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Tuber Sink Potential in Sweet Potato (*Ipomoea batatas* Lam.)

I. Development of tuber sink potential influencing the source activity*

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Abstract : An attempt was made to clarify the relationship between the formation and growth of tubers and the photosynthetic rate during the early growth stage in sweet potato by using the grafts of several cultivars differing in sink potential.

The tuber formation largely depended on the characteristics of stock cultivar. Both of the stock and scion effects on tuber thickening were observed at the stage after its formation. A positive correlation with tuber dry weight was found in the dry weight of petioles, leaf blades or leaf area, and a negative one was observed in the ratio of number of dead leaves to total leaves.

There was no relation between the photosynthetic rate and the root dry weight at the stage before tuber formation. However the photosynthetic rate in a scion correlated with tuber dry weight at the stage after the tuber dry weight amounted to about 10g/plant. Thus the results suggested that the tuber becomes dominant sink of assimilate and the source activity was influenced by tuber sink activity quantitatively after this stage.
Key words : grafting, photosynthesis, sink potential, sweet potato, tuber formation.

サツマイモ塊根の Sink 能力に関する研究　第1報 Source 活性に影響を及ぼす塊根 Sink 能力の発達：
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要　旨：塊根の Sink 能力の異なる数品種の接ぎ木植物を用いて，サツマイモの生育初期における葉身の光合成速度と塊根の形成・肥大との関係を2か年にわたって調査し，以下の結果を得た．

接ぎ木植物の塊根形成の早晩は台木品種の特性によるところが大きかった．形成後の肥大には台木と接穂両者の影響が認められた．塊根重と地上部の諸特性との関係を見ると，葉身，葉柄重や葉面積とは正の，枯死葉率とは負の相関関係が認められた．

光合成速度と塊根および地下部重との間には塊根形成前や形成直後では関連性は認められなかった．ところが，塊根の乾物量がほぼ 10 g に達した後では，同一の接穂の光合成速度は塊根重が大きいほど高い傾向が認められた．このことから，塊根はその乾物重が 10 g 程度に達した時点以降，同化産物の主要な Sink になっているものと思われる．
キーワード：塊根形成，光合成速度，サツマイモ，sink 能力，接ぎ木．

In many crops it has been recognized that sink activity or potential is one of the most important factors in determining the yield[2]. In sweet potato (*Ipomoea batatas* Lam.), it has been clarified by grafting experiments that the sink effects of tubers are the dominant determinant of yield and dry matter production as compared with top source effects[3,5].

It is known that there are interrelation between source and sink activities in some crops[9]. Tsuno and Fujise[10] have suggested that rapid thickening of tubers accelerates the translocation of assimilates from leaves and increases the photosynthetic activities in sweet potato. Hozyo and Park[4] have demonstrated that the grafts with stocks of non-tuber forming wild species show lower photosynthetic rates (Pn) than the grafts with those of tuber forming cultivars in the plants with same scions. The factor in the decrease of Pn in the grafts with stocks of wild type seemed to relate with the deposition of large starch grain within the chloroplasts and the break down of its granum structure[7].

However, the variation in tuber sink potential among cultivars is not so large compared

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Table 1. The characteristics of intact plant of cultivars used for grafts.

Cultivar	Tuber yield	Earliness of tuber growth	Tuber dry matter content	Stem length	Leaf area
Koganesengan (KOG)	High	Early	High	Medium	Large
Beniaka (BEN)	Low	Late	High	Long	Small
Norin 1 (N1)	Medium	Medium	Medium	Long	Large
Kokei 14 (Ko14)	Medium	Early	Medium	Medium	Medium
Okinawa 100 (O100)	High	Early	Low	Medium	Small
Shirosatsuma (SHI)	High	Late	High	Long	Large
Tsurusengan (TSU)	Low	Late	High	Medium	Large
Kyushu 89 (Ky89)	Medium	Late	High	Short	Small

