**Results**

**Drought affects soil water availability and mineral N pools**

Drought severely affects the soil water availability in all cropping systems (Fig.1: Soil GWC; Kost et al. (2024)). We observed that drought-treated soil has lower gravimetric water content compared to the control over the course of drought treatment, and the water availability recovered at the final sampling time (eleven weeks after rewetting event) (Fig.1 A: Soil GWC). The total mineral N content, including the ammonium (NH4+) and nitrate (NO3+) contents, were strongly affected by drought in the mixed- (CONFYM) and mineral fertilized (CONMIN) conventional systems, but not in the biodynamic (BIODYN) cropping system (Fig. 1 B: Ammonium, nitrate, and total mineral N contents, Table S1: N pools statistical analysis). Drought altered the mineral N pools, where the ammonium and nitrate increased during drought treatment, and recovered back to the control levels after the removal of the rain-out shelter and rewetting event (Fig. 1 B: Ammonium, nitrate, and total mineral N contents).

**The effects of drought on the ammonia-oxidizers diversity and composition were marginal**

Overall, there were no differences of the observed richness and Shannon diversity index between drought and control of the AOB and AOA communities in both bulk soil and rhizosphere (Fig. 2: Alpha diversity, Table S2: alpha diversity statistical analysis). Meanwhile, the observed richness of the Comammox community was marginally affected by drought in the bulk soil, but not in the rhizosphere (Table S2: alpha diversity statistical analysis). In contrast, we found that cropping system was a strong driver of the ammonia-oxidizers alpha diversity, with higher AOA and Comammox, but lower AOB alpha diversity in the BIODYN system than in the CONFYM and CONMIN cropping systems (Fig. 2: alpha diversity, Table S2: alpha diversity statistical analysis).

The unconstrained PCoA plots using Bray-Curtis dissimilarity distances showed distinct separation by cropping system on the first axis, meanwhile, the effect of drought was only apparent within block due to a strong block effect (Supplementary Fig. 2: unconstrained PCoA plots). The results of the whole plot PERMANOVA supported the effect of cropping system in bulk soil and rhizosphere (*P*=0.001), and we could not detect the effect of drought on the ammonia oxidizers composition. However, the restricted permutations PERMANOVA showed the effect of drought on the composition of the AOB (*P*= 0.028, bulk soil; *P*=0.007, rhizosphere) and Comammox (*P*=0.042, bulk soil; *P*=0.001, rhizosphere) communities, but not on the AOA community (*P=*0.08,bulk soil and rhizosphere). To further observe the effect of drought on the beta diversity, we performed constrained analysis using CAP, and the differences on the community composition between drought and control within each cropping system become more evident (Fig. 3: Constrained CAP Plots). The AOA community has the highest compositional differences between drought and control as demonstrated by high overall reclassification rates of 94.2 % and 90.3 % in bulk soil and rhizosphere, respectively. Distinct clustering by the drought treatment were also observed in the Comammox community with overall reclassification rates of 78.8 % and 83.3 % in bulk soil and rhizosphere, respectively. In contrast, the AOB community showed only marginal separations between drought and control within cropping system with lower overall reclassification rates of 60.5 % and 54.2 % in bulk soil and rhizosphere, respectively. Evaluation of the Euclidean distances calculated from the positions provided by the discriminant analysis showed that the highest differences between treatment (drought vs control) were within the BIODYN cropping system, particularly in the AOA and Comammox communities (Fig. 3: The distance boxplot calculated from the discriminant CAP analysis). Meanwhile, for the AOB community in the bulk soil, CONMIN system has the largest distance between drought and control (Fig. 3: The distance boxplot calculated from the discriminant CAP analysis).

**Most of the ammonia-oxidizer taxa were resistant to drought**

Mean relative abundance of the ammonia-oxidizing taxa revealed that AOB, AOA, and Comammox communities were dominated by genus *Nitrosospira* (>80%), lineage *Nitrososphaerales* (NS-Delta-1-*Incertae sedis*) (>95%), and genus *Nitrospira* clade B (>90%), respectively. We found that there were no notable shifts of taxonomic composition of the ammonia-oxidizing communities in response to drought, although the community compositions were largely shifted among cropping systems (Supplementary Fig.1: Relative abundance bar plot). The differential abundance analysis showed that most of the ammonia-oxidizing ASVs remained unchanged in response to drought, and we detected a relatively small number of ASVs that were altered by drought (Fig.4: DAA). Among the three ammonia-oxidizing groups, the AOB community has the largest number of affected ASVs in all samples (17 ASVs in total), and the majority of those ASVs were negatively affected by drought. Overall, most of the drought-sensitive AOB ASVs belonged to the dominant taxa (*Nitrosospira* and *Nitrosolobus*) and those ASVs were mainly found in the bulk soil samples within the CONFYM and CONMIN cropping systems. Meanwhile, only a few AOA and Comammox ASVs which were identified as sensitive to drought (less than ten). Those ASVs belonged to the lineages of *Nitrososphaerales* and *Ca. Nitrosotaleales* ,and the drought-affected Comammox ASVs were exclusively assigned to the Comammox *Nitrospira* clade B (Fig.4: DAA).

**Shifts in the abundance of ammonia-oxidizers in response to drought**

While we observed marginal effect of drought on the ammonia-oxidizer diversity and composition, the abundance of amoA genes were largely affected by drought. However, the effects of drought were different depending on the ammonia-oxidizing group, cropping system, as well as sampling date (Table S3: ammonia-oxidizers abundance statistical analysis). Drought influenced the ratio of AOB to the total microbial abundance with decreased the abundance, especially in the

**Relationship between environmental factors and ammonia-oxidizing communities**