REVIEW OF LITERATURE
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The history of plant tissue culture is now a legend and has been recorded by many; by those who were part of making the history and have lived it, and also by several contemporary plant tissue culturists. It was in 1838-39 that Schleiden (1838) independently stated the ‘cell theory’ and proposed the ‘totipotency’, which state that cells are autonomic and in principle are capable of regeneration to give a complete plant. Their theory was in fact the foundation of plant cell and tissue culture. In 1878, Vochting reported callus development in numerous species. Sachs (1880-82), from his work on callusing and wound healing, proposed that the plants contain substances which assist in organ formation and are polar distributed. The basic principles of cells and tissues culture were clearly formulated by Haberlandt in 1902. He worked on single cells derived from palisade tissue of leaves, pith tissue of stem and glandular and stamen hairs of *Tradescantia* and demonstrated that these cells could be kept in a viable state up to 20-27 days mineral solution containing sucrose, asparagines and peptone. Cells were able to synthesis starch as well as increase in size and survived for several weeks, but failed to divide. Robbins (1922) postulated that meristemetic tissues are better starting materials for tissue culture work. One of the milestones in plant tissue culture was the discovery of IAA, a natural auxin by Went in 1926. This lead to the possibility of culturing plant tissues for indefinite period as reported by Nobecourt (1938, 1939) and Gautheret (1939).

The history of plant tissue culture and its applications have been reviewed and discussed from time to time (Gautheret, 1983, 1985; Krikorian, 1984, 1988; Thorpe, 1990, 2007; Gamborg, 2002). The problems and potentials of using tissue culture in micropropagation and biotechnology related to crop improvement have been critically
Plant tissue culture techniques have become powerful tools for studying basic and applied problems in plant biology. The term plant tissue culture is commonly used to describe the *in vitro* and aseptic cultivation of any plant part on nutrient medium. The knowledge of this technique began in 1900. Haberlandt (1902) a German Botanist cultured, single cell isolated from various parts of different plants on artificial medium in controlled laboratory condition.

Gautheret (1934) was the first to obtain calli but not subcultures from cambial explants of angiosperms and conifer trees and also trachied formation noted in these cultures and a few of the hard wood trees explants produced small shoots (Gautheret, 1942). Since then tissue culture technology have been developed and utilized in several plant species during the past three decades, the induction and development of these techniques has allowed the study of problems previously inaccessible and turned the dreams of Haberlandt, White and Gautheret into realities.

Up to this time the main objective of tissue culture work was ascertaining the possibilities of culturing the cell indefinitely. Once this objective was achieved, attention was directed to the possibility of using this technique for vegetative multiplication, organogenesis, synthesis of secondary products etc. The starting point of modern *in vitro* vegetative propagation methods (micropropagation) was started with Ball (1946), as he pointed out exactly which part of a shoot meristem gave rise to a whole plant, Skoog and Miller (1957) found that organogenesis was controlled by a balance between auxin and cytokinin. This leads to the need of standardization of auxin and cytokinin ratio.
The most successful species to respond to tissue culture are from solanaceae family, which have been used as model system for *in vitro* studies. Totipotency was demonstrated with *Nicotiana tobaccum* by regeneration of mature plants from single cells (Vasil and Hilderbrandt, 1965).

The demonstration by Guha and Maheshwari (1964) that immature anthers of *Datura innoxia* when cultured on artificial nutritive media can give rise to plantlets with haploid numbers of chromosome, opened up a new approach to the induction of haploid plants. This technique was later effectively used in different crops.

The culturing of embryo *in vitro* was the first tissue culture technique to be applied to plant improvement. The principal advantages of embryo culture are rescuing embryo after inter-specific hybridization, clonal propagation of recalcitrant plants such as legumes, cereals and overcoming seed dormancy and seed sterility. In several plants of legumes like, *Alfà alfà* (Saunders and Bingham, 1972), Red gram (Walker *et al.*, 1979; Gosal and Bajaj, 1979), Groundnut (Narsimhlu and Reddy, 1983), Moong bean (Bhargav and Chandra, 1983) and Glycine max (Wright *et al.*, 1986); cereals like Sorghum (Wernicke and Brettell, 1982; Baskaran and Smith, 1989 and Sharma *et al.*, 1989).

In general the productivity of sesame is relatively low as compared to that of other oil crops because the cultivation of sesame is restricted by poor soil (Evans *et al.*, 1984), recently cell culture techniques have been successfully utilized to obtain useful variants such as high lysine mutants, salt, aluminium and herbicide tolerant cell lines which may represent a new and useful source of genetic variations (Kwon *et al.*, 1993).
Tissue culture studies in sesame

Efforts are being made to improve cereal crops, legumes, forest and fruit trees through tissue culture, but the oil seed crops have received little attention. International Development Research Centre (IDRC), Canada in 1984, have identified the production of haploids by anther culture as a powerful tool to speed up the breeding work in a number of oil crops such as Sesame, Sunflower and Niger, etc.

