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Phytoremediation of Coastal Land Using Manure and Grass Plants

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Abstract: ***High salt concentrations cause disruption of the absorption of nutrients and water needed in metabolic processes. Characterization of saline soils is needed so that improvements or phytoremediation can be planned so that saline soils can be utilized as agricultural land. Land improvement can be done by using fertilizers and grass plants. Organic matter or fertilizers can play a role in binding grains with secondary soil grains in the formation of solid aggregates. This will affect porosity, water supply and storage, soil aeration, and soil temperature. The characteristics and effects of manure as amendment and grasses as phytoremediation to overcome salinity in saline soils are discussed in this paper.***

Keywords: grass plants, organic matter, porosity, saline soil, soil aeration

1. Introduction

The problem of salinity arises when the salt concentration of NaCl, Na_2CO_3, and Na_2SO_4 is present in excessive amounts in the soil. The high osmotic pressure of a nutrient solution of 25 Ds. m^{-1} inhibits nutrient absorption by plants due to the presence of Na^+, Ca^{2+}, SO_4^{2-} and Cl - ions (Rengasamy, 2010). The salt content in saline soil inhibits the growth and absorption of N0 - and NH4+ elements in plants. High salt concentrations cause disruption of the absorption of nutrients and water needed in metabolic processes (de Oliveira et al., 2013). The absorption of sodium, potassium; and chloride ions by plants and the growth rate varies depending on the type of plant, growth stage, and plant organ. The peak absorption of sodium and chloride ions in plant leaves is at the seed filling stage but in the stem when the plant is old. The concentration of potassium is much higher in the stems during the growing period. Ions present in stems, roots, and panicles increased during seed filling until harvest but decreased when harvesting was delayed (PuHan et al., 2015). Soil salinity affects ionic toxicity, osmotic stress, nutrients (N, Ca, K, P, Fe, Zn), and oxidative stress in plants, and thus limits water absorption from the soil (Shrivastava and Kumar 2015). Based on the research results of Pistocchi et al (2017) showed that high Na concentrations reduced Na levels in plant shoots and roots. It was further explained that the addition of 2.0 mM calcium would reduce the Na content in the plant canopy.

Characterization of saline soils is needed so that improvements or phytoremediation can be planned so that saline soils can be utilized as agricultural land. Land improvement can be done by using fertilizers and grass plants.

Chemical Improvement

Improvement of soil fertility through chemical reclamation is carried out because saline soil fertility is generally low, generally it is abandoned and underutilized land. Physical/mechanical improvement is the arrangement of the layout of the plantation which is carried out by "regulating" the condition of the land. Improvement of soil fertility is done by:

1) Chemical improvement is aimed at improving soil pH, assuming the nutrients available to plants are in the neutral range. After the acidity can be overcome, the addition of macro - nutrients and micro - nutrients for plants must also be carried out on infertile soils.
2) Restoration of soil organic matter and mineral nutrient cycles in the soil. If the land is degraded due to soil erosion or has decreased agricultural productivity, it can be improved by using organic materials, good soil management, such as the use of fertilizers (Ahmad, et al, 2014).

Organic Amendment: Manure

Manure is organic fertilizer derived from animal manure that has been decomposed. The most important components of manure are feces (solid impurities), urine (liquid impurities), straw, and water (Brewin et al, 2014). Manure can increase the availability of nutrients for plants that can be absorbed from the soil, manure has a good influence on the physical and chemical properties of the soil and encourages the development of microorganisms (Miron et al, 2011). The physical characteristics of manure are blackish brown, quite dry, not lumpy, and not stinging. Its chemical nature is a small C/N ratio because the constituent materials are not visible and the temperature is relatively stable (Zhichen et al., 2011).

Organic matter has a role in stimulating granulation, reducing soil plasticity and cohesion, improving soil structure to become more friable, and increasing soil strength in retaining water so that drainage is not excessive, soil moisture and temperature become more stable (Reijnevelda et al., 2014). Organic matter or fertilizers can play a role in binding primary grains with secondary soil grains in the formation of solid aggregates. This will affect porosity, water storage and supply, soil aeration, and soil temperature (Purbajanti et al, 2010). KCl fertilizer can be a useful amendment for phytoextraction of metals by accumulator species, while sheep manure can be very useful

for phytostabilization. KCl fertilizer can be a useful amendment for phytoextraction of metals by accumulator species, while sheep manure can be very useful for phytostabilization. by using organic matter, and good soil management, such as the use of fertilizers (Ahmad, et al, 2014).

