Available online at www.pelagiaresearchlibrary.com

Pelagia Research Library

Asian Journal of Plant Science and Research, 2015, 5(11):38-41

ISSN : 2249-7412
CODEN (USA): AJPSKY

Effects of planting density and fertilizer type on growth and yield of yacon (*Smallanthus sonchifolius*) tubers

Norio Tokita[1], Masako Ichikawa[1], Keiko Kainuma[1], Tomohito Kitazawa[1], Hirotaka Shimamura[1], Asako Narai-Kanayama[2], Shuhei Sato[3], Toyoji Kurita[3], Itaru Yoshimura[3], Teruaki Tokita[4], Emiko Iwasaki[5] and Teruo Iwasaki[5]

[1]*Department of Animal Science, Nippon Veterinary and Life Science University, Musashino-shi, Tokyo, Japan*
[2]*Department of Food Science, Nippon Veterinary and Life Science University, Musashino-shi, Tokyo, Japan*
[3]*Fuji Animal Research Farm, Nippon Veterinary and Life Science University, Fujigane, Nishiyatsushiro-gun, Yamanashi, Japan*
[4]*Department of Animal Sciences, Teikyo University of Science, Uenohara-shi, Yamanashi, Japan*
[5]*IT Research Institute, Mitaka-shi, Tokyo, Japan*

ABSTRACT

We investigated the effects of planting density and fertilizer type (ferrous ferric chloride (FFC) vs. fermented compost) on the growth and yield of yacon tubers. Yacon was cultivated in an experimental field consisting of 18 4 m × 5 m blocks with each block randomly assigned to one of six treatments (combinations of planting densities and fertilizers) with three replications. No insect or specific disease damage was observed over the course of the experiment. Yacon tubers were well developed and were harvested at maturity. Planting density affected tuber number, total yield, and tuber weight. Yacon planted at the highest density (treatment 2) showed the lowest tuber yield. Proper density for cultivating yacon was 100-cm ridge widths and 80-cm intra-row spacing in this experiment. Maximum yield (total tuber weight per plant) of yacon tubers was obtained with 34.0 kg/10a of FFC. Although FFC at 68.0 kg/10a did not increase yield (total tuber weight per plant), it did increase tuber weight.

Key words: Fermented compost, Ferrous ferric chloride, Planting density, Tuber, Yacon.

INTRODUCTION

Yacon (*Smallanthus sonchifolius*) is a tuberous plant that is a member of the Asteraceae family, originating from the Andes Mountains in South America [1]. Yacon produces fructooligosaccharide (FOS) carbohydrates, which are stored in underground tubers. Yacon tubers are light-brown in color, similar to sweet potato (*Ipomoea batatas*), although the tubers have a very watery consistency [2]. Therefore, the texture of yacon tubers is juicy and crunchy with a sweet taste.

Although yacon tubers are used for animal feed [3], FOSs are useful for stabilizing the human intestinal flora community and supporting immune strength [4, 5]. As FOSs are not absorbed in the digestive tract, glucose level in the blood does not increase with the consumption of yacon tubers.

With increased interest in yacon in Japan, we need additional research on field cultivation because our environmental conditions are so different from those in its original Andean area. In general, plant yield is related to

its density in the field. High density planting will tend to depress the growth and yield of targeted plants but broad spacing will not be effective for obtaining the desired yield. Application of fertilizer is also effective for increasing plant growth and yield. Ferrous ferric chloride (FFC) is a granular commercial fertilizer developed by Akatsuka botanical garden, Tsu, Japan, for horticultural crops. FFC application improves the plant rhizosphere and stimulates absorption of nutritional materials from soil.

The objective of this study was to determine the effects of planting density and fertilizer type (FFC vs. fermented compost) on growth and yield of yacon tubers.

MATERIALS AND METHODS

Cultivation of yacon

Tuberous root of yacon were cultivated in a small plastic pot (10 cm diameter) in a greenhouse for 3 weeks, and then transported to the experimental field (Figs. 1A and 1B) at the Fuji Animal Research Farm, Nippon Veterinary and Life Science University, Yamanashi, Japan. Eighteen 4 m × 5 m blocks were randomly assigned to one of six treatments consisting of different planting densities and fertilizer concentrations, with three replications per treatment (Table 1).

One month before planting the yacon seedlings, the experimental field was plowed and then provided with fertilizer according to the experimental design. Yacon tubers were harvested at their full-maturation period (early November) when the above-ground parts (stem, branch and leaves) were completely necrotic, and then tubers were extracted from the soil by digging and measured for fresh weight and number of tubers. Small tubers weighing less than 100 g were not included in the results.

Statistical analyses

Statistical differences among measurements were analyzed by analysis of variance with a completely randomized design. When a significant *F*-test was observed, further means separations were made using Tukey's method [6].

RESULTS AND DISCUSSION

Observation of yacon growth

Potted seedlings of yacon were transplanted to the experimental field (Figs. 1A and 1B) and plants developed normally (Fig. 1C).

Plant height, observed late in July (two months after transplanting), ranged from 49.8 cm in treatment 1 to 66.0 cm in treatment 4; however, there were no significant differences in plant height due to treatment at this time. Late in October, below-freezing temperatures occurred in the experimental area and above-ground parts of yacon gradually senesced (Fig. 1D). No insect or specific disease damage was observed over the course of this experiment. Yacon tubers were well developed (Fig. 1E) and harvested at their normal maturity (Fig. 1F).

