Haploid lines). However, owing to inbreeding depression (note: homozygous individuals of a normally out crossing species typically exhibit reduced vigour, and this is known as inbreeding depression), these lines cannot be used directly, but only as parental inbred lines for the production of hybrid varieties. When inbred lines are being developed via haploids [7], all barriers to repeated sel ng, which are characteristics of natural cross-pollinators, are bypassed, e.g. dioecy, self incompatibility and long juvenile periods. e time saving is particularly apparent in biennial crops, and in crops with a long juvenile period. Inbred lines can be developed in these crops via only haploidy [9].

Haploids have value in allowing the isolation of mutants, which may be masked in a diploid, particularly where the mutant allele is non-functional. Haploids also have value in transformation programmes. If haploids are transformed directly, then true breeding diploid transgenic plants can be produced in one step, following doubling of chromosomes. As such, haploid plants (and doubled haploids) reveal all their genetic information, or in other words, their genotype is completely displayed by their phenotype. Doubled haploid plants (transgenic plants) produce viable seed and the desired trait is passed on to successive generations. Some of the genetically determined traits can be introduced into plants by a single gene or possible a small cluster of genes, including insecticidal activity, protection against viroid infection, resistance to herbicides, delay of senescence, tolerance to environmental stresses, improved nutritional quality of plant products and self incompatibility. Resistance to pest and diseases or unfavorable external factors (drought, salinity, heavy metal toxicity etc) can thus be directly recognized and selected. Haploid plants allow the detection of mutants that are unable to pass through the embryonic phases. For similar reasons, haploid plant tissue make ideal vehicles for genetic transformation, by whatever gene manipulation techniques are

phenotype, they are usually smaller in appearance, partly because of their smaller cell size; in general terms, cell volume in plants is positively correlated to ploidy level. Several methods [35] for the provisional assignment of the haploid status to a plant do exploit this relationship. e most widely used of these phenotypic methods is the measurement of stomatal guard cell length and chloroplast content in these cells, although none of the phenotypic predictors of haploidy is absolutely reliable. Methods providing direct measurements of genome size provide a far more reliable diagnosis of haploid status. ese include direct measurement of the chromosome number, using conventional chromosome counting techniques and measurement of the DNA content using micro densitometry [36], or more especially, ow cytometry [24,25,37-39]. e latter technique has also been applied to characterize the cell cycle stages in various tissues in case of oil palm material, although not for the detection of haploid plants or tissues [40]. It is also possible to exploit the absolute absence of heterozygosity in haploids and doubled haploids to detect such plants using various co-dominantly inherited molecular marker methods [41].

Achievements in Palms of Economic Importance

e literature relating to haploid research in palms is limited to date palm, oil palm, and to some extent, coconut and such works are brie y reviewed in this section.

Date palm

Although, studies dedicated to anther and ovule culture recovery are scarce for date palm, attempts under various conditions have led to achieving cell division and to the formation of globular embryos from immature micro spores. Some of the successful attempts with cold treatment, combined with the use of two auxins and one cytokinin, have been proven to be the key elements to generate embryoids [42,43], that unfortunately were unable to develop. Investigations of di erent treatments and various exogenous factors were successful, when there was a formation of the weak calli surviving only during a short period of time. e main di culties encountered in such studies were related to the short time owering period that does not allow, usually having enough fresh anthers with uninucleate microspores. Furthermore, date palm male anthers typically turned brown and died a few weeks a er their culture.

Some haploid recovery attempts were made with unfertilized ovules also. Due to the small size of these ovules, browning and necrosis were the main limits encountered by such cultures. Although the carpals enlarged and became quite prominent when cultured, the use of activated charcoal is required to ensure them a much longer survival and roots and callus formation [43]. As on date, the best results ever obtained were from owers taken from closed spathes, and in which the embryo sacs were formed that contained undi erentiated cells. ere is a claim that treatment of unpollinated female date palm in orescences with gibberellic acid that induced doubled haploid “apomictic” progeny [44].

Oil palm

Oil palm is a perennial monocotyledon, with a long generation period. Hence, breeding of the crop is a very slow process; generally taking approximately 20 years to develop and progeny test a new generation of palms for commercial seed production. ere are no reports of breeders producing inbred lines by inbreeding (i.e., eight generations of sel ng), because this would take a biological minimum of 40 years to achieve, which is as follows; the time required to make crosses (6 months), process seed (3 months), grow seedlings in nursery (12 months), eld plant seedlings (male and female in orescences

is one report of attempt at ovule culture in coconut [38]. However, no haploid plants were produced from any of these in vitro studies. Nevertheless, there is a single example of a haploid coconut plantlet isolated from a twin seedling [65], and cytological evidence of a haploid chromosome number (n=16) observed from a single embryo from the same species.

However, none of these publications describe an e ective method to produce and select spontaneous haploids or doubled haploids, or provide teaching relevant to the production of haploid or homozygous material of n_j k q,

Conclusion

Haploid research has emerged in the recent as study dealing with fascinating developmental phenomenon in the eld of plant breeding. Recent technological innovations, greater understanding of underlying control mechanisms, and an expansion of end user applications has brought about a resurgence of interest in haploids in higher plants. is is evidenced by the publications being brought out recently, whereas in palms, it has met with less success because of its perennial nature. In the future, haploid research will have an enormous impact on traditional plant breeding programmes, including palms, because it can signi cantly reduce the time taken to develop a new variety against traditional plant breeding techniques. Further, it will also be used to create plants with novel characteristics.

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