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Growth, yield and nutrient uptake of summer greengram [*Vigna radiata* (L.) Wilczek] under organic nutrient management

K Bhargavi, V Sumathi, G Krishna Reddy and V Umamahesh

Abstract
In the summer of 2017, a field experiment took place at Agricultural College Farm in Tirupati. The purpose was to investigate the impact of organic manures and organic sprays on the growth characteristics and yield of summer greengram. The experiment followed a split plot design with three replications. The main plot consisted of four treatments of organic manures *viz.*, Control (M_1), Farm yard manure (M_2), Vermicompost (M_3) and Poultry manure (M_4) and sub plots consisted of three treatments of organic sprays *viz.*, Control (S_1), Panchagavya (S_2) and Jeevamrutha (S_3). The outcomes demonstrated that the combination of poultry manure as a manure treatment and panchagavya as a spray treatment resulted in elevated plant height, leaf area index, and dry matter production in summer greengram.

Keywords: Greengram, organic sprays, panchagavya, jeevamrutha and seed yield

1. Introduction

In India, the cultivation of pulses spans an extensive area of approximately 23.55 million hectares, resulting in an annual output of around 17.15 million tons and an average yield of 728 kg per hectare. In the specific context of Andhra Pradesh, pulses are cultivated across 1.04 million hectares, yielding about 0.95 million tons and achieving a productivity of 911 kg per hectare (Indiastat, 2014-15) [8].

Greengram, originally a rainy season crop, has evolved into an adaptable choice for spring and summer periods due to the development of early maturing varieties. Enhancing growth and yield in greengram necessitates the application of nutrients. With its high fertility demands, greengram exhibits exceptional responsiveness to nutrient inputs. Notably, each 100 g of edible greengram seed contains 75 mg of calcium, 4.5 mg of phosphorus, 24.5 g of protein, and 348 K. Cal. of energy. This crop's increased production has the potential to align with the objectives of food policy makers and nutrition planners. As a leguminous crop, greengram efficiently fixes 30-40 kg of nitrogen per hectare within a short span (60-65 days). Given these considerations, raising awareness regarding the nutritional aspects of greengram requires dedicated attention.

The challenge is compounded by the fact that the majority of farmers in rainfed areas face resource constraints, with limited risk-bearing capacity. As a result, they often deviate from applying the recommended dosage of fertilizers, whether organic or inorganic. Moreover, the current focus of the ICAR (Indian Council of Agricultural Research) centers on identifying crops that are responsive to organic practices within the framework of organic agriculture.

Considering these circumstances, in addition to farmyard manure (FYM), vermicompost and poultry manure were selected for investigation. This choice aimed to uncover their effects on greengram cultivation. Organic manures serve a dual purpose: enhancing soil organic carbon content and augmenting soil water retention capabilities. They also promote soil flocculation and enhance the availability of micro and macronutrients, leading to a more sustainable soil and crop production system.

These organic manures foster increased microbial activity within the soil, thereby enhancing nutrient solubility and subsequent availability. Microorganisms influence plant growth by influencing soil pH at localized sites and by producing chelating organic acids. Furthermore, these manures serve as rich sources of micronutrients, contributing to improved soil structure and increased crop yield.

It is firmly established that a significant portion of plant nutrients can also be absorbed through the leaves, and this absorption process can occur rapidly and with a high degree of completeness. Notably, foliar feeding practices hold particular promise for early maturing crops, presenting an opportunity to be integrated into regular plant protection programs. Furthermore, the foliar application offers several advantages, including swift and efficient nutrient utilization, prevention of losses due to leaching and fixation, and regulation of nutrient uptake by plants. In the context of fermented organic sprays such as panchagavya and jeevamrutha, these not only contain nutrients but also harbour a microbial population and plant growth-promoting substances (PGPR). These components collectively contribute to stimulating plant growth, enhancing yield, boosting metabolic activity, and fortifying resistance against pests and diseases. Given these considerations, the present investigation was initiated to assess the impacts of organic nutrient sources on yield attributes, overall crop yield, and the economic aspects of greengram cultivation.

