Plant sex and flowering date are strong determinants of tuber yield in white guinea yam

White Guinea yam (*Dioscorea rotundata* Poir.) is a tuber crop widely cultivated in West Africa, accounting for more than 90% of global yam production. The average annual yield of yam has been stagnant for decades and varies from year to year. Variability in tuber yield and yield-related traits has been observed even among plants of the same variety grown in the same environment. This study focused on the sex of yam flowers as one of the causes of unstable tuber yield, as flower sex has been known to interact with tuber yield. Yams are a dioecious species, with male and female flowers on different plants (Fig. 1). Moreover, plant-to-plant variability in flower sex expression is common in yam fields. A better understanding of the relationship between flower sex and tuber yield could be crucial for genetic improvement in yam breeding.

This study used F_1-derived clonal progenies from a bi-parental cross to minimize the impact of basal genetic differences between the sex phenotypes. The impact of plant sex on agronomic traits, specifically tuber yield, was evaluated through field trials conducted for four years. The results showed that only plants with a female genotype exhibited diverse sex phenotypes (Fig. 2). Inter-plant variation in tuber yield was affected by both sex phenotype and sex genotype, but greater contribution to tuber yield was observed in the former than the latter (Table 1). Our results revealed that plants with female phenotypes had higher tuber yield than those with male phenotypes (Fig. 3). This result can be attributed to the fact that, compared to male plants, the low flowering intensity in female plants increases the availability of carbon resources for leaf development. The sexual differences in tuber yield were evident when comparing plants with similar flowering dates. Significant difference was observed for plants flowering in late July, but the difference became small for late flowering plants. This is because early flowering can avoid resource competition with tuber enlargement, which starts from mid-August.

Since sex phenotype varies with the surrounding environment in plants with the female genotype, artificial control of sex phenotype would be possible for yield improvement of female-genotyped varieties and could be achieved by appropriate field management, such as soil water control and arrangement of plant light interception, to maintain good culture conditions. The identification of the genetic factors and environmental conditions that determine flowering is currently underway, and it is expected to lead to new cultivation methods that improve tuber yield by successfully controlling flowering phenotype and flowering period, as well as the development of new varieties genetically modified for these traits.

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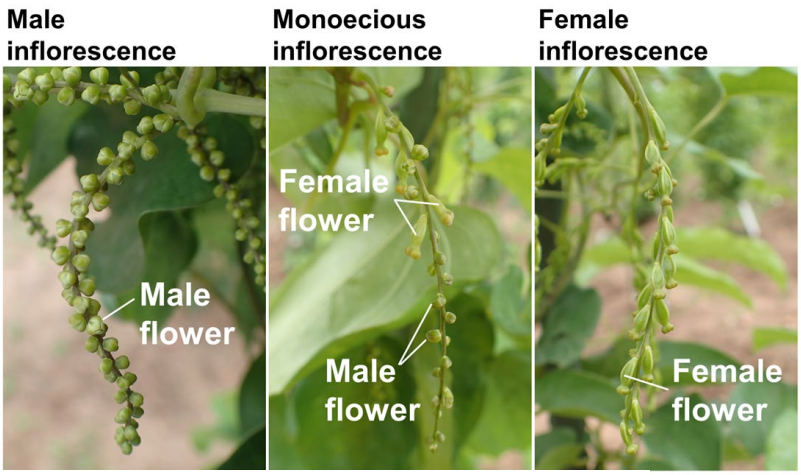

Fig. 1. Sex phenotypes in yam

Male inflorescence of male plant (left) and female inflorescence of female plant (right). Inflorescence of monoecious plant has both male flower and female flower (center).

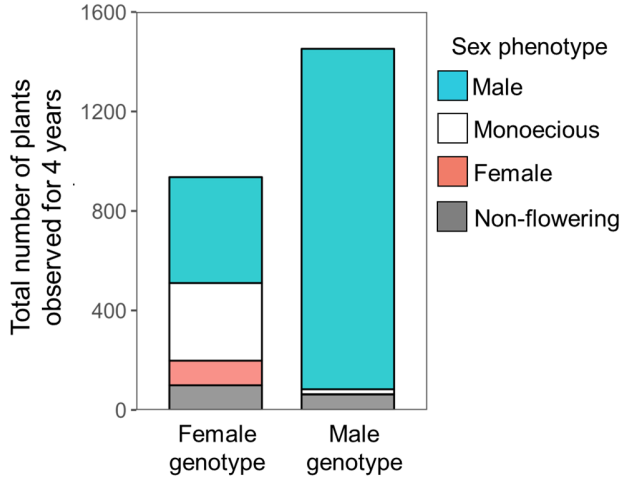

Fig. 2. Observed sex phenotype in plants with male and female genotypes

Distribution of sex phenotypes from a total of 2,400 plants, consisting of 200 accessions with 3 replications over a 4-year period. Approximately half of the plants with a female genotype showed a male phenotype.

Table 1. Effect of sex phenotype and sex genotype on tuber yield

Factor	Contribution (%)
Sex genotype	0.1 *
Sex genotype × Sex phenotype	3.2 **

The results of nested analysis of variance (ANOVA) using sex genotype as the hierarchical factor. Values indicate the contribution ratio of each factor on the total yield variation. ** and * indicate that the contribution is statistically significant at $P<0.01$ and $P<0.05$ levels, respectively.

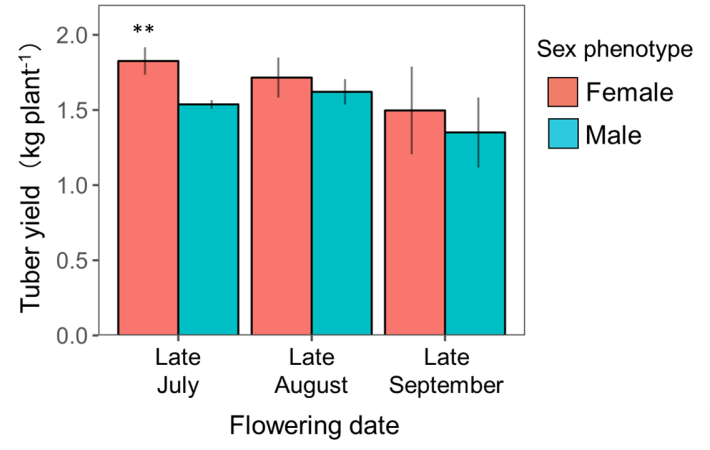

Fig. 3. Relationship between flowering date and tuber yield in plants with male and female phenotypes

Female plants had higher tuber yield than male plants when comparing plants with similar flowering dates. Significant difference at $P<0.01$ level was obtained for plants with early flowering in late July.

Reference: Iseki et al. (2022) *Frontiers in Plant Science* 13: 837951. https://doi.org/10.3389/fpls.2022.837951