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Intercropping fava bean with broccoli can improve soil properties while maintaining crop production under Mediterranean conditions

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Including legumes in intercropping systems may be regarded as a sustainable way to improve soil quality, fertility and land productivity, mostly due to facilitation processes and high rhizospheric activity which can mobilize soil nutrients for plants. Improvements in production and soil quality depend on inherent soil properties, climatic conditions, adopted management practices and fertilization, among others. The aim of this study was to assess the effect of the association between broccoli (Brassica oleracea var italica) and fava bean (Vicia fava) grown under different intercropping patterns on crop production, soil organic carbon (SOC), total nitrogen (Nt), soil aggregate stability (SAS) and soil fertility, compared to a broccoli monocrop. We defined a randomised block field experiment with three replications assessing the effect of monocropping, row 1:1 intercropping, row 2:1 intercropping and mix intercropping, with 30% reduction in fertilization in intercropped systems compared to monocrop. Soil sampling took place at harvest in February 2019. Results showed that the broccoli-fava bean intercropping significantly increased the general land production, with similar broccoli yield of 20000 kg ha^{-1} in all treatments, plus 8000 kg ha^{-1} coming from fava bean. Crop diversification and fava bean cultivation even in monocrop significantly increased SOC and Nt compared to broccoli monocrop. SOC and Nt were 1.06% and 0.09%, respectively, for broccoli monocrop, while they had average values of 1.29% and 0.12%, respectively for the intercropped systems. SAS was also significantly affected by crop diversification, with increases in the proportion of the macroaggregates (size >2 mm) with intercropping. Broccoli monocrop showed an average proportion of these macroaggregates of 9.19%, while they increased up to 17.51% in intercropped systems. CEC was not significantly affected by intercropping SAS showing almost same percentage of aggregates independently of the treatment. Available P significantly increased in intercropped systems, likely due to increased microbial activity with the simultaneous growth of the two crop species. However, no significant effect of intercropping was observed with any other nutrient (Ca, Mg, K, Mn, Cu, Fe, Zn and B), suggesting that microbial communities activated by the crop association are highly related to P mobilization but not so intensively involved in other nutrients. Thus, intercropping systems like broccoli-fava bean association can be regarded as a viable alternative for sustainable crop production while increasing soil fertility despite reducing the addition of external fertilization. However, more crop cycles are needed to confirm this trend.