Original Research Article

Enhancing Nutrient Uptake and Economics of Black Gram through Vermicompost and Vermiwash Application

ABSTRACT

A field experiment was conducted to evaluate the effect of vermicompost and vermiwash on the nutrient uptake and economics of blackgram (*Vigna mungo* L.) at Agronomy farm, S.K.N. College of Agriculture, Jobner (Rajasthan) during *Kharif*, 2020. The treatments comprised different doses of vermicompost and vermiwash being total 20 treatments. It was replicated 3 times in FRBD (factorial randomised block design). Results revealed that application of vermicompost 6.0 t/ha significantly enhanced the nutrient content (nitrogen, phosphorus and potassium) in seed and straw, protein content in seed, the nutrient uptake by seed, straw and total uptake. It also recorded significantly higher gross returns over lower levels. However, higher net returns were observed under vermicompost 4.5 t/ha application. Results further showed that application of vermiwash 15 % foliar spray at the time of flower initiation stage also resulted in significant increase in nutrient content in seed and straw, protein content in seed, nutrient uptake by seed and straw with highest total uptake, gross and net returns of blackgram.

Key words: *Gross returns, Foliar spray, Nutrient uptake, Protein content, Blackgram*

1. INTRODUCTION

Black gram (*Vigna mungo* L.), also known as urdbean or black matpe, is an important leguminous crop cultivated extensively in various parts of the world. This pulse crop holds immense significance due to its versatility, nutritional benefits and contribution to sustainable agriculture practices. As the global population continues to grow, ensuring food security becomes a paramount challenge. In this context, black gram emerges as a promising solution, given its ability to thrive in diverse agroclimatic conditions and its rich nutritional composition, which makes it an essential component of balanced diets. Originating in the Indian subcontinent, black gram has been cultivated for centuries and has evolved into a staple food crop for millions of people across South Asia and beyond. Its adaptability to various soil types and climates, from arid to sub-humid regions, makes it an invaluable crop for both smallholder farmers and commercial agricultural enterprises. The cultivation of black gram provides several agronomic benefits, including its ability to fix atmospheric nitrogen through symbiotic association with rhizobial bacteria, enhancing soil fertility and reducing the need for synthetic fertilizers. This characteristic not only improves soil health but also contributes to sustainable farming practices by reducing environmental impacts and promoting ecological balance. One of the most appealing aspects of black gram is its exceptional nutritional value. As a rich source of protein, dietary fiber, vitamins (thiamine, riboflavin, niacin) and essential minerals (iron, potassium, calcium, phosphorus), black gram plays a crucial role in combatting malnutrition and addressing micronutrient deficiencies prevalent in many developing regions. The consumption of black gram is associated with various health benefits, such as improved digestion, cholesterol regulation and maintaining blood glucose levels, making it a valuable inclusion in human diets. Vermicompost is the most significant source of organic manure for managing or supplementing nutrients to increase crop output. The advantage of the vermicomposting method over composting is often due to the 'humus' content in vermicompost expelled by earth-worms, whereas in conventional composting systems it takes a very long time to generate humus due to the slow decaying process of organic waste (Thakur et al., 2021). It is the most successful approach among all other composting procedures since it is economical, harmless to the environment and extremely good at sanitising solid waste, especially trash with a biological origin. Earthworms, bacteria, and other degradable communities interact in what is known as a bio-oxidative process to speed up the breakdown of organic waste (Patwa *et al*., 2020). Vermiwash, a byproduct of vermicompost, can increase the antioxidant capacity and overall phenolic content of plants (Bagchi *et al*., 2015). When compared to traditional composting, vermicomposting has a substantially smaller and zero impact on the environment in terms of greenhouse gas emissions like methane. Compared to solid organic fertilisers, Vermiwash is a liquid fertiliser that is simpler to apply to crops, decreases the quantity of solids needed for crop production, makes it easier for farmers to fertilise and lowers production costs. Vermiwash application improved crop production, nutritional quality and plant development (Pant *et al.*, 2011). Vermiwash continuously supplies plants with the biologically accessible nutrients throughout time and it also contains biochemical components that are absent from ordinary compost and chemical fertilisers (Bansod, 2020).

