Mass Regeneration of Shoots from Cut Surfaces of Stems in Tomato Stock Plants

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Summary

Multiple tomato shoots were regenerated from calli formed on pruning wounds of young stock plants. Plants that unfolded their 10th true leaf were decapitated between the 7th and the 8th true leaves to force numerous lateral shoots. When these shoots were cut just beneath their first leaf, numerous adventitious buds differentiated from calli that developed into shoots. During 36 days after heading back lateral shoots, 79 shoots were regenerated from the stock plant. More than 62.5% of the lateral shoots developed calli from which additional shoots differentiated. The average number of shoots regenerated from each lateral stem increased with higher leaf positions. Thus, a reliable method is offered to regenerate multiple shoots from young stock plants.

Key Words: adventitious buds, decapitation, Lycopersicon esculentum Mill., vegetative propagation.

Introduction

Successful in vitro regeneration from shoot apical meristem (Kartha et al., 1977) and cotyledon (Uddin et al., 1988) have been reported in tomato plants. However, the in vitro propagation methods have not been introduced in the production of tomato because of incidences of variations and high costs. Therefore, we sought an efficient method of vegetative propagation of this species.

Tomato plants grown in the field often regenerate multiple shoots from the cut surfaces of the main stems at the end of their cultivation. If this phenomenon consistently produces abundant shoots, useful variants can be mass propagated as scions for grafting or cutting. Furthermore, parents of F1 cultivars, whose seed formation tends to be depressed, will be easily maintained without seed propagation if mass propagation of shoots is feasible. However, since a reliable method to regenerate many shoots from the cut surfaces of stems has not been adopted, we developed a practical method to regenerate shoots from calli on young stock plants.

Materials and Methods

This experiment was conducted at a greenhouse in Osaka Prefecture University. On 16 June, 2000, the germinated seeds of tomato (Lycopersicon esculentum Mill. 'Petit' (Takii and Company, Kyoto)) were sown in a 128-cell tray filled with a medium made of peat moss and vermiculite (1:1, v/v). The seedlings were grown in a greenhouse whose light transmissivity was 55% and supplied with a nutrient solution containing 4.6 N, 1.3 P, 2.2 K, 2.1 Ca, 0.8 Mg in me · L⁻¹. Eight seedlings were transplanted into 500 mL plastic pots filled with vermiculite on 29 June. On 19 July, when seedlings had unfolded the 10th true leaf, the main shoots of the seedlings were headed back at the stem between the 7th and 8th true leaves with a sharp razor blade. After decapitation of the main shoot, all lateral shoots were cut off just beneath the first leaf when the lateral shoot reached 5 to 10 cm. Shoots that regenerated from a cullus on the cut surface were harvested from 14 August until 18 September when the regenerated shoots grew to 3 to 5 cm. The maximum and minimum air temperature in the greenhouse were 41 and 23°C, respectively.

Results and Discussion

As a result of removing all shoot apexes, adventitious buds differentiated from calli at the cut surfaces of lateral stems (Fig. 1A) that developed into shoots (Fig. 1B). Although the main shoot was cut earlier than the stems of lateral shoots, calli and shoot primordia appeared later on the cut surface of the main stem rather than on lateral stems. As shoots from calli developed not on the main stem but on the lateral stems, shoots that were initiated from calli were counted only for the laterals. As the results, each plant regenerated an average of 79 shoots during 36 days from the cutting of lateral stems. More than 62.5% of the lateral stems regenerated shoots from the cut surfaces (Fig. 2).

The average number of regenerated shoots from each lateral stem increased with higher leaf position; no shoot regeneration from the cut surface of the main stem was recorded in this experiment. However, we observed that shoots regenerated from the cut surface of the main stem when it was cut back at the cutting of lateral stems (Oda et al., unpublished data). When vigorous plants were grown hydroponically, 508 shoots regenerated from one plant during 90 days after heading back the lateral
shoots: the number continued to increase (Imura and Oda, unpublished data).

Mass regeneration of shoots from the cut surfaces of stems on stock plants occurs readily, but the following care and procedures should be elucidated to establish the mass propagation method: 1) how to maintain the photosynthetic ability of leaves on the stock plants, 2) how to store the regenerated shoots till planting seasons, and 3) the hormonal mechanism of this phenomenon. As the harvesting of regenerated shoots continues for a few months while shoots are in demand at only two peak seasons, the stock plants must maintain leaves for photosynthesis and the harvested shoots should be stored for a few months. A physiological resolution of this phenomenon from the viewpoint of plant hormone would be helpful in establishing stable, cultural technique.

The formation of adventitious buds may be related to a decrease in auxin concentration and an increase in cytokinin concentration in each organ. As polar transport of auxin from shoot apex to root determines apical dominance (Kojima et al., 2002), removing all shoot apices must decrease the concentration of auxin. Colbert and Beever (1981) reported that bud removal and decapitation of tomato and tobacco plants resulted in an increase in both the concentration and the total flux of cytokinin in bleeding xylem sap. Bangerth (1994) reported that, cytokinin concentration increased almost 25-fold in xylem exudates of bean plants 16 h after decapitation, and 40-fold 24 h later.

Suitable combinations of auxin and cytokinin concentrations for shoot regeneration from shoot meristem (Kartha et al., 1977) and cotyledon (Uddin et al., 1988) were investigated in tomato plants. Through these studies, it is clear that morphogenesis is greatly influenced by the ratio of auxin and cytokinin concentrations. Therefore, shoot regeneration by cutting off lateral shoots just beneath the first leaf after decapitation of

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**Fig. 1.** Mass regeneration of shoots from cut surfaces of stems by cutting of main and lateral stems in tomato plant. A, Adventitious buds; B, Regenerated shoots.

**Fig. 2.** Average number of regenerated shoots (□) and percentage of shoot formation at the cut surface of each stem (●) after cutting main and lateral stems. Regenerated shoots were harvested for 36 days. The percentages represent shoots regenerated on lateral stems at the 1st to 7th leaves. C, Average of two lateral stems at cotyledons; M, Main stem. Vertical bars indicate SE (n=8).
main stem should be studied for a balance of plant growth regulators.

From this study, a reliable method for regenerating multiple shoots on the cut surfaces of main and lateral shoots in young stock plants was strongly suggested. Technical and physiological studies are necessary to establish this mass-propagation method.

Acknowledgment

We appreciate Ms. Andrea Sato and Dr. Suguru Sato for their careful proofreading of the manuscript.

Literature Cited


