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Genetic enhancement of banana cultivation: A Biotechnological approach

Shipra Anand[1], Jamal-E-Fatima[2]

[1]*Department of bioengineering faculty of Engineering , integral university Lucknow ,uttar Pradesh-226022*

[2]*Advanced Centre for bioengineering and bioengineering (ACBB), Integral information and Resaerch centre (IIRC), Integral University Lucknow, Uttar Pradesh, India-226026*

Abstract

World banana production is at present around 97 million tons per year, of which bananas developed for the fair exchange represents just 10%. Henceforth, bananas are imperative for nourishment security in the damp tropics and give wage to the farmers. Genetic designing offers an optional strategy for harvest upgrade. Relative accomplishment in the hereditary building of bananas and plantains has been accomplished as of late, empowering the exchange of remote qualities into the plant cells. A successful strategy has been created for the change and recovery of banana by utilizing a few systems Genetic fingerprinting, Hybrid fingerprinting, Particle barrage and Agrobacterium-interceded change and invitro strategies for the higher yield for banana cultivation. This review talks about the methods included Banana development, utilizing plantain breeding, genetics, and biotechnology from right on time to the mid-1995.

Introduction

Genetic enhancement of banana: A Biotechnological approach to attain a Higher Yield

A great array of cell and molecular techniques are increasingly beastlike old wide-ranging to aid and enhance the handling and production of banana germplasm. Biotechnology has optional a number to the benefit of banana varieties and its cultivation. Personal techniques such as tissue culture to enrapture assault bowled over about a boom to the industry. Studies on banana get ahead nearby is
an elicit to analyze the inheritable metamorphosis of the inborn varieties of bananas. Innate fingerprinting is hand-me-down to maker the forge gene merge and varieties, unwell traditional purpose helps the researchers to bring about the genetic makeup for better yields and fruit quality.

Genetic fingerprinting

Different methods are available to detect and monitor tissue culture derived planting material and cultivar identification the effect of mutagens on plants. Molecular markers allow a direct comparison of the effect of genotypes at the DNA level. Different molecular techniques have been developed and are being widely used in many different fields such as agriculture, biology medicine, etc for various purposes, out of the available techniques, These DNA fingerprinting techniques have proven to be simple, fast, and cost-effective. DNA fingerprinting techniques allows the correct identification of plant species and cultivars. The DNA fingerprinting techniques has successfully used various markers such as randomly amplified polymorphic DNA marker (RAPD) [1], restriction fragment length polymorphism (RFLP) [2], microsatellites [3], inter simple sequence repeat (ISSR) [4], and amplified fragment length polymorphism (AFLP) [5]. Among many researchers, AFLP is the marker technology of choice since it combines the reliability of restriction based fingerprinting procedure with the speed and convenience of polymerase chain reaction (PCR)-based marker techniques [6]. The AFLP technique rapidly generates hundreds of highly replicable DNA markers, thus allowing high resolution genotyping [7].

Cloning microsatellites from the A and B Musa genomes.

Genomic libraries from *M. acuminata* and *M. balbisiana* increases have been screened with an assortment of dreary oligonucleotides including (GA)11, (AT)11, (CT)11, (ATT)10 and (CTT)10 [8], USDA, unpublished information). The succession of

chose pieces was then decided and PCR groundworks planned from arrangements flanking the SSR. More than half of the SSR confined from *M. acuminata* had basic dinucleotide (GA) or (CT) center themes [9]. No basic (AT) rehashes were segregated regardless of their reported plenitude in plant species. This is prone to be because of self-strengthening of the (AT)11 test. Be that as it may, a few complex SSR which included (AT)n themes were separated by temperance of their relationship with (GA), (AG) or (CT) themes. In the same manner as other genera, trinucleotide and tetranucleotide rehashes give off an impression of being less plenteous in Musa than dinucleotide rehashes. Along these lines, around 100 helpful microsatellite markers have been created from *M. acuminata* while a comparative number are relied upon to come about because of parallel work on *M. balbisiana*. Comparative microsatellite seclusion ventures are additionally progressing at CIRAD [10], the University of Frankfurt [11] and the University of Saskatchewan while littler ventures have been started somewhere else. This is prone to bring about the accessibility of more than 500 microsatellite markers for hereditary investigation and sub-atomic rearing in Musa.

