EFFECT OF ORGANIC AND INORGANIC FERTILIZERS ON AZOLLA PRODUCTION AT GEZIRA- SUDAN

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(Received: Day Month Year; Accepted: Day Month Year; Published on-line: Day Month Year)

https://doi.org/10.31436/iiumej.vxxix.x

ABSTRACT: This study was undertaken at the Alnashishiba complex, an experimental farm of the Faculty of Agricultural Sciences, Gezira University which lies between latitudes of 14° 22′ to 14° 25′ N and longitudes of 33° 29′ to 33° 30′ E, 405 m above sea level. In addition to the standard control, the treatments included organic and inorganic fertilizers. The organic fertilizers were cow manure and compost at the rate of one kg/m^2 for each, while the inorganic fertilizer (combination of phosphorus and potassium) at the rate of 5 g/m^2 for each which is equivalent to 32 and 18 g of mono phosphate and potassium sulfate, respectively. The four treatments were arranged in a randomized complete block design in four replications. After 24 hours, the Azolla primer was spread (100 g/m^2) and continued to harvest (in 12 days). Productivity of Azolla was measured for all treatments by weight in g, and then the protein percentage was recorded as the nitrogen content using Kjeldhal method. The highest production of Azolla fodder was obtained when supplemented with the cow manure and the production reached 1167 g/m^2 followed by compost (1131 g/m^2) while the chemical fertilizers gave the lowest production (811 g/m^2) making the increase rate over the control as 141%, 133% and 67%, respectively. On the other hand, the addition of compost fertilizer resulted in the highest percentage of protein (41.1%) with an increment of 105% over control whereas the combination of P and K and cow manure approximately gave the same protein content (38% and 37%, respectively). The results of this study revealed that the addition of organic fertilizers *i.e.* cow manure or compost is more beneficial for Azolla production than the chemical fertilizers (P and K).

KEY WORDS: *Azolla, Organic fertilizers, Cow manure, Compost and Chemical fertilizers.*

1. INTRODUCTION

Azolla is a vascular aquatic herbaceous plant with true feathery leaves and is one of several types of ferns whose roots are floating in the water. Ferns differ from the seed plants and gymnosperms in the way of reproduction as they lack in the formation of flower and seed, so they reproduce in what is known as the succession of generation through spore. A spore in botany is an asexual reproduction cell that moves the plant from a state of stagnation to a state of activity or vice versa. It is able to form new individuals directly, so it is caged once in a lifetime, and it is rapidly reproducing and spreading. If a quantity from it is collected in the day, the same amount may return the next day. The Azolla plant is related

to a type of symbiotic algae and works to fix atmospheric nitrogen, so it contains a high percentage of protein ranging from 25 - 35% of its dry weight. It is used as the fodder for laying hens, fattening, rabbits, fish and sheep and can be used as a green manure in the rice paddy fields. It has ability to grow fast, produce high yield and is available all year round.

A fertilizer is any substance that is added to the soil or sprayed on plant foliage to supply one or more plant nutrients [1] and compost is a fertilizing mixture of partially decomposed organic matter from plant and animal origin [2]. The low chemical soil fertility (low nitrogen, phosphorus and organic matter) is one of the most important limitations facing crop-related food security in Africa in general and Sudan in particular. Stoorvogel et al. (1993) [3] reported that the soil organic matter deficiency is an important case of soil degradation, reflected in poor soil physical status, loss of favorable biology and occurrence of several nutrient deficiencies. The challenge is to find ways of replenishing and sustaining soil fertility, soil organic matter and food crop productivity within the existing low-income resources land and labor constraints of the small holder farmers.

Sudan is facing similar challenges regarding soils deficient in organic matter, which needs to be replenished. The soils are deficient in organic matter, which is reflected by the low content of nitrogen (N), available phosphorus (P) and sometimes potassium (K)[3]. Nevertheless, the relatively high cation exchange capacity (CEC) and the percentage of base saturation values of these soils indicate their ability to retain added nutrients and a reduced the tendency to lose them through leaching [4].

Composting could be one of the means to replenish soils organic matter. It is the deliberate of biological decomposition of organic matter under controlled, aerobic conditions to humus-like stable product [5]. It acts to improve soil conditions and plant growth, and reduce the potential for erosion, run off, and non-source pollution.