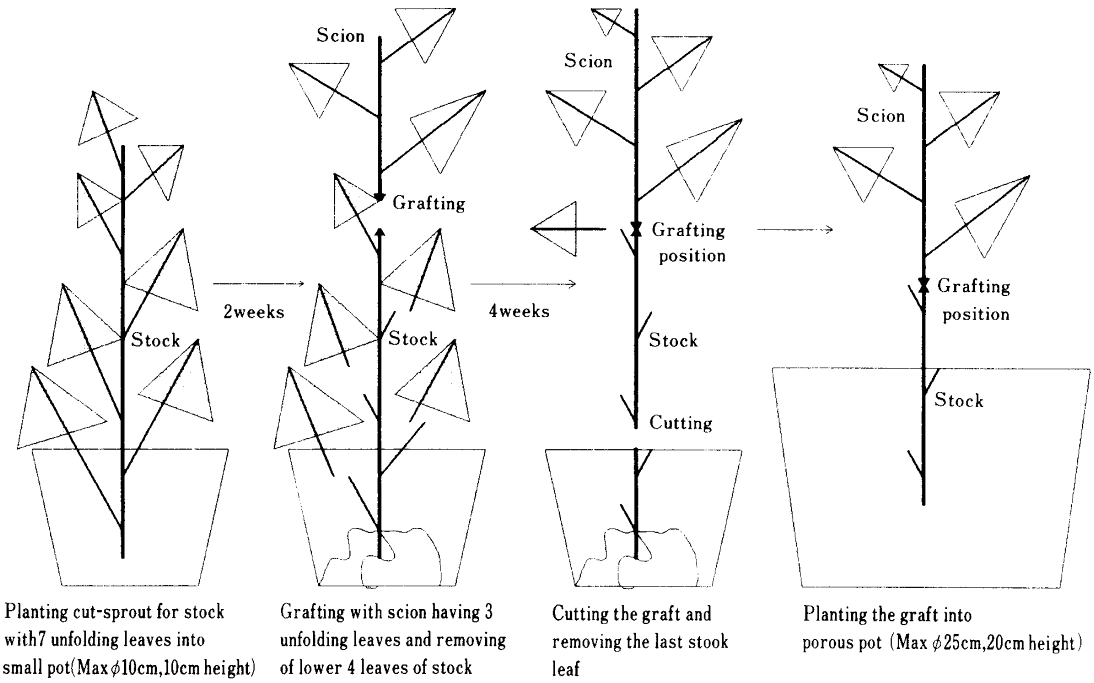

Fig. 1. Procedure of grafting.

with variation in the non-tuber forming wild species. In cultivars with relatively small variation, no reports has been published yet as to whether the Pn is influenced by the tuber sink potential and when the tubers achieve such a Pn influencing sink potential.

In this report we investigated the sink-source interrelation among several cultivars during early growth stage using the grafts, and discussed the development of the tuber sink potential influencing the Pn.

Materials and Methods

The experiments were carried out in 1984 and 1986. The characteristics of intact plants of cultivars used for the grafts were shown in Table 1. In 1984 two cultivars, i.e. Koganesengan (KOG) and Beniaka (BEN), were used for stocks and four cultivars, i. e. KOG, BEN, Norin 1 (N1) and Kokei 14 (Ko14), were grafted as scions. In 1986 KOG, Okinawa 100 (O100), Shirosatsuma (SHI) and Tsurusengan (TSU) as stocks and KOG, N1 and Kyushu89 (Ky89) as scions were used for the

Table 2. Growth of grafts in 1984.

