

Effect of Liquid Manure on Growth and Yield of Summer Green Gram (*Vigna radiata* L. Wilczek)

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Authors' contributions

This work was carried out in collaboration among all authors. Authors SC, RM and MP designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author SC managed the analyses of the study. Authors SB, AM and RM managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was undertaken to study the effect of different liquid manure on growth and yield of green gram during *summer* seasons of 2015 and 2016. The experiment was conducted at Model Organic Farm at Kalyani C block of Bidhan Chandra Krishi Viswavidyalaya Nadia under New alluvial zone of West Bengal with 8 different treatments of liquid manure i.e. (T₁ = Jivamrut+FYM, T₂ = Sanjivak+FYM, T₃ = Panchagavya+FYM, T₄ = Cow urine+FYM, T₅ = Vermiwash+Cow urine + FYM, T₆ = Vermiwash+FYM, T₇ = Vermicompost+FYM, T₈ = Control) and with three replications. The result of experiment revealed that the combined application of Panchagavya @8 kg N equivalent along with FYM @ 12 kg N equivalent (T₃) exerted significant influence towards higher growth parameters like plant height, LAI and dry matter accumulation throughout the crop growth period, yield attributes like number of pod/plant, pod length, number of seeds/pod and test weight and thus achieved maximum grain yield (1085 kg/ha) and stover yield (3224 kg/ha). On the basis of field performance, it may be inferred that the treatment FYM@12 kg N equivalent at land preparation + Panchagavya @8 kg N equivalent (twice equal split applications at 30 DAS and 45 DAS through irrigation water) may be recommended as a better organic package of greengram followed by FYM

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@12 kg N equivalent at land preparation + vermicompost @8 kg N equivalent (twice equal split applications at 30 DAS and 45 DAS as top dressing) among all other treatments applied in the soil.

Keywords: Green gram; liquid manure; panchgavya; grain yield.

1. INTRODUCTION

India has successfully achieved food security, but nutritional security continues to be a cause of concern. Though pulses have variable uses in our diet and their importance in improving soil health by way of fixing atmospheric N and addition of organic matters the increment in production isn't able to keep pace with population growth [1]. India recognized as a major player in pulse production, contributes 27.65% to the global production and holds 35.2% of world's area. In spite of being the largest producer in the World, our country has to import pulses to the tune of two million tones every year to meet its domestic requirement; the increment in the production being not able to maintain the pace with population growth [1]. To make the nation pulse sufficient, productivity level of pulses has to be increased substantially to 1200 kg per hectare by 2020 from the present level of 623 kg per hectare and sizeable area has to be brought under cultivation of pulses. West Bengal produce only 1.5 per cent of total pulse produced in India. Since yields of pulses are generally low and they are less remunerative than cereals and other crops, it would, therefore, not be economically feasible to bring additional area under them at the cost of other crops like rice, wheat, oilseeds, etc. The only alternative to increase the production of pulses is to grow short duration pulses during summer season when most of the crop fields remain fallow. Among the pulse crop Green gram or Mung [*Vigna radiata* (L.) Wilczek] is one of the most important pulse crops of India. It is the third important pulse crop after chickpea and pigeon pea, cultivated throughout India for its multipurpose uses as vegetable, pulse, fodder and green manure crop. It is a good source of protein (20-24 %), carbohydrates (60-62%), water (10%), fat (1.0%), fiber (4.0%) and ash (3.0%). It is a good source of the mineral, pro-vitamin A, B complex and ascorbic acid. It is cultivated across the country during summer, rainy and winter seasons. On account of its short duration, photo-insensitivity and dense crop canopy it assumes special significance in crop intensification and diversification; conservation of natural resources and sustainability of production system. The productivity of this crop is very low because of its cultivation on marginal and sub-