The Azolla appears in ponds, trenches, and rice fields in warm tropical and temperate regions all over the world. Each species has a specific native range: Azollacaroliniana (eastern North America and the Caribbean region), filiculoides (South America), microphylla (tropical and sub-tropical America), Mexicana (northwestern America), nilotica (in upper reaches of the Nile to Sudan) and pinnata (Asia and the coast of tropical Africa). Azolla has many environmental benefits such as nitrogen fixation which requires a nitrogenase and high amounts of energy in the form of ATP. It can also be used as a green manure especially for highland rice and contributes to maintain soil fertility through decomposition besides controlling weeds, reclaiming saline soils as well as in the biogas and bio-energy production. The main objective of this study was to evaluate the effect of organic (cow manure and compost) and chemical/inorganic (phosphorus and potassium) fertilizers on Azolla production and its protein content.

2. MATERIALS AND METHODS

The experiment was conducted at the experimental farm of the Faculty of Agricultural Sciences, Gezira University, which lies between the latitudes of 14° 22′ to 14° 25′ N and longitudes of 33° 29′to 33° 30′ E. The climate of the area according to the meteorological station of Wad Medani- Sudan is semi-arid, characterized by warm summer and cool winter with summer rainfall. The maximum and minimum air temperatures are 41.5 °C in May and 14.3 °C in January, respectively.

The treatments consisted of compost (1 kg/m^2), cow manure (1 kg/m^2) and the third treatment was a combination of 5 g of P (equivalent to 32 g of mono phosphate and 5 g of

K (equivalent to 18 g of potassium sulfate) per m^2 plus the standard control (Fig. 1). The raw materials of the compost consisted of cow manure, leaves of trees and weeds with C/N ratio of 18:1, 19:1 and 35:1, respectively. Twelve holes were dug with an area of one meter with a depth of 30 cm in which plastic tarpaulin was layered. Then, 5 cm of soil was added to each m^2 and each basin was removed from the ponds and left for 24 hours. After 24 hours, the Azolla primer was spread (100 g/m^2) and continued to harvest (in 12 days). Productivity was measured for all treatments by weight in g, and then protein percentage in Azolla was determined by measuring the nitrogen content using Kjeldahl method. Table 1 shows the contents of Azolla.

(a) (b) (c)

Fig. 1. (a) Cow manure; (b) Chemical fertilizer; (c) Compost.

Table 1: The contents of Azolla (%)

Moisture	Ash	Protein	Fat	Fiber
5.7	29.0	47.3	2.1	10.4

3. RESULTS AND DISCUSSIONS

Table 2 summarizes the effect of different fertilizers on Azolla production. The highest production of Azolla fodder was obtained when adding cow manure (1 kg/m^2) and the production reached 1167 g/m^2, followed by compost (1131 g/m^2) while the chemical fertilizers gave the lowest production (811 g/m^2) (Fig. 2). The increase over control was 141, 133 and 67 %, respectively as shown in Table 2. Generally, the positive influence of farmyard manure on crop production was reported by Elaagib (2007) [6] and Ibrahim et al. (2002) [7]. In this context, Ali (1998) [8] found that the use of organic manures is highly encouraged for sustainable agriculture and conservation of soil fertility. The positive influence of applying organic matter to soil is also reported by Elghball (2002) [9]. Moreover, the benefits of compost on plant production and soil properties were discussed and elaborated by Kassim and Ali (1989) [10].

Table 2: Effect of organic and inorganic fertilizers on Azolla production (g/m^2)

Treatments	Protein (g/m^2)	% Increase percent over control
Control	485	-
Cow	1167	141
Compost fertilizer	1131	133
Chemical fertilizer	811	67

