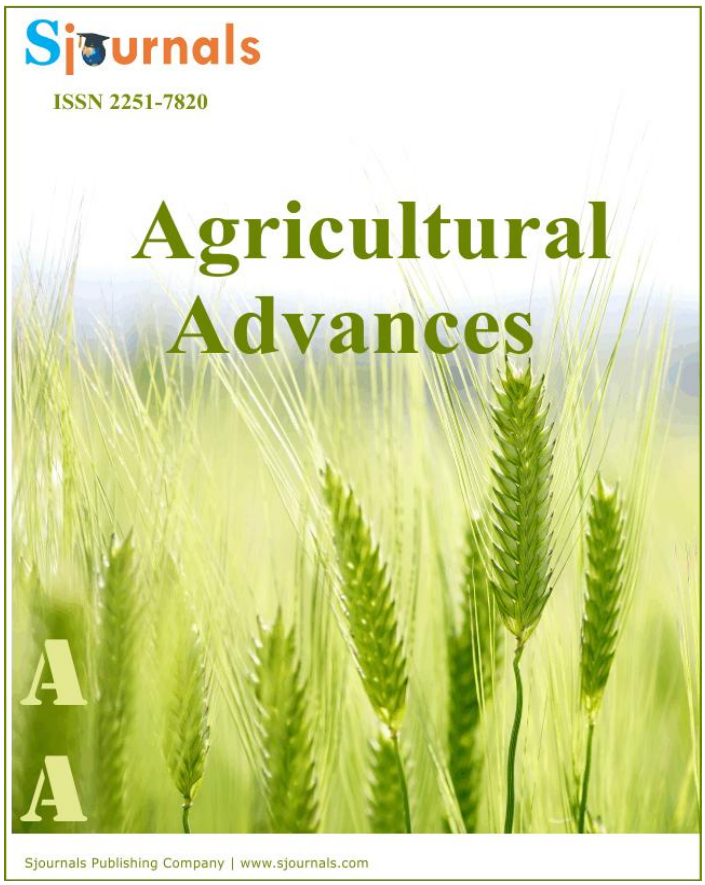

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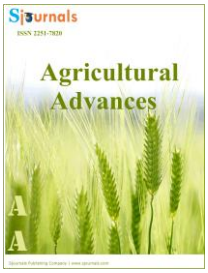

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Original article

Enhancing nitrogen fixation in soybean (*Glycine max* L.) by composting under saline stress condition

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ABSTRACT

Soybean is susceptible to saline stress and reduced yield loss. Organic fertilization has several beneficial effects on agricultural crop fields. To minimize the deleterious effects of the salinity organic fertilization is using which can provide economic yield under saline conditions. Therefore, a greenhouse research was conducted at the Department of Environmental Dynamics and Management, Hiroshima University, Japan to find out the role of compost in alleviating the adverse effects of salinity stress on soybean. The nitrogen-fixing activity was estimated by using gas chromatograph. The results revealed that salinity stress reduced the biological nitrogen fixation and specific nodule activity. Our results show that, there was a corresponding improve in nitrogen fixation with compost application.

1. Introduction

Soybean (*Glycine max* L.*)* is a vital source of protein and oil for human food (Katerji et al., 2001) Soybeans have a good content of protein and soil properties become better through its potential to build root nodule (Abdul

Jabbar and Saud, 2012). It was reported that soybean was negatively affected by salinity stress conditions (Nakasathien et al., 2000).

Abiotic stress causes reducing in growth and productivity of different crop (Islam, 2011; Abd el-wahed et al., 2015a). Various environmental factors harmful affect plant growth and yield crops performance. Salinity is considered as a dominant factor affecting crop productivity in arid and semi-arid region of the world (Munns, 2002). Salinity stress causes negative effects on soybean plant during different growth stages (EL Sabagh et al., 2015a,b,c). Excess salts in the soil causes many harmful effects on plant growth, by providing little osmotic potential of soil soil, specific ions influence (salt stress), and imbalances of nutrition (Islam, 2012). Major yield reduction of crops is responsible to osmotic stress through salinity in the world, especially in semi-arid soil and irrigated agriculture. The area affected by salinity in Egypt and elsewhere is increasing each year (Abd-Alla, 1992). Salinity stress causes a reduction in the nitrogen-fixation capacity (Kenenil et al., 2010).

Using of green manure can potentially improve the productivity of crop under saline environments and could be contribute to agricultural sustainability (Bruning et al., 2015). Composted organic matter application to soil might have a potential effect on plant growth, yield and quality (Abd el-wahed et al., 2015b; EL-Sabagh et al., 2016a,b; Taha et al., 2016). Also, stress tolerance due to its enrichment of humic substances, macro- and micro-nutrients, and enhancing of soil properties of salt-affected soil (Walker and Bernal, 2008). Compost application significantly increased the tolerance against salt stress resulted from improving membrane stability, and accumulation of K and proline, on the contrary, decreased Na content in some crops (EL Sabagh et al., 2015d,e). The current research was, therefore, planned to determine the role of compost application in alleviating the deleterious effects of nitrogen fixation under salinity stress in soybean.

