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学 位 論 文 要 旨
Dissertation Abstract

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学位論文題目：
Title of Dissertation

Development of temporal and spatial sowing methods for increasing soil moisture and yield of upland rice under rainfed conditions in Benin, West Africa
（西アフリカ・ベナンの天水条件下における陸稲の土壌水分および収量増加を目指した時間的・空間的播種技術の開発）

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Rice is an important staple and economical crop in West Africa. However, most of the rice is cultivated in the rainfed environment, where rice yields are low and variable due to various constraints, such as adverse climate conditions and poor water management. Therefore, it is necessary to identify the conditions that cause low yields in rainfed regions and find methods that efficiently utilize the limited rainwater to improve production. The objectives of this study are to identify the differences between low yielding and high yielding farmers in rainfed regions and verify the effects of temporal and spatial sowing adjustment on soil moisture, seedling establishment and yield for improving productivity in rainfed rice.

Farmer interviews and field experiments were conducted between 2015–2016 in Kpakpazoumé, a rural rainfed farming village located in the central region of Benin, West Africa. Interviews were done with 12 randomly selected farmers on management practices such as crop cultivation area, yield and sowing date. The farmers were separated into the low-yielding farmer (LYF, < 2 t ha^{-1}) group and the high-yielding farmer (HYF, ≥ 2 t ha^{-1}) group, and compared for quantitative analysis. Results showed that rice yields positively corresponded with rainfall, and a decreasing trend in average rice cultivation area was seen during the 4 consecutive years from 2013–2016. Compared to HYFs, LYFs significantly reduced their rice area to total farming area, especially in the year following a dry cropping season. LYFs also sowed rice and other crops at a significantly later date.

To verify the effect of sowing dates on yield and soil moisture, a field experiment was conducted with 4 different sowing dates on a LYF and a HYF field in 2015. Sowing rice 3 or 6 weeks earlier than the conventional sowing date resulted in significantly higher yield in both the LYF and HYF fields due to higher soil moisture and terminal drought escape. The

low yield in the LYF field was explained by low soil moisture content, delayed heading, reduced number of spikelets (m^{-2}) and low filled grain percentage.

As a method to retain soil moisture in the plant-root zone, the effect of furrow sowing on emergence and early plant establishment was verified with narrow (width 3 cm) and wide (width 10 cm) furrows compared to conventional sowing under dry and wet conditions on 7–9 fields. Sowing rice in furrows increased soil moisture by 2.5% and emergence rate by 16–25% under dry field conditions. However, the positive effect of the furrow on emergence was only seen in the wide furrow under wet field conditions with soil moisture content higher than 10%. The effect of furrow sowing in a wide furrow (width 20 cm) within a ridge-furrow system on yield and soil moisture was verified in 6 upland fields. Furrow sowing resulted in 1.6% higher soil moisture and 11% higher yield (t ha^{-1}) compared to conventional sowing. The yield increase was attributed to 3% greater number of hills, 2% higher 1000-grain weight and 6% higher filled grain percentage. The increase in these yield components corresponded with significant soil moisture increases during their respective growth periods and the positive effect of furrow was seen in fields with significantly higher soil moisture content.

These results suggest that soil moisture is an important yield-limiting factor in rainfed rice, and that soil moisture and yields can be improved by adjusting the sowing date or by sowing in furrows. In addition, furrow sowing allows farmers to sow earlier than usual, as the ridge-furrow system of earlier crops can be utilized immediately after harvest. Singular or combined use of these sowing methods would be especially useful for LYFs with sub-optimal field-water conditions, as risks of yield loss due to soil moisture stress can be reduced.