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CLONAL MINI HEDGE TECHNOLOGY FOR COMMERCIAL AND RAPID PRODUCTION OF EUCALYPTUS CLONES: ADVANCEMENT IN CLONAL TECHNOLOGY

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Clonal propagation technology is used for mass production of true to type quality planting stock in which all the genetic superiority of the parent tree is retained. Initially we multiply the clonal plants from coppice shoots derived from the mother plant of 1.5-2 years old. The process is cumbersome and involves huge land area for clonal multiplication purpose. The development of micro-cutting technology for *Eucalyptus* allowed the concept of super intensive management of producing vegetative propagules to be achieved at commercial scale as for cuttings systems for large scale production of vegetative propagules *ex vitro*. Originally the system was based on mini hedges established through rooted mini cuttings, grown in small series of technical and Economical benefits as well as good root quality. Despite representing great advance over coppice cuttings in the open field mini cuttings in container faced some limitations. The open mini hedges (cuttings which were collected from Clonal Multiplication area or gene bank) were hostages of climate, and the problem related to adequate maintenance of nutritional status and leaf disease continued, especially during winter. The main problems were: reduced photosynthesis rate, reduced nutritional uptake and high level of nutrition loss by leaching during the periods of excessive rainfall, or even during irrigation. These limitations led to development of an indoor Mini Cutting system.

We have installed naturally ventilated poly house covered with UV rays stabilized 200 micron polythene provided with Fertigation system, temperature and humidity controllers. We have planted superior mother plants in raised bed filled with pure sterilized sand at 15 cm x 15 cm spacing. We are providing the required fertilizer dosage through Fertigation system to the plants. We are also providing constant humidity and temperature to the plants. Every month we are getting about 15-20 juvenile coppice shoots from a single mother plant. The adequate fertilizer dosage and nutritional status in the plant will help in increasing rooting percentage in Mist Chamber.

Key Words: Clonal Propagation, Eucalyptus, Mini Cutting

Mass vegetative propagation has become an important tool for increasing the competitiveness of the forestry based industry. This method reaches its highest potential when it is used to established clonal forests of hybrids endowed with better quality and higher volumetric growth. However, in several hardwood species most notably in Eucalyptus, the popular method of rooting stem cuttings has limitation for example, rapid loss of rooting competence due to ontogenetic ageing, intra-clonal variation resulting from topophysics and poor quality of the root system that in combination negatively affect genetic expression of some clones. Two alternative super-intensive systems, one micro-and one mini cutting, for cloning Eucalyptus at a commercial scale have been applied successfully. These systems have shown great potential for offering technical and economic advantages not available from conventional stem cuttings. The micro-cutting system uses the apices obtained from micro-propagated plantlets, while the mini cutting system is based on the rooting of axillary shoots from rooted stem cuttings. Field clonal hedges are replaced by indoor hydroponic mini-hedges, which provide plantlets or rooted cuttings with a high

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degree of juvenility. The success of the system is also dependent on achieving optimal nutrient status in the resulting mini-cutting.