2. MATERIAL AND METHODS

At the S.K.N. College of Agriculture's Agronomy Farm in Jobner (26°05' N, 75°28' E), Rajasthan, India, the field experiment was undertaken in *Kharif* season, 2020. The research location is situated 427 metres above mean sea level in Rajasthan's agroclimatic zone IIIa (Semi-Arid Eastern Plains Zone). The field study utilised a factorial randomised block design and contained 20 treatment combinations. It was replicated three times. It consisted of five vermicompost treatments (control, 1.5 t/ha, 3.0 t/ha, 4.5 t/ha, and 6.0 t/ha) and four vermiwash foliar spray treatments (control, 5%, 10%, and 15%). N, P, and K contents were measured in representative samples of seed and straw that were taken at the time of threshing and then oven dried before being crushed to a fine powder by an electrical grinder. Nitrogen was determined by digesting the samples with sulphuric acid and then using hydrogen peroxide to remove the black colour. The nitrogen was estimated using a colorimetric approach with Nessler's reagent to develop colour (Snell and Snell, 1949). The phosphorus content of seed and straw was tested using the yellow colour technique 'Vanadomolybdo phosphoric acid'. Tri-acid combination was used to digest the samples, and a Spectophotometer was used to gauge the colour intensity (Jackson, 1973). Potassium content in the samples used earlier was determined by digesting them in tri-acid mixture of HNO_3:H_2SO_4:$HClO_4$ and was estimated by ‘flame photometric method' *i.e.* when atoms of potassium are excited in flame, they emit a flame of specific wavelength. The intensity of emission is proportional to the concentration of potassium which is determined in flame photometer using K filter (Bhargava and Raghupathi, 1993). The total uptake of nitrogen, phosphorus and potassium was computed from nitrogen, phosphorus and potassium concentration in seed and straw at harvest stage using the following relationship:

$$\text{Total nutrient uptake (kg/ha)} = \frac{\text{Nutrient conc. in seed \%} \times \text{Seed yield (Kg/ha)} + \text{Nutrient conc. in straw \%} \times \text{Straw yield (Kg/ha)}}{100}$$

The per cent protein content in seed was calculated by multiplying per cent nitrogen concentration of seed by the factor of 6.25 (A.O.A.C., 1960). The cost of cultivation (₹/ha) of each treatment was worked out by considering the prevailing market price of inputs, charges for cultivation, labour, land and other charges. The net monetary returns (₹/ha) of each treatment were worked out by deducting the mean cost of cultivation (₹/ha) of each treatment from the gross monetary returns (₹/ha) gained from the respective treatments.

3. RESULT AND DISCUSSION

3.1 Nutrient content (%)

Vermicompost : A perusal of data (table 1) revealed that nutrient content in seed and straw was significantly increased with increasing levels of vermicompost upto application of vermicompost 6.0 t/ha over control. The highest nutrient content (nitrogen, phosphorus and potassium) in seed and straw were recorded with the application of vermicompost 6.0 t/ha. However, it being at par with vermicompost 4.5 t/ha, increased the nutrient content in seed and straw over control, vermicompost 1.5 t/ha and vermicompost 3.0 t/ha. Nutrient content and absorption are important measures of a soil's capacity to deliver nutrients that are accessible. The organic carbon in the vermicompost promotes steady and slow release of nutrients in the soil making them more available in the soil (Ansari 2010). Vermiwash and vermicompost are enriched with certain metabolites and vitamins B and D such that when applied over time in the soil they have tendencies of overall improving the soil nutrient quality. These findings are similar to Mayunchi *et al.* (2013) and Arsalan *et al*. (2016).

