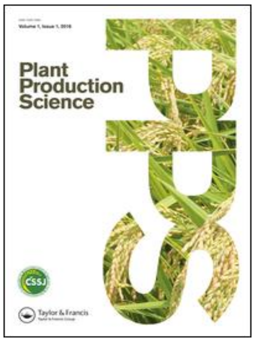

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[Short Report]

Effect of Sugar Solution Infused into Mungbean (*Vigna radiata* (L.) Wilczek) Plant on Seed Yield and Dry Matter Production

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Key words : Mungbean, Source-sink balance, Sugar solution infusion, Yield improvement.

Mungbean (*Vigna radiata* (L.) Wilczek) is one of the widely grown pulse crops in the tropics and subtropics including Bangladesh. This crop is characterized by producing protein-rich seeds with good taste. However, its yield is not high and needs to be improved. The photosynthetic increase and enlargement of the sink capacity of yielding organs are considered to be indispensable for the improvement of mungbean yield.

Photosynthetic rate in a mungbean leaf gradually increases from the earlier to later vegetative stage, peaks at the beginning of the reproductive stage (Srinivasan et al., 1985; Mitra and Childyal, 1988), and drops to about 25% of the peak during the maturity (Hamid et al., 1991). In mungbean cultivars, flowering and fruiting concurrently occur over a period of several days, during which the vegetative and reproductive sinks in a plant compete for available assimilates. This may predict that photosynthetic production at this stage greatly affects the formation and capacity of the sink organ.

Sucrose is the main photosynthate transported from leaves to sink organs in plants. The application of sucrose solutions to white potato plants resulted in a high frequency of tuber formation (Xu et al., 1998). Tubone et al. (2000) and Kadowaki et al. (2000) also reported that the artificial feeding of sugar solutions effectively increased the tuberous root production in sweet potato. The artificial change of source power by solution feeding is considered to be a useful experimental method for investigating the functional role in sink-source relationships in the production of mungbean.

In this study, the effects of sugar solutions infused into mungbean plant on the dry matter production and seed yield were investigated to obtain information on the improvement of yield in mungbean cultivars.

Materials and Methods

The mungbean cultivar, Chinese, was used as an experimental material. This variety is characterized by having vigorous growth and comparatively high yield among the many mungbean varieties. Experiments with this variety were conducted on the experimental farm of Kyushu University (33° N, 130° E) in Japan. Seeds were sown on May 15, 2000 in 8-liter capacity pots containing sandy soil. Before sowing, a compound fertilizer ($N : P_2O_5 : K_2O = 16 : 16 : 16$ in percentage) was applied 5 g to each pot. After the shoot emergence on May 20, two seedlings were allowed to grow in a pot. Sugar solution was infused into the main stem of plant using a glass tube as shown in Fig. 1. Five treatments were designed here; that is, the infusings of distilled water (control), 4 and 8% glucose solutions, and 4 and 8% sucrose solutions. For each treatment, eight 30-day-old plants, which initiated flower buds at the node of the fourth trifoliate-leaf, were used. Just before the treatments, the tip of the main stem was cut off, and a glass tube (8 mm

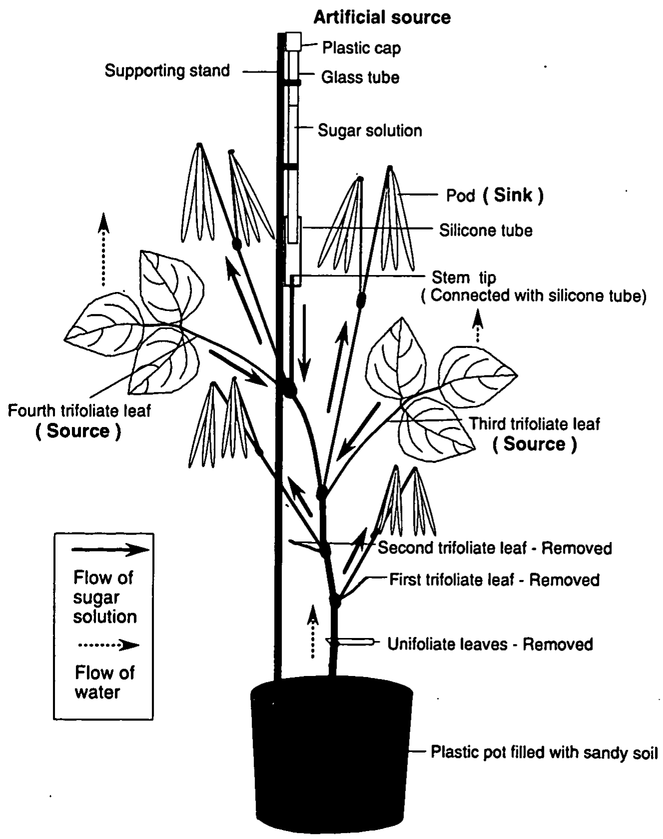

Fig. 1. Method of sugar solution infusion into a mungbean plant.

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Table 1. Effects of infusion sugar solution on parameters related to dry matter production and pod formation.