2. Material and Methods

In the summer season of 2017, a field experiment was carried out at S.V. Agricultural College Farm in Tirupati. The experimental soil exhibited a sandy loam texture, neutral pH (6.8), low organic carbon content (0.38%), and available nitrogen (150 kg ha-1), medium levels of available phosphorus (12 kg ha-1), and high availability of potassium (161 kg ha-1).

The experiment was designed using a split plot layout with three replications. The primary plots encompassed four distinct organic manure treatments: Control (M1), Farmyard manure (M2), Vermicompost (M3), and Poultry manure (M4). The secondary plots contained three organic spray treatments: Control (S1), Panchagavya (S2), and Jeevamrutha (S3).

The organic manures were systematically mixed into the soil 15 days prior to sowing the crop. Panchagavya was prepared one month before its application, while Jeevamrutha was prepared 2-5 days prior to application. Both organic sprays were administered between 10 days after sowing and 10 days before harvest.

3. Results and Discussion

3.1 Growth Parameters

Upon reaching the harvest stage, the plants that exhibited greater height were observed in plots treated with poultry manure. This outcome was on par with the performance of vermicompost-treated plants, but notably taller than those managed with farmyard manure and the control. Remarkably, a higher Leaf Area Index (LAI) was achieved through the incorporation of poultry manure, surpassing the effects of the other treatments. Following this, the next most effective treatment was vermicompost, followed by farmyard manure, while the lowest LAI was evident in the control group.

The incorporation of poultry manure led to substantially higher dry matter production, outperforming the other treatments. Notably, vermicompost incorporation yielded comparable results to that of farmyard manure, whereas the control plots, lacking any organic manure input, exhibited lower dry matter production.

In terms of organic sprays, the application of panchagavya spray resulted in taller plants and a higher LAI compared to jeevamrutha spray. Conversely, the control group exhibited lower plant height and LAI. The highest dry matter production in greengram was recorded in plots treated with panchagavya spray, which was at par with the effects of jeevamrutha spray. In contrast, the plots that did not receive any of the organic sprays exhibited the lowest dry matter production (as detailed in Table 1).

The observed enhancement in growth parameters due to the application of organic manures might stem from heightened microbial activity and synchronized nitrogen release. This, in turn, could stimulate cellular processes, particularly beneficial for cell division. This conclusion is consistent with the findings of Rao *et al.* (2013) [4] and Singh *et al.* (2015) [5].

The augmented growth parameters resulting from organic sprays may be attributed to the presence of growth-promoting substances like IAA, GA, cytokinins, essential plant nutrients, and effective microorganisms found in panchagavya. These substances collectively enhance cell division, cell elongation, and chlorophyll content in leaves, thereby improving photosynthetic activity. These observations align closely with the studies conducted by Chaudhari *et al.* (2013) [2], Yadav and Tripathi (2013) [9], Rao *et al.* (2013) [4], and Jadhav and Kulkarni (2016) [3].

Table 1: Plant height (cm), LAI and Dry matter production (kg ha^{-1}) of greengram at harvest as influenced by different organic manures and organic sprays

Treatments	Plant height	LAI	Dry matter production
Organic manures			
M_1	46.8	1.02	1890
M_2	54.2	1.51	2109
M_3	58.2	1.73	2123
M_4	60.8	2.17	2266
SEm±	0.91	0.023	25.4
CD (P=0.05)	3.2	0.08	88
Organic sprays			
S_1	50.9	1.57	2007
S_2	59.0	1.64	2158
S_3	55.0	1.61	2126
SEm±	0.72	0.014	22.1
CD (P=0.05)	2.2	0.04	66
Interaction			
S at M			
SEm±	1.58	0.040	44.0
CD (P=0.05)	N.S.	N.S.	N.S.
M at S			
SEm±	1.50	0.032	44.2
CD (P=0.05)	N.S.	N.S.	N.S.

