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Effect of humic acid organic fertilizer on growth and yield of sticky maize (*Zea mays*) in Central Vietnam

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ABSTRACT

The aim of this study was to investigate the effects of application of humic acid organic fertilizer (Hop Tri Super Humic - 95.0%) on the growth and yield of sticky maize plants. Field experiment was conducted in spring summer season of 2019 in Central Vietnam. Four different doses of the fertilizer (0, 2, 4. 6 kg/ha) were applied to the soil. Growing time, plant height, ear length, number of leaves per plant, ear leaf area, ear size, yield and its components were investigated. The results indicated that application of Hop Tri Super Humic fertilizer had a positive effect on all the mentioned parameters across the fertilizer levels. The highest yield of 6.95 t/ha was obtained under 4 kg humic acid organic fertilizer treatment. Based on this outcome, use of Hop Tri Super Humic organic fertilizer @ 4 kg/ha was found an optimal dose as a nutrient supplement for obtaining higher growth and yield of sticky maize grown in Central Vietnam.

Key words : Humic acid, organic fertlizer, sticky maize, yield

INTRODUCTION

Maize (*Zea mays* L.) is the third important cereal crops as food crop in the world (Chaudary, 1994) and a cash crop in Vietnam. Its potential could not be utilized fully due to lack of proper agronomic management practices like nutrient management, season and suitable variety (Jang and Kuk, 2018; Shrestha *et al.*, 2018; Suresh Kumar and Bardhan, 2018). There are many factors that affect the maize production but soil nutrient deficiency is the main factor (Bilal *et al.*, 2016; Bayat *et al.*, 2019). The use of chemical fertilizer is the quickest and surest way of boosting crop production, but their continuous use alone is not able to sustain the maize yield (Jasim and Al-Saeedi, 2018; Suresh Kumar and Bardhan, 2018).

Humic acid is a major component of humic substance. Humic matter is formed through the chemical and biological humification of plant and animal matter and through the biological activities of microoganisms. Humic acid has a positive impact on the growth of plant roots. Applying humic acid to the soil enhanced root initation and increased root growth and development (Pettit, 2004; Eyheraguibel *et al.*, 2008; Fahramand *et al.*, 2014). Humic acid promotes good soil structure and increases the water holding capacity of the soil. Biologically, it enhances the growth of useful soil organisms (Fahramand *et al.*, 2014). Masciandaro *et al.* (2002) indicated that humic subtances might have counteracted with abiotic stress conditions e.g., un-favourable temperature, pH and salinity which enhances the uptake of nutrients and reduces the uptake of some toxic elements. Therefore, humid acid effects on plant physiology are mainly positive and thereby enhancement of yields (Ayuso *et al.*, 1996; Arancon *et al.*, 2006).

Previous studies indicated increased maize production through application of humic acid organic fertilizers at different rates along with different amounts of inorganic fertilizers (Ahmad *et al.*, 2013; Azeem *et al.*, 2014; Bilal *et al.*, 2016). The objectives of this study were to determine the effect of humic acid organic fertilizer on the growth, development and yield of sticky maize. The research results may provide a full understanding of use of organic fertilizer for sticky maize production in Central Vietnam.

MATERIALS AND METHODS

The field experiment was conducted in

spring - summer season from 7 March to 22 May, 2019 at Huong An Commune, Huong Tra town, Thua Thien Hue province, Central Vietnam (N16^{0}28'; E107^{0}30) with four application levels with 0, 2, 4, 6 kg/ha of humic acid organic fertilizer named Hop Tri Super Humic. Concentration of humic acid in Hop Tri Super Humic fertilizer was 95.0%. The experiment was conducted using randomized complete block design (RCBD) with five replications. The area of each plot was 20.0m^2 (5.0m × 4.0m). The sticky maize variety Milky 36 was individually sown in rows keeping spacing of 27 x 30cm. The weather parametters of the experiment period were daily recorded with an ATMOS-41 complex weather station (max temp: 41°C; min temp: 20°C; aveg temp: 29.2°C; rainfall: 48.6mm; rainy day: 12 days; huminity: 83.7%; solar radiation: 22.5 MJ/m^2; mean wind: 2.8 m/s).

Fertilizer for the experiment was applied following the recommended dosage used by local farmers such as 90 kg N/ha as urea, 60 kg P_2O_5/ha as superphosphate and 60 kg K_2O/ha as potassium chloride, and added Hop Tri Super Humic organic fertilizer with four levels as described above. The whole amount of P_2O_5 was applied as basal. The remaining fertilizers were applied as top dressing in three splits of equal amount of N, K_2O and Hop Tri Super Humic organic fertilizer. First split of $^1/_3$ dose of fertilizers was applied at third leaf stage, 2nd split of $^1/_3$ dose at seven leaf stage and remaining 3rd split of $^1/_3$ dose was applied at tasselling stage. The fields were irrigated and weeded thrice at the time of top dressing of fertilizers. No chemical pesticide was applied on the field.

Five plants in each plot were randomly selected for recording observations on agronomic traits. Plant height was determined at tasselling stage by measuring the length from the soil surface to the tip of the longest tassel. These randomly selected five plants were harvested for recording the number of leaves per plant, length and diameter of ears, total growth time, yield components and yield.

