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Corn straw mulching affects *Parthenium hysterophorus* and rhizosphere organisms

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ABSTRACT

In a previous study, straw mulching (SM) significantly affected the soil microbial environment, and weed composition and biomass. We hypothesized that corn SM may effectively control *Parthenium hysterophorus*. The growth traits, and the physico-chemical and microbiological properties of rhizosphere soils around *P. hysterophorus* were analyzed in 2014 and 2015. Compared to the control, plant emergence, biomass, plant height, leaf numbers, leaf area index, and flower and seed numbers significantly decreased in the SM treatments. Flowering time was delayed by 5–11 days, pH was slightly reduced, and organic matter and available N/P/K increased in the rhizosphere. The number of culturable bacteria fell slightly during plant emergence, but bacteria levels increased significantly during flowering. Nitrospira and Actinobacteria dominated the microbial communities and their composition ratio increased under SM. The results suggest that SM affects rhizosphere microbial community composition, and the emergence and growth of *P. hysterophorus*.

1. Introduction

P. hysterophorus is an aggressive annual weed, and has an allelopathic effect on other plants that can cause severe crop yield losses (Adkins and Sowerby, 1996; Tamado et al., 2002). It was originally thought to be spreading across tropical countries (Tamado et al., 2002). However, over recent years, it has invaded diverse climatic and biogeographic regions in more than 40countries across five continents (Bajwa et al., 2016), such as North America, Africa, Australia, and Asia (Dhileepan, 2007). In China, *P. hysterophorus* was first discovered in Yunnan Province in 1926, and it now occurs in many mainland provinces, such as Guizhou, Guangxi, Guangdong, Fujian, Jiangxi, Jiangsu, and Shandong Provinces (Zhu et al., 2005). It is an invasive plant and could pose a direct threat to biodiversity and crop yields in Shandong Province, which is the highest latitude that *P. hysterophorus* is found in China (Gao et al., 2013).

In China, nearly 750 million metric tonne of straw is produced per year. However, the vast majority cannot be used in a reasonable and efficient way (Wu et al., 2009). Burning straw is a waste of resources, pollutes the environment, and causes direct damage to the soil ecosystem, such as decreasing the soil organic microbial levels (Neary et al., 1999; Neff et al., 2005), which can result in reduced crop yields. However, rice SM decreased *Myzus persicae* landings, increased plot temperatures, and improved the vegetative growth of kale plants (Silva-Filho et al., 2014). These benefits were related to weed control (Anzalone et al., 2010). Previous reports have shown that SM can significantly reduce weed density, change field weed dominance, improve the field soil microbial environment, and affect the field weed community composition and biomass (Anzalone et al., 2010; Ghosh et al., 2006; Munguia-Lopez et al., 2000; Wu et al., 2009).

The rhizosphere microbiome, which contains a large diversity of microorganisms, directly interacts with target plants, which means that it plays an important role in plant immunity, nutrient acquisition, and adaptation (Jones et al., 2009; Richardson et al., 2009; Ronald and Shirasu., 2012; Van Wees et al., 2008). Rhizosphere communities associated with plant and weed interactions (Jothibasu et al., 2012) play an important role in herbicidal activity and plant tolerance to glyphosate (Johal and Rahe., 1984; Schafer et al., 2012). They affect weed growth and are important when formulating overall weed management strategies (Li and Kremer., 2000). The objective of this study was to investigate the effect of corn SM on *P. hysterophorus* growth and its rhizosphere microorganism community composition.