Treatments	(A) Carbon gain ($g\ plant^{-1}$)	ΔW ($g\ plant^{-1}$)	(B) Carbon in ΔW ($g\ plant^{-1}$)	(A)/(B) (%)	Final TDM ($g\ plant^{-1}$)	LA ($cm^2\ plant^{-1}$)	NAR ($g\ m^{-2} day^{-1}$)	PGR ($g\ plant^{-1} day^{-1}$)	Number of pods ($No.\ plant^{-1}$)	Pod dry weight ($g\ plant^{-1}$)	HI
Control	–	6.79 d	3.01 d	–	11.93 d	399.4 c	6.25 c	0.25 d	5.38 c	4.49 e	0.37 c
(Dist. water)		(100)	(100)		(100)	(100)	(100)	(100)	(100)	(100)	(100)
4% Sucrose	0.13 c	8.11 c	3.60 c	3.6	13.25 c	427.9 bc	7.01 b	0.30 c	6.00 c	5.36 d	0.40 b
		(119)	(119)		(111)	(107)	(112)	(119)	(112)	(119)	(108)
4% Glucose	0.16 c	8.56 c	3.80 c	4.2	13.67 c	454.7 b	7.04 bc	0.32 c	7.75 b	5.96 c	0.43 a
		(126)	(126)		(115)	(114)	(113)	(126)	(144)	(133)	(116)
8% Sucrose	0.29 b	10.12 b	4.49 b	6.5	15.26 b	435.9 bc	8.49 a	0.37 b	7.88 b	6.63 b	0.43 a
		(149)	(149)		(128)	(109)	(136)	(149)	(146)	(148)	(116)
8% Glucose	0.41 a	12.32 a	5.47 a	7.5	17.47 a	523.1 a	8.79 a	0.46 a	9.13 a	7.64 a	0.44 a
		(181)	(181)		(146)	(131)	(141)	(184)	(170)	(170)	(119)
Correlation coefficient to (A)	–	0.991**	0.991**	–	0.991**	0.876*	0.953**	0.988**	0.934*	0.992**	0.885*

Carbon gain, the total amount in the period of sugar infusing; ⊿W, dry matter increase; TDM, total dry matter weight; LA, leaf area; NAR, net assimilation rate; PGR, plant growth rate; HI, harvest index. The values are means of 8 replications. Mean values followed by the same letter are not significant at 5% level according to Fisher's protected LSD test. Numbers in parentheses indicate percentages to control (100).

in diameter and 500 mm in length) was connected to the cut end with a silicon rubber tube. The glass tubes were filled up with sugar solutions or distilled water.

One day after the solution infusion was begun, the unifoliate leaves, and the first and second trifoliate leaves were removed, leaving the third and fourth trifoliate leaves as shown in Fig. 1. During the two days after the start of the infusion, a water mist was periodically sprayed over the plants to prevent the leaves from wilting caused by infusion of the solution with a low osmotic potential. The volume of sugar solution or water absorbed by the plants was measured every day. To promote solution absorption, the silicon tube was reconnected to the stem tip newly cut back at every six-day. The plants were grown for 27 days under the continuous infusion of sugar solutions, and the dry weights of each organ and leaf area were measured. The weight of the infused carbon was calculated from the volume of absorbed sugar solutions.

Results and Discussion

As shown in Table 1, the infusion of sugar solution had a significant effect on the dry matter production, seed yield and growth parameters. Larger weights of carbon were supplied to plants by the application of a high-concentration solution such as 8% glucose or 8% sucrose. There were significant, positive correlation between the growth parameters and the artificially given carbon weight.

The dry matter increase during the treatment period of 27 days (⊿W) was 8.11 to 12.32 g $plant^{-1}$ in the sugar-fed plants, which was 19 to 81% larger than that in the control plant (6.79 g $plant^{-1}$). The carbon weight in ⊿W was calculated as 3.60 to 5.47 g $plant^{-1}$, if the weight of carbon is assumed to account for 44% of the dry weight of plant (starch or cellulose). It may be readily predicted that the sugar solutions applied to plants is effective in increasing dry matter weight of the plants; however, the carbon gain by the infusions of sugar was only 0.13 to 0.41 g $plant^{-1}$, which was equivalent to 3.5 to 7.5% of ⊿W. This means that⊿W in the sugar-fed plants did not depend on the infused carbon itself, but depends on the photosynthetic enhancement caused by the increases in both leaf area (LA) and net assimilation rate (NAR).

The sugar solution infused also had a positive effect on the sink organ formation. The number of pods $plant^{-1}$ increased by 12 to 70%, which are regarded as the main cause of increase in the pod dry matter weight $plant^{-1}$ by 19 to 70% and of increase in the harvest index (HI) by 8 to 19%. It may be considered that the increased demand for photosynthates by the enlarged sink capacity resulted in the increase of LA and NAR. This evidence suggests the possibility that a further genetic or cultivational improvement of leaf photosynthesis after the flowering stage realises a more beneficial relationship between sink and source organs in the yield-determining process, and to realize a quantitatively higher yield production.

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