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EFFECT OF SHRIMP POND SLUDGE ON SEEDLING GROWTH OF MAHOGANY *(Swietenia macrophylla)*

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Abstract: Shrimp farming is economically admired and environmentally accused in Bangladesh. Environmental impacts of shrimp farm are related among others to management of waste water and pond sludge. Pond sludge has the potential to be recycled and also can be used as organic manure considering the presence of high level of nutrients and organic matter. The performance of sludge as organic manure was studied on Mahogany seedlings, which was grown on incremental sludge (10%, 20%, 30% --------- 90%) mixture with soil and the performance was compared with other soil mixtures (soil with chemical fertilizer; soil with cow dung and soil with both chemical fertilizer and cow dung mixture) in the nursery. The height, diameter, biomass (leaf, root and shoot) and nutrient concentrations (N, P and K) in leaf of seedlings were measured after 4 month of germination. It was observed that the height and diameter growth, nitrogen and phosphorus concentrations in leaf of seedlings were similar in soil mixture with 90% sludge and soil with both chemical fertilizer and cow dung mixture. The biomass (leaf, root and shoot) production was higher in soil mixture with 90% sludge than soil with both chemical fertilizer and cow dung mixture.

Keywords: Shrimp farming, pond sludge, mahogany, nutrients, environmental pollution

Introduction

Shrimp farming is an important export oriented economic sector in Bangladesh. The southwestern coastal districts (Bagerhat, Khulna and Satkhira) have conducive climate and local heritage for shrimp farming. The brackish water in low-lying mangrove areas (e.g. the Sundarbans) is the excellent hub for shrimp (Huq *et al*., 2001). A total of 2,46,198 hectares of land have been brought under shrimp farming in Bagerhat, Khulna and Satkhira districts (Mohsin, 2011).

Shrimp farming has been reported for its wide range of environmental impact apart from its role in economic sector (Kabir, 2008). Most of these concerns have been raised for the management of waste water and solid and semi-solid wastes, commonly known as pond sludge. Most management issues of shrimp farming have focused on waste water management and little to pond sludge. Post harvest management has not been well pursued by the farmers due to capital cost and lack of low cost appropriate technologies (Latt, 2002).

Pond sludge produce toxic gas for shrimp and make unsuitable for future crop if it is not removed properly after harvest (Karunarathna *et al.*, 2008). After years of farming, disposal of accumulated sludge is a constraint for sustainable shrimp production (Latt, 2002). The pond waste

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absorbs water and forms a sludge covering on the whole pond bottom. A thin film is produced by dead plankton and it masses together and covers the pond bottom. This shrimp waste is discharged into the surrounding environment or buried without any treatment, thereby causing serious environmental threats (Karunarathna *et al.*, 2008). In shrimp ponds, artificial feeds provide most of the nitrogen (N), phosphorus (P) and organic matter to the pond system. Only 17% (by dry weight) of total feeds is converted into shrimp biomass and the rest remains as sludge containing high level of N, P, K, organic matter and inorganic chemicals (Briggs *et al.*, 1994). It was found that 0.5-1.0 gm biocarbon is present in 1 kg of dry sludge after laboratory experiment (Paul, 2007). This sludge has potential to be recycled for use as organic manure.

The demand of chemical and organic fertilizers has increased recently for raising tree seedling in different nurseries of southwestern part of Bangladesh. It has become a social movement in this region and playing important socio-economic role in development and poverty alleviation. Generally, the demand of organic manure is usually met by cow dung which has limited supply. The shrimp pond sludge has the potential to be substitute for traditional organic manure as it contains a considerable level of different growth promoting organic substances (Latt, 2002). Besides, recycling of this waste would reduce environmental pollution. In this study, the effect of shrimp farm sludge on growth of Mahogany *(Sweitenia macrophylla)* seedlings was investigated by applying different concentration of sludge. The growth of the seedlings was measured in terms of total biomass and nutrient content of leaves of the seedlings were also analyzed.