Grafting Combinations (Scion/Stock)	Dry weight (g/plant)						Number of tubers (/plant)	Leaf area (cm²/plant)	Main stem length (cm)	Number of leaves (/plant)	Number of dead leaves (/plant)	Ratio of dead leaves (%)
	Leaf blades	Petioles	Stems	Fibrous roots	Thick roots	Tubers						
5th week												
KOG/KOG	6.8	2.1	2.2	3.4	0.8	7.4	6.2	1,057	49.0	17.3	0.4	2.3
KOG/BEN	8.0	2.6	2.6	4.1	2.6	1.9	3.1	1,481	41.6	15.9	0.2	1.3
N1/KOG	8.0	2.4	4.1	3.6	0.9	2.3	2.8	2,006	90.2	26.8	1.7	6.0
N1/BEN	6.7	2.2	4.0	3.2	1.1	1.4	2.7	1,578	93.5	20.8	2.0	8.8
Ko14/KOG	6.3	1.8	2.5	2.8	0.6	5.3	5.0	1,421	32.9	19.9	2.9	12.7
Ko14/BEN	8.1	2.3	2.7	3.4	1.6	3.5	5.3	1,735	35.4	19.9	1.3	6.1
BEN/KOG	6.1	1.4	4.5	2.8	0.8	3.5	2.5	1,211	116.3	27.0	1.9	4.5
BEN/BEN	5.8	1.5	5.3	3.1	1.1	2.2	2.1	1,313	154.1	29.3	2.9	9.0
Significance	A, I**	A**	A**	A. B**	B**. A*	A**. I*	A**. I*	A**. I*	A. I**. B*	A**	A. I**	—
8-9th week												
KOG/KOG	18.1	6.7	10.9	7.5	1.2	96.2	7.8	5,103	83.5	76.4	21.5	22.0
KOG/BEN	10.4	4.0	8.6	7.0	1.3	41.7	9.0	2,429	94.4	46.1	24.1	34.3
N1/KOG	18.7	6.1	18.6	7.3	1.0	73.5	6.1	3,901	175.3	109.0	34.1	23.8
N1/BEN	10.4	3.3	13.4	7.5	1.5	51.9	10.9	2,322	192.1	58.5	26.0	30.8
Ko14/KOG	19.9	7.2	13.1	7.0	0.5	88.9	7.9	5,457	82.2	80.5	12.8	13.7
Ko14/BEN	16.1	5.3	10.7	5.9	0.6	95.4	11.2	4,075	91.9	634.8	13.3	17.0
BEN/KOG	9.5	2.3	14.2	6.8	1.2	37.9	9.8	2,089	222.1	104.2	36.0	25.7
BEN/BEN	14.8	3.6	17.5	5.5	0.5	61.2	9.5	3,541	260.8	135.3	36.9	21.4
Significance	Top total	A. B. I**		—	—	A, B. I**	B. I**	—	A**. B*	A**	A**	—

Note : A : scion effect. B : stock effect. I : interraction. ** : 1%, * : 5%,
NS : not significant. — : not analysed.

Table 3. Growth of grafts in 1986.

Grafting Combinations (Scion/Stock)	Dry weight (g/plant) Leaf blades	Petioles	Stems	Fibrous roots	Thick roots	Tubers	Number of tubers (/plant)	Leaf area (cm^2/plant)	Main stem length (cm)	Number of leaves (/plant)	Number of dead leaves (/plant)	Ratio of dead leaves (%)
5th week												
KOG/KOG	2.49	0.56	0.92	2.10	0.96	0.96	2.3	523	23.5	13.0	0.3	2.5
KOG/O100	1.59	0.39	0.56	1.14	0.15	0.42	2.7	352	14.5	8.3	1.7	16.8
KOG/SHI	1.64	0.34	0.57	1.34	0.36	0	0	311	17.0	9.3	1.3	12.5
KOG/TSU	1.70	0.35	0.58	1.21	0.07	0.3	0.3	327	18.5	9.7	0.3	3.3
Ky89/KOG	1.51	0.31	0.57	1.05	0.48	0.38	2.0	387	16.8	8.3	3.3	28.6
Ky89/O100	1.00	0.16	0.37	0.74	0.11	0.26	2.7	206	13.0	7.0	3.0	30.0
Ky89/SHI	1.06	0.13	0.32	0.77	0.22	0.05	0.3	209	12.5	7.0	3.3	32.2
Ky89/TSU	0.90	0.15	0.42	0.79	0.38	0	0	179	12.0	5.7	3.0	34.5
N1/KOG	1.49	0.19	0.85	0.97	0.23	0.26	1.7	322	32.2	9.0	5.3	37.2
N1/O100	1.12	0.16	0.59	0.90	0.09	0.29	2.0	239	27.0	8.7	3.0	25.6
M1/SHI	1.55	0.22	0.95	1.32	0.19	0	0	314	46.5	11.3	4.7	29.2
N1/TSU	1.14	0.18	0.80	0.72	0.21	0	0	244	37.0	8.0	5.0	38.5
Significance	A.B.I**	A**,B*	A**	A.I**,B*	NS	B**	B**	A,B,I**	A**	A**	NS	—
7th week												
KOG/KOG	2.80	0.61	0.74	1.12	0	11.07	7.5	792	25.6	14.5	3.5	19.4
KOG/O100	2.85	0.64	0.63	1.49	0.01	11.38	7.8	796	23.3	14.8	2.0	11.9
KOG/SHI	2.44	0.56	0.60	1.35	0.01	7.60	5.0	649	21.8	15.3	2.5	14.1
KOG/TSu	3.41	0.88	0.97	1.38	0.04	7.51	4.8	904	27.8	17.3	1.8	9.4
Ky89/KOG	2.26	0.50	0.46	0.79	0	8.63	4.0	617	16.9	11.3	4.3	27.7
Ky89/O100	1.79	0.37	0.45	0.95	0	6.47	4.5	458	17.6	11.8	4.0	25.4
Ky89/SHI	2.10	0.45	0.49	1.21	0.02	7.17	3.3	559	18.5	10.8	5.3	33.0
Ky89/TSU	2.55	0.52	0.65	0.99	0	7.33	4.5	619	19.9	11.3	5.0	30.8
N1/KOG	2.76	0.61	1.25	0.80	0	6.10	4.5	821	61.0	18.0	4.8	21.1
N1/O100	2.38	0.44	1.10	1.49	0	5.68	3.3	619	40.5	15.3	4.8	23.9
N1/SHI	3.44	0.78	1.49	1.80	0.13	6.66	5.3	962	54.5	15.3	5.8	27.5
N1/TSU	2.15	0.48	1.26	1.15	0.05	3.68	2.3	583	53.8	14.8	5.0	25.3
Significance	A**	A*	A**	A,B**	NS	A**	A,I**	A*	A**	A*	NS	—