Data were analyzed using Statistix 10.0 (Analytical Software, Tallahassee, FL, USA). To compare the differences in agronomic traits and yield among treatments, one-way ANOVA was used. In all cases, $P < 0.05$ was considered to be significant.

RESULTS AND DISCUSSION

Plant Growth

The growth of crop plants is depending on cultivar, season, environmental conditions and field practices. In particular, cultivar is the decisive factor to a total growth time of plant. This indicator helps farmers to arrange a proper crop calendar to avoid unsuitable conditions and to meet market's requirement. Table 1 show that total growth time of the sticky maize was different among treatments. The total growth time of the sticky maize was ranged between 74 and 76 days, with 1 to 2 days shorter in the humic acid organic fertilizer treatments compared to control. Balbaa and Awad (2013) reported that humic acid application resulted in decrease in days to tasselling and days to silking of maize, caused decrease in total growth time. However, days to silking of maize plants were significantly longer when applied humic acid with high levels as reported by Azeem *et al.* (2014).

Humic acid application with differnt levels had significant effect on plant height and ear length of the sticky maize (Table 1). The plant treated with the humic acid organic fertilizer had higher plant height than that of under control treatment. Plant treated with high levels (4 and 6 kg/ha) of the humic acid organic fertilizer was highest in both plant

Table 1. Effect of humic acid organic fertilizer on growth of stricky maize

Treatment (kg/ha)	Total growth time (days)	Plant height (cm)	Ear height (cm)	No. of leaves/ plant	Ear leaf area (cm^2)
0	76	172.0^a	87.9^a	12.3^a	647.6^a
2	75	193.4^b	95.9^b	13.7^{bc}	722.6^{bc}
4	74	215.6^c	111.1^c	13.5^b	720.8^{bc}
6	75	209.8^c	108.4^c	13.9^c	765.4^c
LSD (P=0.05)	-	11.72	7.67	0.31	65.18

Figures in a column followed by the same letter are not differed significantly.

Table 2. Effect of humic acid organic fertilizer on yield and its component of stricky maize

Treatment (kg/ha)	Ear length (cm)	Ear diameter (cm)	No. of rows in a ear	No. of seeds in a row	1000-seed weight (g)	Seed yield (t/ha)
0	15.9[a]	4.3[a]	15.0[a]	26.8[a]	280.7[a]	5.08[a]
2	17.6[b]	4.4[a]	15.3[a]	27.4[bc]	293.6[b]	5.58[a]
4	19.3[c]	4.8[c]	16.8[b]	29.6[c]	304.6[b]	6.95[b]
6	18.9[bc]	4.7[bc]	16.0[ab]	28.5[ab]	292.4[ab]	5.85[ab]
LSD (P=0.05)	1.43	0.23	1.26	1.17	12.28	7.99

Figures in a column followed by the same letter are not differed significantly.

height (215.6 and 209.8cm) and ear height (111.1 and 108.4 cm). These results are in agreement with the results of some other authors who have also reported that humic acid organic fertilizer significantly affected maize plant height (Daur and Bakhashwain, 2013; Suresh Kumar and Bardhan, 2018) and ear height (El-Shafey and El-Dein, 2016).

The number of leaves of maize plants ranged between 12.3 and 13.9 leaves/plant and the ear leaf area ranged between 647.6 and 765.4cm^2. The higher number of leaves and ear leaf area were obtained by the humic acid organic fertilizer treatments (Table 1). Daur and Bakhashwain (2013) reported that the application 25 kg/ha of humic acid to saline soil improved leaf number and leaf area. However, in one of the recent study it was observed that the additional application 5, 10 and 15% humic acid to acid soil did not increase the number of leaves and green leaf area significantly compared to the application of NPK fertilizer (Wulandari *et al.*, 2019). Therefore, the response of humic acid might be depending on soil properties.

Yield and its Components

Yield is a main trait targeted to improve crop productivity; therefore, it was the key trait used to evaluate the performance of maize in response to fertilizers. Fertilization increases maize yields indicated that local farmers may adopt to use recommended fertilizer doses for obtaining higher yields of maize in central Vietnam. The ear length, ear diameter, number of rows per ear, number of seeds per row, 1000 seed weight and seed yield were significantly affected by the humic acid organic fertilizer (Table 2). The seed yields obtained were 6,95, 5.85 and 5.58 t/ha with the application of 4, 6 and 2 kg/ha humic acid organic fertilizer, respectively . The lowest seed yield of 5.08 t/ha was recorded under control where no humic acid organic fertilizer was applied. These observations are consistent with the findings of other researchers (Balbaa and Awad, 2013; Daur and Bakhashwain, 2013; Azeem *et al.*, 2014; Bilal *et al.*, 2016; Wulandari *et al.*, 2019) who demonstrated that humic acid application had a positive effect on seed yield of maize.

CONCLUSION

It is concluded that humic acid organic fertilizer named 'Hop Tri Super Humic' had a positive effect on the growth, development and yield of sticky maize. Application of 4 kg/ha humic acid organic fertilizer was found optimal for obtaining higher growth and yield of maize. On the basis of these results it may be recommended that farmers of Central Vietnam can use 'Hop Tri Super Humic' fertilizer as a nutrient supplement for sticky maize production.

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