Abstract

The Asian agricultural landscape, which accounts for approximately 12.6% of the world's agricultural land, is highly heterogeneous due to the multicultural cropping system. Information regarding CO_2 exchange and carbon (C) balance of these agro-ecosystems is scarce, even though they are likely to immensely contribute to the global C budget. Net Ecosystem CO_2 Exchange (NEE) and Ecosystem respiration (R_{eco}) were measured between 2009 and 2010 on 5 dominant crops (potato, rice, radish, cabbage and bean) in the Haean catchment of South Korea, using a closed chamber system to quantify CO_2fluxes in this agricultural landscape characteristic of the Asian cropping system. Parallel measurements were conducted on leaf area index (LAI), plant biomass and climatic variables, mainly photosynthetic active radiation (PAR), air temperature, soil temperature and soil moisture. Biomass and LAI development differed among the crops likely as a result of differences in light use efficiencies (α) and carbon allocation patterns. The peak total biomass for radish, cabbage, potato, rice and bean were 0.53 ± 0.07, 0.55 ± 0.12, 1.85 ± 0.51, 2.54 ± 0.35 and 1.01 ± 0.26 kg m^{-2}, respectively, while the respective maximum LAI were 2.8, 3.7, 6.4, 6.3 and 6.7 m^2 m^{-2}. Variations in seasonal patterns, magnitudes and the timing of maximum NEE and gross primary production (GPP) among the crops were likely the result of differences in LAI and α. The lowest peak R_{eco} rate was 3.8 ± 0.5 µmol m^{-2} s^{-1}, measured on rice paddies while the highest was 34.4 ± 4.3 µmol m^{-2} s^{-1} measured on the cabbage fields. The maximum NEE rates were −29.4 ± 0.4 and −38.7 ± 6.6 µmol m^{-2} s^{-1}, measured in potato and cabbage fields, respectively. Peak GPP rates in potato and cabbage fields were 39.5 ± 0.6 and 63.0 ± 7.2 µmol m^{-2} s^{-1}, respectively. PAR explained more than 90% of the diurnal variations in GPP, while LAI and α determined the seasonal trends of maximum GPP. The timing of maximum CO_2assimilation (GPP_{Max}) differed among the crops, thus, even though maximum CO_2 uptake in the respective crops only lasted a couple of weeks, the effect of the staggered peak GPP resulted in extended period of high CO_2 uptake. These differences among crops were significant, hence, modeling approaches need to consider the heterogeneity in ecosystem CO_2 exchange associated with these multicultural agriculture landscapes.