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MODELING OF A BIOSENSOR BASED ON ELECTRICAL MEASUREMENT OF GRAFT UNION IN PLANTS

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ABSTRACT

Grafting is important, feasible and dominant over other means for getting good yields from the plants because it does not implicate soma clonal variation in the yields. The detection of graft compatibility at early stage is, therefore, important in agriculture and forestry production. The other reported methods for detection of graft compatibility in plants are time-consuming, require skilled labour along with repeated treatments and are not user friendly. The compatibility of graft union in plants has been found proportional to the drop of the electrical resistance appeared at the interface of the graft union. The drop of electrical resistance of graft union has been found the universal phenomenon for the successful grafts and can be taken as the analyte to trace the morphological changes in the cell of graft interface. A model of an electrical biosensor has been proposed in the present study to detect the compatibility of the graft union more efficiently in comparison to the techniques used by the other scientists because it is capable of detecting vertical motion of cells of the order of 1 nm, much below the resolution of an optical microscope.

KEYWORDS : Grafting, Electrical Signal, Biochemical Signal, Receptor, Detector

Grafting is an art of joining parts of two plants of the same or allied species in such a way as to bring about an organic fusion of the tissues. Grafting helps in getting an economically important plant having useful characters of two different individuals in a short time.

Various efforts have been made by the scientists to detect the compatibility of the graft union by exploiting its various characteristics e.g. Tensile strength of the graft (Robert and Brown, 1961), applying a weight that increases at constant rate between grafted nodes and introducing breaking weight per unit graft area (Lindsay et al, 1974, Moore, 1984) etc. These techniques were time consuming, laborious as well as not monitoring the changes of the development process in the same plant. Later on the electrical resistance of graft union was measured and its drop at different days after grafting was observed to be correlated with the appearance of secondary plasmodesmata at the site of the scion in a graft union (Yang et al, 1992, Overall et al 1982), where the grafted material has to form lines of communication between the differing cell lines, to allow the passage of small molecules and other information signals from the one cell to the other (Holman and Glockmann, 1985, Dewa and Ko, 1994). The impact of electric field on the plant growth and consequent electrical measurements has been reported for the sample of various plants. The germination rate of Gram seed was observed to be augmented if the seeds were well exposed with the electromagnetic field of suitable strength and beyond an optimum value of electric field the germination rate was observed to be declined in comparison to control (Das and Bhattacharya, 2010). The impact of electric current on morphological growth of the various plants has been found significant for 20 ma current (Mishra and Tiwari, 2011). The electric field in positive control has also been observed to enhance the graft compatibility in plants employed for getting good yields (Mishra et al, 2010). The bio molecular characterization of the impact of electric field on the plant system has already been reported (Mishra, 2015).

Biosensor has two components: a receptor and a detector. The receptor of the biosensor is responsible for the selectivity of the biochemical signal of the sensor. The detector, which is basically a transducer, converts the physical or chemical change by recognizing the analyte and relaying it through an electrical signal. The model of the biosensor based on signal transduction through electrical resistance of graft union has been proposed (Mishra and Tiwari, 2012).

In the present study a model of the biosensor has been developed. The receptor of the present biosensor will accept the electrical resistance for the biochemical signal corresponding to the morphological changes in graft union and the detector will trace the drop of electrical resistance of graft union necessary for the compatibility of the graft.

MATERIALS AND METHODS

The pattern of variation of electrical resistance of

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graft union in autografts of Rosa indica and Lycopersicon esculentum was obtained and it was found similar for both the plants. The electrical resistances in both the plants were measured by the method as described by Yang et. al (1992). The variable resistance across the graft union was incorporated with a constant current source to obtain a variable analog voltage corresponding to the morphological changes in the adherent cells of graft union. This part constitutes the receptor of the proposed biosensor. The variable analog voltage was applied as the input of A/D converter to obtain the digital voltage. Variable digital voltages were processed to the 8085 microprocessor already adhered by the instructions.

The microprocessor was interfaced with the peripheral devices (IC 825) to connect the green and red LEDs as the display devices. This part constitutes the detector of the proposed biosensor. When data were processed through the microprocessor as per the instruction given in flow chart, the glow of green or red LED was observed which was the indication of the success or failure of the graft union respectively.

RESULTS AND DISCUSSION

The model of the biosensor for the said purpose has been developed and shown in the figure 1. This model has been simulated by 8085 Simulator and observed to be functioning as per the experimental findings in the autografts of Rosa indica and Lycopersicon esculentum (Yang et al, 1992, Mishra et al, 2006).

