohormones [38-39] could successfully influence the plant to perform better which finally increased the yield by 33.40% over control. The panchgavya is an efficient plant growth stimulant that enhances the biological efficiency and the productivity of plant by increasing the growth and yield attributes (effective nodules, pods/plant, seeds/pod and test weight) that contributing to the overall higher yields [40]. These results are corroborating the findings of Choudhary et al. [41], Gunasekar et al. [36], Sudhagar Rao et al. [30] and Rajasooriya and Karunaratna [42].

**Table 1. Effect of liquid organic formulations on plant height, dry matter accumulation and crop growth rate at different stages of mungbean**

| Treatments             | Plant height (cm) |        |            | Dry matter accumulation (g/metre row length) |        |            | Number of branches/plant |            |
|------------------------|-------------------|--------|------------|--|--------|------------|--------------------------|------------|
|                        | 30 DAS            | 50 DAS | At harvest | 30 DAS                                       | 50 DAS | At harvest | 50 DAS                   | at harvest |
| Control                | 13.83             | 28.62  | 39.47      | 26.23  | 42.11  | 97.38      | 6.64                     | 6.85       |
| Water -2 Spray         | 14.04             | 29.07  | 40.09      | 26.64  | 42.78  | 98.91      | 6.75                     | 6.96       |
| Panchgavya-2 Spray     | 23.73             | 49.12  | 68.02      | 45.01  | 72.28  | 168.32     | 11.40                    | 11.76      |
| Vermiwash-2 Spray      | 21.09             | 43.67  | 60.22      | 40.01  | 64.25  | 148.58     | 10.14                    | 10.46      |
| Cow urine-2 Spray      | 19.49             | 40.35  | 55.64      | 36.97  | 59.37  | 137.28     | 9.37                     | 9.66       |
| Matka khad-2 Spray     | 15.37             | 31.82  | 43.88      | 29.16  | 46.82  | 108.26     | 7.39                     | 7.62       |
| Panchgavya + Vermiwash | 22.95             | 46.38  | 63.95      | 43.49  | 68.23  | 157.78     | 11.03                    | 11.23      |
| Panchgavya + Cow urine | 20.96             | 43.38  | 59.83      | 39.75  | 63.83  | 147.60     | 10.07                    | 10.39      |
| Panchgavya + Matkakhad | 18.18             | 37.64  | 51.91      | 34.49  | 55.38  | 128.07     | 8.74                     | 9.01       |
| Vermiwash + Cow urine  | 19.64             | 40.65  | 56.06      | 37.25  | 59.81  | 138.30     | 9.44                     | 9.73       |
| Vermiwash + Matkakhad  | 16.86             | 34.90  | 48.12      | 31.97  | 51.34  | 118.72     | 8.10                     | 8.36       |
| Cow urine + Matkakhad  | 16.72             | 34.61  | 47.72      | 31.71  | 50.92  | 117.74     | 8.03                     | 8.29       |
| SEm ( $\pm$ )          | 0.40              | 0.86   | 1.15       | 0.8  | 1.27   | 2.86       | 0.20                     | 0.20       |
| LSD ( $P=0.05$ )       | 1.18              | 2.53   | 3.36       | 2.34   | 3.72   | 8.39       | 0.59                     | 0.59       |

**Table 2. Effect of liquid organic formulations on CGR, RGR, LAI and chlorophyll content of leaves at different growth stages of mungbean crop**

