Varietal mixtures, defined as the concurrent cultivation of several varieties of the same crop in the same field, are receiving growing interest, as increasing genetic diversity in the field could improve agricultural sustainability. This hypothesis is supported by ecological theories, which predicts that genotypes with non-overlapping niches should be more efficient in their use of resources than a monoculture (niche complementarity theory), and that a greater number of limiting resources should favour the coexistence of a higher number of genotypes (niche dimensionality theory). In line with this prediction, varietal mixtures yield slightly higher than their pure stand components on average. However, mixing effects are also very variable, and we still poorly understand how interactions between varieties are affected by resource limitation. In this study, we tested whether diversity in root traits could promote positive interactions between varieties, and whether this pattern would be exacerbated under limiting resource conditions. We grew 36 durum wheat (*Triticum turgidum* ssp. *durum*) varieties in pure stands and in 54 binary mixtures in a high-throughput root phenotyping platform under two resource conditions: a control (C), and a stress condition where both water and nutrient were limited (S). We then compared the above and belowground biomass of three-week-old seedlings in mixed vs pure stands and tested the relationship between the relative biomass of the mixtures and their trait composition. Trait composition was measured by the average trait value and the absolute trait difference between varieties in the mixtures, using trait values from the monocultures. We found that mixed stands produced less biomass than predicted from their pure stands, particularly in the S treatment. A single trait, the average 2D projected area of the root system, explained up to 50% of the relative biomass production of the mixtures in the S treatment. Our results indicate that this biomass reduction most likely resulted from relaxed competition in mixed relative to pure stands, and that the area of the root system captured the competitive hierarchy between cultivars. Plastic changes in root area also contributed to mitigate competition in mixtures. Overall, our results suggest that root area and plasticity in root area are promising breeding targets to reduce intra-specific competition at the seedling stage and important traits to account for when assembling cultivar mixtures.