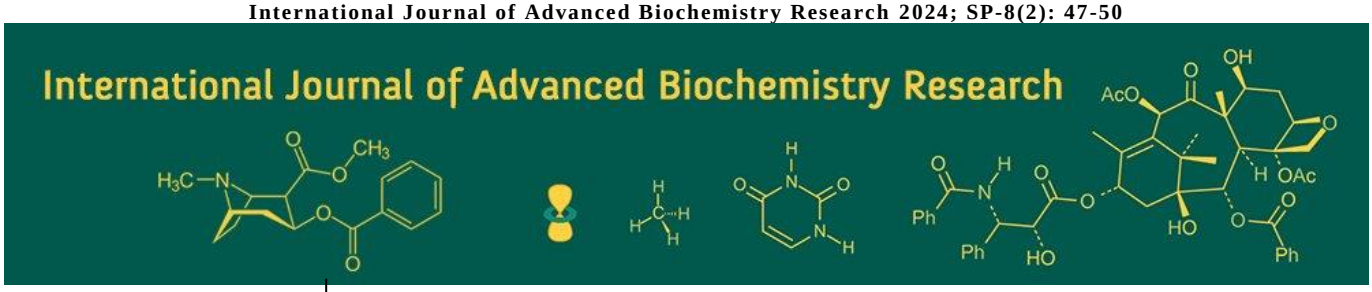

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Effect of *Salvinia molesta* on soil fertility and yield of soybean in acid alfisol soil

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Abstract
An experiment was conducted in the research field of the department of Soil Science, Birsa Agricultural University, Ranchi, Jharkhand, during 2019 with the aim of solving the pressure on fertilizer and global environmental issues. There were nine treatments during the *Rabi* season as T_1: RDF, T_2: 50%RDF, T_3: *Salvinia*@1t/ha, T_4: *Salvinia*@2t/ha, T_5: *Salvinia*@4t/ha, T_6: *Salvinia*@1t/ha + 50% RDF, T_7**:** *Salvinia*@2t/ha + 50%RDF, T_8: *Salvinia*@4t/ha + 50% RDF, T_9: Absolute control. Whereas, during *Kharif* season, *Salvilnia* was not incorporated in soybean crop and only fertilizer treatments were applied. As per the observation of the data it was observed that, the treatment T_1: RDF yielded maximum grain but remained at par to the treatments T_7 and T_8. Thus it has been proved that T_7 and T_8 were equally beneficial to the RDF in producing higher grain in acid Alfisol soil. Available N, P_2O_5 and K_2O were found significantly higher in the treatment where *Salvinia*@4t/ha + 50% RDF was applied (T_8) and the values were 235.72 kg/ha, 39.75 kg/ha and 253.12 kg/ha respectively. Soil organic carbon content was also found maximum under the treatment T_8: *Salvinia*@4t/ha + 50% RDF compared to the other treatments and was significant over other treatments (T_1 & T_2).

Keywords: *Salvinia, Salvinia molesta*, soil fertility, soybean and organic carbon

Introduction
Whole world is worried about the problems of increasing population and its food requirement. These problems are either due to the soil degradation by continuous and imbalanced fertilization in the soil, without organic manure fertilization in soil or improper management. It might also be due to the physical problem and loss in biodiversity. Soil, water and air pollution is common issues of the modern fertility management technique.

Increasing flux of the global carbon pool year by year may increase the growth rate of aquatic weeds abruptly like giant *Salvinia* (*Salvinia molesta*) and its management without any harm is essential. However, fast growing habit is its own character and so, it is already a problem in some countries. Use in soil fertility management may be one of the fruitful way of recycling of *Salvinia*.

It is very efficient in utilizing dissolved nutrient from the water sources therefore, the eroded nutrient which has no way to reutilize into the soil again may possibly be recycled by recycling of *Salvinia*. It may also contribute to the carbon sequestration and global warming may solve the environmental and water pollution Dissanayaka, *et al.* (2023) [2].

Another future problem may be seen as imbalance in the supply and demand of the chemical fertilizer as well as quality organic manure.

