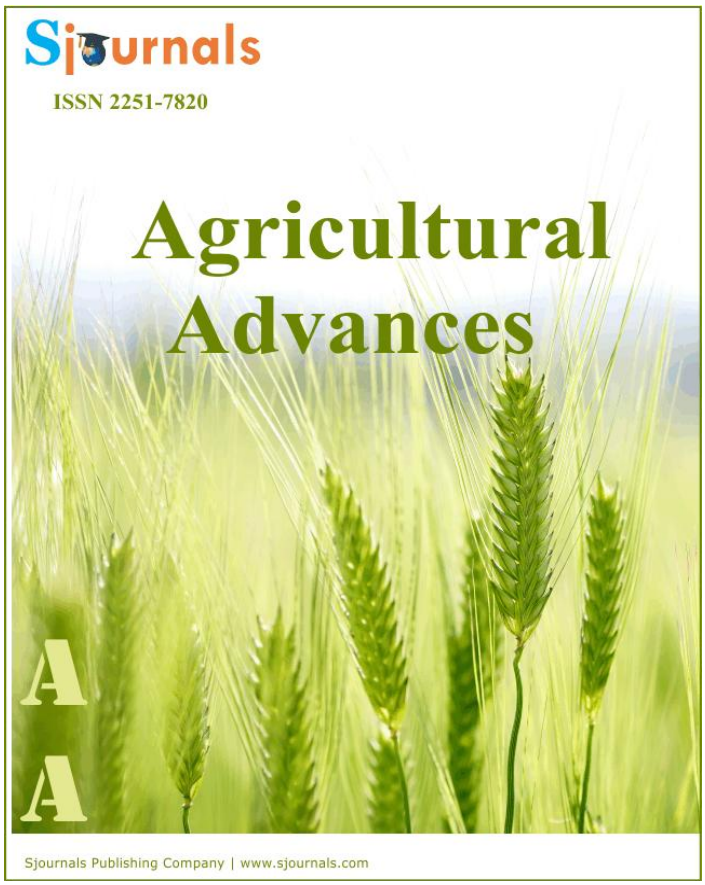

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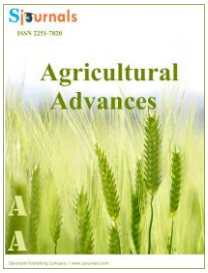

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Original article

Roles of compost fertilizer on nitrogen fixation in soybean (*Glycine max* L.) under water deficit conditions

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ABSTRACT

Presently, increasing nitrogen fixation in soybean is critical because of widespread increase in soil degradation in Egypt. Therefore, a greenhouse research was conducted at the laboratory of Plant Nutritional Physiology, Hiroshima University, Japan for assessing the impact of compost in alleviating the adverse effects of water stress on soybean. The nitrogen-fixing activity was estimated by using gas chromatograph. The results showed that water deficit stress reduced biological nitrogen fixation and specific nodule activity than normal irrigation conditions. Application of compost increased the biological nitrogen fixation and specific nodule activity under water stress conditions. As the results indicate that compost application could help in improving nitrogen fixation in soybean.

1. Introduction

Soybean (*Glycine max* L.) is one the major sources of protein for human consumption and food animal (Silvente et al., 2012; Hossain et al., 2014). It is also a strategic crop grown to obtain edible oil (Farhoudi et al.,

20007). Leguminous crops produce nodules in their roots by fixing atmospheric nitrogen which enhances the growth. A little research work is available regarding soybean yield, and accumulation of carbon and nitrogen compounds under a biotic stress conditions (Miao et al., 2012).

Several environmental stress factors adversely affect the growth, yield and quality performance of different crops (EL Sabagh et al., 2015b; Al-Ashkar et al., 2016; Barutcular et al., 2016a,b,c,d). Water deficit could decrease the premature nodules senescence (Puppo et al., 2005). N-fixation activity regardless of the mechanism of physiological and biochemical of N_2 fixation is constraint by drought stress, and it is documented that legume species have positive genetic variation in their potential to fix N_2 under drought stress (Charlson et al., 2009; Labidi et al., 2009).

Compost application can improve plant growth and productivity as well as, organic matter application might have a potential effect on yield quality (EL Sabagh et al., 2015a; EL Sabagh et al., 2016a,b; Taha et al., 2016) and stress tolerance due to its enrichment of humic substances, macro- and micro-nutrients, and beneficial microorganisms as well as improvement of soil physical, chemical and biological properties of salt-affected soil (Wright et al., 2008; Mora et al., 2010). Therefore, the objective of this research is to assess the impact of compost application in diminishing the adverse effects of water stress on the nitrogen fixation of soybean.