This model of the biosensor has been found as applicable as the model of the biosensor which has been developed by using current to voltage converter as receptor part and transistor switch as detector part (Mishra et al, 2006). This model of the biosensor has advantage of less time to respond because of the microprocessor as a component of detector. The monetary loss resulting from graft incompatibility may be considerable in horticulture and forestry production. Hence the use of biosensor for the detection of graft compatibility will be important in the commercial practice of the grafting.

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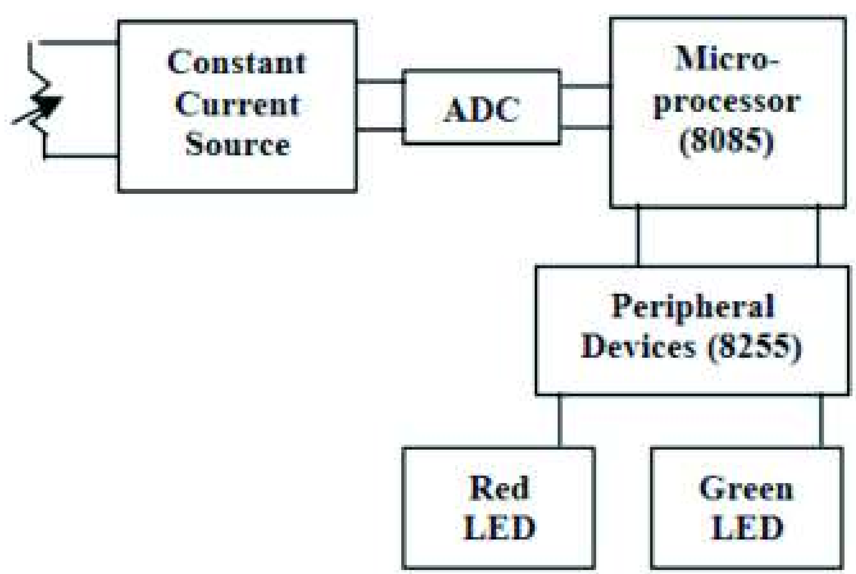

Figure 1 : Block Diagram of the Proposed Biosensor

REFERENCES

Das R. & Bhattacharya R., 2010. Impact of electromagnetic field on seed germination, http://www.ursi.org/Proceedings/ProcGA05/KP.htm.

Dewa A. S. & Ko, W.H., 1994. "Biosensors," Semiconductor Sensors, ed. S.M. Sze (New York: Wiley Interscience : 415.

Holman, R., and Glockmann, C; 1985"Studies on graft unions. I. Plasmodesmeta between cells of plants belonging to different taxa", Protoplasma, Volume **124** : 224-235.

Lindsay, D.W. , Yeoman, M.M and Brown, R; 1974 "An analysis of the development of graft union in Lycopersicon esculentu,", Ann. Bot., **38** : 639-646.

Mishra, A.K. & Tiwari, S.N., 2011 "Emerging activities of biomolecules under electric control enhances plant growth", Journal of Scientific and Technical Research,**1**(1),64-69.

Mishra A. K. & Tiwari S. N., 2012. Biosensor for graft compatibility detection based on signal transduction through electrical resistance of graft union in plants, Proceedings of International Symposium on Physics and Technology of Sensors published in IEEE explore, : 261-264.

Mishra A. K. Tiwari S. N. & Dutta R., 2006. Studies on the Development of an Electrical Biosensor to Detect the Graft Union Success Rate" Proceedings of the Second International Conference on Wireless Communication and Sensor Networks in Macmillan Advance Research Series, Eds. Tiwari et al., : 3-8.

Mishra A. K., 2015. Bio molecular characterization of impact of weak electric field on the plant system, Indian Journal of Scientific Research, **6**(2): 25-29.

Mishra A. K., Mishra K. K. and Tiwari S. N. 2010, Augmentation of graft compatibility through electric control, Indian Journal of Scientific Research, **1**(2):27-31

Moore R, 1982. "Graft formation in Kalanchoe blossfeldiana", J. Exp. Bot., **33**:533-540.

Overall R. L., Wolfe J., and Gunning B.E.S., 1982. "Intercellular communication in Azolla roots. I Ultrastructure of plasmodesmata." Protoplasma , Volume 111, pp. 134-150.

Roberts J. R. and Brown R, 1961. "The development of the graft union", J. of Exp. Bot., **12** : 294-302.

Yang S., Xiang G., Zhang S. & Lou C, 1992. Electrical resistance as a measure of graft union", J. Plant Physiol., **141** : 98-104.