Piotrowska and Wilczewski (2012) [8] reported that use of Tithonia green manure reduced the bulk density of soil and improved the root length. Opala (2020) [9] and Hafifah *et al.* (2016) [10] also reported the similar findings of soil quality on vegetable crop.

Salvinia molesta was used to prepare vermicompost by Hussain *et al* (2018) [4]. These vermicompost was utilized to observe the germination and seed growth in soil. He found that germination per cent was increased up to 98% when these vermicompost were used.

Salvinia is an aquatic weed normally found in the ponds, ditches and in other water bodies which create problem of oxygen demand of water body. It adversely effect on the population of water living organism and creatures. It also suppresses other valuable aquatic plants and recreation activities.

Thus, current study was formulated to overcome these problems and utilize the *Salvinia* to increase soil fertility and hence to improve crop productivity to feed the increasing world population in a holistic way.
Therefore, searching alternative natural resource as well as recyclable source of nutrient for crop is very essential.

Materials and Methods

A field experiment was conducted during 2019 in *Kharif* season in the research field of the department of Soil Science, Birsa Agricultural University, Ranchi, Jharkhand. Soil of the field is a sandy clay loam in texture. Average annual rainfall of the region is 1400 cm whereas, the rain fall during the current year was 791 cm which was drought year and during the crop season rainfall was 599.8 cm.
Initial soil properties (0-15 cm) of the experimental soil was analyzed by the standard procedures. Initial soil pH was 5.6 (1:2.5 soil and water suspension), organic carbon was 0.29%, available Nitrogen was 179.0 $kgha^{-1}$, available P_2O_5 32 $kgha^{-1}$ and available was K_2O 240 $kgha^{-1}$. The treatment consisted of T_1: RDF, T_2: 50%RDF, T_3: *Salvinia*@1t/ha, T_4: *Salvinia*@2t/ha, T_5: *Salvinia*@4t/ha, T_6: *Salvinia*@1t/ha + 50% RDF, T_7**:** *Salvinia*@2t/ha + 50% RDF, T_8: *Salvinia*@4t/ha + 50% RDF and T_9: Absolute control, during the previous *Rabi* season. Whereas, during soybean crop (*kharif*) the treatment consisted of T_1: RDF, T_2: 50% RDF, T_3: No inputs, T_4: No inputs, T_5: No inputs, T_6: 50% RDF, T_7: 50%RDF, T_8: 50% RDF and T_9: Absolute control. Recommended dose of N, P_2O_5 and K_2O for soybean was 30, 60 and 40 $kgha^{-1}$. The experiment was laid out in a randomized block design with 3 replications. Soybean was the test crop (*Birsa safeda* Soybean-2) at a row spacing of 45 cm and between plant 15 cm. Full doses of N, P and K fertilizers were added at the time of sowing as per the treatments. The sources of N, P_2O_5 and K_2O were urea, single super phosphate and mutate of potash respectively. Soil samples were collected before sowing and after harvest of soybean and were analyzed for pH (1:2.5 soil water suspension), organic carbon by Walkley and Black method (1934) [6], available N by Subbiah and Asiza method (1956), available P_2O_5 by Bray and Kurtz (1945) [1] method and available K_2O by flame photometer as described by (Jackson, 1973) [3]. Other parameters were analyzed by the use of standard methods followed by wet digestion method. The N, P and K content of the *Salvinia molesta* was analyzed by the standard methods and it was about 1.7, 0.8 and 1.8 per cent on dry weight basis. *Salvinia* was incorporated in to the soil at the time of land preparation for *Rabi* crop by the help of rotavator and during soybean (*kharif*) no *Salvinia* was incorporated, only fertilizer treatments were applied as mentioned in detail above. Thus residual effect of *Salvinia* was studied in *Kharif* season.

