Cultivar Difference in Growth of Tomato Rootstocks under Low Temperature Stress

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Growth of tomato (Lycopersicon esculentum Mill.) seedlings under low temperature stress was investigated using several cultivars to estimate suitable rootstocks for direct transplanting of plug seedlings under low temperature condition. Plants were grown in a growth chamber at 25°C for 3 weeks, and at 10°C for the following 3 weeks. The increase in dry weight of shoots during the 10°C period showed a maximum in ‘Kagemusya’ followed by ‘Anka-T’, ‘Shin-meito’. ‘Kagemusya’ and ‘Anka-T’ had a greater dry weight of roots; both lateral and main roots increased greatly in ‘Kagemusya’ and ‘Anka-T’. The cultivars were divided into high and low groups for the triphenyl-tetrazoliumchloride (TTC) reduction rate of roots under the 10°C condition. The rate was highest in ‘Kagemusya’, ‘Anka-T’ and ‘Shin-meito’, all of which had a high increase in the dry weight of shoots. From these findings, it is suggested that the growth of tomato rootstocks under low temperature stress differed with each cultivar, and ‘Kagemusya’ showed the best growth. Hence, ‘Kagemusya’ is considered to be suitable for direct transplanting of tomato plug seedlings especially under low temperature conditions.

Keywords: low temperature stress, tomato rootstock, TTC reduction rate

INTRODUCTION

Recently, direct planting of plug seedlings in the field has been attempted for several vegetable crops, which allowed the seedling raising period to be shortened and reduced the cost and labor related to secondary raising after plug raising (Tsukagoshi, 1999; Imura, 2001). In the forcing culture of tomato under low temperature conditions (10–15°C), it is important to promote the initial growth of plug seedlings since a delay of initial growth often occurs after direct planting of plug seedlings (Imura, 2001). On the other hand, Sato et al. (1999) demonstrated that root growth of transplanted plug seedlings was restricted by transplanting stress, resulting in a delay of initial growth and a lack of uniformity in the fields, so that rapid initial growth after transplanting is an important aspect of plug seedling culture. Yoshida (2000) reported that it is important to promote root growth and form deep-rooted structures in order to alleviate the delay of the initial growth after transplanting plug seedlings.

In tomato plug seedlings, the use of grafted nursery plants has increased and several rootstock cultivars are used mainly to afford tolerance to soil-borne diseases (Yoshioka, 2001). Recently, although rootstock tolerance to low temperature stress has been required in tomato (Yoshioka, 2001), the characteristics of tomato rootstock cultivars in the growth response to low temperature is still

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unclear. Therefore, the estimation of growth under low temperature stress may lead to the establishment of a method to promote the initial growth of plug seedlings after direct transplanting in tomato cultivation. Tanikawa et al. (1993) reported that shoot dry weight correlated to the TTC reduction rate of roots in chrysanthemum seedlings and suggested that TTC reduction is closely associated with root activity and plant growth. From the facts, the TTC reduction rate in roots may be also useful in order to evaluate root activity and plant growth in tomato plants.

In this study, the difference in growth and TTC reduction rate under low temperature stress was investigated using several tomato rootstock cultivars.

MATERIALS AND METHODS

Cultural conditions

Seeds of tomato (Lycopersicon esculentum Mill., rootstock cv. Ganbarune, Joint, Anka-T, Kagemusya, Shin-meito, Super ryoen, Doctor-K, Barukan, Magnet, BF-okitsu, Helper-M, Akirese-M; scion cv. Momotaro, Momotaro-8) were sown in plastic pots (10.5 cm in diameter) filled with a mixed soil (N : P : K = 460 : 500 : 440, mg L⁻¹; Takii Seed Co., Ltd.). Thirty seedlings per plot were used. Plants were grown in a growth chamber at 25 ± 2 °C (day)/20 ± 2 °C (night), 16-h daylength, RH 60% for 3 weeks. Then, ten plants were sampled for growth measurement, and the remaining twenty plants were grown in a growth chamber at 10 ± 2 °C, 16-h daylength, RH 60% for the following 3 weeks. All plants were supplied daily with water in the growth chamber. Three weeks after raising at 10 °C, the dry weights of shoots and roots (main and lateral roots) were measured.

Measurement of TTC reduction rate

Three weeks after growing at 10 °C, whole roots of 5 plants per plot were sampled for measurement of the TTC reduction rate in order to evaluate root activity (Tanikawa et al., 1993).

RESULTS AND DISCUSSION

The increase in dry weight of shoot under the 10 °C condition period showed a maximum in ‘Kagemusya’ followed by ‘Anka-T’ and ‘Shin-meito’ (Fig. 1). ‘Magnet’ plants withered during the

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**Fig. 1** Increase in dry weight of shoots in rootstock and scion cultivars of tomato under 10 °C condition. Bars represent standard errors (n = 10). Means with different letters are significantly different at 5% level by LSD.

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10°C experimented period, and ‘Doctor-K’ had a minimum increase. The increase in root dry weight of ‘Kagemusya’ was also greatest among the cultivars; both lateral and main roots increased greatly (Fig. 2). The scion cultivars showed relatively low increases in root dry weight compared with rootstock cultivars except ‘Doctor-K’ and ‘Magnet’. In this experiment, the dry weight of shoot and root before the 10°C experimented period differed slightly among the cultivars (data not shown). However, ‘Kagemusya showed greatest increase in dry weight of shoot and root under 10°C condition. From these facts, it is suggested that ‘Kagemusya’ has a high growth ability under low temperature stress condition. In this case, the increase in main and lateral roots was greater in ‘Kagemusya’ than the others, so that the large increase in dry weight might be associated with rooting ability. Hence, ‘Kagemusya’ is considered to be suitable for direct transplanting of tomato plug seedlings especially under low temperature conditions.

The cultivars were divided into high and low groups for the TTC reduction rate of roots under

Fig. 2 Increase in dryweight of roots in rootstock and scion cultivars of tomato under 10°C condition. Bars represent standard errors for total weight of roots (n=10). ■, lateral roots; ●, main roots. Means with different letters are significantly different at 5% level by LSD.

Fig. 3 TTC reduction rate in roots of rootstock and scion cultivars of tomato under 10°C condition. Bars represent standard errors (n=5). Means with different letters are significantly different at 5% level by LSD.
the 10°C condition (Fig. 3). The rate was highest in ‘Anka-T’, ‘Kagemusya’ and ‘Shin-meito’ followed by ‘Joint’, ‘Ganbarune’ and ‘Super ryoen’. The scion cultivars belonged to the low-TTC group. In addition, there was a correlation between TTC reduction rate in roots and increase in shoot dry weight (Fig. 4). Tanikawa et al. (1993) reported that shoot dry weight correlated to the TTC reduction rate of roots in chrysanthemum seedlings, and supposed that the ability of nutrient uptake in roots might be associated with the TTC reduction rate and shoot dry weight. In this study, no difference was observed in TTC reduction rate among ‘Anka-T’, ‘Kagemusya’ and ‘Shin-meito’. The increase in shoot dry weight was however, markedly greater in ‘Kagemusya’ than in ‘Anka-T’ and ‘Shin-meito’. From these results, we could not clarify the reasons for the relationship between the TTC reduction rate and the increase in the dry weight of shoots. In this study, we measured the TTC reduction rate only 3 weeks after raising at 10°C, so that it should be needed to estimate the TTC reduction rate and the increase in shoot dry weight regularly to clarify the relationship.

REFERENCES


