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RESEARCH NOTE

Effect of varied levels of *Salvinia molesta* vermicompost on soil fertility and crop productivity of rice under coastal conditions of Udupi, Karnataka

Gauthami Kayarga*, N.E. Naveen[1], F.C. Rudragouda, H.S. Chaitanya and S.M. Jayaprakash

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ABSTRACT

It was found that using *Salvinia molesta* vermicompost at a rate of 13.2 t/ha or *Salvinia* vermicompost with an additional 45:13:62 kg N:P:K/ha resulted in significantly improved growth parameters such as plant height (89.94 cm), number of tillers/m2 (520.24), and total dry matter production (77.52 g/plant) at harvest. Additionally, yield parameters like productive tillers/m2 (499.95), panicle length (21.86 cm), grain yield (5.23 t/ha), straw yield (6.66 t/ha), harvest index (0.44), and low chaff percentage were also positively impacted. The next best treatment was the application of 9.9 t/ha of *Salvinia* vermicompost along with 45:13:62 kg N:P:K/ha. Furthermore, significantly higher levels of available N (389.65 kg/ha) and K (225.42 kg/ha) in the soil were observed with the *Salvinia* vermicompost application. However, the application of 3.3 t/ha of *Salvinia* vermicompost with 45:13:62 kg N:P:K/ha resulted in the highest benefit-cost ratio of 2.50.

Keywords: Crop productivity, Rice, *Salvinia molesta* vermicompost, Soil fertility

Rice is a crucial cereal and serves as the primary food source for over half of the world's population. Globally, rice provides 21% of per capita energy and 5% of per capita protein for humans (Maclean *et al.* 2002). India holds a prominent position in rice production among food crops cultivated worldwide, with an area of 45.07 million hectares dedicated to its cultivation, yielding a production of 122.27 million tonnes and a productivity of 2713 kg/ha (Anonymous 2021). In Karnataka, rice is grown in an area of 9.93 lakh hectares, with a production of 29.07 lakh tonnes and a productivity of 2927 kg/ha (Anonymous 2018). In the Udupi district of Coastal Karnataka, rice is cultivated in an area of 37729 hectares, with a productivity of 3729 kg/ha.

In certain areas of the Udupi district in Coastal Karnataka, *Salvinia molesta* has become an extremely invasive and dominant aquatic weed. It is commonly found in lakes, ponds, and rice fields. This plant has the ability to multiply and grow at a rapid rate, increasing its biomass twofold in just two days. As a result, it forms thick, floating mats that block light, reduce oxygen levels, and compete for nutrients, sunlight, and other environmental factors. *Salvinia molesta* can obstruct waterways and disrupt agricultural irrigation. Due to its highly invasive and colonization properties, *Salvinia* has been listed as one of the world's 100 worst invasive alien species. Physical removal is still commonly used to manage *Salvinia*. The biomass that is removed can be turned into organic manure through processes like composting, vermicomposting, or anaerobic digestion. Among these, vermicomposting is the preferred method due to its faster biomass degradation and the higher quality of the end product.

Considering the points mentioned above, one appropriate method at the farmer's level to address the issue of the aquatic weed *Salvinia molesta* in Udupi district is vermicomposting and its application based on the nutrient level. As a result, a field investigation was conducted in the Coastal Zone of Karnataka to assess the direct effects of different levels of *Salvinia* vermicompost on rice as a nutrient source.

The experiment conducting during the *Kharif* (rainy season) of 2021 at the Zonal Agricultural and Horticultural Research Station in Brahmavara, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga. The location is at 12° 542 N latitude and 74° 542 E longitude, with an altitude of 10 meters above mean sea level. This area falls within Karnataka's Agro-Climatic Zone-X (Coastal Zone) as per the NARP (National Agricultural

Department of Agronomy, College of Agriculture, Shivamogga, Zonal Agricultural and Horticultural Research Station, Brahmavara, Udupi,

[1] Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka 577412, India

* Corresponding author email: naveenne@uahs.edu.in

Research Project) classification. The study area experienced an average annual rainfall of 3998 mm, with maximum temperatures ranging from 29.27°C to 31.23°C during the experimental period. The soil at the experimental site was sandy loam in texture, with 1.20% organic carbon and a pH of 5.10. The available N, P, and K content in the soil were 336.00, 59.10, and 106.80 kg/ha, respectively. The treatments included the application of the recommended dose of fertilizers (10 t FYM + 60:30:75 kg N:P:K/ha), and in the remaining treatments, *Salvinia molesta* vermicompost was applied at rates of 3.3, 6.6, 9.9, and 13.2 t/ha, along with 45:13:62 kg N:P:K/ha (with 75% of RDF applied as Nitrogen). Nitrogen content in FYM was 0.45% and 1.49% in *Salvinia* vermicompost. 50% of the Nitrogen was applied at the time of transplanting, 25% was top dressed at 30 days after transplanting (DAT), and the remaining 25% at 55 DAT. The variety used was '*BMR-MS-1-2-1*' (*Sahyadri Brahma*), known for its heavy tillering and a growth duration of 130 to 135 days. The experiment was set up in a randomized block design with five treatments, each replicated four times. The crop was transplanted at a spacing of 20 × 15 cm with a net plot size of 3.8 × 3.6 m.

