EFFECTS OF DEGRADABLE MULCHING FILM ON SOIL TEMPERATURE, SEED GERMINATION AND SEEDLING GROWTH OF DIRECT-SEEDED RICE (*ORYZA SATIVA* L.)

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Abstract. The effect of degradable mulching film on dry direct- seeded rice remains largely unknown. Then the aim of this research is to investigate the effects of degradable mulching film on dry direct-seeded rice. A field investigation of four treatments (CK: non-mulching; MF1: a degradable film (Shanghai Hongrui Biotech, Shanghai, China); MF2: a degradable film (Xifeng Plastic Corp. Ltd., Baishan, China); MF3: common agricultural mulching film (Jialiming New Material Corp Ltd., Hinggan League, China)) was conducted to evaluate the effects of degradable mulching film on the rice seed germination, seedling growth, soil temperature, and grain yield of dry direct-seeded rice. The results showed that compared to CK, mulching film treatments increased soil temperature, especially at night time, improved seed germination rate, plant height, leaf area of seedlings, and grain yield. MF1 showed good degradation performances and had the highest soil temperature at the night time of 13.65 ℃ - 14.08 ℃, grain yield at 7.938t ha^{-1}, and seedling growth with shoot dry mass at 46.73 mg $plant^{-1}$ and root dry mass at 31.34 mg $plant^{-1}$. The germination rate significantly increased by 6.99%-755.60% at MF1 as compared to CK. Overall, mulching films resulted in high yield due to the increasing soil temperature, seedling germination, and improving seedling growth, amongst MF1 performance the best.

Keywords: *hill-drop drilling, grain yield, degradation progress, leaf area, root to shoot ratio*

Introduction

Mulching film in the field provided a suitable microclimate for crop growth (Diaz-Perez et al., 2009; Namaghi et al., 2018; Zhang and Miles, 2020), enhanced the disaster resistance ability of crops and ultimately increased crop production (Bu et al., 2013; O'Loughlin et al., 2017; Deschamps et al., 2019). The use of plastic film mulching allows for an early seeding date and a shortened germination time and increases the germination rate and the emergence rate, and achieves water-saving effects (Li et al., 2013; Biswas et al., 2015; Cosic et al., 2017). Especially, dry direct-seeded rice with mulching film could improve water utilisation rate, inhibit weeds growth, and improve soil temperature after sowing, which were conducive to high and stable yield (Towa et al., 2013; Fawibe et al., 2020). Traditional mulching film is polyethylene (PE), its application has caused environmental pollution and affected the food safety (Chae et al., 2018; Boots et al., 2019;

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Effects of small ridge and furrow mulching degradable film on dry direct seeded rice

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Global climate change and socio-economic development have led to a shortage of water and labour resources, which has had a significant impact on rice cultivation. In this study, the application of micro-ridge-furrow planting technology and degradable film mulching in dry direct-seeded rice was investigated to address the factors restricting the development of the rice industry and reduce the impact of rice production on the environment. The effects of a micro-ridge-furrow planting pattern and degradable film mulching on soil temperature, seedling growth, and yield of dry direct-seeded rice in a semiarid region of China were studied through three field experiments: micro-ridge-furrow mulching with traditional plastic film (T1); micro-ridge-furrow mulching with degradable film (T2); and traditional flat-cropping mulching with traditional plastic film (CK). The experimental results demonstrated that the micro-ridge-furrow mulching film planting pattern promoted the germination of rice seeds and improved the soil temperature, plant height, leaf area, dry mass, and grain yield. T2 had the highest average soil temperature (14.68–17.83 ℃ during the day; 14.4–15.74 ℃ at night), leaf area (41.85 cm^2 $plant^{-1}$), root dry mass (45.32 mg $plant^{-1}$), shoot dry mass (58.46 mg $plant^{-1}$), root–shoot ratio (0.821), and yield (8.112 t ha^{-1}). In summary, the micro-ridge-furrow mulching with degradable film (T2) is recommended as an efficient planting and mulching pattern for sustainably solving environmental problems and improving grain yield in semiarid regions of China.

Rice (*Oryza sativa* L.) is a species of herbaceous rice, also known as Asian Cultivated Rice. Rice, wheat, and maize are the world's three most important food crops, with nearly half of the global population dependent upon rice[1]. According to the United Nations' Food and Agriculture Organization (FAO) statistics, there are 111 countries in the world that produce rice, and the total harvested area is 159 million ha[2]. Therefore, rice plays an extremely important role in grain production.

Due to global warming caused by greenhouse gas emissions, climate change has caused extreme weather, such as drought and extreme temperatures[1]. It was reported that in 2018, the world experienced 16 cases of drought and 26 cases of extreme temperature, which have affected food safety and fresh water supply[3,4]. Drought is one of the most complex hydroclimatic disasters because its severity is difficult to quantify; its effects include crop yield decrease or failure, famine, and ecological damage[5]. In the United States of America, between 1980 and 2020, drought caused $250 billion in damage and nearly 3000 deaths, making it the costliest and second most serious natural disaster[6]. From the autumn of 2009 to the spring of 2010, a severe drought in southwest China caused drinking water shortages affecting about 21 million people and economic losses of nearly $30 billion[7]. Experts predict that by 2050 more than 27% of the world's major cities, with a total population of 233 million, will exhaust their current water resources[8]. Therefore, reducing greenhouse gas emissions to mitigate climate change and saving water are important ways to achieve sustainable development[3,4].

Rice transplanting is an important conventional process for rice cultivation[9]. However, rice transplanting is not only labour-intensive but also water-intensive[10]. In addition, flooded paddy fields account for 18% of the total methane (CH_4) emission into the atmosphere, which is a major greenhouse gas[4]. Therefore, rice transplanting no longer meets the requirements of modern agricultural development. Experts have predicted that because of global climate change, rice cultivation will be reduced by 51% in the next century, which will threaten food security and sustainable development[4]; therefore, measures must be taken to develop more sustainable rice production. Previous research has found that dry direct-seeded rice can not only save water resources, but also reduce methane emissions by 16–54% compared to rice transplanting[4]; hence, dry direct-seeded rice is an important alternative to alleviate these challenges[11,12]. Dry direct-seeded rice is directly sown in the field, convenient to

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