

EVALUATION OF ORGANIC FOLIAR APPLICATIONS FOR SUSTAINABLE RICE FALLOW BLACK GRAM (*Vigna mungo* L.) PRODUCTION

Abstract

A field experiment was carried out during January to March, 2024 at the Experimental Farm, Department of Agronomy, Annamalai University, to evaluate the organic foliar applications for sustainable rice-fallow black gram (*Vigna mungo* L.) production. The study consisted of ten treatments comprising organic and inorganic foliar sprays, arranged in a Randomized Block Design (RBD) with three replications. Among the treatments, foliar application of Vermiwash 2% on 30 DAS + Panchagavya 3% on 45 DAS (T₇) was recorded the highest grain yield (579 kg ha⁻¹), haulm yield (1773 kg ha⁻¹) and nutrient uptake (51.40 kg ha⁻¹ of N, 10.28 kg ha⁻¹ of P and 46.12 kg ha⁻¹ of K). It also exhibited maximum profitability, with a gross return of Rs. 47,206 ha⁻¹, net return of Rs.27,350 ha⁻¹ and a benefit-cost ratio of 2.38. The results confirmed that foliar application of Vermiwash 2% on 30 DAS + Panchagavya 3% on 45 DAS (T₇), can effectively improve the yield, economic returns and nutrient uptake of black gram cultivated under rice-fallow conditions, offering a sustainable alternative to chemical inputs.

Keywords: Black gram, Economics, Foliar nutrition, Nutrient uptake, Yield.

1. Introduction

Pulses are essential to Indian agriculture and nutrition, serving as a major source of dietary protein, particularly in vegetarian diets (Madhusree *et al.*, 2023) ^[1]. Among these, black gram (*Vigna mungo* L.) is widely cultivated for its short duration, soil-enriching capability through nitrogen fixation and adaptability to various agroclimatic zones. Despite its benefits, pulse productivity in India remains below potential, largely due to poor management practices, erratic

rainfall and reliance on rainfed cultivation (FAO, 2022) ^[2]. To bridge the demand-supply gap in pulses, rice fallow cultivation, where pulses are sown post-rice using residual soil moisture offers a promising solution. In Tamil Nadu, black gram is traditionally grown as a rice fallow crop during the rabi season, utilizing the moisture left in the soil after paddy harvest. However, constraints like limited moisture availability and nutrient deficiency during this phase hamper productivity. Foliar nutrition with organic inputs offers a sustainable means to overcome soil fertility constraints, as nutrients are directly absorbed through leaves for rapid uptake. Organic sprays like Panchagavya, Vermiwash, Seaweed Extract, and Fish Amino Acid are rich in growth regulators, micronutrients, and beneficial microbes. Panchagavya enhances enzymatic and hormonal activity, Vermiwash supplies hormones and enzymes from vermicompost, Seaweed Extract improves chlorophyll synthesis and stress tolerance, while Fish Amino Acid provides nitrogen and amino acids for early growth (Kundu *et al.*, 2023) ^[3]. The present study evaluates these organic foliar sprays, individually and in combination, to improve growth, yield, and resource-use efficiency of rice-fallow black gram under sustainable rainfed farming systems.”

2. Materials and methods

A field experiment was conducted at the experimental farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Tamil Nadu, India during January to March, 2024 to evaluate the organic foliar applications for sustainable rice-fallow black gram (*Vigna mungo* L.) production. The experimental site is geographically situated at 11°24' N latitude and 79°44' E longitude, with an altitude of +5.79 meters above mean sea level. The soil of the experimental field was clay loam in texture, moderately drained and slightly alkaline in reaction with a pH of 7.7. Initial soil analysis revealed that the soil was low in available nitrogen, medium in available phosphorus and high in available potassium content. The black gram variety 'ADT-3' was selected for the study due to its adaptability and performance in rice-fallow ecosystems, and sowing was carried out by broadcasting the seeds immediately after paddy harvest under favorable field conditions. The experimental layout followed a Randomized Block Design (RBD) with ten treatments and three replications. Each treatment plot size is 5.1 m × 4 m. The treatments consisted of T₁ - DAP 2% on 30 and 45 DAS, T₂ - Panchagavya 3% on 30 DAS, T₃ - Vermiwash 2% on 30 DAS, T₄ - Fish Amino acid 0.5% on 30 DAS, T₅ - Seaweed Extract 2% on 30 DAS, T₆ - Panchagavya 3% on 30 and 45 DAS, T₇ - Vermiwash 2% on 30 DAS + Panchagavya 3% on 45 DAS, T₈ - Fish Amino acid 0.5% on 30 DAS + Panchagavya 3% on 45 DAS, T₉ - Seaweed Extract 2% on 30 DAS + Panchagavya 3% on 45 DAS and T₁₀ - Control.