Materials and methods

Study site: The seedlings were grown in different proportion of shrimp pond sludge with soil in the nursery of Forestry and Wood Technology Discipline (FWT), Khulna University, Khulna. The chemical analysis of different nutrients has been conducted in the Nutrient Dynamics laboratory of the FWT Discipline of the said University.

Collection, Processing of sludge and Soil preparation with sludge: Sludge was collected after harvesting of giant prawn (*Macrobrachium rosenbergii*) from a fresh water shrimp farm, near Khulna University campus randomly from the bottom of the pond at a depth of 5 cm by using spade and transferred into plastic container and transported to nursery. The collected sludge was air-dried, grounded and mixed thoroughly and kept in plastic bags in dry place for further use. The processed sludge was mixed with soil at 10% increment in terms of weight (Table-1).

Table 1: Soil preparation with sludge

Treatments	Sludge proportion in mixture (%)	Soil proportion in mixture (%)
SP1	0	100
SP2	10	90
SP3	20	80
SP4	30	70
SP5	40	60
SP6	50	50
SP7	60	40
SP8	70	30
SP9	80	20
SP10	90	10
SP11	0	Soil with 25 % cow dung
SP12	0	Soil with chemical fertilizer
SP13	0	Soil with cow dung and chemical fertilizer

Experimental setup

Seed collection: Mahogany seeds were collected during the month of March from a single tree to minimize the genetic variability in growth performance. The collected seeds were air-dried and stored in an air-tight container.

Preparation of poly bags and sowing seeds: Thirty poly-bags of 6´´ x 10´´ were filled with each type of prepared soil thus a total 390 poly-bags were prepared (Figure 1). Two seeds were sown in each poly-bag and one healthy seedling was kept in each bag after germination.

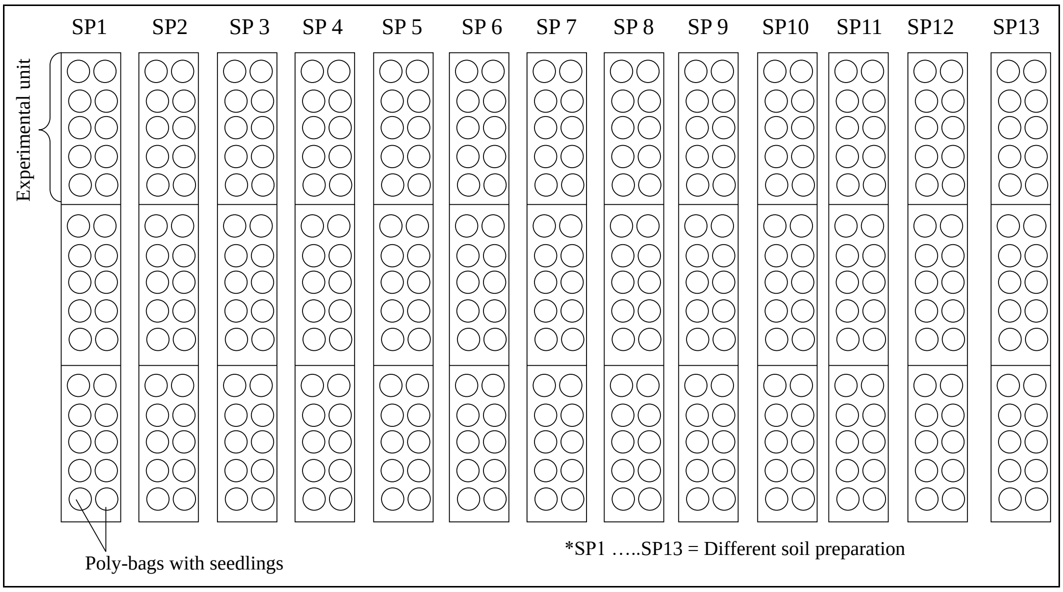

Fig. 1**:** Design layout of growing seedlings

***Growth measurements**:* The seedlings grown in different proportion of sludge with soil were kept for 4 (four) months. Total height (cm), diameter (mm) and biomass (oven dry weight) (g) of seedlings grown in all types of soil preparation was recorded at the end of the experiment