marginal lands of low soil fertility where little attention is paying to adequate fertilization. Another major problem that the excessive use of inorganic fertilizers resulted in a decline in soil organic matter, nutrient imbalance, i.e. secondary or micronutrient deficiencies, adverse effects on beneficial soil micro-flora & native biodiversity, deterioration of physical, chemical and biological functioning of soil, underground water and atmospheric pollution and consequently wide spread problems associated with the toxic residuals of agrochemicals entering into the human and animal food chains [2]. By seeing all the ill effects in the post green revolution era, scientists go for searching the alternatives, rather we can say go for another green revolution. Organic farming has been considered as a tool for another green revolution. Organic farming is a system that avoids the use of synthetic chemical fertilizers, pesticides and growth regulating hormones and raises the crop with the use of organic manures, crop rotation, legumes, green manure and biological pest control. In modern farming liquid manure play a crucial role in significant yield increase as well as reduce the fertilizer dose. The Panchagavya, Jivamrut, Sanjivak are ecofriendly liquid organic preparation made from cow products i.e., cow dung, urine, milk, curd, ghee, legume flour and jaggary etc. results in higher growth, yield & quality of crops. They contain macro nutrients, essential micro-nutrients, vitamins, essential amino acids, growth promoting factors like IAA, GA and beneficial microorganisms [3-5]. So, the present experiment was carried out to study the effect of liquid manure on growth and yield of green gram in Lower Indo Gangetic Plains of West Bengal.

2. MATERIALS AND METHODS

Field experiment was conducted at the Model Organic Farm at Kalyani C block farm of Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal 22°57' N latitude, 88°20' E longitude and at an altitude of 9.75 m above the mean sea level) to study the effect of liquid manure on green gram during summer seasons of 2015 and 2016. The experimental site falls under sub-tropical sub-humid climate. The average rainfall is 1450 mm, 75% of which is

received during June to September. During the crop growth period average maximum temperature ranged between 34.61°C to 37.99°C and average minimum temperature varied between 19.18 to 27.20°C. The average maximum relative humidity varied from 82.00 to 91.90 % and minimum relative humidity varied from 39.10 to 62.56%. The total rainfall was distributed throughout the experimental period but, the highest rainfall received in the month of June (322 mm) followed by April (102.19 mm). The texture of the experimental soil was sandy clay loam and belongs to the order inceptisol with medium fertility and almost neutral in soil reaction. Physio-chemical properties of soil during both the seasons are given in Table 1. The experiment was conducted on a medium land, well-drained Gangetic alluvial soil. The experiment was laid down randomized block design with three replications comprising eight treatments i.e. (T₁ = Jivamrut+FYM, T₂ = Sanjivak+FYM, T₃ = Panchagavya+FYM T₄ = Cow urine+FYM, T₅ = Vermiwash+Cow urine +FYM, T₆= Vermiwash+FYM, T₇ = Vermicompost +FYM, T₈ = Control). (Treatment details are given in Table 2). Jivamrut – In a barrel take 100 lit.water, add 10 kg. cowdung, 10 lit. Cow urine, 2 kg. jaggary and 2 kg. any pulse flour. Mix well with wooden stick.Ferment for 7 days. Sanjivak – In a barrel take 100 lit. water, add 33 kg. cowdung, 33 lit. Cow urine and 200 g. jaggary. Mix well with wooden stick. Ferment for 10 days. Panchgavya – Mix cow dung slurry 4 kg., fresh cow dung 1 kg., cow urine 3 lit., cow milk 2 lit., curd 2 lit. & cow desi ghee 1 kg. Ferment for 7 days with twice stirring per day. Vermiwash – In a 10 litre capacity earthen barrel fitted with tap outlet at four inches from the bottom and filled with small sized gravels upto the tap and thereafter one month old decomposed vermifeed was placed above the gravel. 2000 number of Eisenia foetida was mixed with the feed. The mouth of the earthen pot was covered with nylon net. Water was sprinkled in every alternate day. After 15 days when vermicompost was ready as CTC tea granule, 1.5 litre of water was dripped over the mouth of the earthen pot during night and in the morning one litre vermiwash will be collected through tap outlet 3- 4 times until the colour of the vermiwash tends to colourless. Cow urine – The cow urine was collected through an outlet of the floor of the cowshed in the morning and kept for 7 days. Thereafter, cow urine was diluted with water in 1: 10 and applied through irrigation water. Each plot had an area of 4.0 m × 3.0 m. The seeds of green gram sown with a spacing of 30 cm X 10 cm. The crop was

