AgriCos e-Newsletter
ISSN: 2582-7049
AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
Volume: 03 Issue: 06 June 2022 Article No: 09

Impact of Double Haploid Techniques in Crop Improvement

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SUMMARY

Doubled haploid (DH) technology has become Associate in nursing integral a part of several business breeding programs as DH lines provide many economic, provision and genetic advantages over standard inbred lines. Further, new advances in DH technology still improve the potency of DH line development and fuel its magnified adoption in breeding programs worldwide. Development of haploid inducers with high haploid induction rates and adaptation to totally different target environments have expedited magnified adoption of DH technology within the tropics. New marker systems for haploid identification, like the red root marker and high oil marker, area unit being more and more integrated into new haploid inducers. Automation holds nice promise to any cut back the price and time in haploid identification. Increasing success rates in body doubling protocols and/or reducing environmental and human toxicity of body doubling protocols, as well as analysis on genetic improvement in spontaneous body doubling, have the potential to greatly cut back the assembly prices per DH line.

INTRODUCTION

A doubled haploid (DH) may be a genotype shaped once haploid cells endure body doubling. Artificial production of doubled haploids is very important in plant breeding. The spore culture technique have a significant role in genetic analysis and plant breeding programmes as a result of its potency and effectively in haploid and double haploid production, mutation also as cistron transformation. DH techniques are accustomed accelerate the breeding programme of vary crops principally maize and barley (Segui- Simarro,2015). during this techniques, DH area unit plants those carry 2 sets of chromosomes that area unit created from the haploid spore grains. Double haploids area unit homozygous at each locus having extremely variable phenotypes. during this technique plants derived from one immature spore grain and doubled unnaturally to create homozygous diploids. A DH individual has 2 identical homologues in order that the number of recombination data is like a pair. The advantage of employing a DH population in molecular mapping is that each one people area unit homozygous.

History

Blakeslee et al. in 1992, initial time rumored haploid plant in Datura stramonium and in several alternative species. The potential of condition for plant breeding arose in 1964 with the action of haploid embryo formation from in vitro culture of genus Datura anthers (Guha and Maheshwari, 1964, 1966), that was followed by winning in vitro haploid production in tobacco (Nitsch and Nitsch, 1969. For doubled haploid production Tobacco, oilseed and barley area unit the foremost responsive species. Haploids will originate ad lib in nature or as a results of varied induction techniques like body doubling. Kermicle in 1969, rumored the chance of getting steroid haploids in maize. in place induction of maternal haploids includes, pollenation with spore of an equivalent species (e.g., maize), pollenation with irradiated spore, pollenation with spore of a wild relative (e.g., barley, potato) or unrelated species (e.g., wheat). pollenation may be followed by fertilization of the gamete and development of a hybrid embryo, during which paternal body elimination happens in early embryogenesis or fertilization of the gamete doesn't occur, and therefore the development of the haploid embryo is triggered by pollenation of polar nuclei and therefore the development of reproductive structure. In maize, maternal haploids will occur ad lib. Their rate is sometimes regarding one haploid maize per one or 2 thousands of traditional diploid plants. However, the low frequency of natural haploid generation prevents Associate in Nursing economical use of this approach in breeding programs.

Murovee was later followed by similar reports in tobacco (Nicotiana tabacum), wheat (Triticum aestivum) {and several|and a number of alternative|and several other} other species (Forster et al., 2007). However, spontaneous prevalence may be a rare event and so of restricted sensible worth In fact, beneath optimum conditions, doubled haploids (DH) are habitually utilized in breeding for many decades, though their common use continues to be restricted to chose species. There area unit many reasons for this. These may be classified as biological, supported plant status (annual, biannual, perennial, authogamous, allogamous, vegetativelly propagated) and flower morphology or technical, that area unit the results of the practicability and potency of DH

induction protocol. Induction protocols considerably vary, in fact, not solely among species however additionally among genotypes of an equivalent species.

Double Haploid Production

DHs could also be transferred between completely different laboratories and atmospheres for assessing the result of the environment on organic phenomenon. Pea, alongside several of the large-seeded herb species, has historically been thought of recalcitrant to the current technique. In 2009, the primary production of confirmed haploid plantlets of pea from the culture of immature spore was reportable. Analysis is on about to develop arobust protocol which will be applicable across a variety of genotypes. The mechanisms for switch the immature spore from traditional gametic development have additionally been recently elucidated for peas. Booming production of DHs on a routine basis would scale back variety development time and supply glorious recombinant inbred lines for molecular mapping applications. The ability to come up with homozygous and uniform lines is a very important time constraint in plant breeding. By mistreatment doubled haploids (DHs), homozygous and uniform lines is created in 2 instead of 5 or a lot of generations. Alternative benefits embrace reduced prices to provide cultivars, a lot of precise analysis of constitution traits, effective elimination of undesirable genes, and attribute fixation in haploids mistreatment marker-assisted choice, resulting in effective use of molecular markers and a lot of economical combination of traits. As a result of the success of breeding programs depends on the genetic gain per unit time, the utilization of DH technology has become routine within the breeding of the key autogamous cereal species wheat and barley furthermore as in maize and canola.