Statistical analysis was carried out for all the experimental data.

3. Result and Discussion

3.1. Effect of organic foliar nutrition on Grain and Haulm yield

The productivity of black gram under rice-fallow conditions was profoundly influenced by the type and timing of foliar nutrition applied. The data (Table 1) revealed substantial variation among treatments, with the highest grain and haulm yields obtained from the combination of Vermiwash 2% at 30 DAS followed by Panchagavya 3% at 45 DAS (T₇). This treatment registered grain and haulm yields of 579 kg ha⁻¹ and 1773 kg ha⁻¹, respectively, clearly outperforming all other treatments. The yield superiority of T₇ over the control (T₁₀), which produced only 251 kg ha⁻¹ of grain and 924 kg ha⁻¹ of haulm, demonstrates the enormous potential of organic foliar sprays in enhancing crop performance under resource-constrained rice-fallow systems. A closer examination shows that sequential applications (two sprays at critical growth stages) consistently produced higher yields than single foliar applications. For instance, the foliar application of Panchagavya 3% on 30 and 45 DAS (T₆) produced grain yield of 568 kg ha⁻¹, which was considerably higher than T₂ (Panchagavya 3% at 30 DAS, 406 kg ha⁻¹). Similarly, the combined treatments involving Fish Amino Acid (T₈) and Seaweed Extract (T₉) followed by Panchagavya also outperformed their single-spray counterparts (T₄ and T₅, respectively). These results suggest that nutrient demand in black gram is dynamic, peaking during vegetative expansion and again during reproductive development. Thus, multiple applications ensure sustained nutrient supply, reducing the chances of nutrient stress during critical physiological phases. The exceptional performance of T₇ can be attributed to the complementary biochemical and physiological functions of Vermiwash and Panchagavya. Vermiwash contains a complex mixture of soluble nutrients, humic substances, enzymes, and plant growth-promoting hormones such as cytokinins, auxins, and gibberellins. Its application during the early vegetative phase at 30 DAS promotes rapid establishment, robust leaf development, and strong root architecture, ensuring the crop can effectively utilize available soil moisture and nutrients. Panchagavya, applied later at 45 DAS during the reproductive stage, provides bioactive compounds including indole-3-acetic acid (IAA), gibberellic acid (GA), amino acids, and beneficial microbes that enhance flower initiation, reduce flower drop, and ensure better pod set and grain filling. Together, these inputs act in a synergistic manner, resulting in superior yields. These findings are in close agreement with Ashraf *et al.* (2023) ^[4], who demonstrated that combinations of organic foliar inputs enhanced the growth and yield of black gram under irrigated conditions. Sangothari (2020) ^[5] and Kuttibai *et al.* (2022) ^[6] also reported that sequential organic foliar sprays significantly improved yields in rice-fallow black gram, emphasizing the importance of timely

nutrient delivery in systems with inherently low soil fertility. Another important observation is the comparable performance of organic treatments with inorganic foliar application. The treatment with DAP 2% applied at 30 and 45 DAS (T_1) produced a grain yield of 503 kg ha⁻¹ and haulm yield of 1638 kg ha⁻¹. While these results confirm the effectiveness of inorganic foliar feeding, they also highlight that organic alternatives such as T_6 and T_7 not only match but even surpass the performance of DAP. This underscores the potential of organic inputs in reducing chemical fertilizer dependence while maintaining or even enhancing productivity. The increase in haulm yield is particularly significant in rice-fallow farming systems, where crop residues serve as valuable livestock feed and as organic matter sources for soil fertility improvement. Treatments such as T_6 and T_7 , which enhanced both grain and haulm yield, thus provided dual benefits of higher marketable output and greater fodder availability.