fertilized with 20 kg N ha⁻¹, 60% of required dose was applied as basal in form of 3 t of FYM per ha, rest 40% was applied through various liquid manures as top dressing in 2 equal splits at 30 & 45 DAS through irrigation water based on treatments (Table 1). Necessary field operations like weeding and control of diseases-pests were done as and when required by the crop. One light pre-sowing irrigation was given to get better and uniform plant stand. Otherwise the crop was raised as rain fed. the pods were harvested as soon as pods turned dark brown / black. An area of 8 m² was selected and demarcated for recording yield data. The first two border rows in each side of a plot were left to avoid border effect. Harvesting was done by picking of pods. Only one picking was done. Harvested pods were sun-dried for 2-3 days and then threshing was done manually by beating the pods with the sticks to separate seeds from the pods. Then separated seeds were again sun-dried to bring down the moisture percentage to 12%. Growth parameters viz. plant height, dry matter accumulation (DMA) were recorded periodically at 20, 40 and 60 DAS. Yield components namely number of pods plant⁻¹, number of seeds pod⁻¹, test weight (1000-seed weight) were recorded at harvest. After threshing the grains were properly sun-dried, cleaned, weighed and finally converted into kg ha⁻¹. Stover yield was also estimated as kg ha⁻¹. The data collected on growth parameters, yield components and yields were analyzed following the method of analysis for randomized block design as described by Gomez and Gomez [6]. The significance of different sources of variation was tested at probability level of 0.05. The standard error of mean (S. Em±) and the value of Critical Difference were indicated in the tables to compare the difference between the mean values.

Table 1. Physio-chemical properties of experimental fields (Mean of 2 year)

Physical composition	
Sand %	52.8
Silt%	23.9
Clay%	23.3
Chemical composition	
Soil pH	7.2
Organic carbon %	0.59
Available Nitrogen (kg/ha)	209.6
Available phosphorus (kg/ha)	18.9
Available potassium (kg/ha)	166.5

Table 2. Treatment details and nitrogen content of liquid manure

Treatment	Liquid manures with N content	Amount / split /ha (Litre)
T ₁	Jivamrut (0.434%)	1000
T ₂	Sanjivak (0.6%)	1333
T ₃	Panchagavya (2.44%)	170
T ₄	Cow urine (0.9%)	460
T ₅	Cow urine (0.9%) + Vermi wash (0.11%)	230 + 1893
T ₆	Vermi wash (0.11%)	3785
T ₇	Vermicompost (1.23%)	333
T ₈	Control	Untreated

3. RESULTS AND DISCUSSION

3.1 Effect of Different Liquid Manure on Growth Parameters of Greengram

The plant growth in terms of plant height of green gram was significantly influenced by the application of different liquid manure (Table 3). Plant height increased consistently with the advancement of crop growth stages i.e. 20 days after sowing (DAS) to 60 DAS. Among the different organic management practices treatment T₃ i.e. combined application of FYM +Panchagavya recorded the tallest plant height at 20, 40 and 60 DAS (14.5, 59.1 and 62.2 cm) followed by FYM + cow urine + vermin wash (T₅) and FYM + cow urine (T₄) with no significant difference among them and the least plant heights were noted under the treatment T₈ (control) where no organic liquid was added. This might be due to overall improvement in crop growth at application of liquid manure. The results clearly indicated the need for adding liquid manures to soil which increased the availability of nutrients over a long period, have a positive effect on height of the plant. Application of different liquid manures along with FYM showed significant influence on Leaf area index of greengram at 20, 40 and 60 DAS (Table 3). Significantly higher LAI was noticed for FYM +Panchagavya (T₃) i.e. (1.15, 3.18 and 3.61) followed by FYM+vermicompost (T₇) and vermiwash+FYM (T₆). The lowest value was noted in control plot (T₈). Nitrogen is one of the most important factors affecting the leaf area index which might have helped in enhancing photosynthesis and productivity of the crop. The positive effect of panchagavya on leaf area index might be due to the fact that liquid manure as a source of macro and micronutrients, vitamin, and growth hormones like gibberellins which enhanced leaf area resulting in higher photo assimilates. The real picture of crop growth can be obtained from the data of dry matter

