

食用カンナの生長と収量に及ぼす種イモ重の影響

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Effect of Seed-Rhizome Weight on Growth and Yield of Edible Canna (*Canna edulis* Ker.)*

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Abstract : To clarify the effect of seed-rhizome weight at planting on the vegetative growth and yield of new-rhizomes in edible canna, seed-rhizomes weighing 20–500 g (fresh weight) were planted at 1.0 m × 0.5 m spacing and cultivated in the experimental field of the University of Tsukuba, Ibaraki, Japan. Shoots from the heavier seed-rhizomes required fewer days to emerge from the soil and had more rapid growth and greater yield than shoots from the smaller seed-rhizomes. However, this tendency did not continue for the seed-rhizomes weighing more than 200 g. Therefore, it is concluded that the appropriate weight of seed-rhizome for practical cultivation is about 200 g.

Key words : *Canna edulis* Ker., Edible canna, Growth, Rhizome, Yield.

食用カンナの生長と収量に及ぼす種イモ重の影響：院多本華夫・加藤盛夫**・今井 勝**（筑波大学研究協力部・**農林学系）

要 旨：生体重が20 gから500 gまでの異なる大きさの食用カンナの種イモ（根茎）を、圃場に1.0 m × 0.5 mの栽植密度で栽培し、その生長と根茎収量に及ぼす種イモ重の影響を検討し、経済的な栽培を行うための適切な種イモ重を求めた。その結果、種イモ重の増大は植え付けから出芽までの日数を短縮すると共に、各種の生育形質および収量の増加をもたらすことがわかった。しかし、それらの増加は種イモ重が200 g程度までの範囲内で明らかであったが、200 g以上の種イモ重の効果は明らかではなかった。従って、食用カンナの栽培において実用的な種イモ重は200 g程度であるとみなされた。

キーワード：*Canna edulis* Ker., 根茎, 収量, 食用カンナ, 生長, 種イモ。

Edible canna (= achira, Queensland arrow-root) is a crop that was grown by the Incas¹⁾, which is still cultivated locally in warm regions of the world. The crop has not been improved by intensive selection or breeding⁷⁾. Edible canna has a high potential productivity of starch-rich rhizomes as well as the large aerial production^{2,3,4,5,8,11,12)}.

In general, edible canna is vegetatively propagated by the seed-rhizome and produces 20–30 new-rhizomes per plant (= per hill) during growth in temperate regions such as Japan³⁾. The fresh weight of its rhizome varies widely (20–500 g). Part of the harvested rhizomes must be stored for the next planting as in other tuber and root crops. To minimize the economic loss during storage or planting and to facilitate the preparation of this crop for planting, the use of small seed-rhizomes is desirable. However, too small seed-rhizomes may cause low yield as observed in other crops such as potatoes^{6,10)} and soybean⁹⁾ whose early growth and yield are

influenced by the tuber and seed weights.

In this study, we studied the effects of seed-rhizome weight on growth and new-rhizome yield of edible canna. Our goal was to determine the appropriate size (weight) of seed-rhizomes as a basis for the economic cultivation of edible canna.

Materials and Methods

Edible canna (*Canna edulis* Ker. cv. Aokuki-kei) seed-rhizomes ranging 20 to 500 g fresh weight were used in this experiment. The treatments were: small (S) ≤ 100 g; medium (M) $100 \text{ g} < M < 200 \text{ g}$; large (L) $200 \text{ g} \leq L$. A single plot of each treatment was planted at random, interspaced in 400 m² experimental field with other plots, in 1.0 m rows with the plants spaced 0.5 m in the row. Plot size was determined by the mass at harvest. All plots were fertilized at a rate of 7 gm⁻² each of N, P₂O₅ and K₂O at the time of planting. Planting depth was 5 cm. The soil surface was covered with a clear polyethylene film until early July. This raised the soil temperature at 5 cm depth by 0–7°C. Plants were grown under rainfed conditions.

* Part of this work was presented at the 187th meeting of the Crop Science Society of Japan held on April 6, 1989.

In 1988 the number of days from planting to emergence was recorded at 5 day intervals. At harvest (middle of November) the plant height, stem number, leaf number on the main stem, fresh weights of shoots and roots, and yield of new-rhizomes were measured. For the small seed-rhizome treatment we harvested 24 plants; for the medium, 17; and for the large, 14. In 1989 the dry weights of shoots and new-rhizomes and leaf area were measured for 5 plants in each treatment at 85, 107 and 128 days after planting.

Results and Discussion

Table 1 shows the effect of seed-rhizome weight on the plant attributes of edible canna obtained at the middle of November, 1988. There was variation in the data within each rank (S, M and L) but significant differences due to the weights were found. The days from planting to emergence of the shoot from the soil were less for heavier seed-rhizomes. The plant height, stem number, new rhizome number, shoot weight, root weight and new-rhizome yield per hill all tended to be greater for

the heavier seed-rhizomes. When the new-rhizome numbers per hill in all ranks (Y) were plotted against the initial seed-rhizome weight (X), a logarithmic relation was observed ($Y = -8.764 + 6.319 \ln X$, $R^2 = 0.544$; Fig. 1). Similarly, in Figs. 2 and 3, the shoot weight and new-rhizome yield per hill (Y), respectively, were approximated by Y (shoot) = $-2661.6 + 1007.2 \ln X$ ($R^2 = 0.598$), and Y (yield) = $-1659.3 + 626.9 \ln X$ ($R^2 = 0.633$). As shown in Table 2, the seed-rhizome weight was positively correlated with the growth and negatively correlated with the days to emergence. However, these relationships were more pronounced in the seed-rhizomes which weighed less than 200 g than for which heavier than 200 g.

