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Research Article

## Standardization of transformation protocol for Tomato (*Solanum lycopersicum*)

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## ABSTRACT

*Agrobacterium* mediated gene transformation method is considered as an effective method for transferring foreign genes into plants. Hence, this study was conducted to enhance foreign gene transformation efficiency of cultivars of tomato (*Solanum lycopersicum*) using Single colony *Agrobacterium* culture from freshly grown culture of LBA4404 containing T-*rep* gene construct in pCAMBIA 2301 was grown in 25 ml of Luria broth medium with appropriate antibiotics at 28°C and 180 rpm for overnight. Infection was carried out in antibiotic free MS liquid medium and incubated for co-cultivation in dark for two days. Before the infection overnight grown *Agrobacterium* culture was re-suspended in antibiotic free Luria broth medium and allowed to grow to the log phase. Explants were then transferred to selection medium (MS salts and B5 vitamins, 3% Sucrose, 1mg/l Zeatin, 0.1mg/l IAA, 80mg/l kanamycin, 300mg/l cephotaxime pH 5.8). After 28 days of incubation at 25±2°C in 16 hr photoperiod condition, explants responded with callus induction were transferred to fresh selection medium. The response of the callus induction on kanamycin selection was more or less similar in all sets of experiments. Most of the survived calluses on second selection medium were observed with shoot induction.

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### 1. Introduction

In Tomato is one of the popular vegetables in India. Yield and the quality of tomato are affected by many factors including pest and diseases, unfavorable weather conditions and post-harvest handling. The crop is highly subjected to post harvest losses during storage and transportation. Therefore crop improvement activities have been mainly directed towards the development of varieties with high yield, pest and disease tolerance and resistance to long term storage. Investigations on use of biotechnology for the improvement of Tomatohave been carried out extensively in recent years. Gene-transformation is considered as the only method used to introduce genes with favorable characters. One of the most effective means of gene transfer into dicotyledonous plants has been reported as the *Agrobacterium tumefaciens* mediated transformation. It is well known fact that genes located within the border sequence of the *Agrobacterium* Ti plasmid are inserted into the genome of the host by random integration.

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Utilization of this mechanism for gene transfer requires both, susceptibility to infection by *Agrobacterium* and the ability to regenerate plants from individually transformed cells via tissue culture. A number of factors contribute to the overall efficiency of the *Agrobacterium* gene transformation. Up to now, the researchers have studied some factors affecting *Agrobacterium*-mediated transformation efficiency such as cocultivation duration, plant genotype, stage of explants, role of phenolic compounds, vector construct, *Agrobacterium* strain, bacterial density, infection temperature, and medium composition. Although a dicotyledonous plant secretes phenolic compound by itself, the addition of acetosyringone is found to be critical for stimulation of virulence gene action. This paper describes a successful approach to obtain regeneration of tomato plants from cotyledon explants and transformation of tomato by *Agrobacterium tumefaciens* method.

#### ***Agrobacterium* mediated genetic transformation in tomato:**

*Agrobacterium* cells containing construct; pCAMBIA2301 with T-*rep* antisense gene along with NPTII gene as selectable marker gene (for antibiotic kanamycin as plant selection marker) & GUS gene as scorable marker gene was used for transformation of Tomato (var. TomD4) using protocol of McCormick (1991) with some modifications. Single colony *Agrobacterium tumefaciens* LBA4404 transformed with pCAMBIA2301 construct was grown in Luria broth liquid medium with rifampicin (25 µg/ml) and kanamycin (50 µg/ml) at 28°C for 18 hrs. With constant agitation at 180 rpm. 25ml of well grown culture was centrifuged at 4000 rpm at 4°C for 5 min. pellet was then re-suspended in 25 ml of Luria broth medium without any antibiotic, with acetosyringone at the concentration of 200 µM. Culture was again incubated at 28°C for 18 hrs. With constant agitation at 180 rpm till the OD reaches to ~ 0.8 (at 600 nm). Finally before infection to the leaf explants the culture was diluted to 1:1 ratio using Murashige & Skoog liquid medium with 1% sucrose pH 5.8 before autoclaving.