Physico - chemical characteristics of manure differ from the soil, and the use of sequential extraction in fertilizer analysis should be evaluated. Most of the P in fertilizers is soluble in weak acids such as H2O and NaHCO3, while most soil P requires NaOH and HCl. This is related to the fact that the soil contains Ca, 15 times more Al, and 10 times more Fe as manure, whereas manure tends to have higher Ca and Mg content. Rapid P evaluation of plants is a method of analyzing P in soil used to assess the contribution of manure. Based on the research results Purbajanti et al,. (2010), manure can affect the chemical properties of saline soil (Table 1).

Table 1: The ability of manure to improve soil saline

Treatment	Before remediation	After remediation Using manure
EC (mS)	19.6	7.7
ESP (%)	8.4	7.4
pH	8.3	7.3
Exchangeable Na (cmol)	2.08	1.9
Exchangeable Mg (cmol)	0.49	1.9
Exchangeable Ca (cmol)	1.81	4.4
Exchangeable K (cmol)	0.33	0.6
CEC (cmol)	23.6	26.1

Note: ESP=exchangeable sodium percentage (%), EC=electrical conductivity (mS), CEC: cation exchange capacity
Source: Purbajanti et al,. (2010).

Biological Repair

The application of a cropping system with regard to biological principles is to maintain biological fertility and soil organic matter so that the nutrient cycle can run properly. The plants selected must be considered for their effect on soil quality and productivity. The mechanism of tolerance to salinity can be explained as follows; Salinity has many different effects on plants including tolerance mechanisms (Favas et al., 2014).

These mechanisms can be grouped into three main categories: first, osmotic tolerance, which is regulated by plant physiological substances that reduce shoot growth prior to Na+ accumulation; Second, isolation of ions, where the process of transporting Na^+ and Cl^- in the roots reduces the accumulation of toxic properties of Na^+ and Cl^- in the leaves; and third, tissue tolerance, in which high salt concentrations are found in leaves at both cellular and intracellular levels (especially in vacuoles (Roy et al.2014). Phytoextraction is based on using plants that absorb pollutants from the soil and concentrate them on crops that can be harvested (Sirguey and Ouvrard, 2013). Several ways to improve biology are (1) Phytoremediation, (2) saline soil plant filtration, (3) improvement of soil flora and fauna.

a) Phytoremediation

Phytoremediation processes rely on the ability of plants to metabolize pollutants into non - toxic substances. Contaminant uptake, accumulation and degradationvaries from plant to plant. Plants used phytoremediationare generally selected based on their growth rate and biomass, their ability to tolerate and accumulate contaminants, the depth of their root zone, and their potential to change the soil (Oh et al, 2014). Phytoremediation of saline soil improvement requires a low initial investment which has emerged as a substitute for chemical repair. Phytoremediation works through the action of plant roots which helps dissolve low - solubility calcite ($CaCO_3$) to supply effective levels of Ca^{2+} which functions in the exchange of Na^+ and Ca^{2+} without application of amendments (Qadir et al., 2007).). Vegetative bioremediation in saline and saline - sodic soils is carried out as a biological approach to soil desalination by plants. It is based on three main processes: (i) sodium release from the cation exchange site, (ii) leaching, (iii) phytocalization (Na^+ uptake by plant roots and accumulation in shoots). Washing requires sufficient rainfall or adequate irrigation. Thus, under non - washing conditions, phytodesalination is the only process that can be used in terms of sodium removal (Rabhi et al, 2015).

Halophytes refer to plants that survive high salinity in their habitats and adapt to adaptable and biochemical adaptations. In their habitat, halophytes face a two - fold problem: they must tolerate high salt concentrations, and they must draw water from soil solutions that have low water potential (Zouhaier et al, 2015). *Sesuviumportulacastrum* L. is a multipurpose facultative halophyte and is an ideal system for studying adaptation mechanisms and exploring its ability to reclamation saline soils. It is a fast - growing, herbaceous, perennial halophyte and grows in low soil nutrient concentrations. Also serves as food and forage for pets, is useful as a source of essential oils, for ornamentation, greening deserts, production of secondary metabolites (phytoecdysteroids), and also has the capacity to accumulate heavy metals (Muchatea et al.2016).
The results of Purbajanti et al., (2011) explained that Panicum grass plants are able to absorb Na elements so that they can be used as phytoremediation.

Table 2: Na uptake of four types of grass plants

Grass	Na uptake	
	Before remediation	After remediation
Panicum maximum	0.46	0.25
Pennisetumpurpopoides	0.35	0.28
Pennisetumpurpureum	0.34	0.22
Brachiariabrizantha	0.56	0.35

Source: Purbajanti et al,. (2011).