Vermiwash : It was observed that different concentrations of vermiwash resulted in an increase of nutrient content (%) in the seed and straw separately. The foliar spray of vermiwash 15 % exhibited highest nutrient content in seed and straw over control and foliar spray of vermiwash 5%. However, nutrient content (nitrogen, phosphorus and potassium) in seed and straw obtained by vermiwash 10% spray was found to be at par with vermiwash 15%. Vermiwash is an organic fertilizer that contains both inorganic and organic nitrogen and potassium. Vermiwash provides micronutrients for plants, enzymes including protease, amylases, ureases and phosphatase, as well as nitrogen-fixing bacteria and phosphate-solubilizing bacteria (Zambare *et al.,* 2008). Vermiwash is also strong in plant growth hormones such auxins, cytokinins, gibberellins, amino acids and vitamins, which boost plant growth and productivity as well as acting as nematicides (Gopal *et al.,* 2010). Similar set of findings were also reported by Varghese and Prabha (2014) and Sutar *et al*. (2018).

3.2 Protein content in seed (%)

Vermicompost : The protein content in seed was recorded significantly higher with different levels of vermicompost application over control. Application of vermicompost 6.0 t/ha resulted maximum protein content in seed (23.80 %) which was significantly superior over the lower levels of vermicompost (1.5 t/ha and 3.0 t/ha) and control, while it remained at par with vermicompost 4.5 t/ha (23.29 %). The increase in protein and nutrient content in blackgram could be attributed to better availability of desired and required quantities of nutrients in the root zone of developing plants for longer periods of time as a result of soubilization caused by organic acids produced by vermicompost decay. Because nitrogen is a fundamental constituent of protein and phosphorus is a structural element of some co-enzymes involved in protein synthesis, the favourable effect of vermicompost on protein content has also been observed. Choudhary *et al*. (2013) and Tyagi and Upadhyay (2013) published similar findings.

Vermiwash : Foliar spray of vermiwash with different concentrations resulted in higher protein content in seed. Protein content in seed was recorded the highest with vermiwash 15% spray (23.4%). Foliar spray of vermiwash 10% registered higher protein content than control and vermiwash 5% spray however, it remained at par with vermiwash 15% spray. The foliar spray of vermiwash with various concentrations provided balanced nutrition to blackgram and helped in improving the quality parameters as it provides readily available nutrients and growth hormones. Jagtap *et al.* (2013) and Sutar *et al.* (2018) in soybean obtained comparable results.

Table 1 : Effect of varying levels of vermicompost and vermiwash on nutrient and protein content of blackgram

Treatments	Nitrogen content (%)		Phosphorus content (%)		Potassium content (%)		Protein content (%)
	Seed	straw	Seed	straw	Seed	straw	
Vermicompost Levels							
Control	2.97	1.29	0.327	0.142	0.709	1.528	18.57
1.5 t/ha	3.27	1.38	0.395	0.173	0.778	1.699	20.45
3.0 t/ha	3.54	1.50	0.440	0.194	0.830	1.810	22.10
4.5 t/ha	3.73	1.66	0.468	0.213	0.883	1.922	23.29
6.0 t/ha	3.81	1.72	0.481	0.225	0.897	1.991	23.80

SEm ±	0.07	0.03	0.009	0.005	0.017	0.039	0.41
CD (*P* = 0.05)	0.19	0.08	0.027	0.015	0.049	0.113	1.17
Vermiwash (Foliar Spray)							
Control	3.11	1.39	0.365	0.166	0.733	1.661	19.45
5 %	3.37	1.48	0.415	0.181	0.805	1.746	21.04
10 %	3.63	1.56	0.447	0.201	0.859	1.861	22.70
15 %	3.74	1.61	0.461	0.210	0.879	1.893	23.37
SEm ±	0.06	0.02	0.008	0.005	0.015	0.035	0.36
CD (*P* = 0.05)	0.17	0.07	0.024	0.013	0.044	0.101	1.04