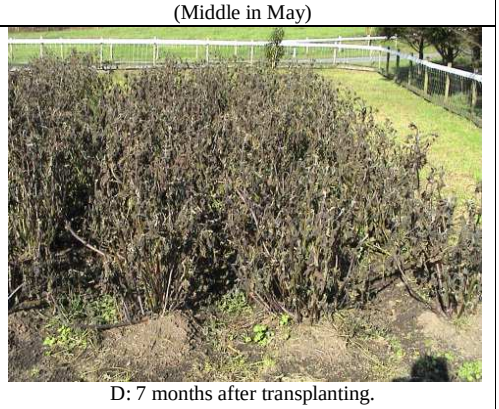
Yield of yacon tubers

Planting density, as defined by ridge widths and intra-row plant spacing, affected yacon tuber number, weight, and yield (Table 1). As seen in treatments 1 and 2 (Table 1), narrowing both ridge width and intra-row spacing, the total yield of tubers per plant was lower (1,064 g) in treatment 2 than in treatment 1 (1,517 g). Mean tuber weight was significantly lower (193.5 g) in treatment 2 compared with that of treatment 1 (289.0 g).

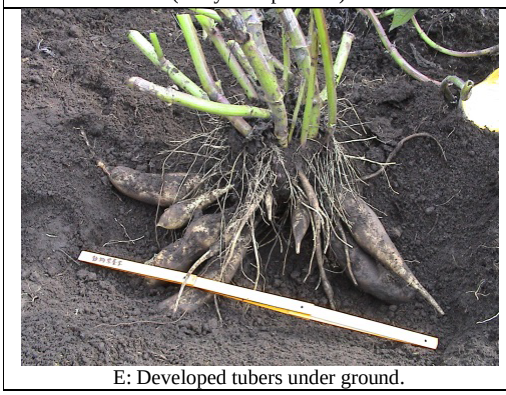
A: Seedlings planted in pot.
(Middle in May)

B: Transplanting in the field.
(Middle in May)

C: 5 months after transplanting.
(Early in September)



D: 7 months after transplanting.
(Early in November)



E: Developed tubers under ground.

F: Matured yacon tubers.

Figure 1. Photografic images of yacon growth and tubers

Table 1. Cultivation design and yield of Yacon tubers

Treatment No.	1	2	3	4	5	6
Ridge widths, cm	100	80	100	100	100	100
Intra-row space, cm	80	60	80	80	80	80
Fertilizer combination						
Compost, kg/10a	180	180	180	0	0	0
FFC[1)], kg/10a	0	0	68.0	68.0	34.0	0
Tuber[2)], number/plant	5.3^{b}	5.5$_{b}$	6.5^{ab}	5.0^{b}	7.8^{a}	5.3^{b}
Tuber weight, g/plant	1517^{b}	1064^{c}	1136^{c}	1572$_{b}$	2052^{a}	1252^{c}
Tuber weight, g	289.0^{a}	193.5^{c}	174.8^{c}	314.4^{a}	264.7^{b}	238.5^{b}

1) *Ferrous ferric chloride, 2) Excluding tubers below 100g fresh weight.*
Kg/10a; kg per 10 are (measure of are, 100sqm × 10)

Although application of FFC resulted in fewer harvested tubers in treatment 4, mean tuber weight was numerically highest (314.4 g) and was significantly greater than that observed in treatments 2, 3, 5, and 6. When half FFC was applied in treatment 5, number of tubers was increased significantly up to 7.8 per plant but tuber mean weight was decreased (264.7 g) compared with that in treatment 4. Using both compost and FFC as fertilizer, total tuber yield and mean tuber size were 1,136 g and 174.8 g, respectively, and were significantly lower than those observed in treatments 1 and 4. In treatment 6, with no compost and no FFC, tuber number, total weight of tubers, and tuber weight were significantly less than some of the other treatments (Table 1).

Although Fernandez [4] reported yield of yacon root tubers reached up to 35 t/ha, in this experiment yield of fresh yacon tubers was calculated to be 25.6 t/ha based on the result of treatment 5. This difference may be due to environmental conditions or edaphic factors.

CONCLUSION

We investigated whether yield of yacon tubers was affected by planting density, fertilizer type, and its application levels. Planting density at 80 cm ridge widths and 60 cm intra-row spacing resulted in lower production of yacon tubers. Recommended density was at 100 cm ridge widths and 80 cm intra-row spacing, which provided for maximum yield of yacon tubers in this experiment. Combination of this density with the application of 34.0 kg/10a of FFC showed the highest production of yacon tubers. Although these results illustrate the effects of plant density and fertilizer, further research is required to determine the optimum density and proper level of fertilizer for maximizing yield. It would also be interesting to compare our results, which were obtained in an experimental field, with those of yacon produced in commercial plant facilities.

REFERENCES

[1] Hotta M, *Useful plants of the world*, Heibonsha LTD, Tokyo, Japan, **1989**.
[2] Santana I, Cardoso MH, *Ciencia Rural*, **2008**, 38, 898.
[3] Koike A, Murata T, Matsuda Y, Masuoka C, Okamoto C, Kabata K, *Grassl. Sci*., **2009**, 55, 6.
[4] Fernandez EC, Viehmannova I, Lachman J, Milella L, *Plant Soil Environ*., **2006**, 52, 564.
[5] Narai-Kanayama A, Tokita N and Aso K, *J. Food Sci*., **2007**, 72, S381.
[6] Snedecor GW, Cochran WG, *Statistical Methods*, 8th ed., Iowa State University, Iowa, **1989**.