Increased root development increases the volume of soil explored for nutrients and air gain. Inoculation methods and various crop production conditions. The practice of inoculation with selected strains of *Azospirillum* sp. make a direct contribution to increasing crop yields and increasing the effective use of production sources with additional environmental benefits (Cassan and Diaz - Zorita, 2016). The combination of nitrogen and *Azospirillum* can ensure better absorption and yield of nutrients in agricultural areas by using high technology. The result of the addition of nutrients. Wheat production increased by 29% in the

treatment with *A. brasilense* and nitrogen compared to nitrogen alone (Ferreira et al, 2013).

b) Soil Flora and Fauna Improvement

Microorganisms can play an important role if we take advantage of their unique properties such as tolerance to saline conditions, genetic diversity, synthesis of compatible solutes, production of plant growth hormones, biocontrol potential, and their interactions with plants (Shrivastava and Kumar, 2015). There are two types of bacteria, namely *Alphaproteobacteria* and Delta proteobacteria that appear in reclaimed soil. The activities of urea, invertase, and phosphatase increased by 19 - 44% with the amendments. Increased microbial and enzyme activity due to the combined use of biochar and poultry manure with pyroligneous solutions can be a practical option to reduce salt stress on microbial communities, plants, and soil to increase crop production in saline soils (Lu et al, 2015).

Azotobacter bacteria are more resistant to salt than *Azospirillum*. Each isolate contained in the inoculants was able to withstand a salinity of 4.0; and 4.0 DS. m^{-1}, with a bacterial population of 27.88 and 79 x 105 g. soil cell, capable of producing PME - ase of 0.62; and 0.55 mg nitrophenol. ml^{-1}, available P at 8.95; and 7.30 ppm and had a positive effect on plant height and fresh weight of spinach plants. The application of this bacterium on saline soil will be useful for vegetable cultivation (Widawati, 2015).

Biological improvement of alkaline saline soils is a strategic soil conservation method. Plant Growth Stimulating Bacteria using bacterial isolates. Rhizobacteria CMH3 (*P. corrugata*) isolate caused higher plant biomass and higher salt uptake by plants, resulting in a decrease in soil salinity (Chang et al, 2014). Vesicular - arbuscular mycorrhizae (MVA) are key players in promoting vegetation development and strengthening soils because of their potential to increase plant growth and soil aggregates. In promoting plant growth, vesicular - arbuscular mycorrhizae provide greater and more efficient access through fungal hyphae for nutrient absorption and delivery to plants. (Sittadewi, 2021). The development of salt - tolerant plants is an alternative for plant development in saline land with the help of plant growth promoter rhizobacteria (PGPR). PGPR is thought to produce phytohormones that can stimulate plant growth and assist the nutrient cycle and consequently reduce salinity. PGPR is also able to increase plant nutrient uptake thereby reducing the need for fertilizers (Vivekanandan et al., 2015).

Plant growth - supporting strains (PGPB) containing the enzyme 1 - aminocyclopropane - 1 - carboxylate (ACC) deaminase can reduce ethylene stress levels and plant growth. The Plant Growth Promoting Bacterial Treatment did not affect salt uptake by mass; Higher plant biomass causes greater salt uptake, resulting in a decrease in soil salinity. This study demonstrates a method for increasing plant growth in marginal salt soils (Chang et al, 2014). Rhizobia used for phytoremediation can act on metals directly by chelation, transformation, transformation, biosorption, and accumulation. In addition, plant growth promoting properties (PGP) of rhizobia including nitrogen fixation, phosphorus solubilization, phytohormone synthesis, siderophore production, and production of ACC deaminase and volatile compounds acetoin and 2, 3 - butanediol may facilitate legume growth while reducing metal toxicity (Hao et al, 2014). Endophytic bacteria *Bacillus shackletonii* and Streptomyces badius proved to have the most significant effect. These bacteria show not only benefits for plant growth, but also extreme tolerance of As, Zn, and Pb. Despite these results, the phytoremediation potential of native nettles can be enhanced by biotechnology. Remediation with nettle can have a much wider range of applications than previously thought (Viktorova et al, 2016).

2. Conclusion

Based on the overall description above, several recommendations can be given to overcome salinity so that it can be utilized for agricultural land, namely:

1) Reclamation method by combining several methods at once can be adopted to reduce salinity and improve soil chemical properties, increase soil fertility in turn reduce toxicity and increase plant nutrient uptake
2) Utilization of livestock manure from goat manure (as well as other livestock) is a source of organic matter that acts as humus which is able to chelate Na, donate humic acid and fulvic acid which can reduce soil pH, exchange cations, and as a source of nutrients.

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