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Effect of Azolla (*Azolla species*) on Physiochemical Properties of the Soil

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Abstract: In order to investigate the effect of Azollla on the physical and chemical properties of the soil, an incubation experiment was carried out in which soil were treated with azolla at 0, 20, 40, 60 and 80 gkg^{-1}. The soils treated were incubated in the dark 25°C for eight weeks at field capacity. Soil pH, organic matter, N, P, K, Ca, Mg and Na increased with rate of Azolla. There was reduction in soil bulk density but increased soil porosity.

Key words: Incubation · field capacity · Azolla · soil bulk density and porosity

INTRODUCTION

Inorganic nitrogen fertilizers are expensive and supplied remain inadequate and uncertain for the majority of farmers in the tropics. Nitrogen-fixing crops and trees, composted crop wastes and livestock manures are least-cost alternatives source of nitrogen which have been adopted by farmers on a wide range of situations. Another option, specifically for those growing rice in flooded or irrigated land, is the use of Azolla. *Azolla* is a free-floating aquatic fern which grows at a fast rate doubling its biomass on 3-5 days and fixes atmospheric nitrogen by forming a symbiotic association with the blue green algae, *Anabaena azollae*. Azolla has long been used as both a green manure for rice and as a fodder for poultry and livestock in China and Vietnam [1,2]. Azolla has a symbiotic relationship with *Anabaena azollae* (Nitrogen-fixing alga) and the Azolla-Anabaena symbiosis can fix 100-170 kgN/hectare/years [3]. Under field conditions, selected species can fix about 1.2kgN/day and in excess of 40kgN in 35 days, thus it is referred to as miniature nitrogen fertilizers factories [4]. Organic matter in the form of green manure and biofertilizers has been found useful instead of the inorganic fertilizers [5]. Biofertilizers are ready to use live formulates of such beneficial microorganisms which on application to soil mobilize the availability of nutrients by their biological activity in particular and helps build up the micro flora and in turn, the soil health in general. Its also affordable and does not cause eutrophication and perturbation of soil [6].

However, there are some major problems to their use which includes the difficulties in transporting them from the areas of production to the areas of use because of their bulkness and their nature. But, on farmer's farm, its production is now made easy with the technology by the Natural Resources Development Project, India [2]. Other constraints include its growth which depends on a constraint and sufficient depth of water in rice fields. Thus the usual practice is to transplant rice with flooded paddles and inoculation with Azolla is followed thereafter. Also, where post emergence herbicides are used, Azolla can only be inoculated after re-flooding the field and the beneficial effects of the azolla showed that it increases soil organic matter, improved soil and supply fixed nitrogen [4,7,8]. After its decomposition, humus is formed which increasees the water holding capacity of the soil and promotes aeration and drainage [4]. However, studies on the effect of Azolla on the physical and chemical properties of the soil have not received much attention. Azolla is expected to supply fixed nitrogen and increase the uptake of some nutrient elements such as Calcium, Magnesium and Potassium. The objective of this study, therefore, is to investigate the effect of Azolla (*Azolla spp*) on the physio-chemical properties of the soil.

MATERIALS AND METHODS

Screen-house experiments: Pot incubation experiment was conducted between January and April 2006 at the dark room of the screen-house of Federal University of

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Technology, Akure (Latitude 7°30'N and Longitude 3°S 52E°E), in the rainforest zone of Nigeria.

Top soils collected from the crop type museum of the Department of Crop, Soil and Pest Management were bulked and mixed thoroughly. 4kg of the soil were weighed with a balance, each into fifteen pots with holes at the base. Some quantities of Azolla that was obtained freshly were weighed using an electric meter in 20, 40, 60 and 80 gkg^{-1} each in three replicated were mixed with the 4kg soil with a hand trowel. There were three pots per treatment and the control experiment inclusive. Amended soils were then packed in labeled plastic pots, watered to field capacity and were placed and arranged in complete randomized design (CRD) in the dark at about 25°C to incubate for eight weeks. Incubated soil samples were collected at second, fourth, sixth and eight weeks for routine analysis.