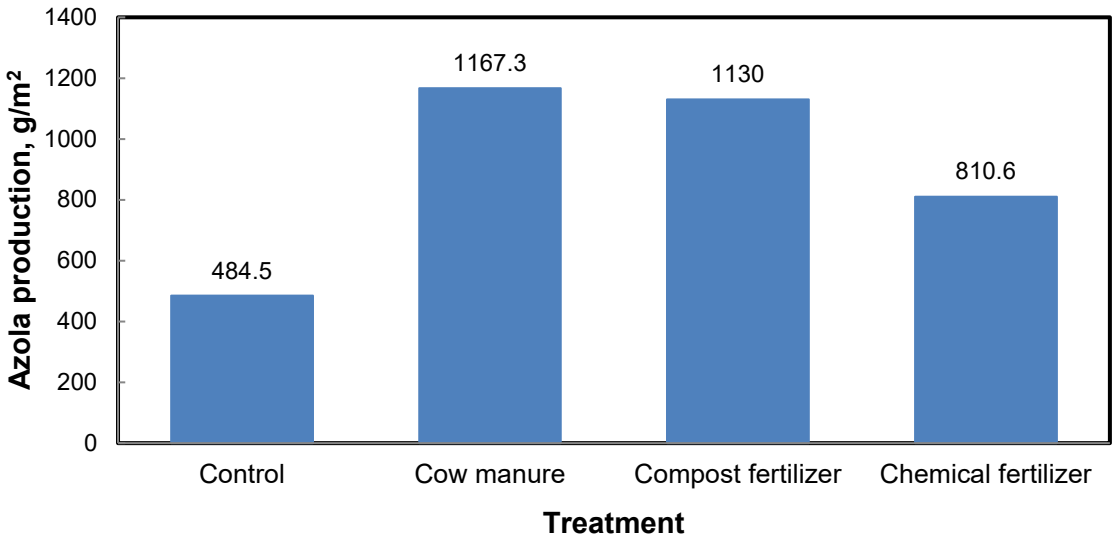

Fig. 2. Azolla production (g/m^2) as affected by different treatments.

Table 3 lists the percent of protein in Azolla fodder. The highest percentage of protein in Azolla (41.1%) was obtained when adding compost fertilizer, with an increase over control of 105%. Chemical fertilizers and cow manure almost gave same protein content (38% and 37%, respectively). The data in Tables 2 and 3 indicate the importance of adding compost or cow manure as organic fertilizers to obtain high production of Azolla. Compost is made up of humus which improves both physical and chemical soil properties as stated by Edward and Araya (2011) [11]. Cow manure can act as a continuous source of nitrogen and other macro and microplant nutrients desired for plant growth and productivity.

Table 3: Effect of organic and inorganic fertilizers on the percent protein in Azolla

Treatments	Protein %	% Increase percent over control
Control	20	-
Cow Manure	37	85
Compost fertilizer	41	105
Chemical fertilizer	38	90

4. CONCLUSION

Based on the results of the study, it be concluded that application of organic fertilizers (cow manure and compost) increased the production of Azolla fodder compared to the chemical fertilizers. The use of compost has been shown to give the highest protein in Azolla fodder. Thus, addition of organic fertilizers (cow manure or compost) to Azolla fodder is

recommended to maximize the overall plant growth, productivity and its protein content instead of using chemical fertilizers (phosphorus and potassium).

ACKNOWLEDGEMENT

The acknowledgements are to all the researchers, technicians, to the departments at Gezira University, Sudan.

REFERENCES

[1] Mahler RL. (1990) Fertilizer primer: Terminology, calculations and application. Bulletin - Idaho Agricultural Experiment Station (USA), 863:4.

[2] Ashraf R, Shahid F, Ali TA, (2007) Association of fungi, bacteria and actinomycetes with different composts. 39(6): 2141-2151:1-5.

[3] Stoorvogel JJ, Smalingand EMA, Janssen BH. (1993) Calculation of soil nutrient balances in Africa at different scales. I. Supranational scale. Fertilizer research. 35:227-235.

[4] FAO. (2006) Fertilizer use by crop in the Sudan. Land and plant Nutrition management service, land and water development division, Rome, Italy. P. 10-24. First version.

[5] Epstein E. (1997) The science of composting. Technomic publishing company, Inc. Lancaster, Pennsylvania, USA.

[6] Elaagib E. (2007) Wheat grain yield on Mukabrab soil series as affected by disc ploughing, chiseling, farm yard manure and nitrogen. Annual Report Land and Water Research Centre, Agricultural Research Corporation, Wad Medani, Sudan.

[7] Ibrahim SH, Mohamed AB, Osman HN, Hashim AA. (2002) Fertilizing with urea and farmyard manure for higher cotton yields and better soil conditions in the Gezira. Paper presented in the national crop husbandry committee meeting, Agricultural Corporation, Wad Medani, Sudan.

[8] Ali NA. (1998) Organic fertilization in Sudan. Paper presented in the first scientific colloquium (19-20 Oct. 1998), Land and Water Research Centre, Agricultural Corporation, Wad Medani, Sudan.

[9] Elghball B. (2002) Soil properties as influenced by phosphorus-and nitrogen- based manure and compost application. Agrn. J. 94:128-135.

[10] Kassim GM, Ali MA. (1989) Soil microbiology. Faculty of agriculture, University of Elmoseil Printing Press, Elmoseil Iraq.

[11] Edwards S, Araya H. (2011) How to make and use compost. Institute for Sustainable Development. Available: http://www.fao.org/docrep/014/i2230e/i2230e14.pdf.