9th week												
KOG/KOG	5.00	1.42	4.34	4.29	0.03	25.1	7.3	1515	38.9	20.4	6.3	23.5
KOG/O100	3.44	0.87	0.77	1.33	0	19.1	6.8	991	23.5	16.0	4.3	21.2
KOG/SHI	4.74	1.33	1.17	2.11	0.22	25.9	6.5	1341	28.6	17.0	4.5	20.9
KOG/TSU	4.65	1.29	1.35	1.61	0	14.5	3.8	1203	37.1	18.0	3.3	15.5
Ky89/KOG	2.79	0.62	0.62	1.00	0	18.5	5.3	774	19.0	14.5	3.8	20.8
Ky89/O100	1.86	0.35	0.57	0.84	0.01	9.6	5.5	519	24.9	10.5	4.0	27.6
Ky89/SHI	2.76	0.64	0.60	1.66	0	13.6	4.0	750	17.3	13.8	3.8	21.6
Ky89/TSU	3.32	0.71	0.89	1.41	0	9.3	2.8	857	21.1	11.8	4.8	28.9
N1/KOG	4.11	0.79	1.93	1.23	0.07	17.2	3.8	1151	66.9	17.8	8.5	32.3
N1/O100	3.00	0.57	1.21	1.08	0	9.7	3.5	884	62.9	18.8	5.5	22.6
N1/SHI	4.57	0.98	2.24	1.79	0	14.6	4.3	1357	46.5	11.8	8.0	40.4
N1/TSU	4.30	0.78	2.05	1.20	0	10.9	3.5	1126	66.5	18.3	8.3	31.2
Significance	A**	A**	A**	B**	NS	A.B**	A**, B*	A**	A**	A*	A**	—
10th week												
KOG/KOG	7.67	2.22	2.11	1.59	0	43.2	8.5	2196	33.8	18.3	9.0	33.0
KOG/O100	2.99	0.72	0.84	1.34	0.08	27.8	7.36	821	23.0	11.8	10.0	45.9
KOG/SHI	5.18	1.41	1.51	1.95	0.43	39.4	7.3	1451	33.6	15.8	9.5	37.5
KOG/TSU	7.81	2.25	2.77	2.10	2.02	32.1	4.5	1951	50.3	20.3	10.0	33.0
Ky89/KOG	3.40	0.86	0.92	1.19	0	25.8	4.5	853	20.4	13.3	5.5	29.3
Ky89/O100	2.27	0.56	0.57	0.93	0.03	21.2	5.0	612	17.8	12.3	5.5	30.9
Ky89/SHI	3.27	0.81	0.72	1.36	0.15	26.2	3.8	861	17.5	11.5	7.3	38.8
Ky89/TSU	5.16	1.28	1.48	1.54	0	21.5	4.0	1723	23.6	16.5	4.3	20.7
N1/KOG	4.05	0.92	2.38	1.18	0.17	26.9	5.0	1181	60.8	11.8	14.0	54.3
N1/O100	4.35	1.00	2.34	1.29	0.02	18.2	3.5	1328	66.4	13.5	14.8	52.3
N1/SHI	6.60	1.53	4.14	1.87	0.28	33.3	535	1941	72.1	9.0	18.8	67.6
N1/TSU	4.52	0.93	3.03	1.99	0.63	18.3	5.0	1144	64.6	12.0	15.0	55.6
Significance	A, B*	A**, B. I*	A**, B*	A, B**	NS	A, B, I**	A**	NS	A**	A**	A**	—

Note : A : scion effect. B : stock effect. I : interraction. ** : 1%, * : 5%,
NS : not significant. — : not analysed.