Nutrients (N, P and K) concentration in leaves of seedlings: The leaves of seedlings were acid digested according to Allen, (1974) to measure nutrients. Nitrogen and Phosphorus concentrations in the extract were measured according to Weatherburn, (1967) and Timothy *et al*., (1984) respectively. Potassium concentration was measured by Flame photometer (PFP7, Jenway LTD, England).

Statistical analysis: Height, diameter and oven dried biomass of seedlings and nutrients in leaves of seedlings were compared by one way Analysis of Variance followed by Duncan Multiple Range Test. Statistical tests of significance was carried out using SAS (V-6.12) statistical software.

Results

Height and diameter of seedlings: The height and diameter of seedlings responded differently towards different treatments. Height growth of SP13 was significantly different from all other treatments but height growth in SP7 and SP10 was more similar to SP13 and there was no significant differences between them (Figure 2).

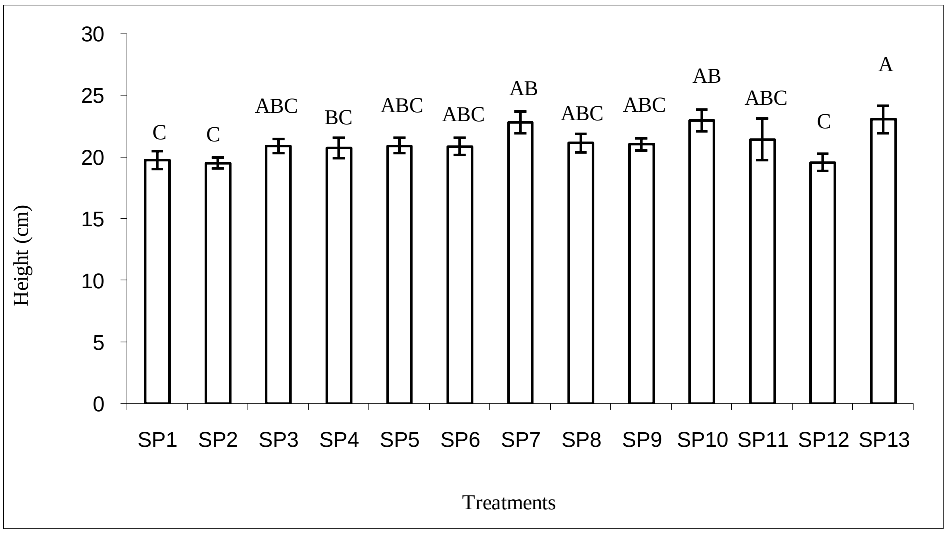

Fig. 2: Height growth pattern of seedlings due to different composition of soil. Means with similar alphabet are not significantly (p>0.05) different.

The highest diameter growth was found in SP1 but diameter growth in SP7, SP9 and SP10 was similar to SP1and there was no significant differences among them (Figure 3).