Healthy seeds were sterilized with 0.1% HgCl<sub>2</sub> for 2 minutes, followed by sterile distilled water wash for 6-7 times and placed on germination medium (1/2 MS medium) after blot drying on sterilized blotting paper. Seedlings were developed in 16 hr photoperiod at 25 ± 2°C for one week after initial incubation in dark for 2-3 days. Cotyledonary leaves each were excised from 10 days old seedlings and explants were prepared by cutting all the sides of cotyledonary leaves. Placed the prepared leaf explants of size ~ 0.5 cm<sup>2</sup> in adaxial position on the pre-culture medium (MS salts and B5 vitamins, 3% Sucrose, 1mg/l Zeatin, 0.1mg/l IAA, phytoagar 0.25 %, pH 5.8 adjusted before autoclaving). Cultures were incubated at 25 ± 2°C in 16 hr photoperiod for two days before infection.

Infection was carried out in sterile glass beaker, two day pre-cultured leaf explants were removed for tissue culture medium safely without keeping any traces of phytoagar before infection. 50 leaf explants at a time were infected with the *Agrobacterium* culture prepared as described above. Cultures were left for 20 minutes for Agrobacterium infection in dark with gentle shaking. Excess *Agrobacterium* culture was removed. These co-cultivated explants were blot dried on sterile filter paper and then placed on co-cultivation medium (MS salts and B5 vitamins, 3% Sucrose, 1mg/l Zeatin, 0.1mg/l IAA, phytoagar 0.25 %, pH 5.8 adjusted before autoclaving). Incubated the cultures in dark for 2 days at 25 °C.

The cotyledonary leaves were then transferred to (MS salts and B5 vitamins, 3% Sucrose, 1mg/l Zeatin, 0.1mg/l IAA, phytoagar 0.25 %, pH 5.8 adjusted before autoclaving) 80mg/l kanamycin, 300mg/l cephotaxime was added to autoclaved medium and poured in sterilized glass plate. The cultures were incubated at 25°C under 16 hr photoperiod for 3 to 4 weeks, with sub culturing at every 15-20 days. Young shoots were then transferred to MS medium containing 3% sucrose, 0.1 mg/l Zeatin, 0.1 mg/l IAA and kanamycin at 50 mg/l for shoot elongation. The shoots so obtained were transferred to MS medium with 0.05 mg/ml of IBA for rooting. Cultures were incubated for 2 to 3 weeks and rooted plants were transferred to pots containing peat and hardened. Hardened plants were shifted gradually to green house for further establishment and analysis. The observations on plant regeneration after co-cultivation were recorded. The seedlings were transplanted and maintained in greenhouse for further analysis along with a set of control plants.