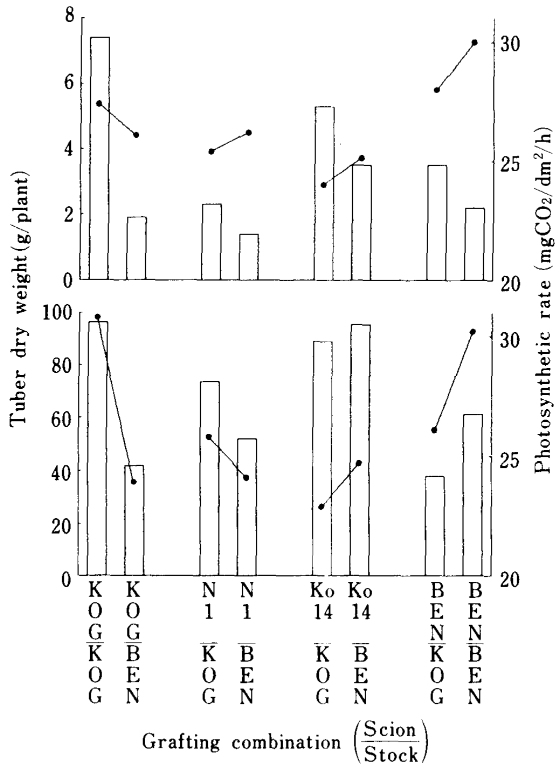

Fig. 2. Tuber dry weight (□) and photosynthetic rate (●) of grafts at 5 (upper) and 8—9 (lower) weeks after planting in 1984.

experiment. The procedure of grafting is shown in Fig. 1. The cut-sprouts with 7 unfolding leaves were used for the stocks. Their basal 2 nodes were inserted into small pots (Max.ϕ 10cm×height 10cm) vertically. At 2 weeks after transplanting the scions with 3 unfolding leaves were grafted with stcocks on their third internode from the soil level. At 4 weeks after grafting the grafts were cut off at the soil level, and their basal 2 nodes (stock) were inserted into porous pots (Max. ϕ 25cm×height 20cm). The grafts were transplanted on 25, June in 1984 and 19, June in 1986. Thus the roots of grafts developed from the stocks under the influence of the scions.

Each pot contained about 8 kg of clay soil and N 0.6 : P_2O_5 2.0 : K_2O 2.0g were supplied to a pot at the time of transplanting. Irrigation was carried out automatically at 8 o'clock P. M. and 4 o'clock A.M. every day.

In 1984 Pn measurements were carried out with 4 plants at 5 and 8 weeks after transplanting. Pn was measured with the fifth unfolding leaf from the apex on the main stem or a dominant primary branch. The apparatus described by Hozyo and Kato[6] was used for

