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研究论文

土壤水分对冬小麦生长后期光能利用及水分利用效率的影响

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摘要 通过控制不同土壤水分条件形成不同的小麦（*Triticum aestivum* L.）群体结构，测定了抽穗到成熟期间小麦冠层光合有效辐射（*PAR*）截获及垂直分布、干物质积累和产量。研究表明，不同处理小麦冠层对PAR的截获量差异较小（小于15.7%），但冠层上部（60~80 cm）的PAR截获量和生长后期PAR转化效率差异明显（100.7%和63.7%），与产量和光能利用效率变化一致，可见土壤水分是通过改变小麦群体内*PAR*垂直分布及*PAR*转化效率对作物产量和光能利用效率产生影响。抽穗到成熟期间维持小麦冠层上部*PAR*截获率在50%左右是实现高产的重要保证。随着土壤水分改善，冬小麦光能利用率和产量持续增加，但水分利用效率却先于二者提前降低，说明改善水分利用效率是提高华北地区农业气候资源利用效率的关键。在底墒充足的条件下，分别在拔节和挑旗期灌水60 mm可获得较高的光能和水分利用效率及经济产量

关键词 土壤水分 冬小麦 冠层结构 光能和水分利用效率

分类号 S512

Effects of Soil Moisture on Radiation Utilization during Late Growth Stages and Water Use Efficiency of Winter Wheat

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Abstract Water stress is a frequent and critical limit to wheat (*Triticum aestivum* L.) production in the North China Plain. It has been shown that photosynthetic active radiation (PAR) has close relation to crop production, and water stress affects the biosynthetic procedure remarkably. However, its mechanism is still not clear. An experiment was conducted at Yucheng ecological station in Shandong Province to investigate the interception and conversion efficiencies of *PAR* in the canopy from heading to maturity stages, and water use efficiency (WUE) of winter wheat at different soil moisture levels. The relationship between soil moisture level and *PAR* vertical distribution in wheat canopy, and its influences on grain yield, PAR use efficiency and WUE were evaluated. Different supplemental irrigation amounts from 0 to 180 mm and timings from jointing to grain filling stages were designed to attain various soil moisture levels, which resulted in different wheat populations and canopy structures. These soil moisture levels showed substantial influences on PAR interception and distributions in canopy from heading to maturity stages, and subsequent *PAR* and water use efficiencies. No great difference (less than 15.7%) in PAR intercepted by the wheat canopies was found between these soil moisture treatments during this period. While great differences in PAR intercepted by the top layer of the canopy (60 – 80 cm) (100.7%) and in PAR conversion efficiency (63.7%) were found between these treatments (Table 4 and Fig.4). This result was mainly caused by the changes in the vertical distributions of leaf area index (Fig.3) and in leaf photosynthesis capability caused by the different soil moisture levels. Maintaining about 50% PAR rate intercepted by the top canopy layer (60 – 80 cm) from heading to grain filling stages is very important for obtaining high grain yield and PAR use efficiency for winter wheat. With soil moisture improving, the PAR use efficiency during the late growth stages and grain yield were increased, but WUE decreased prior to the grain yield and PAR use efficiency (Fig.5), which indicated that improving WUE was essential to increasing other natural resources use efficiency in wheat growing season in the North China Plain. In current conditions with well initial soil moisture, two supplemental irrigations with 60 mm at jointing and booting stages could obtain high grain yield and WUE, and additional supplemental irrigations would not increase grain yield greatly but decrease WUE of winter wheat.

Key words Soil moisture Winter wheat Canopy structure PAR and water use efficiency

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