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Copper and Compost Induced Sweet Potatoes Production in Sandy Soil

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Abstract: *Compostincreases nutrients holding capacity in sandy soil through increasing soil health. To examine the effects of compost-and copper (Cu)-inducedsweet potato production, different plants parameters of sweet potato were measured. A foliar application of diverse concentrations of Cu (0.0, 0.2, 1.5 and 3.0 ppm) with or without compost were arranged according to the completely randomize design with five replications. Copper application enhanced leaf area, chlorophyll (Chl) content, relative water content (RWC), photosynthesis rate, tuber weight of sweet potato. Copper application increased above parameters regardless of Cu application. Copper concentration at1.5ppm showed improved results compared to the control and other concentrations of Cu. These results indicate that compost and Cumight increase the production of sweet potato in low fertile soil through improving physiological functions of the plants.*
Keywords: *chlorophyll contents, leaf area, relative water content, photosynthesis, tuber*

I. Introduction

Sweet potato (*Ipomoe batatas* L.) is the major crop grown in a tropic area and is a source of protein, vitamin A and vitamin E, in pharmaceutical, paper and textile industry (Truong, 1989). The production of the sweet potato decreased due to the poor soil quality such as degradation of the land, mineralization of organic matter, crop removal and high rainfall (IITA, 1995).The application of the manure and fertilizers significantly improve the growth and yield of sweet potato (Salawu and Mukhtar, 2008).Compost is a good source of organic fertilizer for different essential plantnutrients (Franklin, 1998) to be added in soil and sustain crop yields (Chelah et al., 2011).Previous results confirms that organic matter manage low fertile soil for sustainable crop production (Nyamangara et. al., 2003) through improving soil health (Laird et al., 2001; Chelah et al., 2011). Compost on the other hand drops soil-borne diseases,soil pollution and improvenutrients holding capacity(Nyamangara et al., 2003).

Copper controls photosynthetic rate and electron transport chains in the respiratory system and cell wall metabolism (Yruela 2009), signalling mechanism, iron mobilization and phosphorylation in the cells of plants (Yruela 2005). Higher concentration of Cu inhibits plant growth and proteins activity (Morelli and Scarano 2004) which optimize concentrations increase plant growth and development (Verma*et al.* 2011; Syuhada et al., 2014). Lower and higher copper lowers photosynthesis and respiration rate as well as young leaves and defective of reproductive organ (Yruela, 2005; Syuhada and Jahan, 2016).

The earlier report showed that compost improved sandy soil health to sustainriceproduction (Chelah et al., 2011).To date, there is no information on the effects of compost- and Cu-inducedthe production of sweet potato in sandy soil. Therefore, the present study concentrated to justify the effectiveness of compost and Cu on sustains sweet potato production. We showed that compost increased Cu-induced sweet potato productionby way of enhancing physiological functions of the sweet potato plants.

II. Materials and Methods

Experimental Set up

The sweet potato(*Ipomea batatas L.*)variety of VitAto was used for this experiment.Four Cu concentrations (0, 0.2, 1.5 and 3.0 ppm) were applied to the sweet potato plantswith or without compostcondition. Treatments were arranged according to thecompletely randomize design with five replicates.Compost was mixed with the sandy soil and stabilizes for two weeks before planting of vines. The prepared land was constructed into beds where vines were planted in a distance of 30 cm between two veins. Inorganic fertilizers such as nitrogen (100 kg) phosphorous (90 kg) and potassium (200 kg) per ha were applied according to the guidelines provided by the Department of Agriculture, Malaysia. During tuber development, a 300 kg of NPK blue (12:12:17 + TE) was appliedto boost tuber production.

Determine of Parameters

A LP-80 leaf area meter was used to measure the leaf area of sweet plants (Jahan et al., 2014). Relative water content of leaves was estimated as per previous studies (Jahan et al., 2013, Khairi et al., 2015a). Detached leaves were measured for a fresh weight (FW) then incubated in distilled water for 24 hours. The leaves were dabbed dry using soft tissue paper then measure the turgid weight (TW) followed by the dry weight after leaves were oven driedin an oven at 65^0C for 24 hours. The following formula of RWC (%) = [(FW-DW) / (TW-DW)] x 100 was used to calculate relative water content (RWC) of leaves sweet potato. Moisture contentsof tuber weremeasuredas per the previous method (Abdulkadir et al., 2016). The following formula was used to calculate the moisture contents of tuber.