Results and Discussions

Effect of Salvinia on Grain and straw yield of Soybean

The data presented in Table 1 showing the residual effect of the *Salvinia* applied during the previous crop-season. During the Rabi crop (soybean) there were three sets of treatments (T_3, T_4, T_5) which were treated without *Salvinia* and without any NPK inputs. However, other treatments (T_2, T_6, T_7 and T_8) were treated with 50% NPK of recommended dose without *Salvinia*. Result showed that highest increase of grain yield of soybean was observed 38.7 per cent over control in the treatment T_8 (*Salvinia*@4t/ha + 50% RDF) whereas lowest increment 3.3 per cent was observed over control in treatment T_3 (*Salvinia*@1t/ha). In treatment T_7, *Salvinia* was applied only 2 t/ha whereas in treatment T_8, *Salvinia* dose was doubled. But grain yield was increased only 0.7 per cent more over control compared to T_7 in treatment T_8. Thus, it may be concluded that *Salvinia* application at the rate of 2 t/ha might be more remunerative. Straw yield data of T_7 and T_8 revealed that more increment in straw was found in the treatment T_8 if *Salvinia* dose increased as compared to grain yield. It means increasing dose of *Salvinia* beyond 2 t/ha was resulted in the increment of straw and not in the grain yield. Grain and straw yield of T_2 and T_3 were found at par which resulted that 1 t/ha *Salvinia* was shown the same yield as of 50% RDF. It resulted that 1 t/ha salvia might be replaced for 50% RDF dose of inorganic fertilizer.

Table 1: Effect of *Salvinia* incorporation as green biomass on Soybean yield (q/ha)

Treatments		Grain yield	Straw yield	Increase over control (%)	
Previous Crop	Soybean			Grain	Straw
T_1:- RDF	T_1:- RDF	22.4	32.7	34.7	53.1
T_2:- 50% RDF	T_2:- 50% RDF	17.4	26.3	4.7	23.4
T_3:- *Salvinia*@1 t/ha	T_3:- No inputs	17.2	26.2	3.3	22.7
T_4:- *Salvinia*@2 t/ha	T_4:- No inputs	20.0	31.0	20.0	45.3
T_5:- *Salvinia*@4 t/ha	T_5:- No inputs	20.8	31.3	25.0	46.5
T_6:- *Salvinia*@1 t/ha+50%RDF	T_6:- 50% RDF	21.5	30.6	29.0	43.4
T_7:- *Salvinia*@2 t/ha+50%RDF	T_7:-50% RDF	23.0	33.5	38.0	57.0
T_8:- *Salvinia*@4t/ha+50%RDF	T_8:- 50% RDF	23.1	36.0	38.7	68.8
T_9:- Control	T_9:- Control	16.7	21.3		
CD		4.9	3.7		
CV		9.2	10.5		

Nutrient uptake by soybean

Application of *Salvinia* in soybean crop revealed that highest uptake of nitrogen (83.2 kg/ha), phosphorus (6.2 kg/ha) and potash (17.7 kg/ha) were observed in soybean grain in treatment T_8 where 4t/ha *Salvinia* was applied. Total nitrogen uptake (straw and grain) was observed more compared to other crops and soil nutrient status which might be due to leguminous nature of crop. Phosphorus and potash uptake were also observed more in the same treatment because of highest crop yield in this particular treatment (Table 2). Minimum uptake of NPK were observed in treatment T_3 where only 1 t/ha *Salvinia* was applied. This low value of uptake might be due to low yield in this treated plot.

Table 2: Effect of *Salvinia* incorporation as green biomass on the uptake of NPK (kg/ha) in Soybean crop

Treatments		Grain			Straw		
Previous Crop	**Current Crop**	**N**	**P**	**K**	**N**	**P**	**K**
T_1:- RDF	T_1:- RDF	80.8	6.1	17.2	52.3	5.2	19.6
T_2:- 50% RDF	T_2:- 50% RDF	62.8	4.7	13.3	42.1	4.2	15.8
T_3:- *Salvinia*@1 t/ha	T_3:- No inputs	62.0	4.7	13.2	41.9	4.2	15.7
T_4:- *Salvinia*@2 t/ha	T_4:- No inputs	72.0	5.4	15.3	49.6	5.0	18.6
T_5:- *Salvinia*@4 t/ha	T_5:- No inputs	75.0	5.6	16.0	50.0	5.0	18.8
T_6:- *Salvinia*@1 t/ha+50% RDF	T_6:- 50% RDF	77.4	5.8	16.4	48.9	4.9	18.4
T_7:- *Salvinia*@2 t/ha+50% RDF	T_7:-50% RDF	82.8	6.2	17.6	53.6	5.4	20.1
T_8:-*Salvinia*@4t/ha+50% RDF	T_8:- 50% RDF	83.2	6.2	17.7	57.6	5.8	21.6
T_9:- Control	T_9:- Control	60.0	4.5	12.7	34.1	3.4	12.8
CD		17.8	1.0	4.5	12.2	0.8	11.2