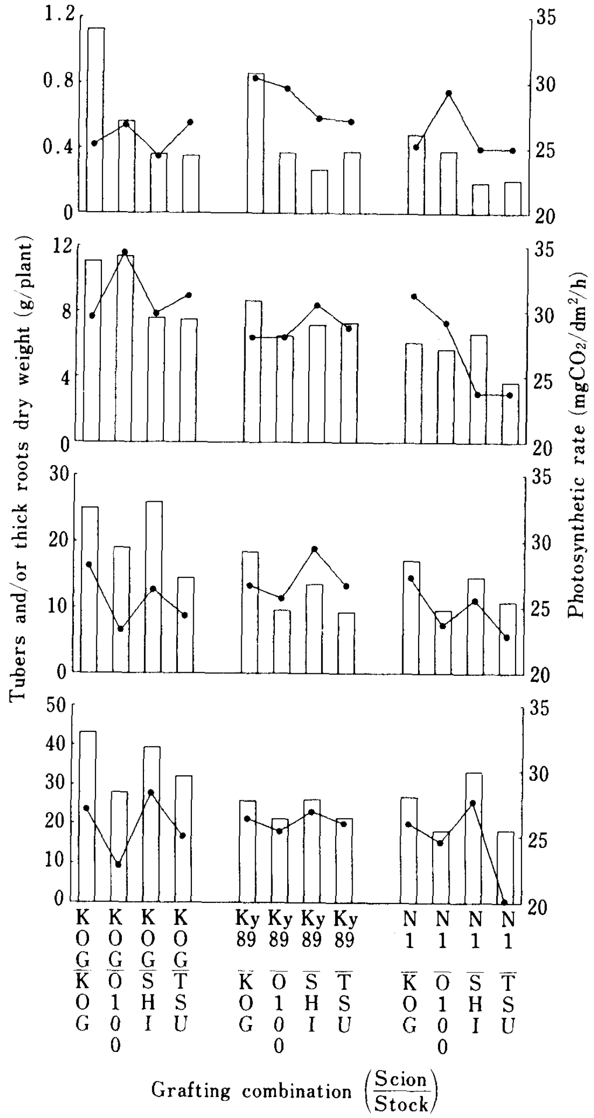

Fig. 3. Tuber dry weight (□) and photosynthetic rate (●) of grafts at 5 (upper), 7 (2nd), 9 (3rd) and 10 (lower) weeks after planting in 1986.

the measurements, and the measuring conditions were as follows: 25°C, 50% relative humidity, 38klx, about 370ppm CO_2, 6l/min flow rate. Twelve plants at 5 weeks and 10 plants at 8—9 weeks including the plants used for Pn measurement were sampled, and measurements were made on the dry weight of each organ, the number of tubers, stem length and leaf area etc.. The roots were divided into 3 categories by their diameter as follows: tuber: 5mm<, thick root: 2—5mm, fibrous root: 2mm>.

In 1986 Pn and growth measurements were carried out with 5—6 plants at about 5, 7, 9 and 10 weeks after transplanting in the same way as in 1984.

Results

The dry weight of each organ, number of tubers, leaf area, stem length and number of leaves etc. at 5 or 8—9 weeks after transplanting in 1984 were shown in Table 2.

The tubers were already formed in all the grafts at the 5th week. Maximum tuber dry weight,6.2g/plant, was obtained in KOG/KOG and minimum one, 1.4g/plant was observed in N1/BEN. Both of the stock and scion effects on the tuber dry weight were significant at 1% level. The larger tuber dry weight was always observed in KOG stocks than in BEN ones. In KOG stock tuber dry weight was the largest in the order as follows: KOG>Ko14>BEN>N1. In BEN stock it was: Ko14>BEN>KOG>N1. No correlations were found between tuber dry weight and any top characteristics.

At 8—9 weeks after planting the difference in the tuber dry weight between stocks or scions was also significant at 1%. A maximum tuber dry weight, 96.2g/plant, was obtained in KOG/KOG, and a minimum one, 37.9g/plant, was observed in BEN/KOG. The significant correlations were observed between tuber dry weight and leaf area, leaf dry weight, petiole dry weight and the ratio of the number of dead leaves to total leaves (r=0.92, 0.87, 0.88 and −0.78, respectively).

Pn and tuber dry weight at 5 and 8—9 weeks after planting were shown in Fig. 2. At the 5th week there was no relationship between Pn and tuber dry weight. Pn correlated only with stem length (r=0.80). At th 8—9th week Pn was changed by th cultivar of stocks, and correlated with tuber dry weight. There was no relationship between Pn and stem length.

The dry weight of each organ, number of tubers, leaf area, stem length and number of leaves etc. in 1986 were shown in Table 3.

At the 5th week thick roots (2mmϕ<) were observed in all the grafts, but the tubers had not yet formed in SHI and TSU stocks with any scions. Only KOG and O100 stocks formed tubers with dry weights of 0.2—1.0g/plant, which correlated with leaf area, dry weight of petioles or leaf blades (r=0.77, 0.71 or 0.69 respectively).

At the 7th week the tubers were observed in all the grafts. A maximum tuber dry weight, 11.4g/plant, was observed in KOG/O100, and N1/TSU showed a minimum one, 3.7g/plant. Only the scion effect was significant in the tuber dry weight. The average tuber dry weight was larger in KOG scion than in the others. Significant correlations were not observed between tuber dry weight and dry weight of any top organs, leaf area, stem length or the number of leaves.