Introduction of Clonal Mini Hedge (Mini Cutting) Technology

The idea came up with the observations that rooting ability of stem-cuttings decreases with ontogenetic ageing and the decline may be faster than reported in the literature. In *E. grandis* for example, the rooting competence decreased from the fourteenth node up (Patton and Willing 1974) while it took longer in the *E. delgupta.* Assis *et al*. (1992) observed that clones of *E. saligna, E. grandis* and *E. urophylla* that had equally high proportion of stem-cutting rooting *in vitro,* showed differential levels of decline in the rooting percentage when managed in clonal hedges. This indicated that some factor related to clone growth, encompassing period between planting and cutting harvest (6 months), could be responsible for these differences. Preliminary tests done at Klabin Riocell showed, independent of the species, almost 100% rooting of the very young mini-cuttings obtained from the cotyledonary leaf pair and the same tendency was maintained in the difficult to root species like *E. citriodora, E. cloeziana*, *E. paniculata, E. dunnii,* and *E. globules*. However, with age, ranging from few days to some months, the cuttings harvested from such young plants showed a marked reduction in their rooting ability and in some cases ability was totally lost. These observations suggested that the rooting potential reaches the maximum value at the high juvenility level and is similar in all species tested. But the decrease in the rooting ability with seedling age differed among species, which was similar to that found in the older material in the field. This suggests that, at some stage, part of the juvenility obtained through rejuvenation process in vitro (Goncalves *et al.* 1986) and /or on basal sprouts of cut adult trees (Hartney 1980) is being gradually eroded during the growth of the clones in the clonal hedges. Results were obtained from trials established to define substrate, growth substances, environmental condition for rooting etc. One of the most significant findings of this new technology was complete elimination of the use of growth substances usually required for the rooting of stem-cutting (Assis *et al*.1992). These substances did not increase rooting of micro-cuttings, instead in some cases reduced it, indicating that the endogenous auxin concentration in the juvenile tissues was sufficient to promote rooting. Based on these results, a super-intensive system of *Eucalyptus* propagation *ex vitro* was established in 1965. The main feature of the technique is the use of juvenile plants or plants rejuvenated *in vitro*, as source of vegetative propagules. Shoot apices are used as micro-cuttings, which are placed to root in a green house equipped with temperature and humidity control. The actual size of micro-cuttings is about 7 to 8 cm with two to three leaf-pairs. Presence of the shoot apex is important for quality of the root system, because its presence induces taproot-like system. The micro-stumps left after micro-cutting harvest, sprout rapidly producing new micro-propagules, which can be harvested for use with in a period of 15 days in the summer and 30 days in the winter. Since its first use, the micro-cutting technique is improving continuously by incorporating new research findings. The evidence of evolution of this technique are well documented in publications of Assis *et al*. (1992); Xavier and Comerio (1996); Wendling *et al*. (2000); Higashi *et al.* (2000).

The technical contributions, reciprocally exchanged through a pre-competitive development model and intense information

exchange, were the bases for the fast evolution of this new concept of cloning *Eucalyptus* in large scale.

MATERIALS AND METHODS

Advantages of Mini-Cuttings

Compared to the traditional stem-cutting rooting, mini-cutting has many advantages leading to operational, technical, economical, and environmental and quality benefits can be summarized as follows:

- ❖ Choice of a culture substratum allowing the production of the best cuttings, independently of local soils characteristics.
- ❖ Operationally, the labour demand and cost is markedly reduced, due to elimination of labour intensive treatment in similar indoor areas at much lower costs.
- ❖ Reduction of risks by the pathogens whose expansion is very difficult to control in field-grown stock plants, and limited to the intensely managed crops, resulting in reduced fungicide application.
- ❖ The rooting time of micro-cuttings is usually reduced to half compared to rooting stem cutting.
- ❖ Mini-cuttings produce better quality root system with a tendency for a taproot-like system in contrast to the predominate lateral root growth habit in the stem-cutting system.
- ❖ Best control of stock plant environment, less exposed to the sun and other environment regime variations of field-grown stock plants.
- ❖ The area culture and installation proximity, reducing stress risks between the instant of the crop and the installation of the cuttings in rooting conditions.
- ❖ Increase of stock plants density and their productivity/ surface.
- ❖ Best physiological conditioning of vegetative material allowing appreciable increase in rooting rate.

RESULTS AND DISCUSSION

In the era of global markets, the development of social and farm forestry plantation for industrial purpose must aim for among other objectives, increasing industrial competitiveness in the distinct markets segments they interact with. In such a scenario, forestry based companies must consider the mode in which the forestry raw material can affect their competitive capacity. The modern concept of competitiveness includes producing products to meet the customer's requirements at low costs, in a sustainable manner and with minimum impact on the environment. Therefore, developing tree breeding programs to obtain quick gains, and also developing cloning systems to have a well established vegetative propagation method becomes important. The vegetative propagation methods should rapidly transform genetic gains obtained through breeding or genetic transformation, into benefits for the industry.