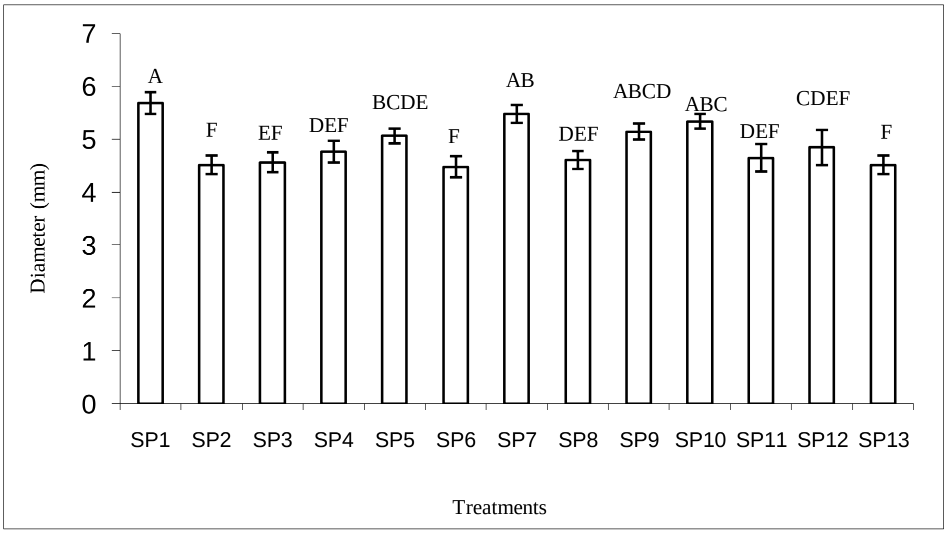

Fig. 3: Diameter growth pattern of seedlings due to different composition of soil. Means with similar alphabet are not significantly (p>0.05) different.

Leaf, root and shoot (oven dried weight) of seedlings: Variation was also found in leaf, root and shoot production (biomass) due to different composition of soil. SP10 has showed the highest oven dried weight of leaf, root and shoot production (Figure 4).

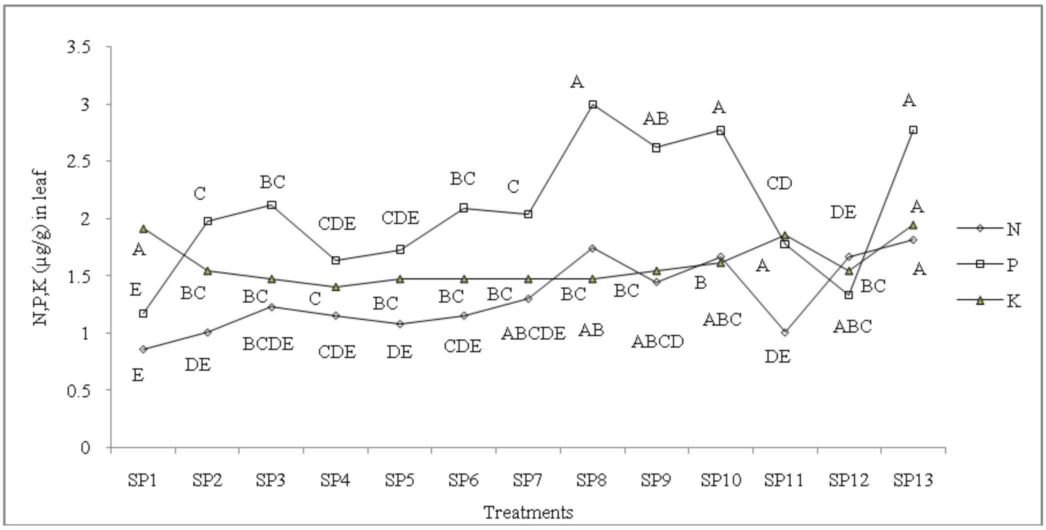

Fig. 4: Leaf, Root and Shoot weight (oven dried) of seedlings due to different composition of soil. Means with similar alphabet are not significantly (p>0.05) different.

Nitrogen, phosphorus and potassium concentration in leaf of seedlings: Seedlings grew on different composition of soil had shown different nutrient concentration in leaf of seedlings. SP13 has showed the highest nitrogen, phosphorus and potassium concentration in leaf but SP10 has showed similar concentration of nitrogen and phosphorus concentration in leaf and there was no significant differences between them (Figure 5).