3.2. Effect of organic foliar nutrition on Nutrient uptake

Foliar application of organic nutrients significantly influenced the uptake of nitrogen (N), phosphorus (P) and potassium (K) by rice-fallow black gram (Table 1). Among the treatments, Vermiwash 2% on 30 DAS + Panchagavya 3% on 45 DAS (T_7) recorded the highest nutrient uptake, with N (51.40 kg ha⁻¹), P (10.28 kg ha⁻¹) and K (46.12 kg ha⁻¹), reflecting its superior efficiency in enhancing plant nutrition. The increased nutrient uptake in T_7 can be attributed to the synergistic effect of Vermiwash and Panchagavya in enhancing both root and foliar absorption processes. Vermiwash stimulates root growth and microbial activity in the rhizosphere, improving the plant's ability to explore soil resources. At the same time, foliar feeding delivers readily available nutrients directly to the leaves, bypassing the limitations of root absorption in low-moisture soils. Panchagavya, rich in beneficial microbes and organic acids, further aids in solubilizing soil nutrients, enhancing their mobility, and facilitating their uptake. The critical timing of foliar sprays (30 DAS for vegetative growth and 45 DAS for reproductive development) ensured that nutrients were available during peak demand periods. This synchronization between nutrient supply and plant requirement is crucial in rice-fallow systems where residual soil fertility is often inadequate. Among the individual treatments, Panchagavya 3% on 30 and 45 DAS (T_6) also showed high nutrient uptake (49.37, 9.85, and 44.15 kg ha⁻¹ of N, P, and K, respectively). This demonstrates the effectiveness of Panchagavya as a stand-alone organic input, although its performance is slightly enhanced when combined with Vermiwash. Treatments with Fish Amino Acid (T_4 and T_8) and Seaweed Extract (T_5 and T_9) showed moderate improvements in nutrient uptake compared to the control, but they were less effective than Panchagavya and Vermiwash based treatments. The superiority of organic foliar treatments in nutrient uptake over the inorganic foliar application DAP 2% on 30 and 45 DAS (T_1) is also noteworthy. While

T₁ recorded respectable uptake values (46.32, 9.12, and 41.42 kg ha⁻¹), it was still lower than T₇. This suggests that organic formulations not only match the nutrient supplying role of inorganic sprays but also promote better assimilation and utilization efficiency due to their hormonal and microbial components. Improved NPK absorption translates directly into higher biomass production and grain filling, as observed in yield results. Moreover, enhanced nutrient-use efficiency reduces nutrient losses, thereby minimizing environmental risks such as leaching or volatilization. These findings are in line with those of Sangothari (2020)^[5], who reported improved nutrient uptake in black gram under organic foliar sprays, and with Kundu *et al.* (2023)^[3], who emphasized the role of organic biostimulants in enhancing nutrient-use efficiency in pulses.

3.3. Effect of organic foliar nutrition on Economics

Economic evaluation of treatments revealed that the foliar application of Vermiwash 2% on 30 DAS + Panchagavya 3% on 45 DAS (T₇) not only maximized yield but also offered the highest profitability (Table 3). The treatment registered a gross return of Rs.47,206 ha⁻¹ and a net return of Rs.27,350 ha⁻¹, with a benefit-cost ratio (BCR) of 2.38. This clearly demonstrates that the yield advantage gained through T₇ directly translates into higher profitability. The foliar application of Panchagavya 3% on 30 and 45 DAS (T₆) followed closely, yielding Rs.46,312 ha⁻¹ as gross return and Rs.24,356 ha⁻¹ as net return and a BCR of 2.11. These values are significantly higher than those of single-spray treatments, which produced lower net returns and BCRs. The superior profitability of T₇ and T₆ is attributable to two main factors: (i) significantly higher yields, and (ii) relatively low input costs of organic foliar formulations compared to inorganic fertilizers or chemical pesticides. Similar findings were reported by Kumar and Verma (2023)^[7], who emphasized that the incorporation of organic foliar inputs in pulse crops caused only a slight rise in input cost but significantly improved the input-output ratio. Farmers adopting these treatments thus gain more output for each rupee invested, improving their overall livelihood security. These findings are consistent with Prasanth (2021)^[8], who highlighted the economic viability of foliar nutrition strategies in pulses, particularly when organic inputs are employed. The results also indicate that while inorganic foliar spray of DAP 2% on 30 and 45 DAS (T₁) was profitable (net return ₹21,503 ha⁻¹, BCR 2.10), organic alternatives provided equal or greater profitability with added environmental benefits. On the other hand, the control treatment (T₁₀) recorded the least economic benefit, with a gross return of Rs.20,542 ha⁻¹, net return of Rs.2,086 ha⁻¹ and a BCR of 1.11, highlighting the limited profitability of relying solely on residual soil nutrients in rice fallow conditions. This was similar with the findings of Kumar *et al.* (2021)^[9].