Table 3 shows the effects of seed-rhizome weight on the dry weight of shoots and new-rhizomes and on the leaf area at three growth stages in 1989. The heavier seed-rhizomes had significant heavier shoots and new-rhizomes and a greater leaf area, except the shoot weight and leaf area at 128 days after planting.

Table 1. Effects of the seed-rhizome weight on the growth and yield attributes of edible canna (1988).

Ranks @	Seed-rhizome weight (gFW)	Sprouting (days after planting)	Plant height (cm)	Stem number /hill	Leaf number on main stem	New-rhizome number /hill
S(n=24)	59	31.0a@@	183a	3.8a	15.0	16.8a
M(n=17)	149	28.1ab	206b	5.2b	15.2	22.2b
L(n=14)	300	26.0b	212b	5.9b	16.0	26.7c
Average (n=55)	148	28.8	198	4.8	15.3	21.0

Ranks @	Shoot weight /hill (gFW)	Root weight /hill (gFW)	New-rhizome weight /hill (gFW)
S(n=24)	1345a	121a	857a
M(n=17)	2359b	187b	1399b
L(n=14)	3001c	246c	1908c
Average (n=55)	2080	173	1292

@ Fresh weight: S ≤ 100 g, 100 g < M < 200 g, 200 g ≤ L.

@@ Figures followed by the same letters within a column are not significantly different at the 5% level.

From the above results, we conclude that the appropriate fresh weight of seed-rhizome at planting is about 200 g. The use of rhizomes lighter than 200 g would result in a decreased

new-rhizome yield through the delay of sprouting and initial growth. However, the seed-rhizomes heavier than 200 g are not so effective from the viewpoint of practical cultivation.

In potatoes, there is an intense relationship between the seed-tuber weight and the yield⁶⁾. In the Republic of China, Lu and Dah⁸⁾ grew edible canna under the spacing at 0.6 m × 0.6 m. They found that the heavier the seed-rhizome the higher the new-rhizome yield, as we observed. However, they did not point out the appropriate weight of seed-rhizomes for planting because they used the ones lighter than 200 g.

The role of heavier seed-rhizome (especially, up to 200 g) is to hasten sprouting and to promote the early vegetative growth through the supply of nutrients, as in the case of potatoes¹⁰⁾. From the viewpoint of photosynthetic activity, edible canna has a

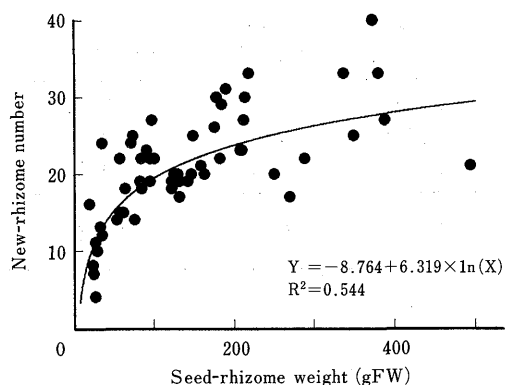


Fig. 1. Relationship between the seed-rhizome weight and the new-rhizome number per hill (1988).

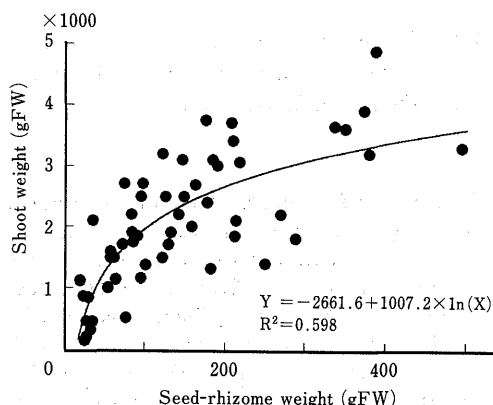


Fig. 2. Relationship between the seed-rhizome weight and the shoot weight per hill (1988).

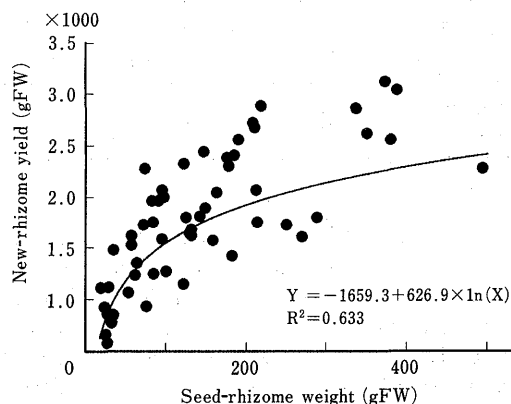


Fig. 3. Relationship between the seed-rhizome weight and the new-rhizome yield per hill (1988).