| Treatments              | Crop growth rate<br>(g/m row length/day) |                       | Relative growth rate<br>(mg/g/day) |                       | LAI    | Chlorophyll<br>content (mg/g<br>fresh leaf) |
|-------------------------|--|-----------------------|------------------------------------|-----------------------|--------|---|
|                         | 30-50 DAS                                | 50 DAS -at<br>harvest | 30-50 DAS                          | 50 DAS -at<br>harvest | 40 DAS |   |
| Control                 | 3.33                                     | 6.80                  | 37.73                              | 17.25                 | 3.20   | 2.17  |
| Water -2 Spray          | 3.68                                     | 7.53                  | 37.78                              | 17.27                 | 3.28   | 2.23  |
| Panchgavya-2 Spray      | 6.30                                     | 12.88                 | 39.02                              | 17.84                 | 5.76   | 3.91  |
| Vermiwash-2 Spray       | 5.89                                     | 12.05                 | 38.74                              | 17.71                 | 5.13   | 3.48  |
| Cow urine-2 Spray       | 5.47                                     | 11.19                 | 37.92                              | 17.33                 | 3.62   | 2.46  |
| Matka khad-2 Spray      | 4.21                                     | 8.61                  | 38.46                              | 17.58                 | 4.72   | 3.20  |
| Panchgavya + Vermiwash  | 5.93                                     | 12.13                 | 38.91                              | 17.78                 | 5.44   | 3.69  |
| Panchgavya + Cow urine  | 5.54                                     | 11.32                 | 38.70                              | 17.69                 | 5.09   | 3.45  |
| Panchgavya + Matka khad | 4.64                                     | 9.49                  | 38.25                              | 17.48                 | 4.38   | 2.97  |
| Vermiwash + Cow urine   | 4.72                                     | 9.66                  | 38.51                              | 17.60                 | 4.77   | 3.24  |
| Vermiwash + Matka khad  | 4.27                                     | 8.74                  | 38.12                              | 17.42                 | 4.03   | 2.73  |
| Cow urine + Matka khad  | 3.87                                     | 7.91                  | 38.09                              | 17.41                 | 3.97   | 2.70  |
| SEm ( $\pm$ )           | 0.11                                     | 0.23                  | 0.50                               | 0.28                  | 0.10   | 0.10  |
| LSD ( $P=0.05$ )        | 0.32                                     | 0.66                  | 1.47                               | 0.81                  | 0.30   | 0.20  |

\*CGR- Crop growth rate, RGR – Relative growth rate, LAI – Land equivalent ratio

**Table 3. Effect of liquid organic formulations on yield attributes of mungbean**

| Treatments              | Total No. of nodules/plant | Effective nodules/plant | Fresh weight of nodules (mg) | Dry weight of nodules (mg) | Pods/plant | Seeds/pod | Test weight (g) |
|-------------------------|----------------------------|-------------------------|------------------------------|----------------------------|------------|-----------|-----------------|
| Control                 | 24.52                      | 23.16                   | 78.33                        | 46.08                      | 13.98      | 5.77      | 40.21           |
| Water -2 Spray          | 24.91                      | 23.53                   | 79.56                        | 46.81                      | 14.20      | 5.86      | 40.28           |
| Panchgavya-2 Spray      | 43.09                      | 39.76                   | 135.14                       | 78.89                      | 23.99      | 10.09     | 45.30           |
| Vermiwash-2 Spray       | 37.42                      | 35.34                   | 119.51                       | 70.31                      | 21.33      | 8.80      | 44.80           |
| Cow urine-2 Spray       | 34.57                      | 32.66                   | 110.42                       | 64.97                      | 19.71      | 8.13      | 44.50           |
| Matka khad-2 Spray      | 27.26                      | 25.75                   | 87.08                        | 51.23                      | 15.54      | 6.41      | 43.61           |
| Panchgavya + Vermiwash  | 39.74                      | 37.53                   | 126.91                       | 74.67                      | 22.65      | 9.35      | 45.00           |
| Panchgavya + Cow urine  | 37.17                      | 35.11                   | 118.72                       | 69.85                      | 21.19      | 8.74      | 44.76           |
| Panchgavya + Matka khad | 32.25                      | 30.47                   | 103.01                       | 60.61                      | 18.38      | 7.59      | 44.24           |
| Vermiwash + Cow urine   | 34.83                      | 32.90                   | 111.24                       | 65.45                      | 19.85      | 8.19      | 44.54           |
| Vermiwash + Matka khad  | 29.90                      | 28.24                   | 95.49                        | 56.18                      | 17.04      | 7.03      | 43.97           |
| Cow urine + Matka khad  | 29.65                      | 28.01                   | 94.71                        | 55.72                      | 16.90      | 6.98      | 43.92           |
| SEm ( $\pm$ )           | 0.75                       | 0.71                    | 2.33                         | 1.34                       | 0.41       | 0.17      | 0.58            |
| LSD ( $P=0.05$ )        | 2.19                       | 2.08                    | 6.84                         | 3.93                       | 1.20       | 0.51      | 1.70            |