2. Materials and methods

2.1. Plant material and culture conditions

The present research was conducted at the Dept. of Environmental Dynamics & Management, Hiroshima University, Japan. The seeds of soybean (cv: Giza 111) saw collected from Egypt Agricultural Research Center, Egypt. The seeds were sown into wood-basin (10m length, 50cm width and 50cm depth) contains a mixture of granite regosol soil and perlite (2:1 v/v). The experiment was designed as a completely randomized block with four replications. Each basin was fertilized at a rate of 40 kg N ha^{-1}, 120 kg $P_2O_5ha^{-1}$, 100 kg K_2Oha^{-1}, calcium carbonate (300 kg ha^{-1}) and soil pH was 6.

Treatments were included water stress treatments (Factor: A) i.e. different soil moisture levels consisting of i) 100%, ii) 75%, and iii) 50% of field capacity, and compost treatments (Factor: B) as i) 0(Mineral) and ii) 24 t ha^{-1} compost. Compost was manufactured by using wood poop, chicken poop and palm. 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 egats (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 collected data 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). All statistical analysis performed using analysis of variance technique by “MSTAT-C”.

3. Results and discussion

Water stress caused a significant reduction on biological nitrogen fixation and specific nodule activity, the maximum nitrogenase activity was observed under control condition (Fig. 1). This reduction could be due to the inhibition to protein synthesis under water deficit, could be due to the reductionin the rate of polyribosomes (Bewley, 1981). The nitrogenase activity was decreased and was high sensitive during the formation of pod to water stress condition (Cure et al., 1985; Singh and Kataria, 2012). It was reported that, a reduction in nitrogen fixation per unit mass of non-empty nodule under water deficit conditions (Labidi et al., 2009). In previous study it was reported that drought stress caused a negative effect on soybean growth during vegetative stage (EL Sabagh et al., 2015a; EL Sabagh et al., 2016a).

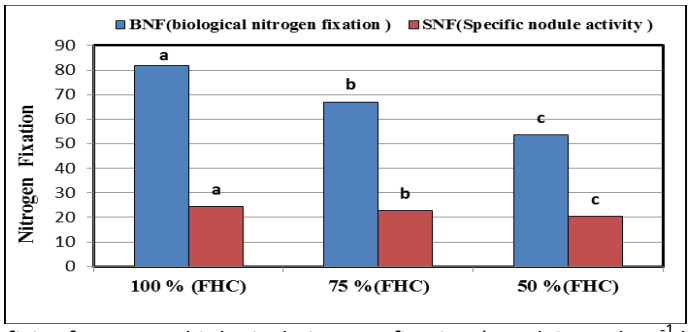

Fig. 1. The influence deficit of water on biological nitrogen fixation (umol C_2H_4 plant^{-1} h^{-1}) and specific nodule activity (umol C_2H_4 g^{-1} nodule h^{-1}) in soybean.

Application of organic compost improved both of biological nitrogen fixation and specific nodule activity compared with control (mineral fertilizer) of soybean plants (Fig. 2). Compost could be involved in regulation of plant gene expression, protein functions, constitution of a number of vitamins that having a strong antioxidant potential and/or enzymatic cofactors (Marschner, 2012; Asensi-Fabado and Munné-Bosch, 2010). Compost implementation improved growth and N-percent of plants and could be led to significant improve in N content and productivity of peanut under sandy soil condition (Abdel-Wahab et al., 2006). Compost application significantly increased the tolerance against drought stress in soybean (EL Sabagh et al., 2015a; EL Sabagh et al., 2016a) and in maize (Abd el-wahed et al., 2015).

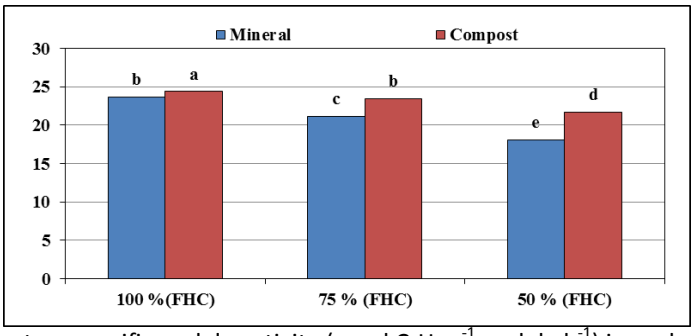

Fig. 2. Effects of compost on specific nodule activity (umol C_2H_4 g^{-1} nodule h^{-1}) in soybean under water stress conditions.

4. Conclusion

In conclusion, our study demonstrates that, water deficit stress significantly decreases biological nitrogen fixation and specific nodule activity than control conditions. As the results indicate that compost application could help in improving nitrogen fixation in soybean.

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