3.3 Nutrient uptake (kg/ha)

Vermicompost : Nutrient uptake by seed and straw varied significantly from the lowest in control to the highest with application of various levels of vermicompost. Nutrient uptake in blackgram increased significantly with increasing vermicompost levels upto vermicompost 6.0 t/ha. However, it was found to be at par with vermicompost 4.5 t/ha (Table 2). The highest total nutrient uptake was also seen with the application of vermicompost 6.0 t/ha. It was superior over the lower levels of vermicompost except vermicompost 4.5 t/ha which was found to be at par with vermicompost 6.0 t/ha. The significantly higher nitrogen, phosphorus, and potassium content and uptake under vermicompost 4.5 t/ha, however, show that uptake is a more accurate parameter because it takes into account the dry matter yield and is also an indicator of the crop's nutrient requirement and level of depletion. Sutaria et al. (2010) in greengram and blackgram intercropping and Sitaram et al. (2013) in mungbean both reported findings that were similar.

Vermiwash : The nutrient uptake (kg/ha) by seed and straw was found to be increased with the increasing concentration of foliar spray of vermiwash. The highest nutrient uptake (nitrogen, phosphorus and potassium) by seed and straw of blackgram was recorded with the foliar spray of vermiwash 15 % which was seen to be at par with vermiwash 10 % spray. The same observations were recorded in case of total nutrient uptake (nitrogen, phosphorus and potassium) by blackgram. The beneficial effect of vermiwash foliar spray on blackgram nutrient content appears to be related to increased nutrient availability in the plant system, which leads to increased uptake of nitrogen, phosphorus and potassium in reproductive structures such as seed and straw. This could be related to the usage of vermiwash, which provides more macro and micro nutrients as well as growth regulators like auxins and GA, resulting in more bio mass and improved nitrogen, phosphorus and potassium recovery in the plant. Similar finding was reported by Singh and Kumar (2012) in soybean.

Table 2: Effect of varying levels of vermicompost and vermiwash on nutrient uptake by seed and straw of blackgram

Treatments	Nitrogen uptake (kg/ha)			Phosphorus uptake (kg/ha)			Potassium uptake (kg/ha)		
	Seed	Straw	Total	Seed	straw	Total	Seed	straw	Total
Vermicompost Levels									
Control	19.63	18.79	38.43	2.16	2.07	4.23	4.71	22.30	27.01

1.5 t/ha	25.28	23.15	48.43	3.08	2.90	5.98	6.02	28.47	34.49
3.0 t/ha	30.77	27.46	58.23	3.84	3.55	7.39	7.20	33.08	40.28
4.5 t/ha	35.19	31.96	67.15	4.41	4.11	8.53	8.32	37.01	45.34
6.0 t/ha	37.69	33.57	71.26	4.76	4.42	9.18	8.87	38.93	47.80
SEm ±	0.98	0.62	1.27	0.11	0.11	0.19	0.23	0.85	1.00
CD (*P* = 0.05)	2.81	1.79	3.64	0.33	0.31	0.54	0.65	2.43	2.87
Vermiwash (Foliar Spray)									
Control	23.79	22.81	46.60	2.83	2.74	5.57	5.68	27.22	32.90
5 %	28.01	25.89	53.90	3.46	3.18	6.64	6.66	30.54	37.20
10 %	32.64	28.89	61.52	4.04	3.74	7.78	7.69	34.44	42.13
15 %	34.42	30.37	64.78	4.28	3.99	8.27	8.07	35.64	43.70
SEm ±	0.88	0.56	1.14	0.10	0.10	0.17	0.20	0.76	0.90
CD (*P* = 0.05)	2.51	1.60	3.26	0.29	0.28	0.48	0.58	2.17	2.57