Percentage Moisture = $\{(W_2 - W_3) x\ 100\} \times (W_2 - W_1)$

Where W_1 = weight of empty crucible (g); W_2 = weight of crucible + sample prior to drying (g) and W_3 = weight of crucible + sample after drying (g).

A portable SPAD chlorophyll meter was used to determine chlorophyll (Chl) contentof leaves as per previous study (Jahan et al., 2014).A portable gas exchange fluorescence system (CI-340 Handheld Photosynthesis System) was used to measure the net photosynthesis rate (pn; µmol/m2/s)of plants (Khairi et al., 2015b; Munirah et al., 2015a). Measurements were taken between 11:00 am and 1:00 pm to avoid the wetness condition on leaves with five replicates. Yields as tuber weight were estimated using a weighting balance. Proper agronomic practices were taken as per previous studies (Sarwar et al., 2004, Sarwar and Khanif, 2005a). Data were analysed by the ANOVA procedure and differences of mean among treatments wereanalysed by the Minitab version-16 software. Differences at P value <0.05 was considered significant.

III. Result

Effects of compost and Cu on leaf area of sweet potato plants

Leaf area of sweet potatoes gradually increased with increasing Cu concentration until at the 1.5 ppm concentration (Fig. 1; closed bars).But Cu at 3.00 ppm showed a similar of effect on leaf area as compared to the 1.5 ppm of Cu concentration. Figure 1 also shows that leaf area of the compost-treated sweet potato plants increased significantly compared to the compost-untreated plants (Fig. 1; open bars). In addition, compost-induced leaf area of sweet potato plants was similar regardless of Cu treatment. Similar results were observed when compost and Cu were applied together. This result confirmed that compost application increased leaf area regardless of Cu application.

Effects of compost and Cu on chlorophyll contents of leaves

Chlorophyll content is related to the light antenna complexes in photosystem II (Jahan et al., 2016) and the net photosynthesis rate in leaves of plants (Munirah et al., 2015b; Syuhada et al., 2014). Cu application gradually induced Chl content in leaves of sweet potato plants with increasing Cu concentration (Fig.2; open Square). In addition, Cu application significantly increased Chl content compared to the control treatment. This result was consistent with the previous study (Syuhadah and Jahan, 2016). Compost-treated Chl contents increased significantly regardless of Cu treatment but a similar trend of Chl content was observed in both Cu and compost conditions. In addition, under 1.5 and 3 ppmCu conditions, compost did not show any effect on Chl content. These results indicate that compost might increase Chl content in leaves throughmodulatingthe function of physiological activity in plants.

Effects of compost and Cu on relative water content of leaves and moisture content in tuber

Figure 3 demonstrates compost- and Cu-induced RWC of leaves and moisture content of tuber of sweet potato plants. Copper increased RWC of leaves with increasing Cu concentration. Likewise, compost increased RWC of leaves of Cu-untreated and -treated sweet potato plants. But Cu-treated plants accumulated higher RWC in leaves than that of Cu-untreated plants in the presence of compost (Fig. 3, bar graphs). Moisture contents in tuber, on the other hand, under different treatments were similar to the RWC of leaves. These results indicate that compost and Cu increased water content in leaves and tuber but compost enhanced Cu-induced water content in leaves and tuber (Fig. 3, line graphs).

Effects of compost and Cu on photosynthesis rate

Figure 4 displays compost and Cu induced net photosynthesis rate of leaves of sweet potato plants. Low concentration of Cu (0.2 ppm) treatment increased net Pn rate of leaves compared to the control and higher Cu concentration (3 ppm of Cu; Fig. 4; closed bars). This result suggests that Pn rate might show adose-dependency to Cu concentration. In addition, compost application not ably enriched Pn rate of leaves of Cu-untreated plants as well as in Cu-treated plants (Fig. 4a; open bars). This result indicates that compost application in sandy soil might improves oil health, therefore Pn rate increased to induce production.

Effects of compost applicationonCu-induced weight of tuber

Whether composting affects Cu-induced sweet potato production, we measuredthe weight of tuber after harvested of the tubers. Figure 5a shows that 1.5 concentration of Cu application significantly increasedweight of tuber compared to the control but similar to 3 ppm Cu application. In addition, compost application significantly inducedweight of tuber regardless ofCu treated plants (Fig. 5; under 0 ppm of Mn). These results indicate that compost-induced production oftuber was not affected bythe different concentrationsof Cu(Fig. 5).Weight of tuber was consistent with physiological functions of the plants. This result suggests that compost andCu increased corn production in low fertile soil.