Sample analysis: The soil samples were collected, air-dried and sieved through a 2mm mesh. In determining the soil properties, a pre-treatment soil analysis was done, soil pH was determined in 1:2 $Cacl_2$ suspension, total N by Kjeldahl approach and available B ray-P1 extraction followed by molybdenum, blue colorimetry, Exchangeable K, Ca and Mg were extracted using ammonium acetate, K was determined on flame photometer and Ca and Mg by EDTA titration. Soil organic matter was determined by wet dichromate method. Azolla was analysed as described for soil [9].

Some physical properties of the soil i.e. the particle size analysis, bulk density and percentage porosity were determined. The particle size analysis was performed using 50g of soil in 0.1m NaOH as dispersing apart with Hydrometer ASTM 1524 readings taken at 40 seconds and 2 hours. Soil bulk density was determined by the core method.

Statistical analysis: Data were subjected to analysis variance to determine treatment effect. The least significant difference at 5% level of signigicance was used to compare mean [10].

RESULTS AND DISCUSSION

Chemical analysis of Azolla weed used in this study is presented in table 1 (% on dry matter base).

Source: Federal University of Technology, Soil Laboratory: Table 2 has data on initial bulked soil analysis used for the experiment. The soil was sandy-loam and it was low in organic matter (OM) available P, marginal in exchangeable k, adequate in total N, exchangeable Ca and Mg and it is slightly acidic [11].

Rate of release of nutrients into the soil treated of Azolla amendments (Tables 3-6) compared with the control showed that, the different rates used increased the amounts of nutrients over time. The rate of release

Table 1: Chemical analysis of Azolla on dry matter basis

Parameters	% Dry Matter
Ash	10.00
Crude Fat	3.0-3.5
Crude Protein	20-25
Soluble Sugars	3.0-3.5
Starch	6.0-6.5
Chlorophyll	0.25-0.50

Table 2: Initial analysis of experimental soil

Property	Soil
OM (%)	2.42
Total N (%)	0.15
P(ppm)	2.54
K($cmolkg^{-1}$)	0.51
Ca (%)	0.18
Mg (%)	0.33
Na ($cmolkg^{-1}$)	0.58
pH	6.31
Sand	6.4
Silt	23
Clay	13
Texture	Sandy Clay Loamy

Table 3: Effect of Azolla on soil organic matter (%)

	Incubation time (week)			
Treatment				
Azolla g/kg soil	2nd	4th	6th	8th
0	2.44	2.39	2.39	2.39
20	3.15	3.29	3.53	3.54
40	3.41	3.43	3.63	3.73
60	3.39	3.51	3.74	3.77
80	3.42	3.62	3.81	3.89

Table 4: Effect of Azolla on soil Nitrogen (%)

	Incubation time (week)			
Treatment				
Azolla g/kg soil	2nd	4th	6th	8th
0	0.15	0.15	0.15	0.15
20	0.16	0.16	0.31	0.34
40	0.27	0.25	0.33	0.38
60	0.38	0.4	0.42	0.54
80	0.38	0.46	0.5	0.53

Table 5: Effect of Azolla on soil available Phosphorus (ppm)

Treatment	Incubation time (week)			
Azolla g/kg soil	2nd	4th	6th	8th
0	2.52	2.56	2.53	2.54
20	2.61	2.76	3.62	4.26
40	2.84	2.86	3.65	5.25
60	4.24	4.41	5.24	5.44
80	4.57	4.86	6.05	5.72

Table 6: Effect of Azolla on Potassium release (cmol/kg)

Treatment	Incubation time (week)			
Azolla g/kg soil	2nd	4th	6th	8th
0	0.51	0.5	0.49	0.49
20	0.52	0.53	0.56	0.59
40	0.52	0.55	0.61	0.62
60	0.53	0.57	0.66	0.75
80	0.57	0.58	0.67	0.69

Table 7: Effect of Azolla on soil physical properties

Treatment	Bulk density (gcm^{-3})	% Porosity	Mechanical analysis		
			% Soil	% Clay	% Silt
Og kg^{-1}	1.44	46	64	23	13
20g kg^{-1}	1.41	47	61	23	16
49g kg^{-1}	1.40	47	59	24	17
60g kg^{-1}	1.38	48	58	24	18
80g kg^{-1}	1.34	49	56	23	21

increased with pericals of experiment that is at 2 weeks, the rate of release is lower than what is obtained at 6th weeks for all the nutrients so examined.