3.4 ECONOMICS

Vermicompost : As the yield of blackgram enhanced with the increasing levels of vermicompost it also resulted in increasing gross and net returns over control and lower levels of vermicompost. The gross returns of the crop increased with the increasing levels of vermicompost and the highest were recorded with vermicompost 6.0 t/ha (₹ 68,864/ha), which was found to be at par with vermicompost 4.5 t/ha application and significantly superior over the rest of the treatments. The net returns grew with each level of vermicompost up to 4.5 t/ha while dropping with further level of vermicompost (*i.e.* 6.0 t/ha), since the expense of adding a bigger dose of vermicompost increases the cost of cultivation while the addition in terms of net returns is low. Vermicompost 4.5 t/ha registered an increase over control and vermicompost 1.5 t/ha however, vermicompost 4.5 t/ha (₹ 33,478 /ha) was found to be at par with vermicompost 3.0 t/ha (₹ 32,936 /ha) and vermicompost 6.0 t/ha (₹ 31,852 /ha) with regard to net returns statistically.

Vermiwash : The foliar spray of vermiwash resulted in an increased gross and net returns over the control. Vermiwash foliar spray recorded the highest gross (₹63,944/ha) and net returns (₹ 34,619 /ha) which was significantly superior over the control and foliar spray of vermiwash 5 % however, it was seen to be at par with the results obtained with the foliar spray of vermiwash 10 %. The utilization of vermicompost and vermiwash in blackgram cultivation can significantly increase crop yield and economic profitability for farmers. These organic inputs not only improve soil health and nutrient availability but also promote sustainable agriculture, making them a suitable alternative to conventional chemical fertilizers.

Table 3: Effect of varying levels of vermicompost and vermiwash on economics of blackgram

Treatment	**Economics**	
	Gross returns (₹/ha)	**Net returns (₹/ha)**
Vermicompost levels		

Control	46859	27846
1.5 t/ha	54566	31053
3.0 t/ha	60948	32936
4.5 t/ha	65990	33478
6.0 t/ha	68864	31852
SEm±	1429	685
CD (*P* = 0.05)	4092	1960
Vermiwash (Foliar spray)		
Control	53690	26990
5%	57891	30316
10%	62257	33807
15%	63944	34619
SEm±	1278	612
CD (*P* = 0.05)	3660	1753

4. CONCLUSION

Based on the results of one year experimentation, it may be inferred that application of vermicompost @ 4.5 t/ha was found better for obtaining higher net returns with significantly higher nitrogen, phosphorus and potassium content in seed and straw and their uptake. It also resulted in higher protein content over lower levels and control. Similarly, foliar spray of vermiwash demonstrated significant positive effect on the nutrient content and uptake of blackgram. Vermiwash 15 % spray had been the most effective vermiwash spray for enhancing gross and net returns. Though this data was based on only one season crop, further research is warranted to optimize the application rates and explore the long-term effects of vermicompost and vermiwash on blackgram.

REFRENCE

[1] A.O.A.C. 1960. Official method of analysis. 18th Edn. Association of Official Agricultural Chemists, Washington.

[2] Ansari, A.A. and Sukhraj, K. Effect of vermiwash and vermicompost on soil parameters and productivity of okra (abelmoschus esculentus) in Guyana. Pakistan Journal of Agricultural Resources. 2010; 23: 137-142.

[3] Arsalan, M., Ahamed, S., Choudhary, J.N. and Sarwar, M. Effect of vermicompost and phosphorus on crop growth and nutrient uptake in mungbean. Journal of Applied Agriculture and Biotechnology. 2016; 1(2): 38-47.

[4] Bagchi, A., Ghosh, B.C., Swain, D.K. and Bera, N. Organic farming practice for quality improvement of tea and its anti-parkinsonism effect on health defense. Journal of Physical Chemistry and Biophysics. 2015; 5: 178.

[5] Bansod, V.M. Effect of eisenia fetida vermiwash on the growth of dianthus plant. International Journal of Multidisciplinary Educational Research. 2020; 9(1): 450-454.