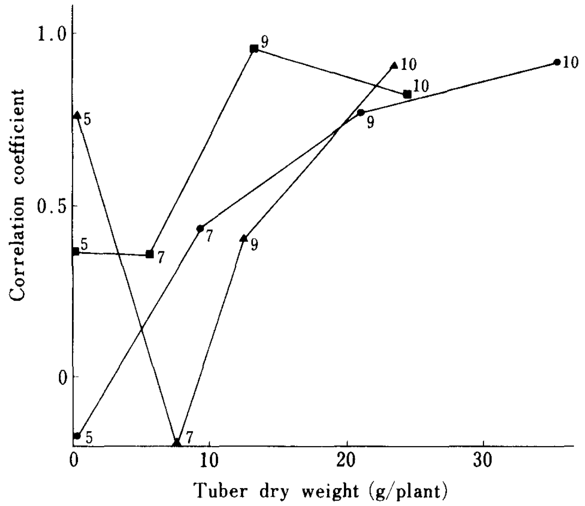

Fig. 4. Relationship between the average tuber dry weight of each scion and the correlation coefficient between tuber dry weight and photosynthetic rate in each scion in 1986.
● : KOG scion, ▲ : Ky89 scion, ■ : N1 scion.
The numbers in the figure show sampling week after planting.

At the 9th week the average tuber dry weight exceeded 9g/plant in all the grafting combinations. KOG/SHI showed a maximum tuber dry weight, 25.9g, and a minimum one, 9.3g was observed in Ky89/TSU. Both the stock and scion effects on the tuber dry weight were significant at 1%. Among stocks tuber weight was higher in KOG and SHI than in O100 and TSU. Among scions KOG showed larger tuber weight than the others. The petiole dry weight and leaf area were correlated with the tuber dry weight (r=0.73, 0.63).

At the 10th week the tuber dry weight reached from 18.2g/plant in N1/O100 to 43.2g/plant in KOG/KOG. The difference in the tuber dry weight between stocks or scions was significant at 1%. The effects of stocks and scions were the same as at the 9th week. The tuber dry weight was correlated with the dry weight of petioles, leaf blades and leaf area (r=0.71, 0.63, 0.59).

Although the ratio of the number of dead leaves to total leaves did not show a significant correlation with tuber dry weight, the correlation coefficients were always negative at every stage (r= −0.30 to −0.47) in 1986.

The changes in the tuber dry weight and Pn in 1986 were shown in Fig. 3. At the 7th week as well as at the 5th week there was no relation between tuber dry weight and Pn. After the 9th week, Pn in a scion changed depending on the cultivar of stocks, and correlated with tuber dry weight. Pn was higher in KOG or SHI stock with higher tuber weight than in O100 or TSU stock with lower tuber weight in any scions. The average tuber dry weight of each scion and corelation coefficient between tuber dry weight and Pn in each scion were shown in Fig. 4. Before the 9th week or in plants with smaller tuber dry weight of less than 10g/plant, the correlation coefficients were relatively low and fluctuated greatly. After that they were higher and relatively stable. There was no relationship between Pn and stem leagth in 1986.

Discussion

It is known that the tuber sink effects influence not only the tuber yield but also the total dry matter production in sweet potato[3,5]. The effects on the dry matter production appear through the sink-source interrelation.

Hozyo and Park[4] have demonstrated that Pn in grafts with the tuber forming stocks are higher than in grafts with those of non-tuber forming wild species. In the present study we used several cultivars as stocks of different sink potentials, but the differences are rather quantitative than qualitative like the non-tuber forming wild species.

Both in 1984 and 1986 at 5 or 7 weeks after planting there were no relations between Pn and the dry weight of tubers or thick roots (Figs. 2 and 3). Thus it is supposed that the sink activities of tubers or thick roots do not affect the source Pn before or immediately after tuber formation. The same tendency has been reported in the grafts using non-tuber forming wild species at the earliest stage[4]. Although it is not clear what is the major sink of assimilate in this stage, it is assumed that the dominant sink before tuber formation is the top growth including the stem elongation since in 1984 Pn is correlated with stem length.

Pn changed depending on stock cultivar and correlated with tuber dry weight at the stage after the 8th week from planting (Figs. 2 and 3). Thus, the source photosynthesis is suggested to be influenced by tuber sink activity quantitatively among cultivars as well as among species which is different in tuber forming ability. As the above discussion, this relationship was not observed before 7 weeks after planting. Although the tuber growth rates were different between 1984 and 1986, the tuber dry weight was below about 10g/plant before the 7th week in both years. As shown in Fig. 4, in 1986 the correlation coefficients between tuber dry weight and Pn were relatively high and stable after the average tuber dry weight reached about 10g/plant. In 1984 the average tuber dry weight at the 8th week was about 70g/plant. These results suggest that the tubers become dominant sink of assimilates influencing the source activity after their dry weight reaches about 10g/plant.

