Synthetic nanozeolite/nanohydroxyapatite as a phosphorus fertilizer for German chamomile (Matricaria chamomilla L.)

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Some regular P fertilizers are less effective in supplying the nutrient P. Thus, a greenhouse experiment was carried out to assess the fertilizing effect of synthetic nanozeolite (nCP)/nanohydroxyapatite (nHA) on agro-morphological characteristics, Chamanzule and phosphorus up take of chamomile (Matricaria chamomilla L.). Treatments consisted of (A) control, (B) saturated nano zeolite with ammonium sulfate (nCP-NH₄⁺), (C) rock phosphate (RP), (D) saturated nano zeolite with ammonium sulfate plus rock phosphate (nCP-NH₄⁺ + RP), (E) nanohydroxyapatite(nHA), (F) saturated nano zeolite with ammonium sulfate plus nanohydroxyapatite(nCP-NH₄⁺ + nHA) (G) triple superphosphate (TSP) (H) saturated nano zeolite with ammonium sulfate plus triple superphosphate (nCP- NH₄⁺ + TSP) were applied in this study. The nanohydroxyapatite (nHA) particles, with diameters of 25–50 nm, were produced by wet chemical process, in order to compare its ability in P solubility with that of a natural fertilizers (as Triple Superphosphate (TSP) and rock phosphate (PR). The results revealed that application of both nCP/nHA particles and conventional P fertilizer (TSP) could enhance the growth of chamomile. Both CP-NH₄⁺ + nHA and CP-NH₄⁺ + TSP showed the highest mean values for most of the measured traits including plant height, branch number, sub-branch number, Chamanzule, flower number, soil, root and shoot phosphorous content, flower fresh and dry weight, and also shoot fresh weight and dry weight. On the contrary, no significant differences were observed among applied treatments regarding total nitrogen content and sulfate. The overall results point out that using nCP/nHA as a new class of P fertilizer can potentially enhance agronomical yield and reduce risks of water eutrophication.

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1. Introduction

According to the World Food Organization (FAO) applying chemical fertilizers is the most important factor toward increasing global agricultural production in the past three decades. It is stated that out of 3900000 tons increase in demand of P₂O₅ between 2014 and 2018, 58 percent is belongs to Asia, 29 percent to America, 9 percent to Europe, 4 percent to Africa and finally 0.5 percent to Oceania (Lin et al., 2013; FAO, 2015). Although it is established that the amount of total P in the soil is relatively high, its availability to plants is often low (Mahanta et al., 2014; Smith et al., 2011). The difficulty in increasing P availability is due to the strong interaction of phosphates with many inorganic and organic soil components (Driessen et al., 2001). In calcereous and alkaline soils, phosphate is usually associated with Ca²⁺ in apatite minerals so that it generates an insoluble form of phosphate (Aziz et al., 2006). Phosphate rock (PR) is the precursor of many P fertilizers, since there are many natural resources and mines worldwide. PR effectiveness as a fertilizer by its very low solubility is limited (Hamdali et al., 2008; Meck et al., 2010; Koppelaar and Weikard, 2013) which is due to large size of these particles and thus restricting phosphate from reaching the root plants (Liu and Lal, 2014). On the other hand, water soluble P fertilizers are easily dissolved in the soil solution and it would be easily available to the plants. Overuse of phosphorus fertilizers cause occurrence of surface water pollution and eutrophication (Fageria, 2009). To resolve this problem, modifiers, such as zeolites, have been recently added to P fertilizers (Bernardi et al., 2010). Liu and Lal (2014) reported the impact of nanohydroxyapatite (nHA) as a new class of P fertilizer to enhance the growth and yield of soybean (Glycine max) through a greenhouse study (Liu and Lal, 2014). Furthermore, Jiang et al. (2014) stated that the only way of passing nHA through cell membrane in to the cytoplasm to inhibit the