Available nutrients of soil

Available nitrogen, phosphorus and potash were analysed for all the nine treatments (Table 3) and the highest value of available nitrogen, phosphorus and potash were observed 235.72 kg/ha, 39.75 kg/ha and 253.12 kg/ha respectively in treatment T_8 (*Salvinia*@4t/ha+50% RDF) which might be due to high dose (4t/ha) of *Salvinia* application in that particular treatment along with 50% RDF. Available nitrogen, phosphorus and potash of T_5 and T_1 were found similar result. Thus, it may be concluded that 4t/ha *Salvinia* alone might be a replaceable source of RDF fertilizer which is not only increased the soil nutrient status but organically good source.

Table 3: Effect of green biomass of *Salvinia* on available N, P and K of soil (kg/ha)

Treatments		Available nutrients (kg/ha)		
Previous Crop	**Current Crop**	**N**	**P_2O_5**	**K_2O**
T_1:- RDF	T_1:- RDF	206.97	28.00	225.11
T_2:- 50% RDF	T_2:- 50% RDF	199.71	25.86	219.95
T_3:- *Salvinia*@1 t/ha	T_3:- No inputs	186.39	25.43	218.14
T_4:- *Salvinia*@2 t/ha	T_4:- No inputs	208.18	27.36	229.12
T_5:- *Salvinia*@4 t/ha	T_5:- No inputs	213.02	30.78	234.93
T_6:- *Salvinia*@1 t/ha+50%RDF	T_6:- 50%RDF	190.02	33.98	236.93
T_7:- *Salvinia*@2 t/ha+50%RDF	T_7:-50%RDF	219.07	32.70	247.84
T_8:-*Salvinia*@4t/ha+50%RDF	T_8:- 50%RDF	235.72	39.75	253.12
T_9:- Control	T_9:- Control	191.23	26.93	215.14
CD		26.73	7.30	24.54
CV		7.4	13.9	6.1

Physico-chemical status of soil

pH of *Salvinia* treated plot with 4t/ha along with 50% NPK and 4t/ha alone were improved the soil acidity slightly. However, the improvement in soil acidity was not observed statistically significant. It might be due to first year of *Salvinia* application. Similar trend was also observed in soil organic carbon, bulk density and soil moisture per cent (Table 4).

Table 4: Effect of green biomass of Salvinia on Physico-chemical properties of soil

Treatments		Physico-chemical parameters			
Previous Crop	**Current Crop**	**pH**	**OC (%)**	**BD (g/cc)**	**Soil Moisture (%)**
T_1:- RDF	T_1:- RDF	5.3	0.27	1.45	9.93
T_2:- 50% RDF	T_2:- 50% RDF	5.7	0.28	1.42	10.03
T_3:- *Salvinia*@1 t/ha	T_3:- No inputs	5.5	0.29	1.40	10.46
T_4:- *Salvinia*@2 t/ha	T_4:- No inputs	5.7	0.30	1.42	10.88
T_5:- *Salvinia*@4 t/ha	T_5:- No inputs	5.9	0.36	1.36	11.57
T_6:- *Salvinia*@1 t/ha+50%RDF	T_6:- 50%RDF	5.6	0.28	1.43	10.45
T_7:- *Salvinia*@2 t/ha+50%RDF	T_7:-50%RDF	5.5	0.34	1.40	11.55
T_8:-*Salvinia*@4t/ha+50%RDF	T_8:- 50%RDF	5.8	0.37	1.38	12.02
T_9:- Control	T_9:- Control	5.6	0.29	1.44	9.63
CD		N.S.	0.046	N.S.	N.S.
CV		5.5	8.56	5.5	13.93

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