Effect of Liquid Organic Formulations on Productivity and Profitability of Mung-beancrop under Semi Arid Environment of Rajasthan

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 investigationwas aimed to know the effect of liquid organic formulations on productivity and profitability of mungbeancrop 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), Matkakhad (2 spray), Panchgavya + Vermiwash, Panchgavya + Cow urine, Panchgavya + Matkakhad, Vermiwash + Cow urine, Vermiwash + Matkakhad and Cow urine + Matkakhad.

Result: The resultsrevealed that independent two spray of panchgavya and spray of panchgavya+ vermiwash (one spray of each) resultedsignificantly 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 befit cost ratio (2.30 and 2.07) which was significant over rest of the treatments. According to our findings independent two spray of panchgavyaat 25 and 45 DAS and combined spray of panchgavya + vermiwash (one spray of each) is recommended for higher productivity with more economic returns.

Key words :Panchgavya, Vermiwash, Matkakhad, LAI, CGR, RGR

1. INTRODUCTION

Pulses are an important source of protein for the poor as well as for thevegetarian which contributeson 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 (30-150kg/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 milliontonnes and productivity of 892 kg/haannually[3].MadhyaPradesh, Maharashtra, Rajasthan, Gujrat,UttarPradesh 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 historic 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 an significant food and economic crop in the rice-based farming systems [4].

India is the largest producer of mungbeanglobally [5]. Itoccupies64.56 lakh hectareareaswith 4.05 million tonnesproduction in India [3] and stands third position among pulses by accounting 10 percent in production and 16 percentin area.The leading contributors to mungbean cultivation in terms of area and production are Rajasthan (46% and 45% respectively), MadhyaPradesh, Maharashtra, Karnataka, Odisha, Bihar, Tamil Nadu, Gujarat, AndhraPradesh and Telangana also playing considerablefunction. In Rajasthan, mungbean crop covers about 23.26 lakh hectare area and production of 9.06 lakh tonneswith productivity of 354 during 2021-22kg/ha [3].

Mungbean crop ismostly cultivated in arid and semi-arid districts of Rajasthan including Jaipur, Nagaur, Jodhpur, Sikar, Jhunjhunu,Paliand Ajmer. Although, its average productivity is quite low as compared to its production potential due to moisture stress and pool soil quality in the state which is a matter of severe concern.Being a drought tolerant crop, it isoutstanding source of high quality protein (24.5%) with tryptophan,lysine, fibres and minerals [6]. It also contains thiamine, riboflavin and has a significant amountof ascorbic acid when sprouted [7-8]. Owing to a short duration crop, it may be grow 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 the India.Organic farming is a production system which escapes or mainly excludes 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 aimsof organic farming.Due to increasing cost and unavailability of fertilizers, growing ecological concern and the government interest in promoting the organic farming have forced us to try new methods of application of nutrients in the form of panchgavya, vermiwash, cow urine, matkakhadetc. [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, matkakhad 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. These potential organic formulations or biological fertilizers would play the key role in

productivity and sustainability of soil and also protect the environment as eco-friendly and costeffective inputs for the farmers [12-13].

2. MATERIALS AND METHODS

The field experiment of a mungbean crop was conducted duringkharif season atAgronomy farm, School of Agriculture, OPJSUniversity,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 loamysand 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) andpotassium (153.24 kg/ha). The field experiment was laid out in randomized block design by using twelvetreatment combinations(Control, water spray (2 spray), panchgavya(2spray), vermiwash(2 spray), cow urine (2 spray), matkakhad(2 spray), panchgavya+ vermiwash (one spray of each), panchgavya+ cow urine (one spray of each), panchgavya+ matkakhad (one spray of each), vermiwash+ cow urine (one spray of each), vermiwash+ matkakhad (one spray of each) and Cow urine + matkakhad (one spray of each)) and replicated thrice. Foliar applications of liquid organic formulations (3% panchgavya, 10% vermiwash, 10% cow urine and 10% matkakhad each) weredone 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 (g $m^{-2}day^{-1}$), relative growth rate (mg $g^{-1}day^{-1}$), chlorophyll content in leafand 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.

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

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

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

Where, α 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

Panchgavyais an liquid orgamic formulation prepared by using five products of cow like cow dung, cow urine, milk, curd, gheein the ratio of 10 : 7: 3 : 2 : 1, respectively. Cow dung and cow ghee were added to wide mouthplastic drum and mixed the ingredients thoroughly both in morning and evening for halfhour 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. Thestock solution was used for the preparation of 3 per cent solution of panchgavya (3 litrepanchgavya in 100 litre of water).