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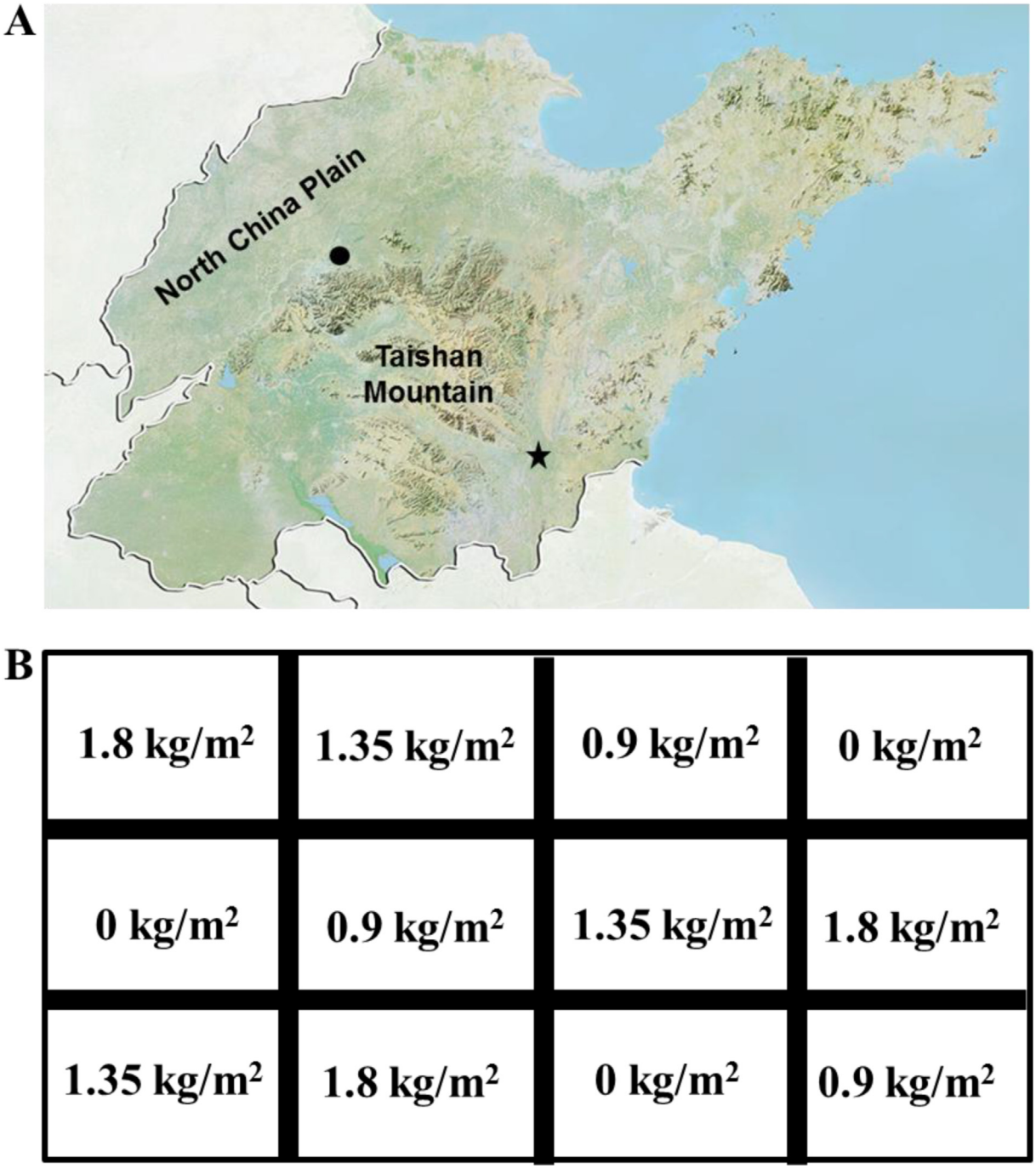

Fig. 1. Location of the study area and the experimental schematic.
(A)Location of the study area. • indicates the test site; ★indicates the seed collection site.
(B)Experimental schematic shows that plots with different amounts of corn straw mulching.

2. Materials and methods

2.1. Location and experimental treatments

P. hysterophorus seeds were collected in Junan County (119°91E′, 35°16N′), Shandong Province, China, where *P. hysterophorus* has invaded cropland, vegetable fields and wasteland in recent years. The experiments were conducted in 2014 and 2015 on an experimental farm in Jinan City (117°08 E′, 36°71 N′) (Fig. 1A). The distance between the experimental sites and the weed collection site was about 200 km and Taishan Mountain acted as a barrier between the two places.

The soil at the experimental farm is a poorly drained, light sandy loam with a pH of 7.9. The corn straw was mechanically broken into 3–5 cm pieces. The air temperature and rainfall data from the experimental field are shown in Fig. 2A. There was relatively little rainfall during April (four weeks after sowing) in 2014 and 2015, which lowered precipitation by 48.0% compared to the long-term average. However, precipitation increased by 9.6% during the later growth stages. Fig. 2A also shows the air temperature during the study period. The weekly air temperature ranged from 18.3 to 29.1 °C. However, the average air temperature in the first three weeks after sowing was 20.4 °C, which was 4.7% lower than the long-term average, but from the fourth week, there was no significant difference in average air temperature compared to the long-term average.