#### **Results And Discussion:**

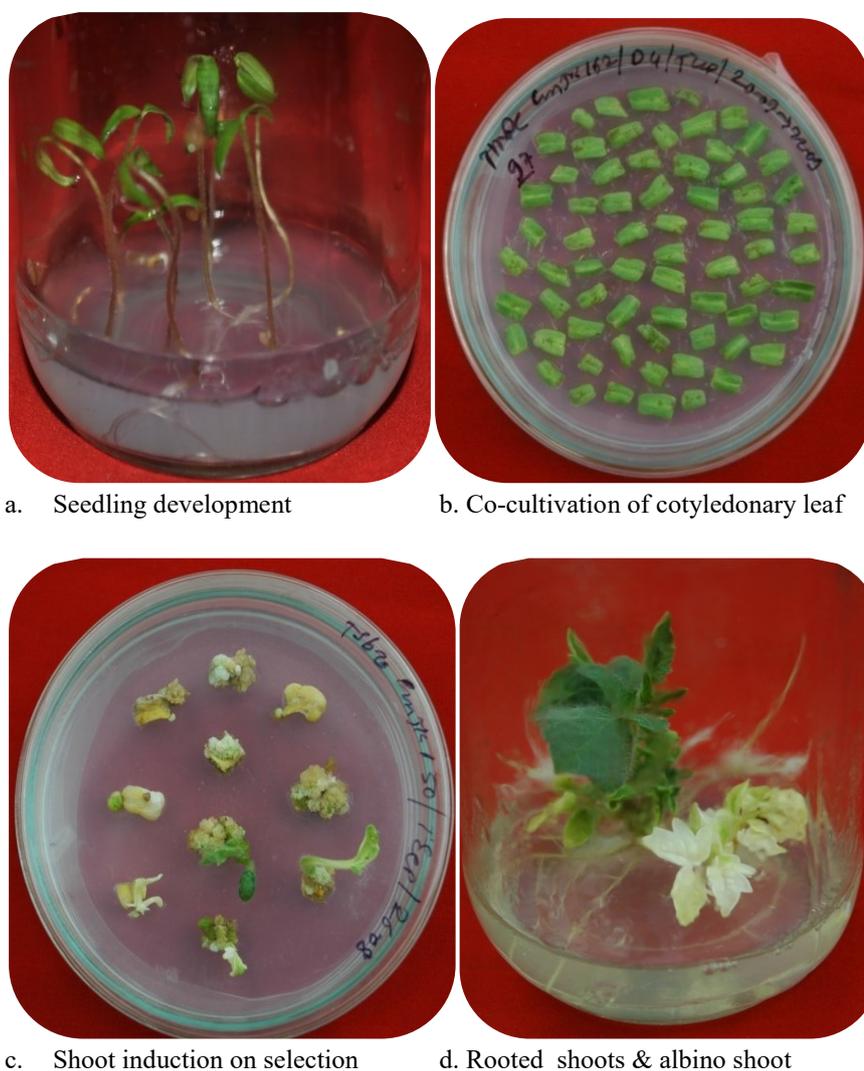
**Table-1:** Transgenic Tomato development summary:

| Experiment | No. of explants infected | Percent of explants responded on selection | Percent of callus induced shoots | No. of plantlets developed |
|------------|--------------------------|--|----------------------------------|----------------------------|
| Set 1      | 156                      | 48   | 28                               | 11                         |
| Set 2      | 151                      | 42   | 33                               | 8                          |

|       |     |    |    |    |
|-------|-----|----|----|----|
| Set 3 | 145 | 46 | 40 | 13 |
| Set 4 | 147 | 40 | 35 | 17 |
| Set 5 | 155 | 51 | 35 | 10 |
| Set 6 | 150 | 39 | 32 | 7  |

Regenerated shoots from callus were harvested & transferred to selection free elongation medium (MS salts with B5 vitamins, 3% Sucrose and 300mg/l cephotaxime. pH 5.8). Well developed shoots transferred to half-strength MS medium with 300mg/l Cephotoxime pH 5.8 for rooting. After 15 days root initiation started & seventy three rooted plantlets transferred to primary hardening and kept in controlled condition green house with high humidity (<90%). Well established plantlets were then transferred to soil in contained polyhouse as per DBT norms. Plantlets were grown till maturity and seeds were collected from self pollinated fruits. Leaf sample from these primary transformants were collected for histochemical GUS assay, genomic DNA isolation for PCR analysis to confirm the gene integration prior to maturity.