2.2 Preparation of Vermivash

Vermiwash isa 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 sev-

eral 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 Matkakhad

Matkakhad was organic formulation prepared by using 5 liter cow urine, 5 kgfresh cow dung, 250g jiggery, 250 g pulse flour. All ingredients were blended thoroughly in a big size earthen pot and kept for 7-10 dayto 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 matkakhad was used for spay on mungbean cropas 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 table 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 formulationsas compared to control and water spray treatment.Plan height continued with the advancement of age of mungbeancrop.At 30 DAS, maximum plant of 23.73 cm was observed with two spray of panchgavyabeing at par with panchgavya+ vermiwash(22.95cm) significant over the rest of treatments.Foliartwo spray of vermiwash(21.09cm) 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 and68.02 cm at 50 DAS and at harvest, respectively) was recorded when two spray of panchgavyaapplied and significantly superior to the rest of the treatments. However, foliar application of panchgavaya+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 vermiwashcontains 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 byMaheshwari *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 ofpanchgavyaapplied and significantly superior to the rest of other treatments.Drymatter 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 withpanchgavya+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 panchgavyaand vermiwash which contains various amount of N, P, K, S, microbial activity as well asmicronutrients 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.Presence of growth enzymes in panchgavyaalso favored rapid cell division and multiplication which resulted higher dry matter productionand 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 whentwo spray of panchgavya applied and significant over the rest of the treatments.Further,foliar application of panchgavya+vermiwash and two spray 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/daybetween 30-50 DAS and at harvest, respectively.Thesewere 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 panchgavaywhich was significant over the rest of the treatments. Treatmentpanchgavya+vermivash spray and two spray of vermiwashwere 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 highervalue of Leaf area index (5.76) and chlorophyll content (3.91mg/g) of mungbean was noted with two spray of panchgavyaand they were also significantly superior over the rest of the treatments. Foliar application of panchgavya+vermiwash and two spray of vermiwashrecorded 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 hormoneswhich enhanced leaf area resulting in higher photo assimilates.The outcome is in the line of conformity byBrindha *et al.*[29], Sudhagar Rao *et al*. [30] and Choudhary *et al*. [31].

3.2 Yield attributes

The data presented in table3 showed that yield attributes like totalnumber 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) wereobtained when two spray of panchgavya applied and significantly superior over rest of the treatments. Foliar application of panchgavya + vermiwash and two spray of vermiwashtreatment 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 overthe rest of the treatments. However, spray of panchgavya + vermiwash and two spray of vermiwashwere 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 vermiwashrecorded 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 panchgavyaand 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 panchgavyaand superior than rest of the treatments (Table 3).Foliar application of panchgavya+vermiwash and two spray of vermiwash recorded pods per plant of 22.65and 21.33 and seed per pod of 9.35and 8.80, respectively,which were significant over the rest of the treatments.However, Panchgavaya+vermiwash and two spray of vermiwash were statistically significant to each other.In respect to test weight, maximum test weight of 45.30 gwas recorded when two spray of panchgavayapplied and significant over control and water spray. This increase in these attributes might be due to panchgavyaapplication which helped in acceleration of various metabolic processesand 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 *etal.* [36], Sudhagar Rao *et al*. [30], Sutar *et al*. [37] andchoudhary*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 panchgavyawhich 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 vermiwashand panchgavya+cow urine spray treatment. Considerable maximum stoveryield (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 vermiwashrecorded 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 ofmany 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 photosyntheticproduct 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 ofChoudhary *et al*. [41], Gunasekar *etal.*[36], Sudhagar Rao *et al.*[30] andRajasooriya and Karunarathna [42].

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 mothbean.

4. CONCLUSION

On the basis of oneyear'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 + vermivash (one spray of each) was best suited for securing higherproductivity and profitability bymungbean 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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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 har-vest	30 DAS	50 DAS	At har-vest	50 DAS	at har-vest
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 (±)	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 (g/m row length/day)	Relative growth rate (mg/g/day)	LAI	Chlorophyll content (mg/g fresh leaf)

	30-50 DAS	50 DAS -at harvest	30-50 DAS	50 DAS -at 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 + Vermi-wash	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 + Matkak-had	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 + Matkak-had	4.27	8.74	38.12	17.42	4.03	2.73
Cow urine + Matkakhad	3.87	7.91	38.09	17.41	3.97	2.70
SEm (±)	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 no-dules/plant	Fresh weight of nodules (mg)	Dry weight of no-dules (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 + Matkakhad	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 + Matkakhad	29.90	28.24	95.49	56.18	17.04	7.03	43.97
Cow urine + Matkakhad	29.65	28.01	94.71	55.72	16.90	6.98	43.92
SEm (±)	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 mung-bean crop

Treatments	Yields (kg/ha)			HI (%)	Net returns (Rs/ha)	Benefit cost 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 + Matkakhad	868	1803	2671	32.58	37265	1.56
Vermiwash + Cow urine	941	1947	2888	32.79	42466	1.79
Vermiwash + Matkakhad	801	1671	2472	32.41	31900	1.30
Cow urine + Matkakhad	794	1657	2451	32.40	33137	1.45
SEm (±)	21	41	49	0.65	1326	0.06
LSD (*P*=0.05)	62	122	144	NS	3889	0.17

*HI –Harvest index