3.2 Seed yield and Haulm yield

The most noteworthy seed yield was documented in plots treated with poultry manure, surpassing the outcomes of all other treatments. Following this, vermicompost treatment emerged as the next effective option, exhibiting comparable results to those achieved with farmyard manure. Notably, the seed yield under these treatments was significantly higher than that of the control. In terms of haulm yield, poultry manure again led to the highest production, which was in line with the outcomes of vermicompost. Farmyard manure was the next best performer in terms of haulm yield. Conversely, the lowest haulm yield was observed in the control group.

This increase in seed and haulm yield can be attributed to the heightened supply of various essential plant nutrients. This supply is facilitated by the translocation of photosynthates accumulated under the influence of organic nutrient sources. Moreover, the translocation and accumulation of photosynthates in economically significant parts of the plant enhance yield attributes, chlorophyll content, and nitrate reductase activity, leading to an overall increase in grain yield. This observation is consistent with the findings of Anil Kumar *et al.* (2007) [1], Rao *et al.* (2013) [4], and Singh *et al.* (2015) [5] as presented in Table 2.

Shifting the focus to organic sprays, panchagavya application yielded the highest seed and haulm yields, on par with the results from jeevamrutha treatment, showing no significant difference between the two. Conversely, the control group yielded lower seed and haulm production. This higher yield can be attributed to the presence of IAA and GA in panchagavya, which, when applied through foliar spraying, potentially triggers stimulatory responses in the plant system. These responses, in turn, could enhance the production of growth regulators within the cellular system. The resulting action of these growth regulators within the plant system spurs necessary growth and development. Moreover, the improved translocation and accumulation of photosynthates from source to sink contribute to the overall increase in grain yield. These findings are consistent with the research conducted by Somasundaram *et al.* (2007) [6], Swaminathan *et al.* (2007) [7], Chaudhari *et al.* (2013) [2], and Yadav and Tripathi (2013) [9].

The combined application of poultry manure and panchagavya spray resulted in the highest seed yield (779 kg ha^{-1}) and haulm yield (1909 kg ha^{-1}) for summer greengram, surpassing the results achieved through individual applications of organic manures and organic sprays.

Table 2: Seed yield and haulm yield (kg ha^{-1}) of greengram as influenced by different organic manures and organic sprays

Treatments	Seed yield	Haulm yield
Organic manures		
M_1 – Control	444	1023
M_2 - FYM @ 10 t ha^{-1}	642	1635
M_3 - Vermicompost @ 2 t ha^{-1}	670	1816
M_4 - Poultry manure @ 2 t ha^{-1}	726	1852
SEm$\pm$	8.9	27.5
CD (P=0.05)	31	95
Organic sprays		
S_1 - Control	529	1482
S_2 - *Panchagavya* as 3% spray	672	1642
S_3 - *Jeevamrutha* without dilution @ 200 l ha^{-1}	660	1620
SEm$\pm$	5.6	17.4
CD (P=0.05)	17	52
Interaction		
S at M		
SEm$\pm$	15.5	47.6
CD (P=0.05)	N.S.	N.S.
M at S		
SEm$\pm$	12.9	39.6
CD (P=0.05)	N.S.	N.S.

3.3 Nutrient uptake by the crop

3.3.1 Nitrogen Uptake

The uptake of nitrogen by the crop was notably affected by different organic manures and organic sprays, as well as their interaction, as indicated in Table 3 and 4.

In terms of organic manures, the plant exhibited the highest nitrogen uptake in plots treated with poultry manure, a result comparable to the effects seen from vermicompost and farmyard manure incorporation. Conversely, the control group showed lower nitrogen uptake by the plant. This trend could be attributed to the improved nitrogen release pattern of poultry manure into the soil, consequently enhancing its availability to the crop. This, in turn, amplified dry matter production, ultimately leading to increased uptake of nitrogen by the crop. These observations are consistent with the findings of Rao *et al.* (2013) [4] and Singh *et al.* (2015) [5].