Three approaches area unit usually won't to develop DH lines:

1) Spore and reproductive structure culture,
2) Wide cross between completely different species (such because the use of maize as a haploid inducer in wheat) to induce body elimination, and
3) The utilization of explicit inducer genotypes at intervals species that facilitate the assembly of kernels with haploid embryos.

This latter approach has resulted within the isolation of genes dominant haploid induction. the primary several factor, indeterminate plant life one (ig1), was discovered in maize and allows the generation of paternal haploids. A simple protein secret writing factor, Cen H3, is chargeable for haploid induction in mouse-ear cress, and a CenH3 homologue offers Hordeum bulbosum the flexibility to induce haploids in barley (Hordeum vulgare). a lot of recently, quantitative attribute loci (QTL) are genetically and physically mapped and wont to management the induction of maternal haploids in maize. Further, the factor lineal (MTL) underlying this QTL has been isolated by 3 freelance analysis teams. It is expected that associate increasing range of genes related to haploid induction management are going to be offered within the close to future. It's been incontestable that these genes or their homologues is wont to establish haploid induction in novel species. These articles is most welcome that specialise in molecular processes associated with haploid induction, ordination doubling, biological processes concerned in doubled haploid plant development in tissue culture (using approaches like transcriptomics, proteomics, metabolomics, and genetic mapping), the event of ways to extend the potency of the DH method (such as novel phenomic ways for haploid – diploid discrimination), introduction of DH technology in novelspecies, and therefore the utilization of DH technology for novel applications (such as for factor editing), in model plants, crop plants, trees, aquatic plants and native species.

Chromosome Doubling

Haploids area unit usually sterile (Chaikam and Mahuku 2012) as a result of cell division divisions cannot occur, and this leads to non-formation of gametes. Indeed, the chromosomes ought to be doubled in order that homologous chromosomes will try, and meiosis continues ordinarily, leading to restoration of fertility. However, a high proportion of haploids (~97–100%) manufacture seeds once pollinated with spore from traditional diploid plants (Geiger et al. 2006), whereas most haploids area unit male sterile. Consequently, restoring haploid male fertility (HMF) is mostly thought of as a limiting think about production of DH lines (Ren et al. 2017a; Wu et al. 2017). Restoring fertility in haploids is achieved by artifcial body doubling ways that think about bound chemicals or spontaneous body doubling.

Artificial Body Doubling

Artifcial body doubling is achieved by treating the haploid seedlings chemically that exhibit anti-mitotic activity. Colchicine is wide used for body doubling in DH line production pipelines (Chaikam and Mahuku 2012; Melchinger et al. 2016b). Colchicine binds to β-tubulin and prevents the formation of tubulin dimers thereby preventing formation of microtubules. Lack of microtubules throughout cell division within the meristematic cells of the shoot apex prevents separation of replicated chromosomes, polar migration and cellular division, leading to a cell with a doubled body range. The quality protocols involve immersing seedlings that have regarding a pair of cm long coleoptiles in colchicine (0.04–0.06%) resolution with zero.5% Dimethyl Sulfoxide (DMSO) for 8–12 h (Chaikam and Mahuku 2012). Recently, body doubling processes supported anti-mitotic herbicides and laughing gas (N2O) gas are optimized. Many herbicides inhibit tubule assembly or tubule organization and will be anti-mitotic

Spontaneous Body Doubling

It is associate another different to chemical-induced body doubling is to rely on spontaneous body doubling and spontaneous restoration of haploid fertility wherever haploid plants manufacture spore and seed while not chemical treatment. This development was 1st delineated by Chase (1949b). The rate of spontaneous body doubling could also be calculated because the proportion of fertile plants (FP) that set seed once pollenation at intervals all the haploid plants.

CONCLUSION

Haploid plants area unit usually weak and show status to varied organic phenomenon and abiotic stresses (Mahuku 2012). Body doubling treatments impose any stress, thereby increasing the mortality of seedlings within the greenhouse and/or within the field. Haploids so ought to be handled with care throughout and once body doubling treatments, and whereas transplantation and growing within the field. Improved irrigation ways like drip irrigation or mechanical device irrigation might facilitate to avoid any water stress. Optimization of body doubling protocols supported spontaneous body doubling and/or non-hazardous chemicals is another vital analysis space that would any increase the general DH production potency. Optimization of growing conditions for D0 plants will improve the number and quality of seed of DH lines, which can eliminate the requirement to extend the seed of DH (D1) lines, thereby saving seed multiplication times and their associated prices. Use of embryo rescue protocols will signifcantly shorten the time (up to three months) in DH line development and can increase the rates of chromosomal doubling as most meristematic cells in the embryo can be exposed to doubling chemicals.

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