Hybrid fingerprinting

DNA fingerprinting for cultivar identification has been achieved with the use of short synthetic DNA probes specific for simple sequence repeats [12]. However, approaches based on hybridization protocols are not well suited to large-scale routine screening. For the same reason, SSRLP assays are also being used for the fingerprinting of IITA's Musa hybrids. By combining the generated banding patterns by two primers, it has been possible to formulate unique fingerprints for each hybrids. A similar procedure was followed in order to fingerprint secondary triploid hybrids derived from tetraploid hybrids mentioned previously. In this case, a single primer was identified which could generate unique fingerprints for the four hybrids which have been registered in the public domain [13]. Comparable analysis using RAPD could not identify a similar level of polymorphism .

Particle bombardment of embryogenic cell suspensions

Laureen Michelle and his colleague in 2005 have shown a plant regeneration method with cell suspension cultures of banana, and the effect of biobalistic on its regeneration potential. The abandon comes up to become of regenerated plants was practical between 45 and 60 days after embryo formation. In the designing try, 401 plants were regenerated wean away outlandish approximately 10 mL of packed cells. In the sanction policy test, 399 plants were regenerated from a stall prepare six months older than that of the first experiment. Stall variant practice fraction greet up several choice plasmid constructions, containing the uid-A gene, resulted in a vigorous GUS transportation five days after bombardment; however, plant regeneration from these bombarded cells was much lower than non-bombarded ones.

Agrobacterium-mediated transformation of meristems:

T.R. Ganapathi 7 and his colleague in 2001 first report reported the transformation in Musa sp. via agrobacterium Tumefaciens.They describe herein the development of embryogenic suspension cultures, Agrobacterium-mediated transformation, and plant regeneration of Rasthali (genome AAB) .Agrobacterium tumefaciens strain EHA 105 [14] harboring pVGSUN (Zeneca Plant Science, UK) was used for transformations.

Biotechnology approaches in enhancement of banana cultivation

Mass clonal propagation

Currently, banana is propagated in vitro by proliferating shoot-tips on culture media containing high BAP (6- benzyl aminopurine) concentrations. Multiplication rate is very cultivar dependent, ranging from duplication to centuplication of meristems a one month. Large-scale clonal propagation, through cell suspension culture and somatic embryogenesis serves as an exciting alternative. This could be achieved by mass cultivation in fermentors (also known as bioreactors). To achieve this, mass clonal propagation procedures need to be perfected (maintenance of genetic integrity, synchronous embryo development, etc.). The mass of somatic embryos thus obtained in bioreactors could also be

used in the production of artificial seeds by encapsulating them in alginate or agar beads.

In Vitro Propagation Techniques for Producing Banana Using Shoot Tip Cultures:

Banana (*Musa accuminata* L.) has a place with the Musaceae family. Banana gives a great many individuals all through the tropics and subtropics with staple sustenance and records for a standout amongst the most broadly sent out organic products on the planet. In the blink of an eye, banana is developed in around 150 nations over the world on a range of 4.84 million ha, creating 95.6 million tons [15]. It represents roughly 22% of the crisp organic product creation and as the second most essential natural product crop; Africa represents 35% of the aggregate world generation [16]. It is one of the most seasoned organic products known not and is the tastiest natural product utilized as backup sustenance. It is utilized as a part of various courses, for example, for table reason and additionally culinary natural product; its leaves and stems are slashed and utilized as dairy cattle bolster. A few types of banana yield fiber, which is utilized for making ropes. The tip of the inflorescence is cooked as a vegetable in some spots [17]. The plant is likewise utilized for adornment reason as a part of wedding, celebrations, and fairs. It is likewise utilized as crude material as a part of commercial ventures for the arrangement of banana powder, chips, juices, and lager. The juice of banana stem is utilized as a part of making paper bond, tissue paper etc. Despite this vital utilization of banana, its creation has been diminishing since the nineteen seventies. In northwestern parts of Tanzania in Kagera district, creation diminished from 10 t to 4 t for every Hectare because of declining soil ripeness and the rise of vermin and ailments [18]. This is low generation contrasted and banana creation in different parts of the world like India where the creation was on a normal of 26.7 t for every Hectare.Banana plants are typically engendered by vegetative means by utilizing suckers which develop from sidelong buds starting from corms, and suckers are utilized for generation of individual plants. In some cases, finish or isolated corms with one or a few buds might be utilized. This procedure is moderate as the rate of augmentation of suckers through customary vegetative means has been found to express a few negative effects which incorporate transmission of sicknesses, low creation and poor conservation of unique plant hereditary material [19]. The non-proficient development rehearses, bug scourge and viral maladies influence the yield and nature of banana product [20].