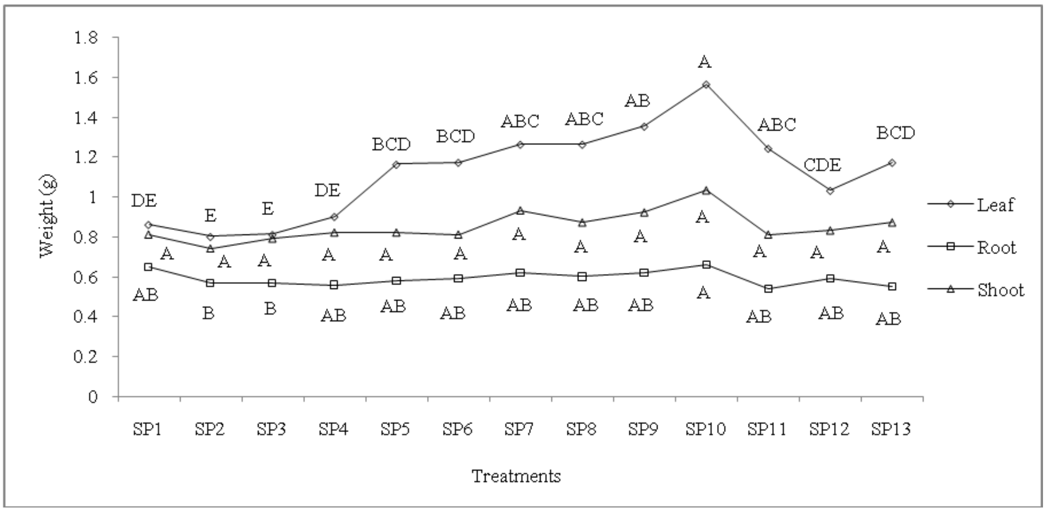

Fig. 5: Nutrients (N, P and K) in leaf of seedlings due to different composition of soil. Means with similar alphabet are not significantly (p>0.05) different. (SP1, SP2, SP3-----Sp13 indicates soil mixture of normal soil; 10%, 20%, 30%----- 90% sludge with rest (%) of soil; soil with cow dung; soil with chemical fertilizer and soil with both chemical fertilizer & cow dung respectively).

Discussion

Shrimp pond sludge contains high level of nutrients and organic matter (Latt, 2002) and the concentrations of N, P, K, S, Ca, Mg, Na, Mn and Zn increases in shrimp pond sludge which increases the growth of plants (Ritvo *et al;* 1998). In this study it was found that the growth performance of Mahogany seedlings in soil with both cow dung and chemical fertilizer and soil with 90% sludge was similar. The leaf, root and shoot production was the highest in soil with 90% sludge among all the treatments. The nutritional composition (N, P, K) of leaf was the highest in the seedlings grew on soil with both chemical and cow dung fertilizers but soil with 90% sludge also showed similar concentrations of nutrients in leaf of seedlings. Thus, from nutritional point of view shrimp pond sludge (90% sludge and 10% soil) alone can substitute mixture of chemical fertilizer and cow dung. Latt (2002) found increased growth for *Rhizophora mucronata, R. apiculata and Bruguiera cylindrica* using mixture of 75% sludge and 25% soil and there was no negative effect observed in terrestrial Banana, Rubber and Jasmine plant species. Hopkins *et al.* (1994) also proposed its use to improve terrestrial crop yield. In this study, the positive effect was observed for leaf, root and shoot production of seedlings that grew on the mixture of 90% sludge and 10% soil medium. The sludge was collected from a fresh water shrimp (*Macrobrachium rosenbergii*) farm so there exists no salinity which will affect the growth of other plants. This approach will be applicable in different agricultural, agroforestry and/or agroforestry with fresh water fishery/shrimp farms which will increase the productivity of the soil.

Conclusion

Recycling of shrimp farm sludge is a major concern for shrimp farmers. Alternative use of shrimp farm sludge as organic manure will not only be beneficial for shrimp farmers, but also will be instrumental to control environmental pollution. Besides, the use of sludge will meet the demand of organic manure to the seedling raising nurseries and other relevant practices.

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