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Salt Stress Effects on the Vegetative Growth of *Pleurotus tuberregium* (FR) Sing

S.M. Ayodele and O.J. Ojogoro
Department of Botany, Delta State University, Abraka, Nigeria

Abstract: Vegetative growth studies of *Pleurotus tuberregium* were carried out on sawdust of *Khaya ivorensis* under different salinity conditions of sodium chloride (NaCl), sodium sulphate (Na₂SO₄), Potassium chloride (KCl), Potassium sulphate (K₂SO₄), Magnesium chloride (MgCl₂) and magnesium sulphate (MgSO₄). The mycelia of *Pleurotus tuberregium* grew in all the salts and in all the concentrations tested except at 15 and 20% on sodium chloride where slight mycelial growth was initiated and few days later it withered leaving the substrates uncolonized. Inhibitory effects of the different salts was found to be varied at different concentrations.

Key words: Salt stress, vegetative growth, *Pleurotus tuberregium*

INTRODUCTION

Humanity use of mushrooms dated back to paleolithic times (Stamets, 2000). Edible mushrooms are special group of higher fungi that are considered as delicious health food in many developed countries such as Japan, China and United State of America. The cultivation and production of edible mushrooms is on the increase in these countries. This is because of the nutritional and medicinal attributes of edible mushrooms (Garcha *et al.*, 1993; Liu *et al.*, 1993; Crisan and Sands, 1978; Sakagami *et al.*, 1991; Ayodele and Okhuoya, 2007).

Pleurotus tuberregium is an important edible mushroom in many parts of the world particularly in the tropical countries where spectacular amounts of salinity exists in the soils, rivers and irrigation water (Ashraf and McNeilly, 2004; Kamkar *et al.*, 2004). The sclerotia of *Pleurotus tuberregium* are usually found under the ground or inside the substrates where it grows. The environment in which plants grow consists of physical, chemical and biological factors. An imbalance in any of these factors causes stress (Ekanayake, 1998; Yokoi *et al.*, 2002). According to Ekanayake (1998), crop productivity can be constrained by various environmental stresses.

Salinity has been shown to affect germination, seedling growth and yield of crops adversely (Maurya, 1979; Kamkar *et al.*, 2004; Ashraf and McNeilly, 2004). Types of salinity also affect plant growth and metabolism differently (Levitt, 1980; Hasegawa *et al.*, 2000; Zhu, 2001). Although, much study has been done on the effect of salinity on various aspects of higher plants growth and development (Walker *et al.*, 1979; Mizrahi, 1982; Esenowo, 1991; Yokoi *et al.*, 2002; Kamkar,

2004; Ashraf and McNeilly, 2004; Hasegawa *et al.*, 2000; Zhu, 2001) attention has not been paid to the effect of salt stress on mushrooms. As such the present study was undertaken to find out the vegetative growth performance of *Pleurotus tuberregium* under different levels of salt stresses.

MATERIALS AND METHODS

The pure culture of *Pleurotus tuberregium* was collected from the mushroom unit of the Department of Botany, Delta State University, Abraka, Nigeria in May, 2006. The pure culture was used to prepare the mushroom spawn (mushroom seeds) on guinea corn grains (*Sorghum bicolor*). Saw dust of Mahogany (*Khaya ivorensis*) was collected from a local sawmill in Abraka, Delta State, Nigeria. The sawdust was soaked in water for 24 h and drained completely. Five hundred grams (500 g) oven dry weight equivalent of the moistened sawdust were loaded into cellophane bags measuring 15×30 cm each. These were loaded in a steamer and steamed for 4 h. The sterilized bags were allowed to cool down over night. One hundred milliliter (100 mL) of specific salt solutions (NaCl, NaSO₄, KCl, K₂SO₄, MgCl and MgSO₄) which were prepared in the following concentrations 0, 1, 5, 10, 15 and 20% in sterile distilled water was mixed with each substrate bag. Three bags were prepared for each salt and each concentration. Substrates without salt solution (0%) were used as control.

Substrate bags containing different salts and different salt concentrations were inoculated with the spawn of *Pleurotus tuberregium*. Inoculation was done at 5% level of spawning. The inoculated substrates

were kept on clean laboratory benches for 14 days. The following parameters were determined (a) Time of complete mycelial colonisation of the substrates (b) Mycelial density on each substrate which was determined by arbitrary measure adopted from Kadiri and Fasidi (1994).

The data were analysed using simple descriptive statistics such as means and standard error and mean were separated by ANOVA.

RESULTS

Vegetative growth studies of *Pleurotus tuberregium* on selected salt concentrations showed that the mushroom can tolerate or utilize a wide range of salts at different concentrations. The mycelia of the mushroom grew on all the salts tested and in all the concentrations except at 15 and 20% on sodium chloride (NaCl) where slight mycelial growth was initiated and few days later it withered leaving the substrate uncolonized. The level of tolerance or utilization of these salts differed as evidence in the rate of colonization of each salt substrate and mycelial density on each salt concentration.

The mushroom grew on sodium chloride at a very low concentration. The mean days of complete colonization of the substrate was found to increase with increasing levels of concentration (Table 1). The mycelial density followed in opposite direction. There was a significant ($p = 0.05$) increase in the number of days between the lower and higher concentration of sodium chloride.

