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Short Report

Effect of Grafting on the Activity of Adenosine 5'-diphosphate Glucose Pyrophosphorylase and Tuberous Root Production in Sweet Potato (*Ipomoea batatas* Lam.)

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カンショ塊根におけるアデノシン二リン酸グルコースピロホスホリラーゼ活性と塊根生産に及ぼす接木処理の影響：
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キーワード：アデノシン二リン酸グルコースピロホスホリラーゼ（EC 2.7.7.27），カンショ，光合成，シンク，ソース，接木．
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Adenosine 5'-diphosphate glucose pyrophosphorylase (AGPase ; EC 2.7.7.27) is the enzyme catalyst in the formation of adenosine 5'-diphosphate glucose in starch synthesis and is regarded as one of the important determinants for sink capacity and tuberous root production of sweet potato[2]. A significant difference was detected in AGPase activity in tuberous roots among cultivars ; the high enzymatic activity facilitating a large production of tuberous root[4,7].

AGPase activity has been examined primarily from sink side in many reports[5], but it is not clear whether the source ability (CO_2 exchange rate x leaf area) is influential for AGPase activity in roots of sweet potato. In this study, using grafted sweet potato plants in which the source ability and source-sink relation were artificially altered, the relationships between AGPase activity, CO_2 exchange rate (CER) and tuberous root production were investigated.

Materials and Methods

Three cultivars were used in this experiment ; Koganesengan (K), a recently improved cultivar with high yield ; Tsurunashigenji (T), a local, traditional cultivar with poor yield ; and Histarch (H), a cultivar with high concentration of starch in tuberous roots. Koganesengan or Tsurunashigenji was grafted as a scion on the stocks of these three cultivars. K/T, for example, indicates the combination of Koganesengan scion and Tsurunashigenji stock.

A grafted plant (six different grafting combinations and three replications for each combination) was grown in a sand culture pot (8.0 L in capacity) in a greenhouse in the experimental field of Kyushu University in 1995. Kimura's solution-A[1] at standard concentration was supplied as fertilizer at regular intervals.

Three plants were sampled for each grafting combination on the 64th and 97th days after grafting to measure dry matter weight and the activity of AGPase. Roots with a diameter of more than 5 mm were classified as tuberous root. From tuberous roots, AGPase was extracted using the method of Yatomi et al.[7], and the enzymatic activity was assayed according to the procedure described by Nakamura et al.[3].

CER of young expanded leaves was measured in a photosynthetically saturating light intensity with a portable photosynthesis system (SPB-H3, ADC, UK) on the 58th and 59th days after grafting. The air temperature in the assimilation chamber was 34±1°C.

Results and Discussion

As shown in Fig. 1 (A and B), tuberous root weight had statistically significant positive relationships with AGPase activity. The activity of this enzyme is regarded as one of the important determinants for tuberous root production in grafted plants. AGPase activity varied considerably with grafting combination among cultivars. For example, the root of Koganesengan (a high yield cultivar) represented a high AGPase activity in K/K, but the enzymatic activity decreased in T/K.

Table 1 shows CER of a leaf and leaf area of a plant. The average of CER was 12.09

Table 1. Leaf CER and leaf area in grafted plants.

Grafts	A			B			Average	
	K/K	K/T	K/H	T/K	T/T	T/H	A	B
CER (μmol m^{-2} s^{-1})	13.60 ±0.81	11.10 ±0.76	11.57 ±0.34	6.17 ±0.46	8.73 ±0.46	7.47 ±0.20	12.09	7.46
Leaf area (m^2 $plant^{-1}$)	0.178	0.163	0.176	0.107	0.169	0.177	0.172	0.151

K, T and H represent Koganesengan, Tsurunashigenji and Histarch, respectively.
Values of CER are averages of 3 replications±standard error.
A statistically significant difference at the 1% level was detected between the average CER of A and B.

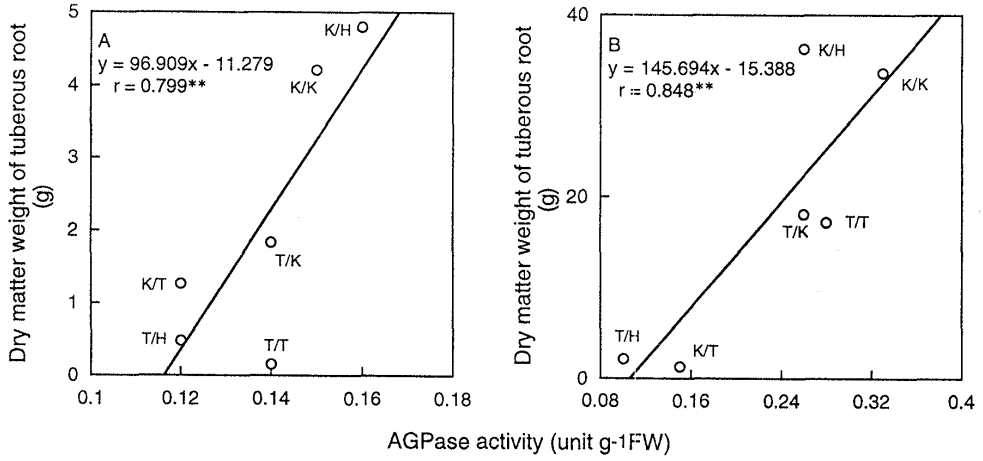

Fig. 1. The relationship between the activity of AGPase and dry matter weight in tuberous roots on the 64th (A) and 97th day (B) after grafting. ** ; statistically significant at the 1% level.

μmol m^{-2} s^{-1} when Koganesengan was grafted as a scion, whereas it decreased to 62% in the plants with Tsurunashigenji scion. In the former, both stomatal and mesophyll conductances were higher (data not shown). Leaf area production was also large in the plants with Koganesengan scion. The plant with high source ability is expected to have an increased production of tuberous root, but as shown in Fig. 1, production changed to a large extent in some scion-stock combinations.

According to a report by Stark et al.[6], the enhancement of AGPase activity by introducing an AGPase gene into a white potato plant resulted in an increase in starch yield. In addition, they described the yield of transgenic plants as not limited by photosynthetic carbon assimilation and AGPase activity primarily regulated the end product. We also recognized the positive relationship between AGPase activity and tuberous root weight. AGPase activity, however, seemed to vary considerably in grafted sweet potatoes depending on the photosynthetic activity of the scion cultivar. Thus, AGPase activity in roots of a cultivar is not determined by genetic base only, but it is likely to be modified by other factors such as photosynthetic source. This suggests that genetic manipulation is not always effective on the enhancement of AGPase in sweet potato root.

References

1. Baba, T. et al. 1957. In Togari, Y. et al. eds., Experimental Methods for Crop. Nogyo Gijutsu Kyokai Press, Tokyo. 161—171*.
2. Murata, T. et al. 1969. Arch. Biochem. Biophys. 130 : 604—609.
3. Nakamura, Y. et al. 1989. Plant Cell Physiol. 30 : 833—839.
4. Nakatani, M. et al. 1992. Jpn. J. Crop Sci. 61 : 463—468.
5. Preiss, J. 1991. In Miflin, B.J. ed., Oxford Surveys of Cellular and Molecular Biology, Vol. 7. Oxford University Press, Oxford. 59—114.
6. Stark, D.M. et al. 1992. Science 258 : 287—292.
7. Yatomi, M. et al. 1996. J. Agron. and Crop Sci. 177 : 17—23.

* In Japanese.