Table 2. Correlation coefficients between the ranks of seed-rhizome weight and the growth or yield attributes of edible canna (1988).

Ranks @	Plant Sprouting	Plant height	Stem number	Leaf number on main stem	New-rhizome number	Shoot weight	New-rhizome weight
S	-0.526**	0.421*	0.351	0.406*	0.725**	0.697***	0.772**
M	-0.020	0.013	0.452	0.618**	0.731**	0.427	0.571*
L	-0.147	0.242	0.001	0.146	0.144	0.480	0.297
Total	-0.346*	0.366**	0.515**	0.278*	0.641**	0.726**	0.729**

@ Ranks are the same as in Table 1.

*, ** Significant at the 5 and 1% level, respectively.

Table 3. Effects of the seed-rhizome weight on the shoot weight, new-rhizome weight and leaf area of edible canna (1989).

Ranks @	Shoot weight/hill (gDW)			New-rhizome weight/hill (gDW)		
	Days after planting			Days after planting		
	85 (Jul. 12)	107 (Aug. 4)	128 (Aug. 25)	85 (Jul. 12)	107 (Aug. 4)	128 (Aug. 25)
S (n=5)	27.6a@@	85.1a	173.5	3.5a	13.2a	43.3a
M (n=5)	45.9b	125.9b	174.7	7.9ab	38.9b	62.8b
L (n=5)	53.3c	127.0b	179.5	9.8b	33.0b	63.7b
Average (n=15)	42.3	112.7	175.9	7.1	28.4	53.3

Ranks @	Leaf area/hill (cm ²)		
	Days after planting		
	85 (Jul. 12)	107 (Aug. 4)	128 (Aug. 25)
S (n=5)	4264a	11953a	17427
M (n=5)	6978b	14431b	17942
L (n=5)	7720b	15767b	18691
Average (n=15)	6321	14051	18020

@ Ranks are the same as in Table 1. Mean values of seed-rhizome fresh weight were 58, 142 and 262 g, respectively.

@@ Figures followed by the same letters within a column are not significantly different at the 5% level.

broad range of adaptability to light environments²⁾. Its leaf area index is very high and the level is sustained for a long period (usually until receiving the frost)^{3,4,5,11)}. These characteristics are conducive to high potential productivity^{3,7)}. If a seed-rhizome of edible canna weighing about 200 g or more is planted in the field, the emergence of new shoots is not delayed and the leaf area, and therefore the photosynthetic capacity, increases quickly and the photosynthates accumulate effectively.

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References

- Gade, D.W. 1966. Achira, the edible canna, its cultivation and use in the Peruvian Andes. *Econ. Bot.* 20: 407-415.
- Imai, K. and T. Ichihashi. 1986. Studies on matter production of edible canna (*Canna edulis* Ker.). I. Gas exchange characteristics of leaves in relation to light regimes. *Jpn. J. Crop Sci.* 55: 360-366.
- , K. Kawana, K. Shimabe, K. Intabon, and T. Ichihashi 1986. Studies on matter production of edible canna (*Canna edulis* Ker.). II Dry matter production during the growth season. *Jpn. J. Crop Sci.* 55 (Extra issue 2): 71-72*.
- , K. Shimabe, K. Kawana and K. Intabon 1988. Studies on matter production of edible canna (*Canna edulis* Ker.). III Changes of the production structure during the growth. *Jpn. J. Crop Sci.* 57 (Extra issue 2): 163-164*.
- Kato, M., K. Inthavongsa and K. Imai 1989. An estimation of leaf area in edible canna (*Canna edulis* Ker.). *Jpn. J. Crop Sci.* 58: 753-754.
- Kawakami, K. 1954. Potatoes. Yokendo, Tokyo. 75-79*.
- Koyama, T. 1984. Resources Botany. Kodansha, Tokyo. 152-155*.
- Lu, A.N. and P.N. Dah. 1983. Effects of tuber size and planting depth on the growth and yield of edible canna. *Ann. Rep. Dryland Food Crops Improvement* 24: 311-313***.
- Matsuda, I. 1950. On the seed weight effect on the growth and the yield in soybean cultivation.

- Proc. Crop Sci. Soc. Japan 20 : 53—54**.
10. Noda, K. 1950. A study of tuberization in the potato plant. V. A relation of the mother tuber on the plant growth and tuberization with plant growth. Proc. Crop Sci. Soc. Japan 20 : 185—188**.
11. Oka, M., O. BoonSeng and W. Watananonta 1987. Characteristics of the dry matter and tuber production of Queensland arrowroot (*Canna edulis* Ker.). Jpn. J. Trop. Agric. 31 : 172—178.
12. Toyohara, H. 1987. Studies on the *Canna edulis* for starch crop. In Development, Technique and Cooperation in Agriculture, Memoirs of the 30th anniversary, Department of International Agricultural Development, Tokyo University of Agriculture, 18—27**.
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* In Japanese.

** In Japanese with English summary.

*** In Chinese with English summary.