Effects of Media Composition on Growth and Development of Banana Shoot Tips :

The elements of plant tissue society media can be sorted as inorganic salts, natural mixes, complex common arrangements and idle strong materials [21]. The triumphs with plant cell and organ societies have been relied on upon utilization of proper supplement media. By giving the vital chemicals in great blends and structures, it has been conceivable to build up societies from for all intents and purposes each plant part [21]. Inorganic macronutrient and micronutrient levels utilized as a part of most plant tissue society media depend on levels built up in the plant tissue society medium created by [22] for tobacco tissue society "MS medium" [23]. Thus, no single medium can be recommended as being completely acceptable for a wide range of plant tissues and organs [23]. Murashige and Skoog [22], is the most generally utilized plant society medium [24]. A few media plans have been accounted for banana shoot tip society with slight alterations of MS media [25]. Other prevalent media incorporate B5 [26], SH (Schenk and Hildebrant [27], N6 [28] and Linsmaier and Skoog (LS) [29] media [30] [31]. The MS medium of Murashige and Skoog (1962) is a salt organization that supplies the required large scale and micronutrients. With a specific end goal to accomplish development and separation of cells or tissues, groupings of inorganic supplements must be streamlined such that the medium meets the necessities of the cells or tissues utilized [32].

The Role of Vitamins in Banana Tissue Culture :

In spite of the fact that the premise of all supplement media is a piece of fundamental supplements [34], vitamins are required in follow adds up to serve the reactant capacities in chemical frameworks [32]. Some plants can orchestrate the vitamins key for their development. However when plants are developed in vitro, vitamins may go about as constraining variables for cell development and

separation [35]. Different studies have affirmed that the vitamins thiamine and nicotinic corrosive influenced cell division in the pea root meristem [36] [37]. These vitamins worked in the mix, i.e. both the nearness of thiamine and nicotinic corrosive advanced the root development. The four vitamins; myoinositol, thiamine, nicotinic corrosive, and pyridoxine are elements of Murashige and Skoog (1962) medium and have been utilized as a part of changing extents for the way of life of tissues of numerous plant species [38]. The necessities of cells for added vitamins fluctuate as indicated by the way of the plant and the sort of society [39]. This makes it difficult to infer that every one of the vitamins which have been utilized as a part of a specific investigation were fundamental or they will work for another experiment. In banana, vitamins supplementation to the tissue society media has been barely concentrated and frequently laborers have a tendency to embrace a "belt and supports" mentality towards minor media segments, for example, vitamins and add uncommon supplements just to guarantee that there is no missing component which will confine the accomplishment of their analysis. Here and there complex blends of upwards of nine or ten vitamins have been utilized [39] [40]. In this way, there is a need to examine the ideal measure of regularly utilized vitamins for every banana assortment in tissue society.

The Role of Growth Regulators (Auxins and Cytokinin) on Growth and

Development of Banana Shoot Tips:

Growth regulators assume a key part to developing a particular method of development in the cultured cells or tissues, which might be because of a collection of particular biochemical substance in them. The single or mix of various hormones in the medium causes upkeep of particular and adjusted inorganic and natural substance in the developing tissue. This leads the cells or tissues to form either into shoots/or roots or even passing [41]. In tissue society, plant development controllers are essential media segments in deciding the advancement and formative pathway of the plant cells. Development controllers are utilized as a part of various extents to break torpidity and upgrade shoot arrangement as the apical lethargy is under the control of these development controllers [42]. The cytokinins and auxins are of significance in in vitro society as the auxins are concerned with root development, whereas cytokinins are primarily required in the media for shoot arrangement and development of buds [43]. These development controllers are required in the mix in the media as it is dependably the control and variety of auxins and cytokinins levels that can effectively change the development conduct of plant societies [44].Cytokinins, for example, benzyl aminopurine (BAP) and kinetin are known not the apical meristem strength and prompt both helper and extrinsic shoot arrangement from meristematic explants in banana [45].However, the use of higher BAP fixations hinders prolongation of unusual meristems and the transformation into complete plants [46].Auxins and other development controllers, for example, gibberellins assume critical parts in the development and separation of refined cells and tissues [47] [48]. Auxins, for example, Naphthalene acidic corrosive (NAA) have been accounted for to advance plant establishing in vitro [5] [14]. The utilization of plant development controllers (PGRs) in plant supplement media for in vitro society relies on upon plant tissue development arrange and expected final item. Cytokinins assume a vital part in buds development in vitro. However buds multiplication in vitro is affected by the apical strength which is controlled by various development regulators[56] [57]. The genotype of given plant species decides its buds multiplication in vitro. Aside from the impact of genotypes, shoot multiplication rate and lengthening are affected by cytokinin sorts and their concentration.Adenine-based cytokinins are utilized as a part of a few Musa sp. for in-vitro spread [58]. N6-benzylaminopurine (BAP) is the most normally favored cytokinin [14]. The others are isopentyl adenine (2-ip), zeatin and kinetin [59]. The grouping of exogenous cytokinin has all the earmarks of being the principle element influencing multiplication.Many concentrates on have reported the utilization of auxins and cytokinin in tissue society. Gubbuk and Pekmzci [58], reported that direct convergences of cytokinins expanded the shoot expansion rate, yet high fixations diminished duplication and particularly discouraged shoot lengthening [58]. Likewise, they reported higher shoot expansion and extension with Thidiazuron (TDZ) than with BAP. Notwithstanding, BAP above 20 µM and TDZ more than 2 µM diminished shoot prolongation. The utilization of TDZ is known not shoot prolongation. In a study directed by Lee (2004), it was found that TDZ at 0.91 µM impelled the biggest number of shoots, yet at higher