IV. Discussion

Sandy soil has high percentage of sand which lowersthe water and nutrients holding capacity in soil to inducea detrimental effectfor most field crops.On the other hand, compost improves structure of sandy soilstomaintain nutrients availability from where plants absorb nutrients.Good compost contains essential plant nutrients at different concentrations to be used by the plant as well as improve plantgrowth (Rosen & Bierman, 2005) and soil health (Chelah et al., 2011). Soil water condition affects Cu in soil solution (Sarwar and Khanif, 2005b).This studyshowed that compostand Cu both significantly increased the area of leaf of sweet potato plants (Fig. 1). This result indicates that application of Cu and compost improved physiological and soil function, respectively. In this connection, the Chl content increased in leaves of Cu-treated sweet potato plants (Fig. 2). Increasing Chl content in leaves indicates of higher photosynthesis production in plants, which might increase physiological functions in plants (Jahan et al., 2014, 2016).Chlorophyll content is associated with the GSH accumulation in plants and light-dependent physiological functions in the plants (Nozulaidi et al., 2015, Inani et al., 2015; Munirah et al., 2015b). These results indicate that light related parameters are regulated by the Chl function in leaves to maintain the growth of the plants. Low fertile soil affects CO_2 assimilation in leaves that shrink Chl contents in leaves to regulatethe productivity of crops (Sheela and Alexander, 1996; Chelah et al., 2011). Above results showed consistent with this study that accumulation of lower level of Chl content in plants under sandy soil (Fig. 2). In addition compost application increased Chl content was irrespective to the Cu application (Fig. 2). This result indicates that the health of sandy soil might be improved due to the application of compost at least at the character ofwater holding capacity of soil. Increment of Chl content in leaves of compost-treated plants indicates of higher GSH accumulation that might improve physiological functions of plants (Jahan et al., 2011 and 2014).

Water levels (Khairi et al., 2015b; 2016), salinity (Nozulaidi et al., 2015), nutrients andsandy soil(Syuhada and Jahan, 2016; Inani et al., 2015; Munirah et al., 2015a)shake RWC of leaves of plants. Fig 3 demonstrates that application of Cu and compost enhanced RWC in leaves and moisture content of sweet potato. This is the indication of improvingthe health of sandy soil with the coordinationof the application of compost in sandy soil. Leaf-low-water causes considerable fluctuations of the transformation of the light energy in photosystems (Kameli & Losel, 1993) which might enhance physiological functions of the plants. In this relation, the photosynthesis rate in leaves of plants increased in the presence of compost (Fig. 4) and consistent with previous study (Berkowitz, 1998) might improvethe transpiration rate (Mukhopadhyay et al. 2013) and cell membrane integrity (Richardson et al. 1993). The application of compost increases microbial activity,nutrients concentration to sustainyield of production (Tejada and Gonzalez, 2003). Finally, Cu and compost applications increase the production of weight of tuber and 1.5 ppm of Cu with compost show better result.In conclusion, compost might improve the soil health and Cu increased physiological functionsthat together sustain yield of sweet potato plants in sandy soil.

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Figure Legend

Fig. 1 Effects of different concentration of Cu onarea of leaf of compost (open bars)-treated and compost (closed bars)-untreated sweet potato plants. Error bars represents standard deviation with 5 replicates.

Fig. 2 Effects of different concentration of Cuon chlorophyll content of leaves of compost (open square)-treated and compost (open triangle)-untreated sweet potato plants. Error bars represents standard deviation with 5 replicates.

Fig. 3 Effects of different concentration of Cu and composton relative water content in leaves (bad graphs) and moisture content of tuber (line graphs) of sweet potato plants. Error bars indicate standard deviation with 5 replicates.

Fig. 4 Effects of different concentration of Cu and composton photosynthesis rate of leaves of sweet potato plants. Error bars indicate standard deviation with 5 replicates.

Fig. 5 Effects of different concentration of Cu and composton weight of tuber of sweet potato plants. Error bars indicate standard deviation with 5 replicates.