Whole plants of the aquatic weed *Salvinia* (*S. molesta*) were directly vermicompost. *Salvinia* weed is pre-treated with animal manure in a 70:30 ratio (*Salvinia molesta*: cow dung) and left to pre-decompose for 20-25 days. After that, earthworms were introduced for further decomposition. The *Salvinia* vermicompost was ready in 60 to 65 days.

Growth parameters such as plant height (cm), number of tillers per square meter, and total dry matter production (g/plant) were measured at 30, 60, and 90 days after transplanting (DAT) and at crop harvest. Five plants were randomly selected through destructive sampling within the gross plot area at each of these stages to record dry matter production. The samples were oven-dried at 65°C to 70°C until they reached a constant weight. Total dry matter production was recorded and expressed in grams per plant. Yield parameters, including the number of productive tillers per square meter, filled grains per panicle, chaffy grains per panicle, grain and straw yield (kg/ha), and harvest index (HI), were recorded at harvest. Grain and straw yield were measured from a 1 m² area, with rice grain yield expressed at 14% moisture content.

Soil samples from all treatments were collected after crop harvest from a depth of 0 to 15 cm. These samples were analyzed for available nitrogen, phosphorus, and potassium. Available nitrogen (kg/ha) was determined using the alkaline potassium permanganate method. Available phosphorus and potassium (kg/ha) were measured using Bray's method and the Flame photometric method with a neutral normal NH4OAC extractant, respectively.

The data underwent statistical analysis through Fisher's Analysis of Variance (ANOVA) method. The significance level for the 'F' test was set at 5%. Critical difference (CD) values, indicating significant differences, were provided in the tables at a 5% level of significance wherever the 'F' test yielded significance.

Crop growth components

The use of different amounts of *Salvinia molesta* vermicompost has produced significant results, greatly impacting growth parameters. Upon harvesting, observed that, applying 13.2 t/ha of *Salvinia* vermicompost along with 45:13:62 kg N:P:K/ha led to the tallest plant height (89.94 cm) and the highest number of tillers/m2 (520.24). This exceptional outcome was similarly achieved with 9.9 t/ha of *Salvinia* vermicompost + 45:13:62 kg N:P:K/ha, resulting in a plant height of 87.26 cm and 506.24 tillers/m2. Notably, these superior results surpassed the plots treated with the recommended dose of fertilizer (RDF) (10 t/ha FYM + 60:30:75 kg N:P:K/ha) in terms of plant height, tillers/m^2, and total dry matter production/plant (**Table 1**).

The higher growth components observed can be attributed to the presence of humic acids in *Salvinia molesta* vermicompost. Humic acids are known to play a vital role in stimulating plant growth by promoting increased cell division, enhancing the uptake of nutrients, and enriching the soil microbial population (Xu *et al.* 2016). The application of *Salvinia molesta* vermicompost likely led to an increased availability of nutrients throughout the crop growth period, consequently contributing to higher growth, improved dry matter partitioning, and greater dry matter accumulation (Kumar and Gajalakshmi 2015).

Yield attributes

The result showed that applying 13.2 tons per hectare of *Salvinia* vermicompost + 45:13:62 kg of N:P:K per hectare resulted in significant improvements in various rice growth and yield parameters. These included an increase in the number of productive tillers per square meter (499.95), longer panicles (21.86 cm), a higher number of filled grains per panicle (90.00), and a lower number of chaffy

grains per panicle (11.00). This led to a significantly higher grain yield of 5231.00 kilograms per hectare, which was comparable to the application of 9.9 tons per hectare of *Salvinia* vermicompost alongside 45:13:62 kilograms of N:P:K per hectare (**Table 2**). As the levels of *Salvinia molesta* vermicompost increased, there was a corresponding rise in nutrient release in the soil due to microbial action, leading to improved nutrient availability, uptake, and ultimately higher growth and yield components. The harvest index ranged from 0.41 to 0.44, consistent with the findings of previous research by Singh *et al.* (2008) and Garg *et al.* (2006).