At these stages the negative correlation coefficients with significance in 1984 or without significance in 1986 were observed between the tuber dry weight and the ratio of the number of dead leaves to total leaves. Shimotsubo et. al.[8] have reported the same relationship during the late growth stage in the field grown grafts. From these facts it is presumed that the competitive sink of assimilates against the tubers is the leaf turn over after the tubers become dominant sink.

Generally, it is believed that the tuber growth of a cultivar depends largely on its own tuber characteristics, and top effects are relatively small on tuber growth[5]. In the present study it was also observed that only the stock effect was significant on the tuber formation at the 5th week in 1986, and the stock effects were significant in almost all the stages (Tables 2 and 3). Moreover, as the effects of tuber sink influence the source activity, the characteristics of tuber or underground parts are really important. However, the top characteristics are not negligible. After tuber formation the scion effect was always significant on the tuber weight, and the leaf area, leaf weight and petiole weight, etc. were correlated with tuber weight in the present study. It is recognized that the leaf area index is the determinant factor of dry matter production in the early growth period[1,10]. Therefore, among the three factors of leaf area, leaf and petiole weight, the most important characteristic is thought to be the leaf area.

On the other hand the substances of tuber sink potential including its varietal differences are not so clear. Generally, for example, BEN is a late cultivar in tuber growth, but in the present study the tuber growth of grafts with stocks of BEN was not so late compared with those with KOG which was early cultivar (Tables 1 and 2).Since the top characteristics are influential on tuber growth in early growth stage, it is suggested that the potential of tubers is suppressed by top characteristics in some cultivars. In the present study the effect of the interaction between the scion and stock on tuber dry weight were often significant. Also top growth of a scion was often different between stocks; therefore, the amount of the source organ and the other sink organ was different. Hahn[3] has estimated the sink capacity of the underground parts using reciprocal grafting. Ideally speaking, however, the tuber sink potential should be estimated under the system in which the source amount and sink amount except tuber are uniform. Further investigations are needed.

References

1. Agata W. and T. Takeda 1982. Studies on matter production in sweet potato. 1. The characteristics of dry matter and yield production under field conditions. J. Fac. Agr. Kyushu Univ. 27 : 75—82.
2. Evans L. T. 1975. The physiological basis of crop yield. In Crop Physiology (Ed.) L. T. Evans, Univ. Press, Cambridge. 327—355.
3. Hahn S. K. 1977. A quantitative approach to source potentials and sink capacities among reciprocal grafts of sweet potato varieties. Crop Sci. 17 : 559—562.
4. Hozyo Y. and C. Y. Park 1971. Plant production in grafting plants between wild type and improved variety in *Ipomoea*. Bull. Nat. Inst. Agr. Sci. D22 : 145—164*.
5. ————, T. Murata and T. Yoshida 1971. The development of tuberous roots in grafting sweet potato plants, *Ipomoea batatas* Lam. Bull. Nat. Inst. Agr. Sci. D22 : 165—191*.
6. ———— and S. Kato 1978. The facility for measuring photosynthetic rate of crop plants in the controlled environment. Misc. Publ. Nat. Inst. Agr. Sci. D2 : 1—29*.
7. Shimotsubo K., Y. Hozyo, S. Kato and N. Chonan 1983. The interrelationship between photosynthetic activity and sink capacity on the crop production. Bulletin of Green Energy Program Group-II No.3. Ministry of Agriculture, Forestry and Fisheries, Tokyo. 3—12*.
8. ——————, M. Nakatani, A. Oyanagi and Y. Watanabe 1986. Interrelationship between source activity and sink capacity in crop production. —Relationship between top characteristics and tuberous root growth in sweet potato—. Bulletin of Green Energy Program Group-II No.11. Ministry of Agriculture, Forestry and Fisheries, Tokyo. 92—109*.
9. Thorne G. N. and A. F. Evans 1964. Influence of top and roots on net assimilation rate of sugar beet and spinach beet and grafts between them. Ann. Bot. 28 : 499—508.
10. Tsuno Y. and K. Fujise 1965. Studies on the dry matter production of sweet potato. Bull. Nat. Inst. Agr. Sci. D13 : 1—131*.

* In Japanese with English summary.