accumulation. Dry mass of aerial parts of plants/ m² was determined in this experiment at 20, 40 and 60 DAS and the data are reflected in (Table 3). Application of different liquid manures along with FYM showed significant influence on dry matter accumulation of green gram at 20, 40 and 60 DAS. Higher dry matter accumulation was noticed for FYM +Panchagavya (T₃) i.e. (50.9, 181.9 and 288.3 g/ m²) followed by FYM + vermicompost (T₇) and vermiwash +FYM (T₆). It supported the seed yield and have positive interaction with seed yield (Fig. 1). Lowest dry matter accumulation was recorded in untreated control plot. Panchagavya contains N, P, K, S, Fe and Zn. Thus, balanced nutrition might have resulted in better development and robust growth. Panchagavya is also known to contain beneficial micro-organisms such as Azospirillum, Azotobacter, Phosphobacteria and Pseudomonas besides Lactobacillus which promotes the plant growth parameters. Similar observation of dry matter production was reported by Yadav and Lourduraj [7].

3.2 Effect of Different Liquid Manure on Yield Attributes, Yield and B:C Ratio of Green Gram

There was significant effect on yield attributes and yield of green gram grown under different liquid manure practices (Table 4). The number of pods plant⁻¹ was significantly influenced by application of different liquid manure (Table 4). The treatment FYM+Panchagavya (T₃) produced maximum number of pods/plant i.e. (25.1) followed by the treatment FYM+ vermicompost (T₇) which was statistically at par, with the application of organic manures in combination with fermented organics viz. beejamrit, jivamrit, panchagavya over organics alone application, the yield parameters like number of pods/plant was significantly higher in soybean crop [8]. It supported the seed yield and have positive interaction with seed yield (Fig. 2). The number of

seeds per pod of greengram was varied significantly in all treatments in comparison to control (Table 4). The treatment FYM+Panchagavya (T₃) recorded significantly higher number of seeds/pod (11.1) followed by FYM+vermicompost (T₇) (10.5) and FYM + vermiwash + cow urine (T₅) (10.1) while there was no significant difference between the later two treatments. The plumpness or boldness of seed in terms of test weight (1000 grain weight) varied significantly among the different nutrient management practices (Table 4). The combined application of FYM+Panchagavya showed highest test weight i.e. 37.1 g followed by the treatment FYM+vermicompost (36.6 g) which was statistically at par. The positive impact of availability of individual plant nutrients and different growth hormone from organic manure and balanced supplement of major nutrient through organic manure might have induced cell division, expansion of cell wall, meristematic activity, photosynthetic efficiency that help to produce healthy seed. The lower value show in control plot. The land productivity in terms of seed yield of summer green gram was significantly influenced by the application of different liquid manure (Table 4). The maximum grain yield was recorded in the plot fertilized with the combined application of FYM + Panchagavya (T₃) treatment (1085.5 kg/ha) followed by FYM + vermicompost (T₇) treatment (1011.5 kg/ha) with no significant difference between them. The treatment FYM+jivamrut (T₁) also produced appreciable grain yield (959.7 kg/ha) of greengram followed by T₃ and T₇. The lowest value was recorded in control plot where no organic liquid manure were applied. The yield variation due to differential nutrition was 68.17%. Soil application of FYM and Panchagavya of the crop led to better photosynthetic activity of the