Available nutrients in soil

The addition of nutrients through *Salvinia molesta* vermicompost significantly affected the available nutrient levels in the soil (**Table 3**). The treatment of 13.2 t/ha of *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha resulted in higher available N and K content in the soil, at 389.65 kg/ha and 225.42 kg/ha, respectively, which was significantly better than the other treatments. This was closely followed by the treatment of 9.9 t/ha of *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha. The increase in available nutrients may be attributed to the release of nutrients bound in organic matter and

Table 1. Effect of varied levels of *Salvinia molesta* vermicompost on growth parameters of rice

Treatment	Plant height (cm)				Total no. of tillers/m^2				Total dry matter production (g/plant)			
	30 DAT	60 DAT	90 DAT	At Harvest	30 DAT	60 DAT	90 DAT	At Harvest	30 DAT	60 DAT	90 DAT	At Harvest
RDF (10 t/ha FYM + 60: 30: 75 kg N: P: K/ha)	35.80	71.55	79.83	83.42	246	372	415	371	4.12	17.25	47.49	65.74
3.3 t/ha *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha	36.25	72.20	82.88	84.18	277	400	498	454	5.10	20.34	52.23	70.48
6.6 t/ha *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha	37.10	72.70	83.19	86.02	300	434	506	469	5.26	21.03	54.51	72.60
9.9 t/ha *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha	37.15	76.58	85.75	87.26	322	462	547	506	5.53	22.11	56.69	75.94
13.2 t/ha *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha	37.25	79.95	87.08	89.94	338	486	567	520	5.98	23.49	59.17	77.52
LSD (p=0.05)	NS	3.39	3.80	3.90	13	20	23	21	13.55	0.52	0.94	2.45

RDF- Recommended dose of fertilizers; FYM- Farm yard manure; DAT- Days after transplanting; cm-centimeter; t/ha-tonnes per hectare; g/plant- grams per plant

Table 2. Yield attributes of rice as influenced by varied levels of *Salvinia molesta* vermicompost

Treatment	No. of productive tillers/m^2	Panicle length (cm)	Grain yield (t/ha)	Straw yield (t/ha)
RDF (10 t/ha FYM + 60: 30: 75 kg N: P: K/ha)	385.11	18.15	4.27	6.15
3.3 t/ha *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha	413.82	19.20	4.51	6.23
6.6 t/ha *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha	448.14	20.18	4.83	6.36
9.9 t/ha *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha	475.53	21.51	5.02	6.65
13.2 t/ha *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha	499.95	21.86	5.23	6.66
LSD (p=0.05)	20.21	1.60	0.22	0.29

RDF- Recommended dose of fertilizers; FYM- Farm yard manure; cm- centimeter

Table 3. Available nutrient status [N, P, K (kg/ha)] in soil as influenced by the varied levels of *Salvinia molesta* vermicompost in rice after the harvest

Treatment	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
RDF (10 t/ha FYM + 60: 30: 75 kg N: P: K/ha)	289.42	29.05	179.51
3.3 t/ha *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha	317.98	34.89	190.06
6.6 t/ha *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha	341.41	38.60	204.82
9.9 t/ha *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha	375.29	40.91	216.24
13.2 t/ha *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha	389.65	42.50	225.42
LSD (p=0.05)	15.69	1.69	9.23

RDF- Recommended dose of fertilizers; FYM- Farm yard manure; N- Nitrogen; P- Phosphate; K- Potassium

Table 4. Economics of rice as influenced by varied levels of *Salvinia molesta* vermicompost

Treatment	Cost of cultivation ₹/ha	Gross returns ₹/ha	Net returns ₹/ha	B: C ratio
RDF (10 t/ha FYM + 60: 30: 75 kg N: P: K/ha)	74087	116232	42145	1.57
3.3 t/ha *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha	38377	95812	57435	2.50
6.6 t/ha *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha	54877	104300	49423	1.90
9.9 t/ha *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha	71377	108607	37230	1.52
13.2 t/ha *Salvinia* vermicompost + 45: 13: 62 kg N: P: K/ha	87877	111750	23873	1.27

RDF- Recommended dose of fertilizers; FYM- Farm yard manure; COC- Cost of cultivation

exchange reactions in the soil. These findings were similar to those of Kiyasudeen *et al*. 2015.

Economics

The success of any technology hinges on its economic viability. In the realm of rice cultivation, economic performance varied based on the levels of *Salvinia molesta* vermicompost, outlined in **Table 4**. Additionally, the total cost of rice cultivation exhibited variations in line with the differing rates of application of *Salvinia molesta* vermicompost. Notably, the application of 3.3 t/ha of *Salvinia* vermicompost in conjunction with 45:13:62 kg N:P:K/ha resulted in higher net returns (₹ 57435/ha) and a commendable benefit-cost ratio of 2.50. As a result of the lower cost of cultivation and the higher economic yield, this approach significantly augmented net returns and the benefit-cost ratio. Conversely, the relatively lower net returns observed in the case of RDF (₹ 42145/ha) can be attributed to the comparatively lower economic yield of rice.

Conclusion

After conducting the study, It has been confirmed that applying 3.3 tons per hectare of *Salvinia molesta* vermicompost in combination with 45:13:62 kilograms of N:P:K per hectare is more financially viable in contrast to RDF (10 tons of farm yard manure + 60:30:75 kilograms of N:P:K per hectare) in the Coastal zone of Udupi, Karnataka, India. This suggests that the invasive aquatic weed *Salvinia molesta* could be effectively repurposed as a valuable source of nutrients.

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