CASSAVA CULTIVATION IN A TEMPERATE REGION – A CASE STUDY IN KAGOSHIMA SOUTHERN PART OF JAPAN

Minami Sayaka[1], Yabuta Shinn[1], Matsumoto Satoshi[2], Fukudome Yasuhiro[2], Taura Issei[2], Kawamitsu Yoshinobu[3], Imai Katsu[4] and Hakoyama Susumu[5]*

1: Student of postgraduate course, Faculty of Agriculture, Kagoshima University, 2: Staffs in Experimental field belonging to FA, Kagoshima Univ., 3: Professor, Crop Science Laboratory, FA, Univ. of the Ryukyus, 4: Professor, Crop Science Laboratory, FA, Meiji Univ. and 5: Prof. of Tropical Crop Sci. FA, Kagoshima Univ., E-mail: hakoyama@agri.kagoshima-ac.jp, Korimoto 1-21-24, 890-0065, Kagoshima, Japan

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INTRODUCTION

World cassava production was 202 million tones in 1997, of which 53% was produced in Africa, 30% in Asia and 17% in Latin & South America (FAO, 2007). During the previous decade, production increased by about 30% in Africa, 20% in Asia and 13% in Latin & South America, respectively (IFAD & FAO, 2000). Although still important as a staple food, a feed for livestock and for starch manufacture, cassava has recently considered as a raw material to make bio-fuels.

Kagoshima locates southern part of Japan with annual mean temperature of 18.3°C, monthly average daily minimum temperature of 4.1°C in January and monthly average daily maximum temperature of 32.0°C in August. Annual rainfall is 2280mm and several times of frost are in the winter season, especially from December to March. This climate of Kagoshima is not suitable condition but a marginal one for cassava growth.

However, cassava ranks very high among crops that convert the greatest amount of solar energy into soluble carbohydrates per unit ground area. Among the starchy staples, cassava accumulates carbohydrate about 40% higher than rice and 25% more than maize, and starch content is about 24% (NYERHOWO, 2004) to 29% (WEÇOLOVIS et al., 2003). By using the proper characteristics of cassava such as high efficiency to convert the solar energy into carbohydrates per unit ground area, i.e. high ability of starch accumulation, it is useful to enlarge cultivation areas with the marginal conditions like Kagoshima, and to produce an alternative source of energy to fossil fuels, thus contributing to environmental sustainability. The object of this study is to confirm whether economic production of cassava is possible in an area with a marginal climate, such as Kagoshima.

MATERIALS AND METHODS

Materials used in this study is a cultivar., IAC-576-70, of the cassava (*Mannihot esculenta* Crantz) , which were obtained from Instituto Agronomicas de Campinas, Sao Paulo, Brazil, by a kindness of IAC staffs of cassava breeding section, Professor Dr. Silvio JOSE BICUDO, UNESP/Botucatu-SP and Dr. Joao NAKAGAWA. Twenty-six cuttings, already initiating sprouts from each axil on arrival at Kagoshima, were planted temporary in the experimental field of Kagoshima University (UF) with the spacing of 30cm x 30cm on 8 July 2006. About two weeks later, 22 plants were transferred to a farmer's field at Kiire (KF), Kagoshima, with the spacing of 120cm between rows and 60cm between plants in the row. Four plants with the spacing of 90cm x 120cm were maintained in UF. After transplanting, at 2-weekly intervals plant height and numbers of leaves per plant were measured for 5 plants at KF and 4 plants at UF. At the final measurement on 19 December, tuberous root weight per plant, starch value of tuberous root by specific weight method (WEÇOLOVIS et al., 2003) and total dry weight per plant were determined.

RESULTS AND DISCUSSION

Climate at Kagoshima

Annual change of monthly mean, maximum, and minimum temperature, monthly precipitation, and monthly amounts of solar energy from 1971 to 2000 at local Meteorological Observatory at Kagoshima 33.33°N and 130.32°E, are shown in the Figures 1 and 2. The

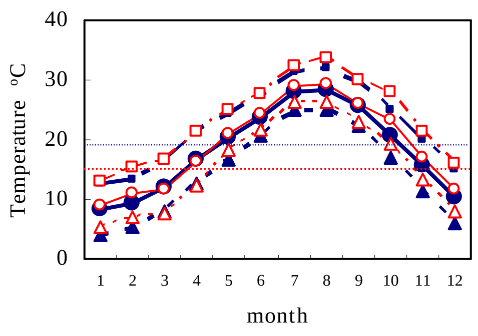

Fig.1. Annual change of monthly average daily mean, maximum and minimum temperature during '71-'00 and in '06 at Kagoshima

monthly average daily mean temperature during '71-'00"
monthly average daily maximum temperature during '71-'00"
monthly average daily minimum temperatre during '71-'00
monthly average daily mean temperature in '06
monthly average daily maximum temperature in '06
monthly average daily minimum temperature in '06

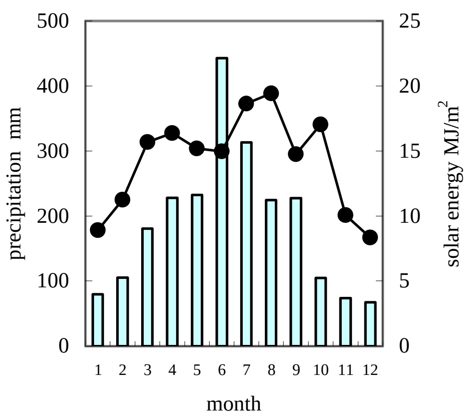

Fig.2. monthly average precipitation and solar energy at Kagoshima

monthly average of precipitation during '71-'00
monthly average of solar energy during '71-'00

duration of monthly mean temperature above 20°C is only 6 months, May to October, which is not long enough to be for ideal growing cassava, but monthly precipitation and solar energy are not limiting factors. However, duration of monthly mean temperature above 15°C is 3 months longer than that of monthly mean temperature above 20°C. These climatic features show that cassava can be grown at Kagoshima.