plant and more extensive root system and thus, enabled the plant to extract nutrient from the soil thereby resulting in better development of yield attributes and yield of green gram. The results are in line with those of Somasunderam, et al. [9] and Ali, et al. [10]. The stover yield of greengram significantly varied by different liquid manure treatments (Table 4). Significantly higher stover yield of greengram was obtained in FYM + Panchagavya (T₃) treatment (3224.2 kg/ha) followed by FYM + vermicompost (T₇) treatment (3036.9 kg/ha) and FYM + jivamrut (T₁) treatment (2887.9 kg/ha). This might be due to adequate supply of nutrients at throughout the growth period of the crop as well as presence of growth regulators in panchagavya contributing to higher grain as well as higher stover yield. Desai, et al. [11] also reported that foliar spray of Panchagavya @ 6% and Jivamrut @ 500 l/ha significantly increase the grain and stover yield of cowpea. The source to sink ratio in terms of harvest index of greengram was significantly influenced by application of liquid manure (Table 4). Different liquid manure treatments exerted appreciable effect on harvest index of greengram (Table 4). The treatment FYM + Panchagavya (T₃) showed maximum harvest index (25.2) followed by T₇ (FYM + vermicompost) treatment (24.98) and FYM + jivamrut (T₁) treatment (24.98). More acceptability of any research finding among small and marginal farmers depends on its economic viability. In the present study, the economics of summer green gram cultivation was influenced by different liquid manure (Table 3). The B:C ratio higher in the plot fertilized with combined application of Panchagavya and FYM (2.98). The next best economic benefit (in terms of B:C ratio) was obtained when the plot fertilized with the combination of vermicompost and FYM (2.84).

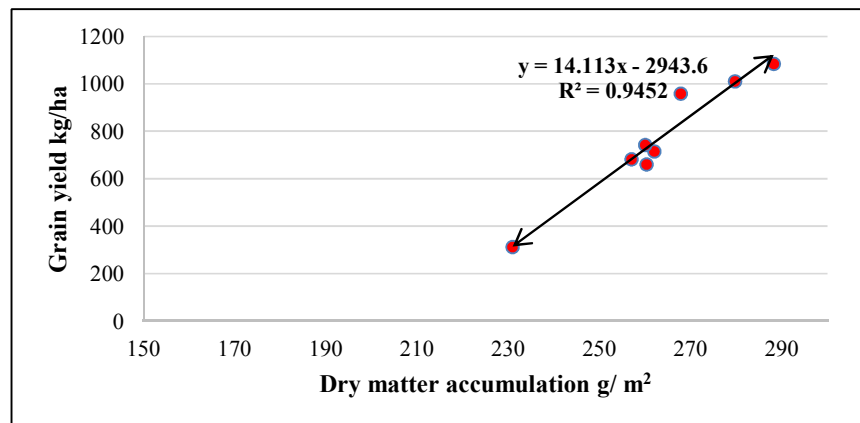


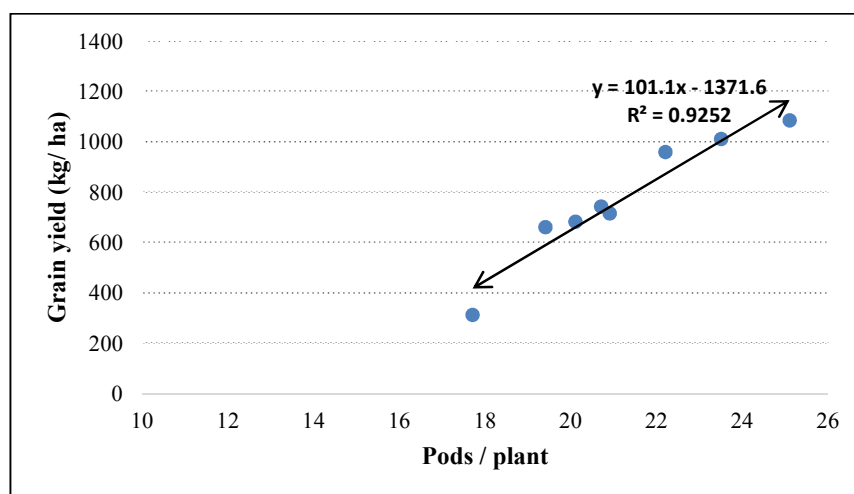
Fig. 1. Correlation between dry matter accumulation at 60 DAS (g/ m² and grain yield (kg/ ha)