Figure 1

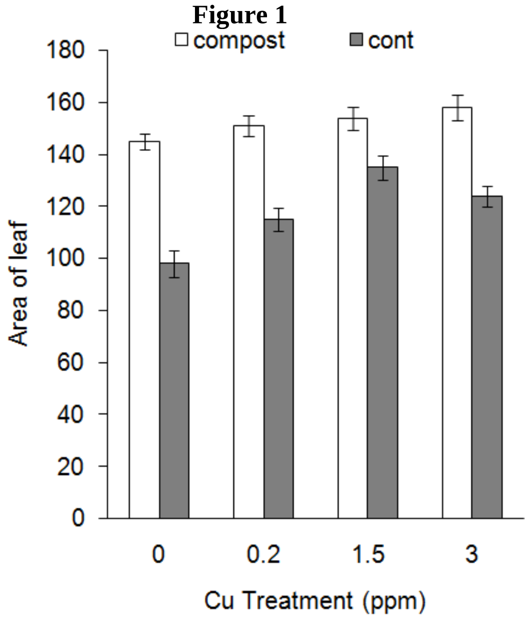

Figure 2

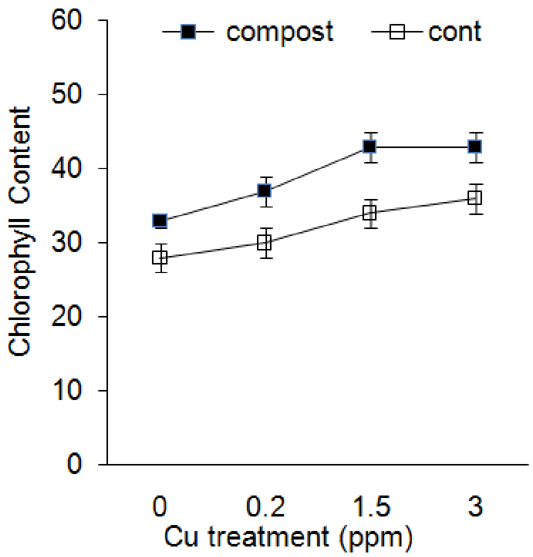

Figure 3

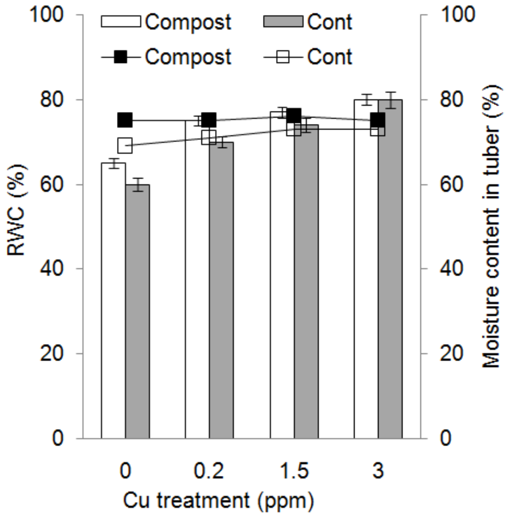

Figure 4

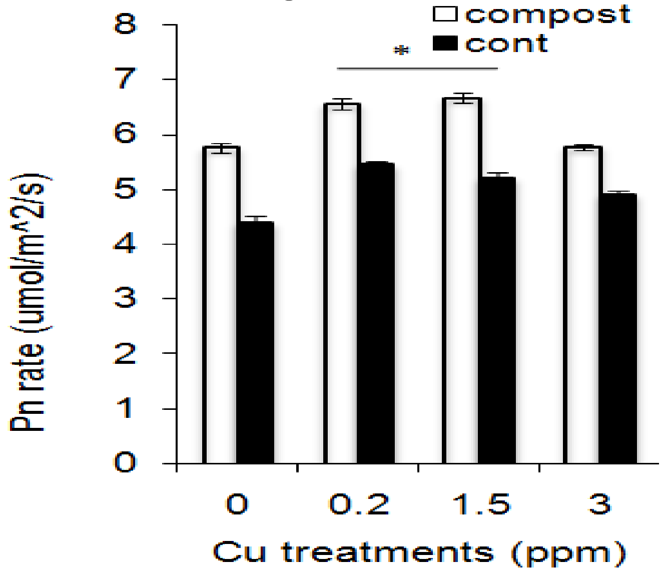

Figure 5