Figure: Steps during *Agrobacterium* mediated transgenic tomato development



a. Seedling development

b. Co-cultivation of cotyledonary leaf

c. Shoot induction on selection

d. Rooted shoots & albino shoot



e. Plantlets ready to harden



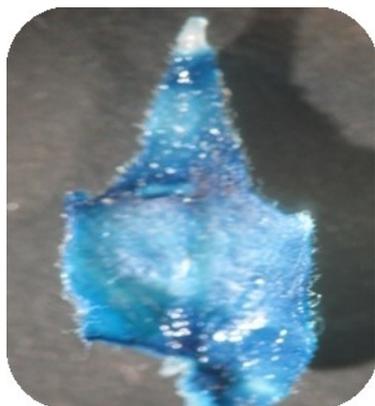
f. Hardening of plants



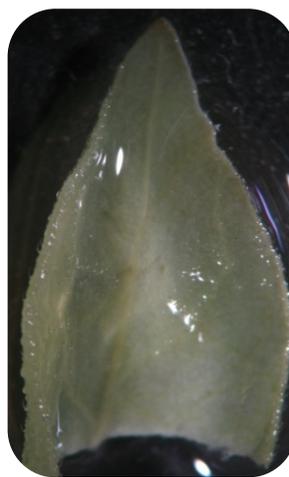
g. grown to maturity

**Histo-chemical GUS assays:**

Gene construct *T-rep* used in this study to develop transgenic tomato was cloned in pCAMBIA 2301 which has GUS reporter gene along with selection marker *nptII* gene. During transformation experiments kanamycin antibiotic was used as selectable marker and GUS as reporter gene to check the gene expression at different stages of transformation in laboratory. To confirm the expression of inserted gene in primary transgenic tomato plant was carried out using the leaf pieces of the well established plants from contained polyhouse. Among the plants tested thirty plants were showing prominent GUS expression, control check was used from non transgenic leaf tissue from the tomato seedling which was positive control in transformation experiments. These GUS expressing plants were further used to confirm the gene integration by polymerase chain reaction (PCR).



Transgenic leaf expressing GUS gene



Non transgenic control leaf

### Conclusion

Tomato was successfully transformed & regenerated using cotyledon explants cultured on MS salts and B5 vitamins, 3% Sucrose, 1mg/l Zeatin, 0.1mg/l IAA, phytoagar 0.25 %, pH 5.8 and this has been proved by GUS histochemical assay hence this protocol can be utilized for transferring gene of interest to Tomato system.

### Reference

1. Ankenbauer, R. G. and Nester, W. E., (1990). Sugar-mediated induction of *Agrobacterium tumefaciens* virulence genes: Structural specificity and activities of monosaccharides. *Journal of Bacteriology* 172, 6442-6446.
2. Anna, N.O. and Waclaw, O., (2000) Study of the Factors Influencing *Agrobacterium* Mediated Transformation of Pea, *Mol. Breed.*, 6, 185-194.
3. Horsch, R. B., Fraley, R. T., Rogers, S. G., Sanders, P. R., Lloyd, A. and Hoffman, N., (1984). Inheritance of functional foreign genes in plants. *Science* 223, 496-498.
4. Jefferson, R. A., Kavanagh, T.A. and Bevan M.W., (1987). GUS fusions:  $\beta$ -glucuronidase as a sensitive and versatile gene fusion marker in higher plants. *EMBO J.* 6, 3901-3907.
5. Kottarachchi, N. S., Kertbundit, S. and Juricek, M., (2000). *Agrobacterium* mediated transformation of *Cucumis melo* with replicase gene from papaya ringspot virus and regeneration of transformed plants. *Tropical Agricultural Research and Extension*, 3 (2), 94-97.
6. Moghaieb, R.E.A., Saneoka, H., Youssef, S. S., EL-sharkawy, A.M. and Fujita, K., (2006). Improvement of salt Tolerance in Tomato plant (*Lycopersicon esculentum*) by transformation with ectoine biosynthetic genes. *Transgenic plant journal*, 1(1), 228-232.
7. Murashige, T. and Skoog, F., (1962). A revised medium for rapid growth and bioassays with tobacco tissue culture. *Physiologia Plantarum*, 15, 473-379.
8. Prematilake, D.P., Power, J.B. and Davey, M.R., (2002). Genetic transformation of cultivated tomato (*Lycopersicon esculentum*) with *Agrobacterium*. *Annals of the Sri Lanka Department of Agriculture*, 4, 207-214.
9. Van Roekel, J. S. C., Damm, B., Melchers, L. S., and Hoekema, A., (1993) Factors Influencing Transformation Frequency of Tomato (*Lycopersicon esculentum*), *Plant Cell Rep.*, 12, 644-647.
10. Wu, Y.F., Chen, Y., Liang, X.M., and Wang, X.Z., (2005) An Experimental Assessment of the Factors Influencing *Agrobacterium*-Mediated Transformation in Tomato, *Plant Physiology*, 53 (2), 252-256.