4. Conclusion

The present investigation clearly revealed that the foliar application of organic nutrients, particularly the combination of Vermiwash 2% on 30 DAS and Panchagavya 3% on 45 DAS, significantly enhanced the grain yield, haulm yield and nutrient uptake of rice-fallow black gram. The economic analysis also showed that the organic foliar application resulted in higher profitability and benefit-cost ratio, making it not only agronomically effective but also economically viable. These findings emphasize the potential of organic foliar applications as an eco-friendly and sustainable alternative to conventional chemical inputs for maximizing yield and income in rice fallow pulse systems.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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Table 1. Effect of organic foliar application on grain yield (kg ha⁻¹), haulm yield (kg ha⁻¹) and nutrient uptake (kg ha⁻¹) of rice fallow black gram

Treatments	Grain yield (kg ha ⁻¹)	Haulm yield (kg ha ⁻¹)	Nutrient uptake (kg ha ⁻¹)		
			N	P ₂ O ₅	K ₂ O
T ₁ - DAP 2% on 30 and 45 DAS	503	1638	46.32	9.12	41.42
T ₂ - Panchagavya 3% on 30 DAS	406	1345	37.95	7.38	31.75
T ₃ - Vermiwash 2% on 30 DAS	423	1380	38.79	7.53	32.80
T ₄ - Fish amino Acid 0.5% on 30 DAS	344	1209	33.93	6.42	27.36
T ₅ - Sea weed extract 2% on 30 DAS	357	1242	34.79	6.67	28.49
T ₆ - Panchagavya 3% on 30 and 45 DAS	568	1745	49.37	9.85	44.15
T ₇ - Vermiwash 2% on 30 DAS + Panchagavya 3% on 45 DAS	579	1773	51.40	10.28	46.12
T ₈ - Fish amino Acid 0.5% on 30 DAS + Panchagavya 3% on 45 DAS	460	1512	42.38	8.25	36.51
T ₉ - Sea weed extract 2% on 30 DAS + Panchagavya 3% on 45 DAS	469	1534	43.14	8.37	38.33
T ₁₀ - Control	251	924	24.08	4.91	6.83
S. Ed	15	48	1.38	0.29	1.24
CD (p=0.05)	32	101	2.90	0.60	2.60

Table 2. Effect of organic foliar application on economic analysis of rice fallow black gram

Treatments	Cost of cultivation (Rs. ha⁻¹)	Gross returns (Rs. ha⁻¹)	Net returns (Rs. ha⁻¹)	BCR
T ₁ - DAP 2% on 30 and 45 DAS	19556	41059	21503	2.10
T ₂ - Panchagavya 3% on 30 DAS	20206	33152	12946	1.64
T ₃ - Vermiwash 2% on 30 DAS	19856	34530	14674	1.74
T ₄ - Fish amino Acid 0.5% on 30 DAS	19306	28124	8818	1.46
T ₅ - Sea weed extract 2% on 30 DAS	21356	29181	7825	1.37
T ₆ - Panchagavya 3% on 30 and 45 DAS	21956	46312	24356	2.11
T ₇ - Vermiwash 2% on 30 DAS + Panchagavya 3% on 45 DAS	19856	47206	27350	2.38
T ₈ - Fish amino Acid 0.5% on 30 DAS + Panchagavya 3% on 45 DAS	21056	37556	16500	1.78
T ₉ - Sea weed extract 2% on 30 DAS + Panchagavya 3% on 45 DAS	23106	38287	15181	1.66
T ₁₀ - Control	18456	20542	2086	1.11