centralization of TDZ (9.1 μM), prolongation of shoots was hindered and bunches of little globular buds showed up at the base of shoots [60].In a study on impacts of auxin/cytokinin mix on shoot multiplication on banana cultivars, [61], reported M. Ngomuo et al. 1618 that joining of a solid auxin in the media stifled the shoot multiplication rates of the banana cultivars.On media adjusted with low cytokinin/auxin proportions, for instance, 16.8/1.0 and 16.8/1.2 ZN/NAA mixes, the East African Highland banana (AAA-EA) cultivars demonstrated single shoot advancement and callus incitement because of apical predominance coming about because of expanded level of auxin fixation [61]. In another study, Buah et al. [62], exhibited that distinctions existed in the relative qualities of various cytokinin sorts in prompting shoots. This differential capacity of various hormones in instigating shoots in vitro was ascribed to components, for example, soundness, versatility and the rate of conjugation as well as oxidation of hormones [62]. The focus and mix of auxins and cytokinins in the supplement mediums is a critical component which decides effective plant recovery [22]. In this way for productive in vitro proliferation of banana, the foundation of an ideal blend of cytokinins and auxins and their collaboration in a tissue society medium for a particular cultivar is important.

Transgenic technique to for improvement in fungal and viral resistance free plant:

Transgenic plants are plants that have been genetically modified by inserting genes directly into a single plant cell. Transgenic plants that have been modified for improved flavor, pest resistance, or some other useful property are being used more and more. Transgenic plants are unique as they develop from only one plant cell. In normal sexual reproduction, plant offsprings are created when a pollen and an ovule fuse. In a similar laboratory procedure, two plant cells with their cell walls removed can be fused to create an offspring. There are three general approaches that can be used to insert DNA into a plant cell: direct DNA absorption, particle-mediated transformation, and vector-mediated transformation. With vector-mediated transformation, a plant cell is infected with a virus or bacterium that, in the process of infection, inserts the DNA. The most commonly used vector is the crown gall bacterium and Agrobacterium tumefaciens. With particle-mediated transformation (particle bombardment), using a tool referred as a "gene gun," the DNA is inserted into the cell by metal particles that have been accelerated.

Fungal resistance plant:

Transgenic plants have been produced by inserting antifungal genes to confer resistance to fungal pathogens. Genes of cell wall-degrading enzymes from fungus, such as chitinase and glucanase, are frequently used to produce fungal-resistant transgenic crop plants.

Virus resistance free plant: An RNA interference Technology

isease damage despite substantial pathogen levels. Disease outcome is determined by three-way interaction of the pathogen, the plant and the environmental conditions (an interaction known as the disease triangle).Disease resistance protects plants from pathogens in two ways: mechanisms and by infection-induced responses of the immune system. In comparison to a susceptible plant, disease resistance is the reduction of pathogen growth on or in the plant, while the term disease tolerance can be described as plants that exhibit little

Conclusion

This review portrays the potential techniques for the upgrading of Musa production for ailment and pest resistance utilizing the current change frameworks. The utilization of fitting develops may permit the generation of nematode, growth, bacterial and infection safe plants in an essentially shorter timeframe than utilizing ordinary reproducing, particularly if a few qualities can be presented in the meantime. It might likewise be conceivable to consolidate different attributes, for example, dry season resilience, along these lines amplifying the geographic spread of banana and plantain production.The transgenic approach indicates potential for the hereditary change of the yield utilizing a wide arrangement of transgenes at present accessible which may give pest resistance and disease. Today, biotechnology provides banana and plantain improvement programs, clean and fast multiplication of genotypes via micro-propagation, genetic markers and diagnostics to ensure virus-tested germplasm, for assisted selection and gene introgression.

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