Sodium sulphate salt supported the vegetative growth of *Pleurotus tuberregium* at all levels of concentration tested. There was no significant ($p = 0.05$) difference in the rate of growth and mycelial density in all the concentrations tested (Table 1). Growth inhibition was observed in Magnesium chloride. As the concentration of the salt is increasing, so also the number of days for complete colonization increases. The mycelial density was higher at lower concentration compared to the higher concentration of the salt (Table 1). *Pleurotus tuberregium* grew well on all the concentrations of magnesium sulphate. The highest mycelial extension and density was on 5% level of concentration (Table 1). Mycelial growth and development was inhibited by Potassium chloride. The mushroom can only grow on a very low level of

concentration. The fastest and the highest mycelial extension and density was on 1% (Table 1). Potassium sulphate was well utilized by *Pleurotus tuberregium*. There was no significant difference ($p = 0.05$) in the mycelial extension at all concentrations except at 1%. The mycelial density was however higher at higher concentration (Table 1).

DISCUSSION

In this study, salinity is observed to affect the growth and development of *Pleurotus tuberregium* at different levels of concentrations of the six salts tested. This result confirms the study of Yokoi *et al.* (2002) and Esenowo (1991) and Ekanayake (1998) on higher plants. It was observed that vegetative growth and development of *Pleurotus tuberregium* was inhibited mostly by NaCl, MgCl and KCl where as less inhibition was observed in MgSO₄, Na₂SO₄ and K₂SO₄. This observation is in line with the report of Esenowo (1991), Yokoi *et al.* (2002), Ekanayake (1998), Kamkar *et al.* (2004) and Ashraf and McNeilly (2004). The reduction or retardation in growth under salt stress may be due to osmotic or ionic effect or combination of both as reported by Greenway and Munns (1980) Kamkar *et al.* (2004) and Ashraf and McNeilly (2004). The inhibitory effects was more with chloride salts compare to sulphate salts at concentrations of 15 and 20%. This may be due to the interference with uptake of water by the salts which is very essential for growth and development of mushrooms. This probably lead to the withering effects observed on substrates containing NaCl and failure to grow further at higher concentrations of the salt. This confirms the study of Esenowo (1991) who reported that increase in the level of salt stress reduces germination and growth of higher plants. He further reported that higher levels of salinity delay the emergence and reduces the final percentages of germination in higher plants. In this study, it was observed that increase in the concentrations of certain salts (NaCl, MgCl₂ and KCl) inhibit or cause reduction in the growth of *Pleurotus tuberregium*.

Excess Na⁺ and Cl⁻ have been shown to cause protoplasmic swelling and affect the activity of enzymes so that quantitative and qualitative changes occurs in the metabolism (Larcher, 1980; Nakamura and Schroeder,

Table 1: No. of days taken by *Pleurotus tuberregium* to fully colonize the substrates

Concentration (%)	NaCl	Na ₂ SO ₄	MgCl ₂	MgSO ₄	KCl	K ₂ SO ₄
0	20.00±0.00 (3+)	20.00±0.00 (3+)	20.00±0.00 (3+)	20.00±0.00 (3+)	20.00±0.00 (3+)	20.00±0.00 (3+)
1	21.30±0.88 (4+)	18.30±0.88 (3+)	18.70±0.19 (4+)	20.00±0.00 (3+)	18.70±0.33 (4+)	17.70±0.33 (4+)
5	22.30±1.45 (3+)	18.30±0.33 (4+)	20.20±0.88 (4+)	19.70±0.33 (4+)	22.30±0.33 (3+)	19.30±0.12 (4+)
10	25.00±0.58 (2+)	19.30±1.45 (3+)	21.30±0.88 (4+)	20.30±0.53 (3+)	23.00±1.16 (3+)	19.30±0.33 (4+)
15	0.00±0.00 (-)	19.30±0.88 (3+)	25.50±0.67 (3+)	21.10±0.67 (3+)	24.30±0.88 (2+)	20.70±0.13 (3+)
20	0.00±0.00 (-)	22.00±1.16 (3+)	25.70±0.33 (3+)	22.00±0.00 (3+)	26.40±0.88 (2+)	21.00±0.58 (3+)

(1+ → 4+) = Increasing level of arbitrary measure of density of mycelial growth adopted from Kadiri and Fasidi (1994)

2000; Zhu, 2001). In this study, the quantitative and qualitative mycelial production is affected by Na⁺ and Cl⁻. Higher concentration of NaCl in the soil reduces the uptake of mineral nutrients and this leads to reduction in dry matter production and growth rate (Levitt, 1980).

The observation in this study clearly showed that chloride ions in association with sodium, magnesium and potassium are inhibitory to the mycelial growth and development of *Pleurotus tuberregium* as compared to the sulphate ions in association with magnesium potassium and sodium whose direct effects were not significant. This supported the observations of Redmann (1974), Verma (1981) and Kamkar *et al.* (2004) on germination and growth of alfalfa, rice and wheat.

The ability of *Pleurotus tuberregium* to withstand or tolerates some salts and their various concentrations may suggest a potential for utilization of such salts for enzymes production that may enhance the ability of the mushroom to degrade its substrates and utilize such substrates for growth.

From this study, it can be concluded that chloride ions in association with sodium, magnesium and potassium are inhibitory to the growth and development of *Pleurotus tuberregium* as compare to the sulphate ions of potassium, magnesium and sodium. The observations further suggest that water, soils and substrates rich in these salts (KCl, MgCl₂ and NaCl) are not favourable for cultivation of *Pleurotus tuberregium*. For effective growth performance of *Pleurotus tuberregium* during cultivation, the salt level of water, soils and substrates should be determined.

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