Table 7 has the data on the effect of Azolla on soil physical properties. Azolla application tended to reduce the bulk density from 1.44g/cm^3 in the control to 1.34cm^3 in 80kg^{-1} of the soil and increased its porosity. This might be due to increased organic matter released into the soil. The greater the organic matter content of a soil, the greater the increased porosity; the small the soil compaction, the greater the water content [12]. Soil organic matter (SOM) contents are usually positively related with specific. specific soil properties or process forstering crop growth, such as cation-exchange capacity, rainfall infliteration or soil structure [13]. Generally speaking, the less organic matter a soil contains, the weaker its structure and the greater the risk of serious erosion [12].

Table 8 has data on soil chemical properties of soil chemical properties of soil as affected by Azolla for eight weeks. Soil incubation leads to increase in soil pH,

Table 8: Effects of Azolla on soil chemical properties

Treatment Level (gkg^{-1})	pH	OM (gkg^{-1})	N (%)	P (ppm)	K ($cmolkg^{-1}$)	Ca (%)	Mg (%)	Na ($cmolkg^{-1}$)
0	6.31	2.42	2.42	0.15	0.50	0.18	0.33	0.58
20	6.31	3.38	3.38	0.25	0.56	0.92	0.45	0.65
40	6.56	3.55	3.55	0.31	0.58	0.99	0.55	0.68
60	6.63	3.60	3.60	0.44	0.63	1.10	0.75	0.68
80	6.25	3.67	3.67	0.47	0.63	1.38	0.93	0.71
LSD(0.05)	0.44	0.22	0.22	0.09	0.01	0.76	0.04	0.00

Table 9: Standard soil parameters

Factor	Status of factor in the soil		
	Good	Deficient	Poor
pH	5.5-7.0	-	-
Organic matter(%)	>1.7	0.9-1.7	<0.9
Total nitrogen (%)	>0.1	0.05-0.10	<0.05
Available phosphorus (mg/kg)	>6	3-6	<3
Cations (cmol/kg)	>10	5-10	<5
Available Potassiums (cmol/kg)	>0.25	0.10-0.25	<.10

organic matter (OM), N, P, K, Ca, Mg and Na. There were significant differences (P>0.05) among untreated control and other treatments (20, 40 60 and 80gkg^{-1} of Azolla) compared with the available soil standard (Table 9).

Difference between Ogkg^{-1} were not significant for most chemical properties in the soils except with organic matter. There was a significantly higher mean value of nitrogen with soil treated with 80gkg^{-1}. The significantly high mean value of nitrogen as a result of high N content in Azolla is reported by Anand and Shetty [14]. The higher mean values of pH in 60g/kg had shown that Azolla is able to control soil acidity by raising pH value which is in the line with the findings of Kotpal and Bali [4]. The higher significant mean values of small phosphorus in the soil were due to high phosphorus content of Azolla [15]. It may also be as a result the increase in soil pH values. The significantly high mean values of Ca and K may be due to high mean values of nitrogen which has enhanced their uptake [16].

CONCLUSION

Application of Azolla has been found to improves the physical and chemical properties of the soil. These improvements were significant for Nitrogen, Organic Matter and other cations (Mg, Ca and Na) released unto the soil. Careful management of soils in the tropics with Azolla results in better production of crops since its production is cheap, affordable and can be done in farmers farm.

It is sure that Africa, where the recovery of nutrient is so low, more systematical work is needed on soil organic matter on soil quality in a physical and biological way [17].

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