**Table 4. Effect of liquid organic formulations on yields, harvest index and economic returns by mungbean crop**

| Treatments              | Yields (kg/ha) |       |            | HI (%) | Net returns<br>(Rs/ha) | Benefit cost<br>ratio |
|-------------------------|----------------|-------|------------|--------|------------------------|-----------------------|
|                         | Seed           | Straw | Biological |        |                        |                       |
| Control                 | 708            | 1371  | 2079       | 34.01  | 29321                  | 1.47                  |
| Water -2 Spray          | 729            | 1392  | 2121       | 34.35  | 29411                  | 1.38                  |
| Panchgavya-2 Spray      | 1128           | 2402  | 3530       | 31.95  | 55576                  | 2.30                  |
| Vermiwash-2 Spray       | 1015           | 2091  | 3106       | 32.66  | 45866                  | 1.80                  |
| Cow urine-2 Spray       | 934            | 1932  | 2866       | 32.56  | 43661                  | 1.98                  |
| Matka khad-2 Spray      | 762            | 1524  | 2286       | 33.34  | 29819                  | 1.27                  |
| Panchgavya + Vermiwash  | 1051           | 2221  | 3272       | 32.14  | 49361                  | 1.99                  |
| Panchgavya + Cow urine  | 1008           | 2078  | 3086       | 32.68  | 47790                  | 2.07                  |
| Panchgavya + Matka khad | 868            | 1803  | 2671       | 32.58  | 37265                  | 1.56                  |
| Vermiwash + Cow urine   | 941            | 1947  | 2888       | 32.79  | 42466                  | 1.79                  |
| Vermiwash + Matka khad  | 801            | 1671  | 2472       | 32.41  | 31900                  | 1.30                  |
| Cow urine + Matka khad  | 794            | 1657  | 2451       | 32.40  | 33137                  | 1.45                  |
| SEm ( $\pm$ )           | 21             | 41    | 49         | 0.65   | 1326                   | 0.06                  |
| LSD ( $P=0.05$ )        | 62             | 122   | 144        | NS     | 3889                   | 0.17                  |

\*HI – Harvest index

### 3.4 Economics

An examination of data in Table 4 revealed that net returns and benefit cost ratio significantly increased with the foliar application of organic formulations. Highest net returns (55576 Rs/ha) and benefit cost ration (2.30) was obtained when two spray of panchgavya applied which was significantly higher than rest of the treatments. Similarly, spray of panchgavya + vermiwash also obtained net returns of 49361 Rs/ha which was significant over rest of the treatments. While, minimum net returns of 29321 and 29411 Rs/ha was obtained with control and water spray treatment. Maximum benefit cost ratio of 2.30 was recorded with two spray of panchgavya whereas minimum benefit cost ratio of 1.47 and 1.38 was obtained under control and water spray treatment. The increase in net return and benefit cost ratio may be due to more grain and straw yields and low cost of panchgavya and vermiwash preparation because most of the ingredients required are low price inputs. Choudhary et al. [41] showed that application of panchgavya significantly resulted increased the gross return (89642 Rs/ha), net return (67042 Rs/ha) and B: C (2.96) ratio of blackgram as compared to control. Choudhary et al. [31] reported that the higher net return (24091 Rs/ha) and B:C ratio (1.5) were obtained with application of panchgavya 5% at 20 DAS+35 DAS in moth bean.

### 4. CONCLUSION

On the basis of one year's experimental findings it might be inferred that independent two sprays of panchgavya at 25 and 45 days after sowing and combined spray of panchgavya + vermiwash (one spray of each) was best suited for securing higher productivity and profitability by mungbean crop. Thus, use of liquid organic formulations as foliar spray might be beneficial under semi arid eco-regions of Rajasthan. However, these consequences are just indicative and need further experimentation to arrive at a more consistent and accurate conclusion.

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### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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