Likewise, higher nitrogen uptake by the plant was evident in plots subjected to panchagavya spray, with the next effective treatment being the application of jeevamrutha spray. The lowest nitrogen uptake occurred in the absence of any organic spray. This disparity is attributed to the augmented supply of plant nutrients made available through the application of organic sprays. This supply occurs in a form that plants can readily uptake, possibly enhancing the accumulation of dry matter and positively influencing root branching. Similar outcomes were observed by Chaudhari *et al.* (2013) [2] and Rao *et al.* (2013) [4].

The interaction between organic manures and organic sprays significantly influenced nitrogen uptake. The most substantial nitrogen uptake by the crop was observed in plots treated with the combined effect of poultry manure and panchagavya (M4S2). This result exceeded the outcomes of all other combinations attempted. In contrast, the lowest nitrogen uptake was recorded in plots where neither organic manure nor organic spray was applied (M1S1). These interactions underscore the significance of the interplay between organic manures and organic sprays in altering nitrogen uptake. These findings align with the conclusions drawn by Rao *et al.* (2013) [4].

Table 3: Nutrient uptake (kg ha^{-1}) by greengram as influenced by different organic manures and organic sprays

Treatments	Nitrogen uptake *	Phosphorus uptake	Potassium uptake
Organic manures			
M_1 – Control	18.2	3.5	9.9
M_2 - FYM @ 10 t ha^{-1}	54.2	5.9	17.7
M_3 - Vermicompost @ 2 t ha^{-1}	54.3	6.5	18.5
M_4 - Poultry manure @ 2 t ha^{-1}	54.9	8.5	22.5
SEm$\pm$	0.34	0.05	0.11
CD (P=0.05)	1.2	0.2	0.4
Organic sprays			
S_1 - Control	44.4	6.1	16.9
S_2 - *Panchagavya* as 3% spray	46.4	6.1	17.5
S_3 - *Jeevamrutha* without dilution @ 200 l ha^{-1}	45.4	6.1	17.1
SEm$\pm$	0.18	0.07	0.16
CD (P=0.05)	0.6	N.S.	N.S.
Interaction			
S at M			
SEm$\pm$	0.59	0.08	0.19
CD (P=0.05)	1.2	N.S.	N.S.
M at S			
SEm$\pm$	0.45	0.12	0.29
CD (P=0.05)	1.5	N.S.	N.S.

* Interaction table furnished separately

Table 4: Nitrogen uptake (kg ha^{-1}) by greengram as influenced by interaction of different organic manures and organic sprays

Treatments	Organic manures				
Organic sprays	M_1	M_2	M_3	M_4	Mean
S_1	17.3	52.6	53.9	55.0	44.4
S_2	18.9	56.4	54.8	55.6	46.4
S_3	18.4	53.7	54.4	55.3	45.4
Mean	18.2	54.2	54.3	54.9	

	SEm±	CD (P=0.05)
S at M	0.59	1.2
M at S	0.45	1.5

3.3.2 Phosphorus and Potassium Uptake

The impact of organic treatments on crop phosphorus and potassium uptake followed a similar pattern across both manures and organic sprays.

The uptake of phosphorus and potassium by the crop was notably influenced by the application of organic manures. However, neither the application of organic sprays nor their interaction demonstrated a significant effect on phosphorus and potassium uptake by the crop, as indicated in Table 3.

In terms of organic manures, the highest phosphorus and potassium uptake by the plant occurred through the incorporation of poultry manure, which outperformed all other treatments. Following this, vermicompost and farmyard manure incorporation were the next most effective treatments. Conversely, the non-manurial plots resulted in lower phosphorus and potassium uptake by the plant. This trend might be attributed to the superior nutrient release pattern of poultry manure into the soil, consequently enhancing its availability to the crop. This, in turn, led to amplified dry matter production and ultimately increased the uptake of phosphorus and potassium by the crop. These findings align with the conclusions drawn by Rao *et al.* (2013) [4] and Singh *et al.* (2015) [5].

4. Conclusion

In conclusion, the experiment determined that achieving high greengram production could be accomplished through the pre-sowing incorporation of poultry manure at a rate of 2 t/ha and by applying 3% panchagavya spray at intervals of 10 days.

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