Sesame is an important oil crop plant; cultivation of sesame suffers from considerable yield loss because of pathogenic diseases like phytophthora blight and root/stem rot (Gangopadhyay et al., 1998), in addition it is difficult to determine the time of harvest a sesame crop to maximize yield because plant growth is indeterminate and spontaneous capsules dehisce when mature (Day, 2000).

The in vitro technologies for the improvement of this species have been applied since long back, but little progress has been achieved with respect to plant tissue culture because Sesamum is found to be highly recalcitrant for in vitro studies (Baskaran and Jayabalan, 2006; Rajender et al., 2002). The first reported study on tissue culture in sesame was that of Brar and Ahuja (1979). There are few reports dealing with the tissue culture of sesame (Lee et al., 1985 and 1988, Bapat et al., 1989; Shuwen and Caiming et al., 1989).

Pertaining to tissue culture studies in sesame, several authors have reported using different types of explants (cotyledon, hypocotyl and deembryonated cotyledon), among the explants used hypocotyl explants showed good response in number of publications. (Mary and Jayabalan, 1997 and Seo et al., 2007).
Callus induction in sesame

Explants and hormone combinations on callus induction was studied by Kim et al., (1987) in order to obtain herbicide tolerant lines of sesame using in vitro selection for the first time. Callus obtained from seedling derived explants is reported by Mary and Jayabalan 1997; Xu et al., 1997 but with low plant conversion frequencies. Callus induction from hypocotyls and cotyledon explants of S. indicum L. VRII was investigated by George et al., 1987; Kwon et al., 1993; Kariyallappa et al., 2003; Baskaran and Jayabalan; 2006. Lokesh et al., 2007 reported callus induction and followed a new method by inoculating the sterilized seeds directly on MS medium supplemented growth hormones in six varieties. Were, et al., 2006; Almelu et al., 1992; Datta et al., 1990; Kim, 2001; Lee et al., 1988; Mary and Jayabalan, 1997; Rao and Vaidyanath, 1997a and 1998 reported for induction callus in sesame. Hypocotyl explants excised from two in vitro grown S. indicum and S. mulayanum species were studied for callus induction by Shashidhar et al., 2011.

Induction of somatic embryos

Somatic embryogenesis is an efficient method of plant regeneration allowing rapid production of large number of “True to Type” plants within a short period. The plants derived from somatic embryos are usually unicellular in origin and hence genetically uniform. Somatic embryogenesis is useful in many ways viz., large scale propagation of plants, production of synthetic seeds. The first observation of in vitro
somatic embryogenesis was made in *Daucus carota* (Steward *et al*., 1958; Reinert, 1958).

Effect of culture manipulation, nutritional, physical and chemical factors for the induction of somatic embryogenesis has been well documented (Ammirato and Steward, 1971; Ammirato, 1983; Lazzeri *et al*., 1987; Reddy and Reddy, 1993). Auxins are usually more suited for induction of somatic embryos (Ranchi *et al*., 1985; Barwale *et al*., 1986; Tian *et al*., 1994; Rani and Padmaja, 1997).

Somatic embryos were induced from zygotic embryos reported by Ram *et al*., 1990 and somatic embryos induced from callus derived from hypocotyl explants in sesame (*Sesamum indicum* Var. TMV 6) reported by Mary and Jayabalun, 1997 and somatic embryo formation using cotyledon explants and plant conversion from somatic embryos at low rate reported by Xu *et al*., 1997. Direct somatic embryogenesis in *Sesamum indicum* L. CV-E8 using cotyledon and hypocotyl explants and successful conversion of plantlets is reported by Honnale and Rao, 2013.

**Regeneration studies in sesame**

Plant tissue culture technology has been available to the plant breeders for nearly four decades and has been extensively employed for crop improvement in several oil seed crops, however very little information is available on *in vitro* culture of sesame (Tiwari *et al*., 2011).

The first report on tissue culture in sesame was by Lee *et al*., 1985 using shoot tip explants followed by George *et al*., 1987 using different explants of sesame. In sesame,
micropropagation is achieved from shoot tip (Rao and Vaidyanath, 1997a), nodal explants (Gangopadhyay et al., 1998) and leaf explants (Sharma and Pareek, 1998).

Indirect adventitious shoot regeneration from hypocotyl and/or cotyledon explants has also been reported at low frequencies (Rao and Vaidyanath, 1997b; Taskin and Turgut, 1997; Kim, 2001; Kariyallappa et al., 2003; Shashidhara et al., 2008 and Baskaran and Jayabal 2006). Effect of different media supplements on multiplication and regeneration of sesame was reported by Saravanan and Nadarajan, 2005.