Cassava Growth

The cassava cuttings differentiated several shoots, developed several leaves and grew to about 25cm in height during two weeks after temporally planting at UF. After transplanting at KF until middle September, cassava grew well in terms of plant height and numbers of leaves developed because of consistent high summer temperatures. These growth parameters of cassava were superior at UF than at KF throughout growth cycle with statistical significance ($p<0.05$), except for plant height during October and for number of leaves after a

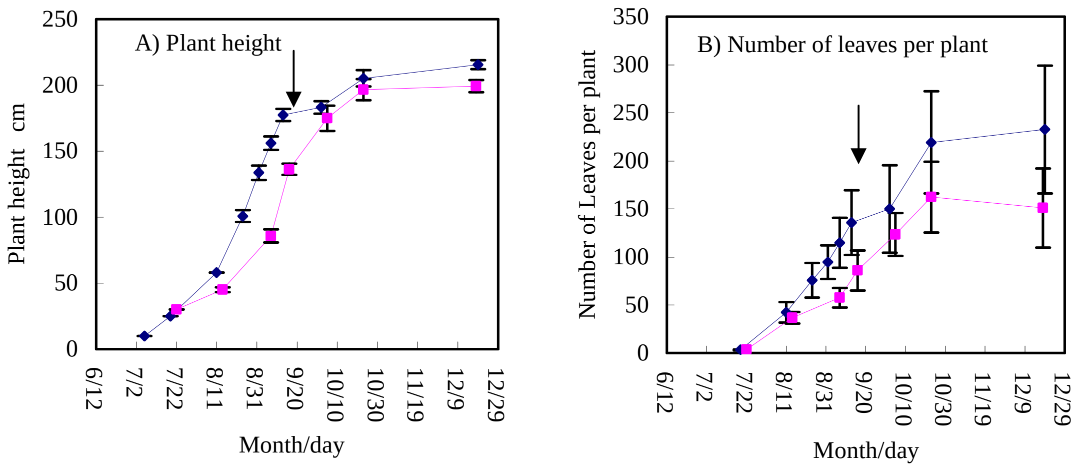

Fig.3.Time course of cassava growth in plant height (A) and numbers of leaves (B)

UF KF

Arrows in the Figure show the day of typhoon and vertical bar at each observation represents standard deviation.

typhoon (Figure 3.). At KF, cassava growth seemed to be delayed by root injury at the time of transplanting from UF. Some shoots apices were broken or damaged by strong typhoon winds on 18 September. Although, this damages were minimized by pre-protect treatments, it was more serious at UF than at KF. At harvest, plants were height 2m or more with about 200 leaves per plant.

Tuberous root weight and starch content

The mean tuberous root weight per cassava plant at harvest was 4.10kg at UF, 2.19kg at KF. Although the experiment was small in scale because of limited plant material available, these tuberous root weight correspond to yields about 38t/ha at UF and 30t/ha at KF respectively. The starch value of about 17, based on specific weight method, is equivalent to a starch content of about 23%. While root weight differed significantly ($p<0.01$), starch content did not differ between two fields. These results show that tuberous root fresh weight per plant and starch content were not inferior to the results by NYERHOWO (2004) and WEÇOLOVIS et al., (2003), even though growth period was only 5 months. This fact suggests a possibility to be cultivated cassava economically in a temperate region like as Kagoshima.

Table 1 Tuberous root weight per plant and starch value at harvest

Field	Harvest date	Plants measured	Numbers of tuberous root per plant	Tuberous roots weight	tuberous root gravity	Starch value
UF	19-Dec	3	-	4100	1.094	17.02
KF	11-,19-Dec	8	22.4 (n=5)	2193	1.095	17.16
t-value				t= 4.62	t= 0.085	t= 0.085
statistic significance				P<0.01	NS	NS

NS mean no significance statistically in the t-test

Cassava yield (dry matter base) has been increased by 90 percent during 1971-1996 in the highland tropics as a result of the cultivation of newly released cassava varieties. In region with elevations above 2000m or in mountainous areas, however, cold temperatures limit cassava cultivation (CGIAR, 1996), suggesting that temperature is the major limiting factor for cassava growth.

CONCLUSION

Our results from a small scale, one-year trial showed that cassava can be cultivated in a temperate region, producing plants of good height and leaf numbers per plant, and adequate tuberous root production and starch accumulation. It is considered that cassava can be cultivated economically even in mid-latitudinal areas, i.e. temperate regions. However, some technological developments will be needed, such as the breeding of a new low- temperature-tolerant variety and reducing the cost of crop maintenance during winter, etc.

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