One of the most efficient tools to acquire these objectives is the combination of interspecific hybridization and establishment of clonal forestry derived from superior hybrid individuals.

The traditional *Eucalyptus* clonal technology using coppice cuttings from 1.5 to 2 years old plants is cumbersome also requires about 2 years starting multiplication of *Eucalyptus*. The traditional clonal technology is also liable for insect infestation like Gall insect, little leaf etc.

From 320 sqm naturally ventilated Poly house (Mini Hedge House), we are getting about 15000 mini juvenile cuttings per month and

180000 per annum (about 20-22 cuttings/plant). We need to maintain about 8000 mother plants in clonal Multiplication area in field covering and area of about 10 acres land. The survival of coppice cuttings will be about 62-65% which has increased to 85-88% by using mini hedge technology. The mini hedge technology has also reduced time required for rooting from 45 days to 35 days which helps in increasing production capacity of Clonal plants. By use of mini hedge technology anyone can introduce/ produce new

(A) Collection of pricks from Mini Hedge Garden

(B) Mini Cutting charged inside Mist Chmaber

(C) Sprouted shoots in Mini cuttings in Mist Chamber

(D) Rooted shoots in Mist Chamber

(E) Hardening and Acclimatization in Hardening Chamber

(F) Hardened plants in Open Nursery

(G) Ready plants in Open Nursery

Fig:1- A-G: Clonal production system Through Mini Cutting Technology

clone with in the period of 2 months. On the other hands traditional technology takes at least 1.5 year for the same. The cost of clonal production will reduce drastically by using mini hedge technology hence we can provide cheaper clones to the farmers to take up plantation by using genetically superior seedlings. This will increase yield by 2-3 times as compared to normal seedlings (Fig-1).

CONCLUSION

To meet the increasing demand for timber in the future, fast growing Eucalyptus plantations are expected to make great contribution. In this direction, Clonal Eucalyptus has shown promising future with fast growth and development by giving 3-5 times more biomass than the seedlings plants. The quality as well as quantity of wood products achieved from the commercial plantation through clonal *Eucalyptus* through scientific management is one of the major achievements. Farmers, who do not follow the scientific method of plantation, results are not encouraging whereas farmer who follow the right and scientific package of practices has got excellent returns in quantity and quality and achieved high yield with good economic returns as compare to seedling *Eucalyptus*. This shows the eye opening to the farming communities and local inhabitants for large scale takeover of *Eucalyptus* clonal plantation which may directly and indirectly benefits to the pulp and paper industries in the coming years for the point of raw material security.

Mini hedge technology has gained lots of attention for commercial growers who are actively engaged in clonal production of *Eucalyptus*. Excellent results are coming from this effort. It would also be proven a boon for commercial growers of *Eucalyptus* to enhance production level in short time period with less requirement of land. The use of mini hedge technology has resulted in significant increase in clonal plants productivity in same nos. of mist chamber area. Nos of days required for rooting of cuttings inside the mist chamber will also be reduced from 45 days to 35 days. Nos. of days required to produce/introduce new clones will also be reduced from 1.5 years to 2 months. This would also increase rooting percentage inside the mist chamber increased from 65 % to 85%. The early production of quality material of clonal eucalyptus using mini hedge technology will provide an opportunity to the farmers to grow Eucalyptus on their farm lands on large scale. Field performance of these clones gives an idea to understand their field growth, their suitability and superiority in different field conditions. This would also improve and increase the level of agroforestry and forest cover. Farmers would be benefitted from plantation of clonal *Eucalyptus* on their farm land either in block or using intercropping pattern to get extra income from the plantations.

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