Influence of macronutrients, plant growth hormones and genotype on adventitious shoot regeneration from cotyledon explants was reported in sesame by Were et al., 2006. High-frequency plant regeneration via adventitious shoot formation from de-embryonated cotyledon explants of sesame was reported by Seo et al., 2007. An efficient protocol for shoot regeneration from sesame internodes using the transverse thin cell layer (TCL) culture method established by Chattopadhyaya et al., 2010. Abdellatef et al., 2010 evaluated the in vitro regeneration of sesame cultivars in culture media containing ethylene inhibitors such as cobalt chloride and silver nitrate and also found growth promoting effects because of reduction in ethylene concentration and then by inhibition of ethylene action. Direct regeneration from hypocotyl explants was achieved by Rao and Honnale, 2011.

Deembryonated cotyledons are also found to be efficient explants for high frequency plant regeneration via adventitious shoot formation (Seo et al., 2007 and Lokesha et al., 2012).

The only option left for improvement of S. indicum is to transfer genes from other sources through genetic transformation techniques. However the main obstacle to genetic
transformation is the recalcitrant nature of sesame to in vitro regeneration (Baskaran and Jayabalan, 2006).

**Genetic transformation**

Genetic engineering techniques play an important role in crop improvement and in combination with breeding will provide the tools with which new improved varieties will be developed at a faster pace in the future.

More than 120 plant species have already been successfully transformed and these include representatives from the major vegetables, fruits, trees and ornamentals. Over 60 species are involved in field tests in 45 mainly, industrialized countries.

In USA, insect resistant cotton and maize, virus resistant squash, several herbicide resistant transgenic crops including soybean are commercially produced and different genetically engineered tomatoes with extended shelf life are sold in supermarkets. In 2004, transgenic crops were grown on 81.0 million hectares spread over six continents and 17 countries, including India, on six continents, marking a 47 fold increase in the area since their first commercialization in 1996. The dominant transgenic traits were insect resistance (IR) with *Bacillus thurengensis* and herbicide tolerance (HT), either alone or both stacked. USA is the leading country in the commercial cultivation of transgenic crops, accounting for 59% (47.6 m ha) of the total 81 m ha followed by Argentina 20% (16.2mha), Canada 6% (5.4mha), Brazil 6% (5.0mha), China 5% (3.7mha), Paraguay 2% (1.2mha), India 1% (0.5mha) and South Africa 1% (0.5mha). The figures demonstrate that plant transformation has now become a routine methodology whereby the key issue is no longer the production of individual transgenic plants but the
generation of transgenic populations with a uniformity and predictable pattern of transgenic expression.

*Agrobacterium tumefaciens* mediated genetic transformation in *Sesamum indicum* L.

Genetic transformation provides an opportunity for single gene or gene combinations, to be extracted from the genome of the source organism and transferred directly into the desired variety. This allows the variety in question to retain its entire original characteristic with the simple addition of the desired trait.

As per the survey of literature pertaining to the transformation study in *Sesamum indicum* L. there are only two reports by Taskin et al., 1999 and Yadav et al., (2010) and both worked on *Agrobacterium* mediated genetic transformation using different expressing genes.

The soil salinity problem is widespread in the arid to semi arid areas and in the sub humid to humid climates particularly in the coastal regions where increases of sea water results in large scale soil and water salinization (Panda, 2001). Sodium chloride is by far the most abundant in saline soils. In order to overcome these problems crops which are resistant to salinity to be grown. It would therefore be important to identify the morphological, physiological as well as biochemical parameters identifying for salinity sensitivity in the crops (Panda, 2001).

Abiotic stresses such as salinity, drought, desiccation, low temperature and high temperature stresses are adversely affect the cultivation of corps to a significant extent (Pareek et al., 1998). The extent of damage caused by these stresses varies depending upon various parameters (Yoshida, 1981).
Transgenic over expression of the *AP37* in rice increased the tolerance to drought, high salinity and low temperature at the vegetative stage and transgenic plants also showed significantly enhanced drought tolerance at the reproductive stage, as evidenced by the increase in grain yield over controls under severe field drought conditions (Kim *et al.*, 2009).

The over expression of *AP37* and *AP59* in rice under the control of the constitutive promoter OsCc1 increased the tolerance to drought and high salinity at the vegetative stage. Increased tolerance to low temperatures was observed only in OsCc1:AP37 plants. More importantly, the OsCc1:AP37 plants showed significantly enhanced drought tolerance in the field, which increased grain yield by 16% to 57% over controls under severe drought conditions, yet exhibited no significant difference under normal growth conditions. This suggests that *AP37* gene has the potential to improve drought tolerance in rice without causing undesirable growth phenotypes (Oh *et al.*, 2009).