[6] Bhargava, B.S. and Raghupathi, H.B. (In) Method of analysis of soil, plant, water and fertilizers. H.L.S. Tondon (Ed.) F.D.C.O., New Delhi. 1993; 41: 250-253.

[7] Choudhary, V.K., Kumar, P.S. and Bhagawati, R. Influence of organic nutrient sources on growth, seed yield and economics of cowpea under mid hills of Arunachal Pradesh. Journal of Food Legumes. 2013; 26(3): 51-54.

[8] Gopal, M., Gupta, A., Palaniswami, C., Dhanapal, R. and Thomas, G.V. Coconut leaf vermiwash: a bio liquid from coconut leaf vermicompost improving the crop production capacities of soil. Current Science India. 2010; 98: 1202-1210.

[9] Jackson, M.L. 1973. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd. New Delhi, pp. 498.

[10] Jagtap, D.K., Gaikwad, R.B., Thakare, V.G. and Jakhi, P.S. Effect of vermiwash and GA on seed germination in fenugreek. International Journal of Biotechnology and Biosciences. 2013; 3(4): 230-234.

[11] Mayunchi, M.M., Chitambwe, T., Phiri, A., Muredzi, P. and Kanhukamwe, Q. Effect of vermicompost, vermiwash and application time on soil physiochemical properties. International Journal of Chemical and Environmental Engineering. 2013; 4: 216-220.

[12] Pant, A., Radovich, T.J.K., Hue, N. and Arancon, N. Effects of vermicompost tea (aqueous extract) on pakchoi yield, quality and on soil biological properties. Compost Science and Utilization. 2011; 19(4): 279-292.

[13] Patwa, A., Parde, D., Dohare, D., Vijay, R. and Kumar, R. Solid waste characterization and treatment technologies in rural areas: An Indian and international review. Environmental Technology & Innovation. 2020; 20: 101066.

[14] Singh, M. and Kumar, N. Effect of FYM, vermicompost, vermiwash and NPK on growth, microbial biomass and yield of soybean. Soybean Research. 2012; 10: 60-66.

[15] Sitaram, T., Sharma, S.K. and Reager, M.L. Effect of vermicompost and zinc on yield attributes, yield and quality of green gram [Vigna radiata var. aureus (L.) wilczek] in arid western Rajasthan. Internationational Journal of Agricultural Sciences. 2013;10(1): 138-141.

[16] Snell, P.D. and Snell, G.T. 1949. Colorimetric methods of analysis, 3rd Edn. II D Van Nostrand Co., Inc. New York.

[17] Sutar, A.U., Vaidya, P.H., Deshmukh, A.V., Lilhare, M.A. and Landge, R.B. Effect of foliar application of vermiwash, compost tea and panchagavya on yield and quality of soybean in inceptisol. Journal of Pharmacognosy and Phytochemistry. 2018; 8(5): 1228-1230.

[18] Sutaria, G.S., Kabari, K.N., Vara, V.D., Hirpara, D.S. and Padmani, D.P. Response of legume crops to enriched compost and vermicompost on Ustochept under rainfed. Legume Research. 2010; 33(2): 128-130.

[19] Thakur, A., Kumar, A., Vinay C. and Kumar, B. A review on vermicomposting: by-products and its importance. Plant Cell Biotechnology and Molecular Biology. 2021; 22(12): 156-164.

[20] Tyagi, P.K. and Upadhyay, A.K. Effect of integrated nutrient management on yield, quality, nutrients uptake and economics of summer green gram. Annals of Plant and Soil Research. 2013; 17(3): 242-247.

[21] Varghese, S.M. and Prabha, M.L. Biochemical characterization of vermiwash and its effect on growth of Capsicum frutescens. Malaya Journal of Biosciences. 2014; 1(2): 86-91.

[22] Zambare, V.P., Padul, M.V., Yadav. A.A. and Shete, T.B. Vermiwash: biochemical and microbiological approach as eco-friendly soil conditioner. Journal of Agriculture and Biological Science. 2008; 3(4): 1-5.