Flooding mitigation for cowpea by the close mixed-planting with rice in the paddy field

Pamwenafye I. Nanhapo1,2, Koji Yamane1, Maliata A. Wanga3, Yoshimasa Kawato1, Morio Iijima1,4

Introduction: Flooding stress causes the decrease in the productivity of flood intolerant crops such as pearl millet, sorghum and cowpea. Recently, flooding has been common in the arid and semi-arid regions of the world because of the erratic rainfall pattern. Thus, farmers who cultivate these drought tolerant crops in arid or semi-arid regions are afraid of crop failure due to flooding stress. Recently, we have demonstrated that the growth and physiological traits of flood sensitive cereals in semi-arid region were ameliorated by the closed mixed-planting with the flood tolerant plant of rice in the greenhouse experiment (Iijima et al., 2016. J. Plant Physiol. 192: 21-25) and in the field (Awala et al., 2016. Europ. J. Agron. 80:105-112), probably because oxygen which is released from rice roots is transferred to pearl millet and sorghum. In the present study, we investigated the alleviative effects of the closed mixed-planting (hereafter “mixed cropping”) with rice (cv. Nipponbare) on the physiological traits and growth of cowpea under flooded paddy field conditions.

Materials and Methods: This study was conducted in a paddy field at Kindai University in Nara prefecture (latitude 34° 40’ N, longitude 135° 43’ E), during Japan summer in 2015. Three cropping patterns of rice and cowpea (mono cropping of cowpea and rice and their combination) were tested in the field. Rice was first grown for two (2) weeks in cell tray, and then pre-germinated cowpea was planted in the same cell for the mixed cropping. The plants of mono and mixed cropping were transplanted in a paddy field after 2 weeks of hydroponic growth. The experiment was arranged in RCBD with 5 replications (3 plants/rep). Before transplanting, a basal application of N, P2O5 and K2O was applied at the rate of 2, 3 and 2.7 g m-2. Plants were subjected to 12 days of flooding stress at a mean water level of 8 cm followed by 14 days of recovery. The soil redox potential during the flooding period ranged between 100 to - 45 mV. Photosynthesis rate (Pr), shoot dry weight (SDW) and the relative growth rate (RGR) were evaluated at the end the flooding and also recovery periods.

Results and Discussion: At the end of 12 days of flooding stress, SDW of cowpea mix-cropped with rice was higher than that of mono-cropped cowpea, while the difference was not statistically significant. On the other hand, RGR of cowpea mix-cropped with rice was significantly higher than that of mono-cropped cowpea. The Pr of cowpea mix-cropped with rice was significantly higher at the end of flooding and recovery periods. The higher Pr in the mixed cropping could allow cowpea to maintain higher assimilation rate during flooding stress and enhance the growth of cowpea after the recovery period. These results indicated that the close mixed-planting with rice would be effective in mitigating the growth inhibition of cowpea by flooding stress.

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