Table 3. Effect of liquid manure on plant height, leaf area index and dry matter accumulation on summer green gram (Mean value of 2 years)

Treatments	Plant height (cm)			LAI			Dry matter accumulation (g/ m ²)		
	20	40	60	20	40	60	20	40	60
	DAS	DAS	DAS	DAS	DAS	DAS	DAS	DAS	DAS
T ₁ (Jivamrut + FYM)	12.1	50.3	53.5	0.85	2.19	3.48	41.2	175.8	267.8
T ₂ (Sanjivak + FYM)	11.7	55.4	58.4	0.71	2.07	3.39	41.0	173.4	262.0
T ₃ (Panchagavya +FYM)	14.5	59.1	62.2	1.15	3.18	3.61	50.9	181.8	288.2
T ₄ (Cow urine + FYM)	12.6	52.7	57.4	0.66	2.26	3.36	40.6	171.0	260.3
T ₅ (Cow urine + Vermiwash +FYM)	12.7	55.6	60.8	0.98	2.33	3.22	41.1	172.5	260.0
T ₆ (Vermiwash +FYM)	12.0	56.9	59.2	0.65	2.07	3.08	41.6	171.6	257.0
T ₇ (Vermicompost +FYM)	11.8	53.4	56.8	1.03	2.91	3.51	43.5	176.3	279.7
T ₈ (Control)	10.9	46.8	52.9	0.58	2.06	2.67	39.8	167.9	230.9
S. Em (±)	0.20	2.23	2.50	0.02	0.07	0.21	0.50	1.12	1.51
CD (P=0.05)	0.64	6.85	7.65	0.07	0.23	0.64	1.55	3.43	4.63

Table 4. Effect of liquid manure on Yield attributes, Yield and B:C of summer green gram (Mean value of 2 years)

Treatments	Yield attributes			Yield			B:C
	No. of Pods /plant	No. of seeds/ pod	Test weight (gm)	Grain yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)	
T ₁ (Jivamrut + FYM)	22.2	10.0	35.5	959.7	2887.9	24.94	2.64
T ₂ (Sanjivak + FYM)	20.9	10.0	32.2	716.1	2194.8	24.60	2.42
T ₃ (Panchagavya +FYM)	25.1	11.1	37.1	1085.4	3224.1	25.18	2.98
T ₄ (Cow urine + FYM)	19.4	9.9	35.3	661.2	1935.4	25.46	2.03
T ₅ (Cow urine + Vermiwash +FYM)	20.7	10.1	33.7	743.2	2258.7	24.75	2.41
T ₆ (Vermiwash +FYM)	20.1	9.6	34.5	682.9	2228.1	23.45	2.12
T ₇ (Vermicompost +FYM)	23.5	10.5	36.5	1011.5	3036.9	24.98	2.84
T ₈ (Control)	17.7	9.0	35.6	312.9	1917.1	14.03	1.01
S. Em (±)	0.56	0.19	0.49	30.07	42.18	-	-
CD (P=0.05)	1.73	0.59	1.51	92.81	129.19	-	-

**Fig. 2. Correlation between pods per plant and grain yield (kg/ ha)**

4. CONCLUSION

Thus it concluded that considering the results of the experiment, it may be advocated that the treatment FYM@ 12 kg N equivalent at land preparation + Panchgavya @8 kg N equivalent (twice equal split applications at 30 DAS and 45 DAS through irrigation water) may be recommended as a better organic package of greengram followed by FYM @ 12 kg N equivalent at land preparation + vermicompost @8 kg N equivalent (twice equal split applications at 30 DAS and 45 DAS as top dressing) among all other treatments applied in the soil.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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