2. Materials and methods

2.1. Plant material and culture conditions

The present study was conducted at plant nutritional physiology laboratory, Hiroshima University, Japan. The seeds of soybean (cv: Giza 111) was collected from Egypt Agricultural Research Center, Egypt. The seeds were sown into basin from wood (length10 meter, width 50cm, and depth 50cm) contains a mixture of granite regosol soil and perlite (2:1 v/v). The experiment was designed as a completely randomized block and replicated four times in the greenhouse. Before sowing the seeds, each basin was fertilized at a rate of 40 kg N ha^{-1}, 120 kg $P_2O_5ha^{-1}$ and 100 kg K_2Oha^{-1} and soil pH was adjusted to 6.0 with application of calcium carbonate (300 kg ha^{-1}).

Treatments were included two salinity levels (0 and 15 mM NaCl) and two rates of compost (Zero (Mineral) and 24 t ha^{-1}). Compost was applied and mixed with soil as per treatment. The soil was irrigated with saline water and normal water (tap water) as per treatment. Saline treatments were applied up to fully developed trifoliolate leaf node (VI). Chemical analysis of the compost was done and it contained (0.91%) nitrogen (0. 90%), phosphorous (0.50%), potassium, and 24% of C/N ratio.

2.2. Plant sampling and measurements

During the vegetative stage (six fully developed trifoliolate leaf nodes), the dinitrogen-fixing activity was measured according to the ARA (Hardy et al., 1973) by using a gas chromatograph.

2.3. Statistical analysis

The data that was collected for both seasons were subjected to analysis of variance according to Gomez and Gomez, 1984), and treatment means were compared using Duncun Multiple Range Test (Duncan, 1955).

3. Results and discussion

In the present experiment, efforts were made to find out the role of organic compost in improving nitrogen fixation rate of soybean under salinity stress conditions. Imposition of saline stress reduced (nitrogenase activity) in soybean as well as decreased specific nodule activity through salt stress (Fig. 1). The decrease could be due to reduce in nodule dry weight as well as the growth in soybean (EL Sabagh et al., 2015 b). Moreover, the number of nodules and dry weight per plant under salt stress varied with control conditions (data not show). (Lauter et al.,

1981) found that salinity stress caused inhabitation of nodule of chickpea. Salinity stress decreased symbiotic nitrogen fixation of fababean (Chaker Haddadj et al., 2014).

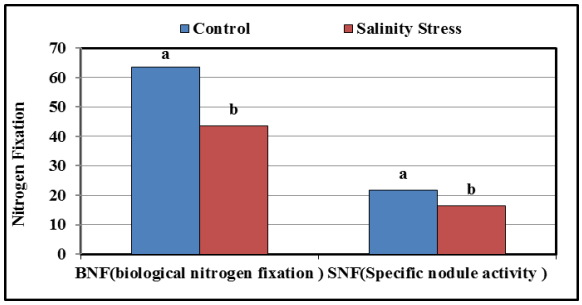

Fig. 1. Effects of salinity stress on biological nitrogen fixation (umol C_2H_4 $plant^{-1}$ h^{-1}) and specific nodule activity (umol C_2H_4 g^{-1} nodule h^{-1}) in soybean.

Application of compost was more effective than mineral fertilizer, and compost fertilization significantly increased nitrogen fixation of soybean plant under salinity condition (Fig. 2). Several previous studies reported that addition of organic fertilizer to saline conditions can accelerate Na^+ leaching, rise the CEC, and decreasing the ESP, EC, and salinity of soil (Oo et al., 2013). Compost application significantly increased the tolerance against salt stress of soybean (EL Sabagh et al., 2015d,e).

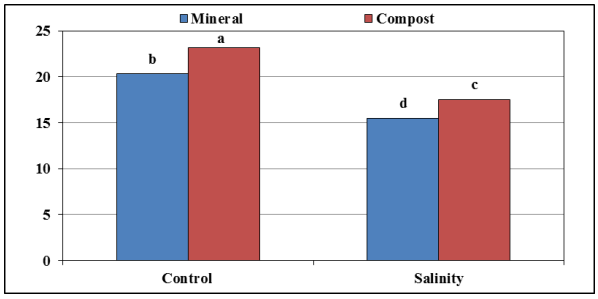

Fig. 2. Effects of compost application on specific nodule activity (umol C_2H_4 g^{-1} nodule h^1) in soybean under salt stress conditions.

4. Conclusion

Our data showed that, salinity stress remarkably reduced nitrogen fixation. Compost application significantly improved nitrogen fixation under salt stress conditions in soybean.

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